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The effects of elite public colleges on primary and secondary schooling markets in India☆

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ABSTRACT

We present the first estimates of the effects of higher education investments on lower levels of schooling. Using the roll-out of elite public colleges in India, we show that investments in higher education increased educational attainment among school-age children. Private schools entered districts with new elite public colleges, and students switched from public to private schools. In addition, elite public colleges crowded in investments in electricity, roads, and water services. We find suggestive evidence that public investments in infrastructure may have reduced setup costs for private schools, and consequently, travel costs for school-going children.

1. Introduction

While educational attainment has long been linked to economic development (Barro, 2001), a debate surrounds the magnitude of public investments directed towards different levels of education. Investments in primary education are less politically contentious, as primary education is perceived to be a broad public good with few distributional issues, whereas public investments in higher education are decried as an income transfer to the elites, magnifying income inequality (Schultz, 1998). International donors have long argued that public investments in universities and colleges bring in lower returns compared to investments in primary or secondary schools (Birdsall, 1996; The World Bank, 2000; Psacharopoulos and Patrinos, 2004). Such analyses ignore any potential developmental ‘spillovers’ of higher education investments. More specifically, if public investments in higher education increase lower levels of schooling, strengthening the entire education system, policymakers should account for these benefits and reevaluate the social returns to investments in higher education. To this end, we use the roll-out of elite public colleges in India to present the first estimates of the spillover effects of public higher education investments on local markets for primary and secondary education, study the channels that determine these consequences, and interpret our results through the lens of the literature on school entry and school choice.

India has the world’s largest number of 5 to 24-year-olds, with roughly 500 million young people, and while primary and secondary school enrollment in India is over 95% and 70% respectively, enrollment in higher education is roughly 20% (Census, 2011). It is perhaps unsurprising that public budgets for higher education have been steadily increasing to fund the expansion of colleges and universities, and keep up with educational attainment at the secondary level: in 2016-17, almost two-thirds of the budget for school education and literacy was allocated to higher education (Budget, 2017). Yet, observers in the popular press have criticized these increases in higher education investments as inordinate, and expenditures on colleges and universi-

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ties are perceived to come at the expense of schooling infrastructure.[1] Such observations may seem simplistic if higher education investments in turn facilitate the expansion of primary and secondary education. For instance, access to higher education may increase the demand for lower levels of education by raising aspirations. Higher education institutions may also crowd-in public expenditure on other services like power, roads and water, and in turn facilitate private investment in primary and secondary education.[2]

To measure the causal effect of public investment in higher education on local schooling markets we use the staggered rollout of elite public colleges in India at the district level between 2004 and 2014 in an event study framework (e.g., Bailey and Goodman-Bacon, 2015).[3,4] Our event-study framework allows us to make fewer assumptions than a traditional difference-in-differences design. First, we do not compare districts that received an elite public college to plausibly dissimilar districts that did not receive these elite institutions. Instead, we restrict the sample to districts that eventually received an elite public college between 2004 and 2014. Second, unlike certain difference-in-difference designs where the 'treatment' is rolled out in one specific year, the staggered rollout of elite public colleges allows us to study the effects of elite college entry free of coincident changes in one particular year. Moreover, we employ year fixed effects to control for year-specific unobservables common across all districts, and district fixed effects to control for time-invariant unobserved characteristics that affect local education markets. In sum, our event study design allows us to identify impacts of elite public colleges by examining within-district changes in primary and secondary schooling outcomes that correspond to the year of elite public college entry specific to that very district. Importantly, our set up allows us to test for preexisting trends and the dynamic longer term effects after entry of elite public colleges.

We use three nationally representative education data sets: the National Sample Survey (NSS), the Annual Status of Education Report (ASER) and the District Information System for Education (DISE). We use all available rounds of the NSS data set over our period of analysis (these are 2004, 2007, 2010 and 2012), to examine the effects on educational attainment for primary- and secondary school-age children at the district level. We use annual data from ASER and DISE to study the effects of elite public colleges on school enrollment (2006–2014) as well as the impacts on the number of schools (2004–2014).

We present three key results. First, the establishment of a new elite public college increased years of education by 0.3 years among school-age children at the district level. Correspondingly, new elite public colleges led to significant increases in educational attainment at the primary, middle, secondary and higher secondary level.[5] Second, elite public colleges increased the probability of private school enrollment by 15%, while decreasing the public school enrollment by 9%. Third, elite public colleges increased the number of private schools at the district level by 20%, but had no impact on the number of public schools. We find that gains in educational attainment were driven by children staying in school longer as elite public colleges decreased dropouts in primary school. Overall, these findings suggest that private schools entered districts with new elite public colleges, students switched from public to private schools, and stayed in school longer.

There exist two key challenges for our identification strategy. First, public investment in higher education may anticipate changes in local schooling markets rather than causing it. Second, the precise timing of entry in each particular location of these elite colleges may be correlated with unobserved determinants of primary and secondary markets for education that are changing, concurrently driving both the location of elite public colleges as well as changes in the local education sector (for instance, industrialization). However, such changes happen gradually, and the existence of these confounding effects will be evident in the form of preexisting trends. If elite public colleges were introduced in places where children are staying in school longer, or if industrialization was the driving force, we would expect to see evidence of a pre-trend. Instead, the following pattern is visible across all our results: no pre-trends in outcomes followed by a sharp and statistically significant change in the year of elite public college entry. Moreover, a key feature of elite colleges is that student admissions are determined by extremely competitive nationwide entrance exams, as students enroll from all over the country. Therefore, there is little reason to believe that the precise timing of entry of these colleges is driven by coincident changes in local schooling markets.

Our results are immune to robustness and falsification tests supporting the validity of our baseline specification. For instance, we run falsification tests by randomly re-assigning the year of entry of elite colleges among districts that receive an elite college and re-estimate our event study specification: the resulting distribution of point estimates indicate that less than 5% of these estimates are larger in magnitude than the actual coefficient. The remaining threat to a causal interpretation of our estimates is if the specific year of entry of elite public college for each district systematically coincides with the timing of unrelated shocks, that have no observable pre-trends, but are correlated with the education market for that district. We believe that plausible omitted variables are unlikely to have all these properties and therefore propose that our baseline estimates are unbiased.

Our analysis of potential mechanisms that may be driving these effects of elite public colleges are informed by reports in the popular press that indicate that elite public colleges can transform a district into an educational hub, and crowd in public investments in other infrastructure services like roads, electricity and water. Indeed, we find compelling evidence that elite public colleges led to focal investments in infrastructure services at the village level, and may be one mechanism driving our results. We use the precise latitude-longitude coordinates of elite public colleges, and Census Village Directories from 1991, 2001 and 2011, to show that even within-districts, the decrease in distance to the closest elite public college, driven by the entry of new elite public colleges, led to a significant increase in access to electricity, roads and water services at the village level. Moreover, these effects were larger for villages closest to new elite public colleges. This is what one would expect if elite public colleges led to focal investments in other public infrastructure services. As a falsification test, we estimate the effects of changes in distance to elite public college between 2001 and 11 on change in access to roads, water and electricity between 1991 and 2001, and find that future changes in distance to the elite college do not predict current infrastructure investments.

We corroborate these effects using annual, satellite-measured nighttime lights data between 2004 and 2012 as a proxy for electrification, and show that an increase in proximity to elite public colleges led to corresponding increases in village level nighttime lights intensity. We include both village and year fixed effects, and examine the year-by-year change in distance between a village and nearest college in a semi-parametric manner. Similar to the results observed using Census Village

[1] See for instance: The Wire, 2017 b; The Times of India, 2016) a; The Hindu, 2011; NDTV, 2017.

[2] If public capital reduces the cost of production for private capital, it is possible for public investments to crowd-in private capital (Cutler and Gruber, 1996; Aschauer, 1989 a,b).

[3] Districts are administrative units within a state, and are a second-level administrative division (after states). India has 29 states and roughly 600 districts. Villages are the lowest level of subdivision in India after blocks, which are parts of districts.

[4] In line with the larger trend of increased public spending on higher education, almost half of all elite public colleges were established countrywide over the last decade. These elite institutions are established and funded by the federal government and specialize in offering undergraduate or post-graduate education.

[5] Primary school ranges from grade 1 to grade 5, middle or upper-primary school ranges from grade 6 to grade 8, secondary school comprises of grade 9 and grade 10, higher secondary school includes grade 11 and grade 12. Tertiary or higher education includes undergraduate and post-graduate education or grade 13 and above.

Directories, we find that the effects of elite public colleges on changes in nighttime light intensity decreased with an increase in the changed distance to the nearest elite public college. These results are not driven by coordinated "big push" public infrastructure policies or coordinated bureaucratic or political actions.

Consistent with our theoretical model, we find suggestive evidence that conditional on the availability of higher education institutions, investments in public infrastructure reduced setup costs for private schools, and consequently, the entry of private schools decreased travel costs for marginal students, enabling them to get additional years of education. Using the 2004 and 2011 rounds of Indian Human Development Survey (IHDS), we find that elite colleges decreased the distance traveled to the nearest private school at the household level. These results are also consistent with previous evidence that shows that private schools in India are more likely to be present in villages with access to public infrastructure (Kremer and Muralidharan, 2008; Pal, 2010), and the literature on school choice in developing countries that indicates that distance to school is a central determinant to school choice and educational attainment in low income countries (Carneiro et al., 2015; Muralidharan and Prakash, 2017; Alderman et al., 2001).

We explore various additional mechanisms that might be driving these effects. For instance, it is plausible that colleges increase local populations due to an influx of children of faculty. Similarly, colleges may create new employment and increase local incomes, raise parental aspirations, help overcome the lack of information, or increase actual or perceived returns to education. Although we fail to find evidence in support of these channels, we can not completely rule them out. Indeed, we consider demand externalities such as changes in parental aspirations, or effects on actual or perceived returns to education, as plausible complementary channels.

The rest of the paper is organized as follows. In Section 2 we provide a brief literature review. Section 3 gives background information on elite public colleges in India. In Section 4 we provide a theoretical model of school choice and private school entry to understand the underlying possible mechanisms. Section 5 describes the data. In Section 6 we investigate the impacts of elite public colleges on educational attainment, enrollment in both public and private schools, and the number of primary and secondary schools. We discuss potential mechanisms behind these empirical patterns in Section 7, and Section 8 concludes.

2. Contributions to the literature

If higher education institutions are a policy tool for economic development, knowledge about the precise channels through which universities bring about development impacts will help identify optimal locations for higher education investments. Existing evidence, almost exclusively from affluent countries, suggests that investment in higher education generate long-term local effects through *direct* increases in the supply of human capital and greater innovation.[6] However, such mechanisms may be less relevant for lower-income countries.[7] We show that higher education institutions facilitate educational attainment among school-age children in India, *indirectly* increasing the supply of human capital. In India, over 80 million children are out of school (Census, 2011). Thus, optimally targeted higher education investments may strengthen both the foundations of the education system (i.e., primary and secondary school), as well as tertiary education, since lower levels of schooling are critical as prerequisites for higher education.

We also speak to the literature on place-based policies that target infrastructure investment towards underdeveloped regions.[8] A small number of papers within this literature have studied place-based programs in developing countries (Shenoy, 2018; Park et al., 2002; Ravallion and Jalan, 1999). Here we present the first estimates of the developmental impacts of college infrastructure in a lower-income country. Our findings suggest that place-based policies that involve the construction of elite public colleges in India may have larger effects on provision of public goods than certain last-mile programs that target specific infrastructure services. We find that elite public colleges increased nighttime brightness by 0.5 units at the village level. In comparison, a rural electrification program in India that provided electricity access to hitherto unconnected villages increased nighttime brightness by only 0.15 units (Burlig and Preonas, 2016). Our estimates are comparable to a policy that targeted massive improvements in public infrastructure, a generous investment subsidy and a complete exemption from corporate and excise taxes for a newly formed state in India (Shenoy, 2018).[9] In India, access to public goods like electricity, roads, water and education is a matter of who can extract them from the political system (Banerjee and Somanathan, 2007). For instance, even Special Economic Zones in India have failed to crowd-in public expenditure on services like power, roads and water (Alkon, 2018).

3. Elite public colleges

As of 2011, India's Universities Grant Commission lists 42 central universities, 275 state universities, 130 deemed universities, 90 private universities, and 93 Institutes of National Importance (hereinafter referred to as elite public colleges). The federal government establishes and funds all elite public colleges. These elite colleges specialize in both undergraduate and post-graduate education in technical fields like medicine, information technology, sciences, engineering, architecture or business – most famously the Indian Institutes of Technology (IITs) and Management (IIMs).[10] Importantly, they share certain unique features that are useful in investigating the causal effects of higher education investments on lower levels of schooling and understanding the underlying mechanisms.

First, student admission into these institutions are determined by extremely competitive nationwide entrance tests. For instance, any student who wants to gain admission into an elite medical college (AIIMS) is required to appear for a common, nationwide entrance exam. Importantly, this means that all elite public colleges in a particular field of

[6] See for instance: Kantor and Whalley (2014); Cantoni and Yuchtman (2014); Valero and Van Reenen (2019); Hausman (2012); Andersson et al. (2004); Andersson et al. (2009); Abramovsky et al. (2007); Abramovsky and Simpson (2011); Belenzon and Schankerman (2013); Toivanen and Vaananen (2016); Jaffe et al. (1993); Jaffe (1989).

[7] For instance, higher education institutions in India are quite small in relation to the size of the local population, as average enrollment is just over 700 students (Government of India, 2013), so benefits to the local economy from increases in human capital endowment might not be substantial. Also, research is not the primary mandate of higher education institutions in India, and they lag significantly behind universities in high- and middle-income countries in terms of research output. See: The Wire (2017 a); Indian Express (2017); The Hindu (2010).

[8] See Neumark and Simpson (2014) for a review on the literature examining the economic effects of place-based policies.

[9] A possible interpretation of our results could be that a suite of focal infrastructure investments may have larger development impacts than certain last mile programs that target specific infrastructure services. For instance, Burlig and Preonas (2016) find that a rural electrification program in India had no effects on educational attainment, while Adukia, Asher and Novosad (2017) find that a rural road construction program in India increased middle school completion by 7%. In comparison, we find that elite public colleges increased middle school completion by 14%.

[10] Specifically, elite public colleges include Indian Institute of Information Technology, Design and Manufacturing, Indian Institute of Science Education and Research, Rajiv Gandhi Institute of Petroleum Technology, Indian Institute of Management, Indian Institute of Science Education and Research, Indian Institute of Technology, School of Planning and Architecture, School of Planning and Architecture, Academy of Scientific and Innovative Research National Institute of Technology, and All India Institute of Medical Sciences.

study are drawing applicants from the same national pool.[11] As such, the market for students at elite public colleges are national.[12] Second, the location of newer elite colleges is a function of addressing regional imbalances caused by the location of older such institutions.[13] For instance, a state is unlikely to get a new elite public college in medicine if an elite medical college already exists within the state boundaries.[14] However, within a state, the location of elite public colleges is often determined through discussions between the federal and state government.[15] While this means that such colleges are not placed randomly, since admissions are determined by competitive countrywide exams, the year of entry at a certain district is unlikely to be driven by anticipated changes in local schooling markets. We restrict our analysis to districts that received an elite public college between 2004 and 2014, ensuring that we are not comparing dissimilar districts, and include district fixed effects to adjust for level differences across districts. We therefore identify impacts of elite public colleges by examining within-district changes in primary and secondary schooling outcomes that correspond to the year of elite public college entry specific to that district.

Lastly, discussions between administrators, covered extensively by the popular press, help inform our analysis of the potential mechanisms through which elite public colleges effect primary and secondary schooling markets. For instance, local administrators believe that elite public colleges can transform a district into an educational hub and encourage economic activity. State administrators often lobby the federal government to procure these elite institutions for underdeveloped districts.[16] It is therefore plausible that these institutions lead to focal public investments in infrastructure like roads, electricity and water.

Quotes from the foundation stone laying ceremony of an elite business school in an underdeveloped state of India, Jharkhand, are a case in point.[17] Some capture the sentiment of locals: *"A nondescript village devoid of proper electricity and drinking water supply, Cheri (village) has one single kutcha (temporary) road that links it to Ring Road that leads to Ranchi (capital of Jharkhand). However, with today's high-profile installation, its residents hoped of good tidings in the future."* Others, capture the expectations of the Minister for Rural Development: *"Such institutions in backward regions like Jharkhand are beneficial."*

Figure A.2 shows districts where elite public colleges have been established across India. Figure A.3 shows districts where elite public colleges were setup between 2004 and 2014, and used in our analysis: we leverage the staggered rollout of elite public colleges between 2004 and 2014 in 25 (treatment) districts, spread across 22 states, to identify the effects of public investment in higher education on lower levels of schooling.[18]

4. Theoretical framework

In this section, we present a conceptual framework of household school choice and private-school entry and determine the equilibrium in local markets for primary and secondary education. To help guide our empirical analyses, we allow elite public colleges to disrupt this equilibrium and highlight the mechanisms through which elite public colleges may affect primary and secondary schooling. Details are in Appendix A.1.

4.1. Setting: market for primary and secondary schooling

The supply of public schools is determined exogenously by district administrators. The supply of private schools, however, is market determined; they enter if they can earn positive profits.[19] Private schools are profit maximizers, have heterogeneous costs/efficiency (Kremer and Muralidharan, 2008), and are price takers in a competitive market, charging p.[20]

Total educational output (in student-years) of school j with inputs X_j, is $Q_j = \overline{\theta} X_j$, and the school's cost function $Z(X_j) = z_{1j} X_j + \frac{1}{2} z_2 X_j^2$ is quadratic.[21] $\overline{\theta}$ is the average education level in the district and captures demand externalities driven by aspirations and peer effects (Birdsall, 1982; Bobonis and Finan, 2009) that may be associated with proximity to elite colleges. z_{1j} reflects the heterogeneity in costs across schools, drawn from a distribution that varies across districts given infrastructure levels. The total number of potential private schools is N, and schools that make a positive profit enter the district. Appendix A.1 shows that profit maximization implies the total supply of private schooling is:

$$Q_{Sy} = \sum_{j=1}^{N_1} Q_j = \sum_{j=1}^{N_1} \overline{\theta} \frac{p\overline{\theta} - z_{1j}}{z_2} = \frac{p\overline{\theta}^2 N}{z_2} (p\overline{\theta} - \overline{z_1}) \tag{1}$$

Demand for schooling depends on the costs of going to school and the returns to schooling. Costs c_{ij} vary across individuals based on tuition p, travel costs to the nearest school(s) T_{ij}, ability Δ_i and wealth W_i: $c_{ij} = \alpha p + \beta T_{ij} - \gamma ln(W_i) - \Delta_i$. Children will attend school if the returns to education, r, are greater than the costs. In Appendix A.1 we show, for N_0 number of public schools, and a student population the size of M, the aggregate demand for private schools is:

$$Q_d = M N_1 F(\varphi - \alpha p)[1 - F(\varphi)]^{N_0} [1 - F(\varphi - \alpha p)]^{N_1 - 1}, \tag{2}$$

where φ is a function of the returns to education, travel costs, wealth, and ability, and the idiosyncratic components of the cost function are drawn iid from $F(.)$.

4.2. Comparative statics: entry of elite public college

This set up allows us to deduce the equilibrium, and examine the effects of elite public colleges on the supply Q_{Sy} and demand Q_d for

[11] Except for the National Institutes of Technology or NITs, which reserve 50% seats for state students, other elite public institutions have no such reservation policy for local state students. Our results are robust to dropping these elite public colleges from the sample. However, every higher education institution in India has to reserve 15%, 7.5% and 28% seats for candidates from the 'Scheduled Caste', 'Scheduled Tribe' and 'Other Backward Classes', respectively.

[12] For instance, students residing in roughly half of all PIN codes in India appeared for the 2009 entrance exam for admission into 15 Indian Institute of Technology - IITs. See: The Times of India (2009, 2014 a,b) for media reports. Similarly, students across the country appear for national entrance exams that determine admission into elite public colleges in other fields of study. The market for faculty at elite public colleges are national as well. In fact, new elite public colleges have successfully attracted young faculty educated in top institutions in India and abroad (See: The Economic Times, 2014).

[13] See: The Hindu (2014); The Hindu Business Line (2003); Daily News and Analysis (2015).

[14] We examine if states with an elite public college in a certain field of study, before 2004, received a new elite college in the same field of study, between 2004 and 2014. We find no such instance (Figure A.1).

[15] There were no know prerequisites for locations of these elite public colleges.

[16] See: The Telegraph India (2014); The Times of India (2015, 2016 b); The Telegraph India (2011); Firstpost (2014).

[17] See: The Pioneer (2013); The Telegraph India (2013).

[18] In robustness checks we rule out the possibility that a single treatment district or single treatment year is driving our results. We cluster-bootstrap standard errors following Cameron et al. (2008).

[19] For notational convenience we drop the district sub-script from our equations, even though quantities vary across districts.

[20] Muralidharan and Venkatesh (2015), find that children enrolled in private schools do not perform better than their peers in public schools on subjects taught in both schools, although private schools are more cost-effective. Our specification reflects these points – private schools have the same output as public schools (an assumption easily relaxed without a change in comparative statics), although the operating costs are different.

[21] It is easy to hire the first few teachers, it is more costly to hire the next as the pool dwindles.

private schooling at the district level.[22]

Effects of Infrastructure Upgrades: If elite public colleges lead to investments in water, roads and electricity, it may reduce entry costs, and cause an outward shift in the supply of private schools ($dQ_{Sy}/d\overline{z_1}|_p < 0$; $dQ_{Sy}/dz_2|_p < 0$). Increases in the supply of private schools lowers the equilibrium tuition charged at a private school ($dp/d\overline{z_1} > 0$; $dp/dz_2 > 0$) and the distance to the nearest private school (lower T_{ij}). Lower distances, in turn, will increase the demand for private schooling ($dQ_d/dT_{ij} < 0$). If elite public colleges increase the number of private schools by lowering setup costs, it may increase private schooling, and educational attainment.[23]

Effects of Changes in Income, Population, and Aspirations: Increases in income ($dp/dln(w) > 0$; $dN_1/dln(w) > 0$), population ($dp/dM > 0$; $dN_1/dM > 0$), a rightward shift in student's ability distribution ($dp/d\delta > 0$; $dN_1/d\delta > 0$), increases in actual or perceived returns to education ($dp/d\underline{r} > 0$; $dN_1/dr > 0$) or increases in educational aspirations ($dp/d\overline{\theta} > 0$; $dN_1/d\overline{\theta} > 0$) will increase the demand for all schooling (both public and private), as well increase the equilibrium tuition and the number of private schools. New elite public colleges may increase the demand for all schooling through any of these mechanisms. Our theoretical framework, therefore, generates the likely candidates for the mechanisms that we explore in our empirical exercise.

5. Data

5.1. The National Sample Survey (NSS)

The National Sample Survey (NSS) is a nationally representative survey consisting of yearly small sample rounds ('thin' rounds), and five yearly large sample rounds ('thick' rounds). These surveys ask detailed questions about different levels of education and contain extensive information on schooling outcomes including years of education and educational attainment. The probability-weighted sample is constructed using a two-staged stratified sampling procedure with the first stage comprising of villages and block, and the second stage consisting of households. Households are selected systematically with equal probability, with a random start. We use four different rounds of the NSS data, between 2004 and 2012. The 2004, 2010 'thick' rounds are the large sample rounds. The 2007, 2012 are small sample 'thin' rounds. Using these four NSS rounds, we evaluate the impact of elite public colleges on years of schooling and educational attainment. We present summary statistics on years of schooling and educational attainment in Table A.1.

5.2. Annual Status of Education Report (ASER)

The Annual Status of Education Report (ASER) is a yearly education survey for rural school-age children in India. The sample is a representative repeated cross section at the district level.[24] The survey contains information on enrollment status, current grade and school type for every child in the sampled household. Children are also tested in math and reading ability. The ASER is useful for our analysis for multiple reasons. First, ASER provides national coverage and a large sample size for each district. Second, unlike schools-based data, it is not administered in schools and therefore covers children both in and out of school. Third, it is administered each year on 2 to 3 weekends from the end of September to the end of November limiting considerations of spatially systematic seasonality in data collection, and endogenous sampling as in school children are likely not available on weekdays. We use nine rounds of the ASER data between 2006 and 2014 to examine the effects of elite public colleges on private vs. public school enrollment. We present summary statistics on private and public enrollment in Tables A.2 and A.3.

5.3. District Information System for Education (DISE)

District Information System for Education (DISE) is an administrative dataset on primary schools in India. Data collection involves a census of all schools in India, coordinated by districts. Annual district level statistics across the country are made publicly available in the form of 'District Report Cards.' These data are designed to reflect statistics as of September 30 of the school year, which starts in July. We use eleven rounds of DISE data between 2004 and 2014 to examine the effects of elite colleges on the number of private and public schools. Although, DISE data only provide statistics on primary schools, these include primary schools offering post-primary education. We present summary statistics on number of private and public schools in Tables A.4 and A.5.

6. Effects on lower levels of schooling

6.1. Years of schooling and educational attainment

Using NSS data for individuals between 6 and 20 years of age, we estimate Equation (3) to evaluate the impact of elite public colleges on years of schooling and educational attainment. Our empirical strategy exploits variation in the timing of establishment of elite public colleges in districts that received an elite public college between 2005 and 2011 in an event study framework (e.g., Bailey and Goodman-Bacon, 2015). We estimate the following model:

$$y_{ijt} = \sum_{\tau=-p}^{-2} \beta_\tau 1(t - T_j^* = \tau) + \sum_{\tau=0}^{m} \beta_\tau 1(t - T_j^* = \tau) + \mu_j + \chi_t + \epsilon_{ijt}, \quad (3)$$

where y_{ijt} is the outcome of interest for child i in district j in year t.[25] Estimates characterizing the effects of elite colleges are the coefficients on the event year dummies, $1(t - T_j^* = \tau)$, which are equal to 1 when the year of observation is τ rounds away from T_j^*, the year when the elite college was established in district j ($\tau = -1$ is omitted). These estimates are average treatment effects of elite public colleges relative

[22] Detailed derivations are in Appendix A.1.

[23] Note that the number of public schools are set by district adminstrators, and are as such, not directly affected by market prices. So we may have enrollment in public schools fall even if the number of public schools do not change.

[24] In each Indian district, 30 villages are sampled from the latest Census list of villages, using the PPS (Probability Proportional to Size) sampling technique. A team of two surveyors go to the village, meet the village head, and make a list of households in the village. They divide the village into 4 sections ('hamlets'), and select 5 households from each hamlet, to get a total of 20 households per village. In each household, they record information about all children in the age 5–16 years. Children are interviewed at the household on weekends so as to include both school-going and unrolled students in the testing. This produces about 600 samples households per district, or about 300,000 households across India each year.

[25] Since the NSS data is collected with time gaps, τ denotes number of survey rounds for the NSS data, where t = 2004, 2007, 2010, 2012. Therefore, as a robustness check we report estimates separately by event year (Figures A.4 and A.5). It is reassuring that these results are quantitatively similar to our baseline estimates. However, because we observe 4 NSS survey rounds between 2004 and 2012, each event year only includes a few treatment districts. For instance, $\tau = 0$ only includes districts where an elite public college was introduced in 2007 and 2010. Therefore, we prefer our baseline specification. Note that for the ASER and DISE data sets, which are collected annually, τ denotes number of years.

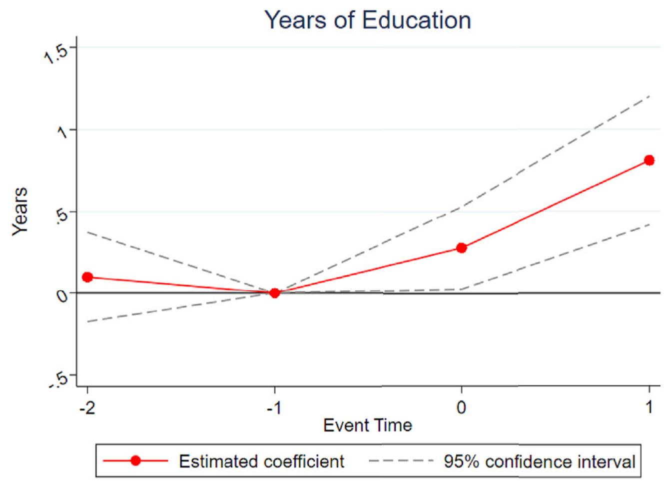

Fig. 1. Impact of Elite Public Colleges on Years of Schooling (Age 6–20). Notes: Sample includes a repeated cross-section of individuals between 6 and 20 years of age from a balanced district level panel of 25 treatment districts across 4 NSS survey rounds (2004, 2007, 2010 and 2012). The figure presents the effects of elite public colleges on years of schooling. $\tau = 0$ is the round of entry of elite public colleges. These are average treatment effects on treated districts of elite public colleges relative to the round before elite public colleges were established ($\tau = -1$). For instance, if the treatment district received a new elite public college in 2008, 2009 or 2010, the NSS surveys conduced in 2004, 2007, 2010, and 2012 are denoted as $\tau = -2$, $\tau = -1$, $\tau = 0$ and $\tau = 1$, respectively. The regression, Eq. (3), includes district and year (round) fixed effects. 95% con_dence interval is presented, standard errors are clustered at the district level. Since the NSS data is collected with time gaps, τ denotes number of survey rounds for the NSS data, where t = 2004, 2007, 2010, 2012. As a robustness check we report estimates separately by event year (Figure A.4).

to the round before elite public colleges were established, $\tau = -1$.[26],[27] For instance, if an elite public college was established in 2008 in a district j, the 2004 and 2007 rounds capture the pre-period $\tau < 0$, whereas The, 2010 and 2012 rounds capture the post-treatment period $\tau \geq 0$. μ_j are district level fixed effects, while χ_t are survey-round indicators. We restrict our sample to districts that ever received an elite college so that we do not compare estimates to dissimilar districts. By adding district fixed effects μ_j, we control for time-invariant unobserved characteristics that affect local education markets and may also be correlated with the presence of elite public colleges. Round indicators control for round-specific unobservables common across districts.

We, therefore, identify impacts of elite public colleges by examining within-district changes in primary and secondary schooling outcomes that correspond to the year of elite public college entry specific to that district. This approach allows us to make fewer assumptions than a traditional difference-in-differences design as we do not include any districts that never receive a college (which are likely to be rather different), and there is no longer just one particular year that affects all treated districts (which may be correlated with other year-specific shocks).

Two challenges remain for our identification strategy. First, the location and precise timing of entry of elite public colleges may be correlated with unobserved determinants of the primary, middle and secondary markets for education that are changing continuously, and concurrently driving entry of elite public colleges. Second, public investment in tertiary education may anticipate changes in local schooling markets rather than causing it. Since student admissions to elite colleges are determined by highly competitive nation-wide entrance exams, and students enroll from all over the country, there is little reason to believe that the establishment of these colleges is driven by anticipated future changes in local schooling markets. The more relevant concern is whether the timing of public college entry is correlated with preexisting trends in education markets. As most changes are gradual, the existence of confounding effects would be evident in the form of preexisting trends.

Using Equation (3), we investigate impacts on years of schooling, as well as completing primary school (Grades 1–5), middle or upper-primary school (Grades 6–8), secondary school (Grades 9–10) and higher secondary school (Grades 11–12). Fig. 1 presents the estimates for years of schooling. We find that the coefficients for the treatment rounds are positive and statistically significant. Elite public colleges increased schooling by over 0.3 years in the short-run ($\tau = 0$), and by 0.8 years in the longer-run ($\tau = 1$).[28]

Next, we examine the effects on educational attainment. We find that elite public colleges increased educational attainment at each schooling level (Fig. 2). Colleges increased primary and middle school attainment by 5 percentage points (8% and 14%, respectively) in the short-run, and 10 percentage points (17% and 30%, respectively) in the longer-run. Secondary and higher secondary attainment increased by roughly 2 percentage points (13% and 40%, respectively) in the short-run.

We find no evidence of preexisting trends, and instead detect a statistically significant change in the years of education that coincides with the first round following the establishment of the college, $\tau = 0$.[29] If elite public colleges were introduced in places where children are staying in school longer, or if rapid industrialization was driving the timing of elite public college entry as well as changes in the local schooling market, we would expect to see evidence of a positive pre-trend. As such, the only remaining threat to a causal interpretation of our estimates is if the specific year of entry of elite public college for each district systematically coincides with the timing of unrelated shocks, that have no observable pre-trends, but are correlated with the education market for that district. We believe that plausible omitted variables are unlikely to have all these properties.

In other robustness checks, we estimate the effects of elite public colleges on children's enrollment status (Figure A.8). As one might expect, we find suggestive evidence that the entry of elite public colleges increases school enrollment. We estimate the effects on years of schooling and educational attainment for individuals that were too old to change their education decisions – individuals between 21 and 65 years of age – as a falsification test (Figures A.9 and A.10). Next, we control for district-specific time trends; our point estimates remain relatively unaffected (Figures A.11 and A.12). We show that the effects on years of schooling are robust to restricting the sample to older children (Table A.13), and that the attainment results are robust to restricting estimation for each tier of education – primary, middle, secondary and higher secondary – to the corresponding age-appropriate sample (Figure A.14). We also show that the effects on years of schooling and

[26] We expect to observe effects of elite public colleges somewhat concurrently. That is, the causal impact of elite public colleges is identified from the change in our outcomes of interest in the first observable round of data after entry of these institutions ($\tau = 0$). Thus, $\tau = -1$ is the natural baseline to capture these effects.

[27] Once the location (district) for these elite public colleges is finalized, the year of announcement and the year they start functioning almost always coincide. In the few cases these do not coincide, we use 'announcement year' as year of entry or treatment year.

[28] Here, $\tau = 1$ denotes 3–4 years after the entry of elite public college.

[29] In Figure A.6 and Figure A.7, we extend our analysis of educational attainment to 8 years prior to entry of elite public colleges. That is, we include event time $\tau = -3$ in our analysis: for example, if the treatment district received an elite public college in 2012, the education outcomes from NSS surveys conduced in 2004, 2007, 2010, and 2012 are denoted as $\tau = -3$, $\tau = -2$, $\tau = -1$ and $\tau = 0$, respectively. Therefore, the point estimate for $\tau = -3$ indicates whether entry of elite public college is associated with changes in educational outcomes 6–8 years prior to entry. We fail to find evidence for a trend in educational outcomes 6–8 years prior to entry of elite public colleges.

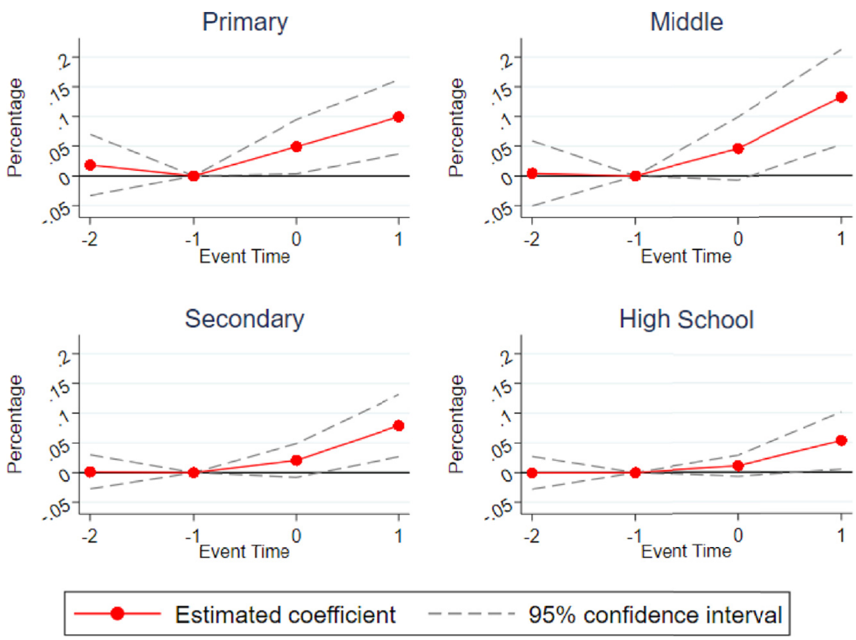

Fig. 2. Impact of Elite Public Colleges on Educational Attainment (Age 6–20). Notes: Sample includes a repeated cross-section of individuals between 6 and 20 years of age from a balanced district level panel of 25 treatment districts across 4 NSS survey rounds (2004, 2007, 2010 and 2012). The figure presents the effects of elite public colleges on educational attainment for four levels of schooling; primary school (0/1), middle school (0/1), secondary school (0/1), and high school (0/1). $\tau = 0$ is the round of entry of elite public colleges. These are average treatment effects on treated districts of elite public colleges relative to the round before elite public colleges were established ($\tau = -1$). For instance, if the treatment district received a new elite public college in 2008, 2009 or 2010, the NSS surveys conducted in 2004, 2007, 2010, and 2012 are denoted as $\tau = -2$, $\tau = -1$, $\tau = 0$ and $\tau = 1$, respectively. The regression, Eq. (3), includes district and year (round) fixed effects. 95% confidence intervals are presented, standard errors are clustered at the district level. Since the NSS data is collected with time gaps, τ denotes number of survey rounds for the NSS data, where t = 2004, 2007, 2010, 2012. As a robustness check we report estimates separately by event year (Figure A.5).

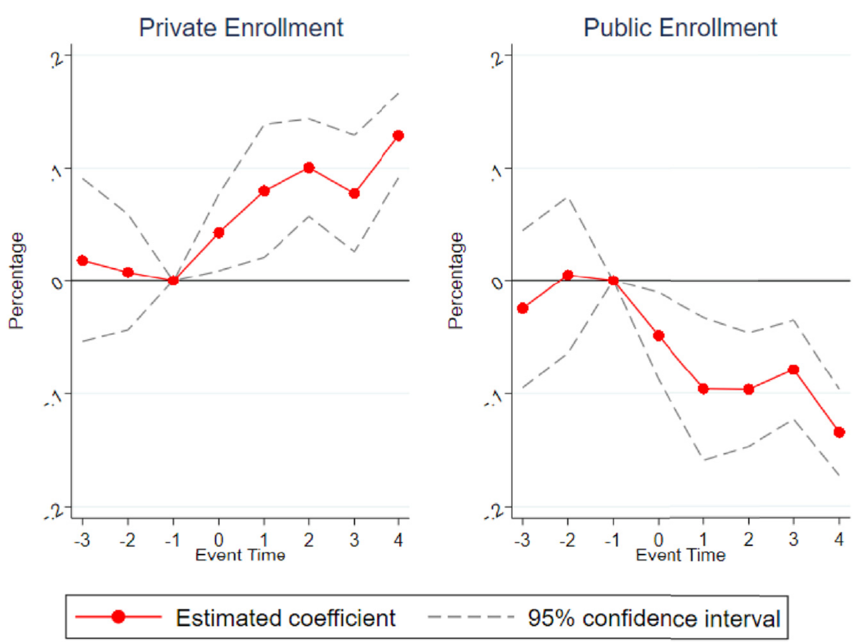

Fig. 3. Impact of Elite Public Colleges on Private vs. Public Enrollment (Age 5–16). Notes: Sample includes a repeated cross-section of individuals between 5 and 16 years of age from a balanced district level panel of 14 treatment districts across 9 years of ASER data (2006-2014). The figure presents the effects of elite public colleges on private school (0/1) vs. public school (0/1) enrollment status. $\tau = 0$ is the year of entry of elite public colleges. These estimates are average treatment effects of elite public colleges relative to the year before elite public colleges were established ($\tau = -1$). For instance, if the treatment district received a new elite public college in 2009, the ASER surveys conducted in 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 are denoted as $\tau = -3$, $\tau = -2$, $\tau = -1$, $\tau = 0$, $\tau = 1$, $\tau = 2$, $\tau = 3$ and $\tau = 4$, respectively. The regression, Eq. (3), includes district and year (round) fixed effects. 95% confidence intervals are presented, standard errors are clustered at the district level.

educational attainment are robust to restricting the sample to younger children (Tables A.15). Since our sample consists of only districts that ever received a college, it is possible that a single outlier may drive our results. Therefore, we drop each district, one at a time, estimating Equation (3) each time (Figures A.16 and A.17). In addition, we drop all districts where elite public colleges were introduced in a single year, 1 year at a time (Figures A.18 and A.19). We find that these estimates are not driven by a single district or treatment year. Next, we rule out the fact that the whole state is experiencing the same evolution in schooling outcomes. In Figure A.20, we estimate the impact of elite public colleges on years of schooling for untreated districts, in each case assigning the treatment year as the year in which the district in the state received an elite public college. We do not find evidence that the whole state is experiencing the same evolution in schooling outcomes as the treatment district: we fail to find an effect on years of schooling for untreated districts for states where an elite public college is established. Lastly, we cluster-bootstrap our standard errors following Cameron et al. (2008) (Table A.6). Our estimates remain precisely estimated.

6.2. *Private vs. public enrollment*

Next, we investigate the effects of elite colleges on private vs. public enrollment for children in Grades 1–10 (5–16 year olds). We employ an event study framework, estimating Equation (3), but now use the *annual* ASER data set. Here too, we restrict our sample to districts that ever received an elite college so that we do not compare dissimilar districts.

In Fig. 3 we show the impact of elite public colleges on private and public school enrollment. For public school enrollment, the coefficient in the year of treatment ($\tau = 0$), the year when elite public colleges were established, is −0.05, which means that public colleges led to a 5 percentage point (8%) decrease in the probability of public school enrollment. These effects get larger in the longer-run or 4 years after

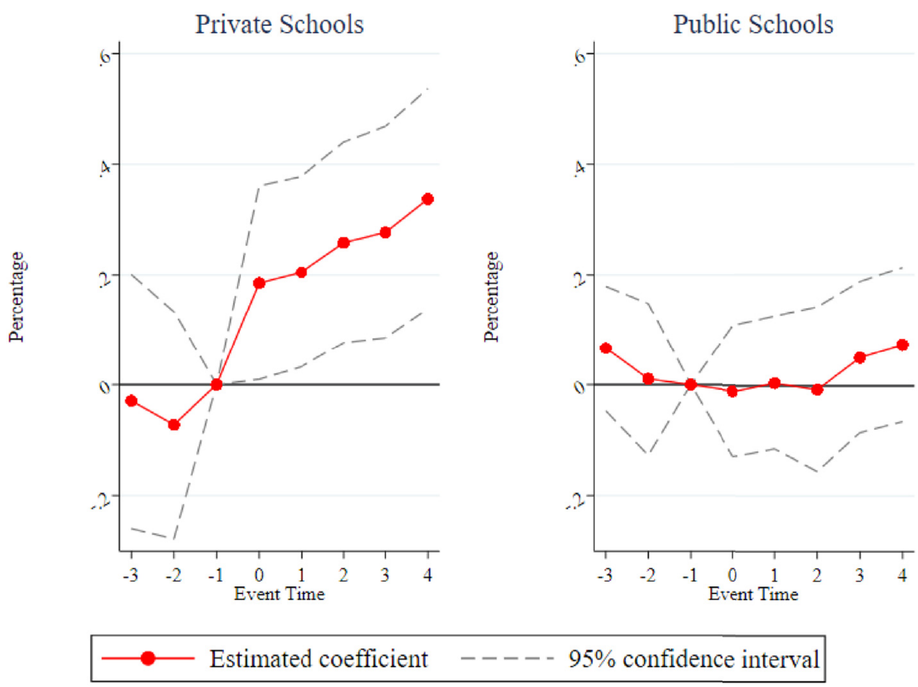

Fig. 4. Impact of Elite Public Colleges on Private vs. Public Schools. Notes: Sample includes a balanced district level panel of 23 treatment districts across 11 years of DISE data (2004-2014). The figure presents the effects of elite public colleges on number of private and public schools (natural logarithm). $\tau = 0$ is the year of entry of elite public colleges. These estimates are average treatment effects of elite public colleges relative to the year before elite public colleges were established ($\tau = -1$). For instance, if the treatment district received a new elite public college in 2007, the DISE surveys conducted in 2004, 2005, 2006, 2007, 2008, 2009, 2010, and 2011 are denoted as $\tau = -3$, $\tau = -2$, $\tau = -1$, $\tau = 0$, $\tau = 1$, $\tau = 2$, $\tau = 3$ and $\tau = 4$, respectively. The regression, Eq. (3), includes district and year (round) fixed effects. 95% confidence intervals are presented, standard errors are clustered at the district level.

the entry of an elite public colleges ($\tau = 4$). In contrast, elite public colleges are associated with an increase of 5 percentage points (20%) in the probability of private school enrollment in the year of treatment, and of over 10 percentage points (40%) by $\tau = 4$. We find no evidence of preexisting trends in our estimates. Indeed, the trend break at $\tau = 0$ is apparent, as well as economically and statistically significant for both public and private enrollment. The estimates of the pre-treatment periods are small in magnitude and statistically indistinguishable from zero.[30]

In robustness checks we control for district-specific trends, age, and gender; our estimates remain relatively unchanged (Figure A.21). Next, we drop each treatment district, one at a time, estimating Equation (3) every time (Figure A.22). In addition, we drop all districts where elite public colleges were introduced in a single year, 1 year at a time (Figure A.23). We find that these estimates are not driven by a single district or treatment year. We also conduct a placebo test where we run 200 iterations of Equation (3), by randomly assigning the year of treatment among treated districts for each iteration. Inspections of the resulting distribution of point estimates can help test the appropriateness of our statistical model and the likelihood that our results are an artifact of chance or of a systematic structure in the data. Indeed, the distribution of point estimates at $\tau = 0$ indicates that less than 5% of these estimates are larger in magnitude than the actual coefficient (Figures A.24 and A.25). Lastly, we cluster-bootstrap our standard errors following Cameron et al. (2008) (Table A.7). Our estimates remain precisely estimated.

The ASER data set also helps us investigate the pattern of gains in educational attainment observed using the NSS data set. In ASER, the proportion of children who never attended school at the baseline ($\tau = -1$) was less than 2 percent. It is plausible then, that gains in educational attainment were driven by children staying in school longer. Indeed, we find that the grade students dropped out of school increased by 0.5 at $\tau = 0$, and by almost 0.8 in the longer-run ($\tau = 4$). We also examine the effects of colleges on dropouts in primary school (Grade 8). We find that public colleges decreased the probability of dropouts in primary school by 8 percentage points in the short-run ($\tau = 0$) and 20 percentage points in the longer-run among children who eventually dropped out (Figures A.26 and A.27).

6.3. *Private schools*

Next, using the *annual*, district level DISE data set, we estimate Equation (3) and examine the impact of elite public colleges on the number of private schools. Here y_{jt} is the log of number of private schools in district j in year $t \in [2004, 2014]$

In Fig. 4 we show the effects of elite public colleges on the number of private and public schools. Entry of elite public colleges led to a 20 percent increase in the number of private schools at $\tau = 0$ and a 30 percent increase by the fourth year ($\tau = 4$). Importantly, we find that elite colleges have no impact on the number of government schools, suggesting that the colleges did not lead to broader increases in public expenditure on education in treatment districts. In robustness checks we show that our results remain unaffected by the addition of district-specific linear trends (Figure A.28). Next, we drop each treated district, one at a time, estimating Equation (3) every time (Figures A.29). And drop all districts where elite public colleges were introduced in a single year, 1 year at a time (Figure A.30). Our estimates are not driven by a single district or treatment year. We also conduct a placebo test where we run 200 iterations of Equation (3), randomly assigning year of treatment among treated districts for each iteration. The magnitude of the effect presented in Fig. 4, at $\tau = 0$, is observed in less than 5% iterations (Figure A.31). Lastly, we cluster-bootstrap our standard

[30] Table A.8 shows mean test scores for children enrolled in public vs. private schools in the ASER data. School-age children enrolled in private schools perform better on both math and reading compared to school-age children enrolled in public school. Yet, these differences should not be thought of as causal. There is other excellent work that documents differences inputs and learning achievements across public and private schools in India (Kremer and Muralidharan, 2008; Muralidharan and Venkatesh, 2015; Pal, 2010). The best causal evidence on differences in learning outcomes comes from Muralidharan and Venkatesh (2015) who show that for subjects taught in both types of schools, test scores are similar; yet, for subjects more likely to be taught in private schools (like English) test scores are higher in private schools. Kremer and Muralidharan (2008) and Pal (2010) show that better infrastructure inputs at the local level is correlated with more private schools, in support of our main mechanism.

errors following Cameron et al. (2008) (Table A.9).[31]

7. Mechanisms: public infrastructure investments

We find strong evidence that one mechanism responsible for the effects of elite public colleges on lower levels of schooling is infrastructure upgrades. We find that elite public colleges increased access to paved roads, electricity and tap water, and the intensity of these effects was largest among villages closest to the elite public college. While we find insufficient evidence in support of alternative channels, we can not rule them out.

To fix ideas, consider a simple explanation. Elite public colleges led to infrastructure investments lowering the setup costs for private schools. New private schools enter the market and students living closer to the private school transfer from public to private schools, staying enrolled for longer. Comparative statistics from our model suggest that decreases in entry costs for private schools increase supply ($dQ_{Sy}/d\overline{z_1}|_p < 0$; $dQ_{Sy}/dz_2|_p < 0$). If elite colleges increase access to infrastructure, this would lead to the entry of new private schools.

7.1. Census Village Directories

To test this prediction, we link infrastructure indicators from the 2001 and 2011 Census Village Directories to latitude-longitude coordinates of each village, as well as each elite public college.[32] Then, for each year we calculate the distance of every village in India to the closest elite college. We leverage variation in the change in distance to elite colleges at the village level, driven by the entry of new colleges, and capture the difference in effect sizes for villages at varying distances from the new college. If elite colleges led to focal investments in public infrastructure, we should observe larger effects for villages where a new public college was established, but smaller effects for villages that were farther away. Thus, as new colleges enter, it changes the distance of each village to the closest public college, and we leverage this change to estimate the following semi-parametric model:

$$y_{ijt} = \sum_{\tau=1}^{z} \alpha_\tau 1(DistancetoCollege \in [m, m+20])_{ij} + \beta\, Post_t + \sum_{\tau=1}^{z} \gamma_\tau 1(DistancetoCollege \in [m, m+20])_{ij} \times Post_t + \mu_j + \epsilon_{ijt} \quad (4)$$

where $m = 0, 20, \dots, 60$ kms. y_{ijt} is the outcome of interest for village i in district j in year t. Estimates characterizing the effects of elite public colleges are captured by the vector of coefficients γ_τ. The variable $1(DistancetoCollege \in [m, m+20])_{ij} = 1$ if the distance of village i in district j has ever been between 0 and 20 kms, 20–40 kms, 40–60 kms, or 60–80 kms away from the closest elite public college, 0 otherwise. Variable $Post_t$ is a post-treatment year for being in Census year 2011. $1(80 <= DistancetoCollege)_{ij}$ is the omitted distance category. μ_j are district-level fixed effects.

We present these results in Fig. 5. We find that elite public colleges increased access to infrastructure, and the effects on electricity (6 percentage points), water (8 percentage points) and roads (4 percentage points) were larger for villages closer to elite colleges than for villages farther away. As a placebo test, we examine the effects of future changes in distance to colleges on current changes in infrastructure. We estimate Equation (4) to evaluate the effects of changes in distance to colleges between 2001 and 2011 on changes in access to roads, water and electricity between 1991 and 2001. If villages closest to the colleges were targeted for investments in public infrastructure services and colleges were a consequence and not a cause of such a program, we would expect to see an association between future changes in distance and current infrastructure investments. However, Fig. 5 indicates that future changes in distance (between 2001 and 2011) do not predict current infrastructure investments (between 1991 and 2001).

Do location and timing of large public infrastructure initiatives launched in the 2000s and elite public colleges coincide? If location and timing of large public infrastructure initiatives launched in the 2000s and elite public colleges coincide, it is plausible that public infrastructure programs, and not elite public colleges, led to an increase in access to public infrastructure. There were at least two independent public infrastructure initiatives launched in the 2000s across India, Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) and Pradhan Mantri Gram Sadak Yojana (PMGSY). PMGSY was launched in 2000 while RGGVY was launched in 2005. Both programs were targeted to villages above a certain population cut-off, 1000 for PMGSY (Adukia et al., 2017) and 300 for RGGVY (Burlig and Preonas, 2016). We examine if villages nearest to elite public colleges were more likely to meet the village level population cut off required to be eligible for these programs (Figure A.33). We fail to find evidence for a positive association between distance to the nearest elite college in 2011 and village-level population in 2001, suggesting that the location of elite public colleges and the increase in public infrastructure investments in nearby villages were not associated with these rural infrastructure initiatives.

However, there was some discretion in the targeting of public infrastructure initiatives. For instance, the population targeting was not always followed rigidly for PMGSY. Therefore, it is plausible that elite public colleges did not crowd in investments in electricity, roads, and water services, but that certain districts were targeted by the administration to receive public goods at the same time and these may happen to include an elite public college as well as electricity, water, and roads. To rule out this explanation, we procure PMGSY village-level road completion data between 2000 and 2014; we use an event study specification to examine the effect of elite public colleges on road completion via PMGSY (0/1) (Figure A.34). We fail to find evidence for an increase in PMGSY-induced rural road completion before or after entry of elite public colleges. This result is less likely to be consistent with the hypothesis that certain districts were targeted to receive both public infrastructure initiatives like PMGSY and elite public colleges. It also suggests increases in public infrastructure investment in response to elite public colleges were not due to larger infrastructure programs rolled out by the federal government in the 2000s.

7.2. Village night lights

Next, we estimate the effects of elite public colleges on village-level nighttime lights, as a proxy for rural electrification. Here too, we use latitude-longitude coordinates for each village and elite public college in India and calculate the distance of every village to the nearest elite college for each year between 2004 and 2012. We estimate Equation (4) where y_{ijt} is now log mean nighttime lights in village i, district j, year t. Since we have 9 years of night lights data, we include village fixed effects (μ_i) and identify the effects from year-on-year changes in distance to elite public college, due to entry of new elite public colleges, on electrification at the village level. We estimate an even more flexible version of Equation (4), where we use 10 km bins between 0 and 150 kms, with $1(150 <= DistancetoCollege)_{ijt}$ being the omitted category. Our identifying assumption is that, conditional on village and year fixed effects, changes in the distance of villages to the closest elite college are not correlated with unobservable village specific, time-varying

[31] The DISE data also includes information of enrollment in primary and secondary school at the district level. Therefore, as a robustness check, we use DISE to corroborate the effects of elite public colleges on private vs. public school enrollment observed in the ASER data (Figure A.32). We find that the estimates are qualitatively similar. However, we prefer using the ASER data to estimate the effects on public vs. private school enrollment as questions have been raised about the veracity and trustworthiness of enrollment data from DISE (Page 15, Kingdon et al., 2016).

[32] We describe the data from Village Census Directories and Village Night Lights in Appendix A.4.

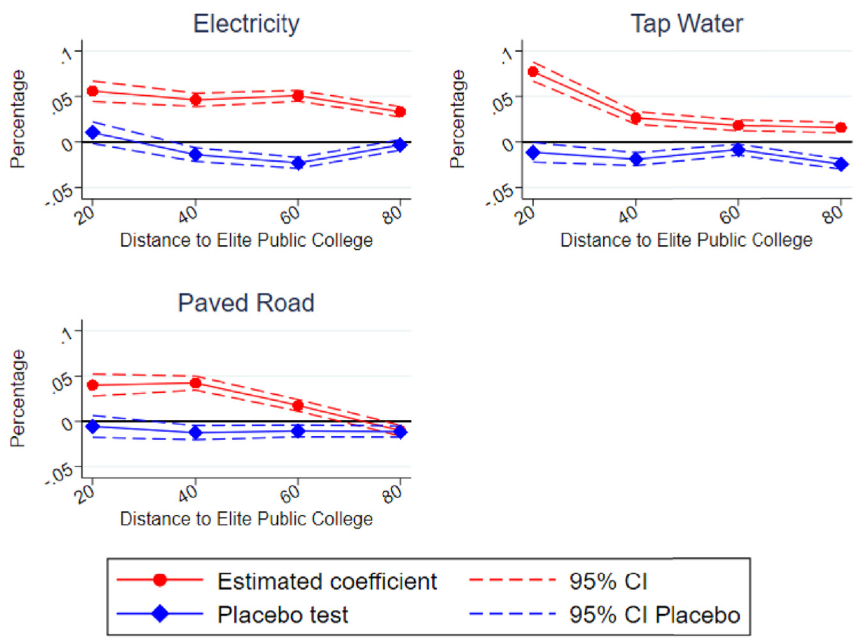

Fig. 5. Impact of Elite Public Colleges on Access to Electricity, Tap Water and Roads. Notes: Sample includes a balanced panel of 489,576 villages across 3 Census Village Directories (1991, 2001 and 2011). The figure presents the difference-in-difference estimates of the effects of change in village-specific distance to the nearest elite public college, due to the entry of new elite public colleges between 2001 and 2011, on the change in access to village level infrastructure (electricity (0/1), tap water (0/1), and paved roads (0/1)) between 2001 and 2011. In addition, the figure also presents placebo estimates of the effects of the change in village-specific distance to the nearest elite public college, due to the entry of new elite public colleges between 2001 and 2011, on the change in access to village level infrastructure between 1991 and 2001. The regression, Eq. (4), includes district and year (round) fixed effects, as well as indicator variables that denote if the village is less than 20, 40, 60 and 80 kms away from the nearest elite public college in 2011, respectively. 95% confidence intervals are presented, standard errors are heteroskedasticity-robust.

attributes that also affect changes in night time lights by distance bins.

Fig. 6 presents the effects of elite public colleges on village night lights. The coefficient for $1(DistancetoCollege \in [0,10]km)_{ijt}$ is 0.15, implying that villages within 10 kms from the new college saw a 15 percent increase in mean night light intensity. Importantly, the effects of elite public colleges on changes in nighttime light intensity decreased with an increase in the changed distance to the nearest college.[33,34]

In Figure A.36 we estimate equation (3) and document a sharp and statistically significant increase in night lights intensity in villages closest to the elite public college immediately after entry of elite public colleges. Elite public colleges led to an increase in night lights intensity by roughly 7–10% (5–7%) for villages 0–20 (20–40) kilometers away from the elite public college immediately ($\tau = 0$ and $\tau = 1$) after entry of elite public colleges; these effects are statistically significant at the 5% level. 5 years after entry of elite public colleges villages 0–20 km away observe an increase of roughly 30% in intensity of night lights; however, corresponding effects for villages 20–40 km away from the elite public college are closer to zero. Furthermore, we fail to find evidence for the existence of pre-trends; prior period coefficients are not statistically significant.

Why are effects on public infrastructure diffused by distance to elite public college? The infrastructure upgrades (tap water, roads, electricity) are part of larger networks. As such, one would expect there to be wider (albeit diffused) effects on areas further away. For instance, connecting new lines to the electricity grid, water network, or road network will affect electrification, water supply, and connectivity in areas along the route. Consistent with such an explanation, we find strongest effects are in areas closest to the elite public college, and diffused effects further away.

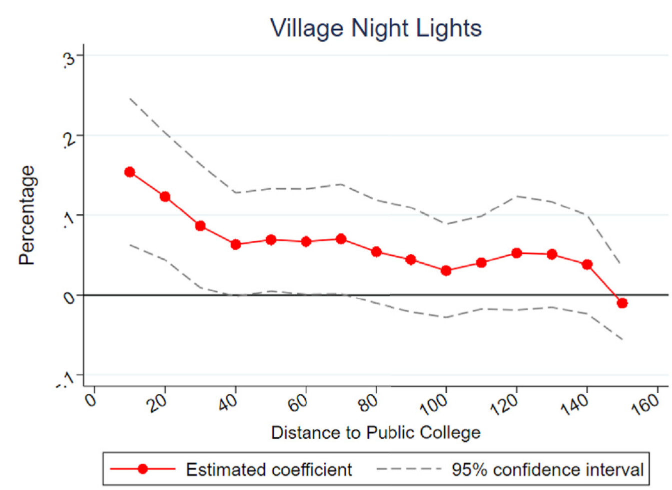

Fig. 6. Impact of Elite Public Colleges on Village Level Night Light Intensity. Notes: Sample includes a balanced panel of 453,921 villages across 9 years of night time lights data (2004-2012). The figure presents the difference-in-difference estimates of the effects of year-by-year changes in village-specific distance to the nearest elite public college, due to the entry of new elite public colleges between 2004 and 2012, on year-by-year changes in village level night lights (natural logarithm), a proxy for rural electrification. The regression, Eq. (4), includes village and year (round) fixed effects. 95% confidence intervals are presented, standard errors are clustered at the district level.

Khanna (2018) finds similarly diffused effects of network-based infrastructure in India, showing how building major highways can affect economic activity even 90 km away, because highways ease connections to smaller roads. Our results are also consistent with work on network-based infrastructure in other contexts: Banerjee et al. (2012); Faber (2014); Storeygard (2016); Donaldson (2014) find that attempts to connect a specific region (in our case, villages closest to the elite public college) to the transit network will facilitate connections to locations that lie on the route between that region (elite public colleges) and the preexisting network. Given the nature of network-based infrastructure, building one road/overhead power line/water line will lead to

[33] These effects are robust to the inclusion of state-by-year fixed effects where we control for all year-specific unobservables that vary by state as opposed to just year fixed effects that only control for year-specific unobservables common across India (Figure A.35).

[34] In Table A.10 and Table A.11, we use a linear measure of distance to elite public colleges, allowing us to use all the distance variation, and examine how change in distance to elite public colleges, due to introduction of new elite public colleges in the 2000s, impacts public infrastructure investments. These results are consistent with estimates obtained via our binned measure of distance: a 1% decrease in distance to elite public college increases access to electricity and tap water by 2 percentage points and 5 percentage points, respectively. Furthermore, a 1% decrease in distance to elite public college increases night lights intensity by 5 percentage points.

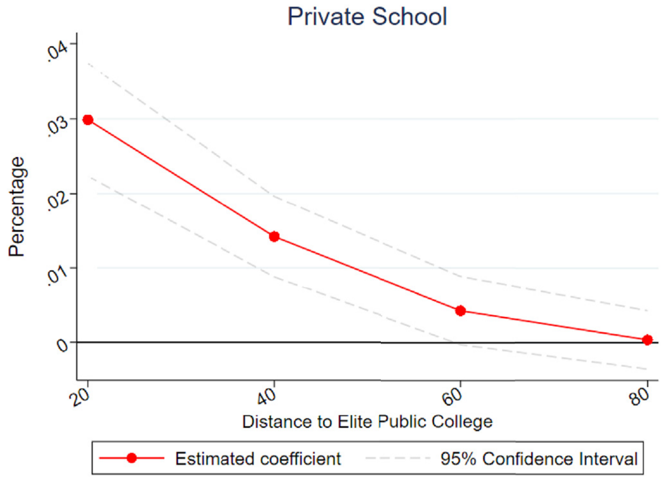

Fig. 7. Impact of Elite Public Colleges on Private School Presence. Notes: Sample includes a balanced panel of 489,576 villages from the 2011 Census Village Directories. The figure presents the estimates of the relationship between village-specific distance to the nearest elite public college and presence of private schools (0/1) in 2011. The regression includes district fixed effects. 95% confidence intervals are presented, standard errors are heteroskedasticity-robust.

construction of roads/electricity/water lines further away.[35]

7.3. Public infrastructure investments and private schooling

In Section 6.3, we showed that elite public colleges increase the entry of private schools at the district level. Combined with our estimates on infrastructure indicators, we would expect that infrastructure upgrades played a critical role in the entry of private schools. Such a claim is backed by existing evidence: Kremer and Muralidharan (2008) and Pal (2010) find that private schools in India are more likely to be present in villages with access to public infrastructure. However, public schools are less likely to respond to such investments as governments may prioritize under-served regions when choosing where to place public schools (Kremer and Muralidharan, 2008; Duflo, 2001).

If infrastructure upgrades are driving the entry of private schools, effects on private school entry should be largest in villages closest to the elite public college, as the effects on public infrastructure are highest among villages closest to colleges. Using The, 2011 Census Village Directory, we estimate Equation (4) to examine the association between elite public colleges and private schools in a cross-section with district fixed effects. We find that private schools are more likely to be present in villages closest to elite public colleges (Fig. 7).

Last, we examine the effects of elite public colleges on the distance to private schools. Distance is a central determinant of school choice in low income countries (Carneiro et al., 2015; Alderman et al., 2001). Using 2004-05 and 2011-12 rounds of the Indian Human Development Survey (IHDS), we evaluate the effect of elite public colleges on distance to school for children attending private schools in treatment vs. control districts in a triple difference framework.[36] We find suggestive evidence that elite public colleges led to a decrease in distance to private schools (Table 1). More specifically, we find that the entry of elite public colleges between 2005 and 2011 increased the likelihood that private-school going children were attending schools less than 1 km away from home in treatment districts by 13 percentage points. The entry of private schools may have potentially solved a (travel) cost constraint for marginal students, enabling them to get additional years of education as they transfer from public to private schools.[37]

Table 1
Impact of elite public colleges on distance to private school.

	(1) Distance < =1 km (0/1) Full Sample β/SE	(2) Distance < =1 km (0/1) Rural Sample β/SE
Private∗2011∗Public_College	0.131**	0.129*
	(0.056)	(0.067)
Mean	0.73	0.72
Observations	76659	54215
R^2	0.118	0.144

Notes: Sample includes a repeated cross-section of children between 5 and 16 years of age from a nationally representative household level panel across 2 rounds of Indian Human Development Survey (2004-05 and 2011-12). The table presents the triple difference estimates of the effects of entry of elite public colleges at the district level between 2005 and 2011 on the change in distance to private school (1 if private school is less than or equal to 1 km away from home, 0 otherwise) for children attending private school in treatment districts (or districts that received an elite public college between 2005 and 2011), *Private**2011**PublicCollege*. Regressions includes district fixed effects as well as an indicator variable for whether the child is attending a private school, indicator for treatment districts, indicator for survey round, and the interactions between these variables. Standard errors are in parentheses, clustered by district.

7.4. Alternative explanations

We rigorously explore other explanations that could potentially explain the relationship between elite public colleges and lower levels of schooling. We consider six alternative explanations: (1) increase in population, (2) increases in income, (3) increase in aspirations or returns to education, (4) better access to higher education, (5) influential politicians, and (6) competent bureaucrats.

We find insufficient evidence for these explanations. For instance, if perceived returns to education or aspirations were driving our result, one would expect an increase in both public and private enrollment; instead, we find an increase in private enrollment but a decrease in public enrollment. Similarly, if children were working harder due to access to higher education, one would expect to observe an increase in test scores; we fail to find evidence for an increase in test scores. Furthermore, we fail to find evidence for increase in in-migration or decrease in out-migration in districts where elite public colleges were established. Finally, we fail to find evidence that political expediency or bureaucratic competence are responsible for our results. We discuss these and other tests in detail in Appendix A.2.

8. Conclusion

In a country plagued by low literacy and school completion rates, questions are raised when public expenditure is directed towards higher rather than lower levels of education. This skepticism, however, misses the fact that higher education institutions may have 'spillover' effects on primary and secondary education markets in low-income countries like India.

In this paper, we find that elite public colleges encouraged the entry of private schools and increased private school enrollment as students

[35] There exists similar evidence for higher education institutions: Valero and Van Reenen (2019) use data from 15,000 universities across 78 countries to study impacts on local economic activity. They find higher education institutions have substantial impacts on economic activity even in areas 200 km away, consistent with the mechanism we posit.

[36] In Appendix A.4, we briefly describe the data set.

[37] Albeit noisier, these point estimates remain relatively unaffected when we add household fixed effects (Table A.12).

switched from public to private schools. In the era of shrinking public budgets, investment in higher education facilitated the expansion of primary and secondary education with private capital. Overall, this translates into gains in educational attainment (0.3–0.8 years) as children stayed enrolled in school longer. In fact, our back-of-the-envelope calculations indicate that the indirect benefits of elite public colleges due to transfers to private schools,[38] and returns to extra years of primary and secondary schooling, are *at least* half the size of the direct benefits accrued through the training of undergraduate and graduate students (Appendix A.3).

Importantly, we show that elite public colleges crowded in focal investments in electricity, water and road services. That is, the increase in access to public infrastructure services was largest for villages closest to new elite public colleges. We find suggestive evidence that public investment in infrastructure reduced setup costs for private schools, and the entry of private schools solved a (travel) cost constraint for marginal students, as they stayed in school longer. We explore various alternative mechanisms that might be driving the effects of elite public colleges on primary and secondary schooling markets. While we fail to find evidence for changes in population or income as potential explanations for these effects, we can not completely rule out demand externalities such as changes in parental aspirations, or effects on actual or perceived returns to education. Indeed, it is plausible that elite public colleges raised parental aspirations for children's education or perceived returns to education due to improved information flows.

It is important to note we fail to find evidence that public infrastructure investments (electricity, road, and water services) were conceived as a "big push" policy that includes both infrastructure and higher-education components (e.g., elite public colleges). We show that the elite public college placement did not overlap with either the *de jure* rules underlying large public infrastructure programs launched in the 2000s, nor the *de facto* placements of projects under these programs. In fact, consistent with reports in the popular press, the data appears most consistent with the interpretation that non-college public infrastructure (electricity, road, and water services) is crowded in by elite public colleges.

It is important to note that the magnitude of the effects on educational outcomes reflect district-level average treatment effects on districts where elite public colleges entered between 2004 and 2012. Therefore, the estimated β captures all location-level spillover effects of elite public colleges via private schools, as well as the effects of roads, water, and electricity services documented in the literature. School construction programs can have large effects on educational attainment: Duflo (2001) finds that each primary school constructed per 1000 children led to an average increase of roughly 0.2 years of education in Indonesia. Distance to school is a central determinant of school choice in lower income countries, and Carneiro et al. (2015) show that increasing the distance to school by 0.5 km decreases the likelihood of choosing that school by roughly 5 percentage points in Pakistan. Lastly, studies have shown that access to public infrastructure services like roads, electricity, and water have large effects on education outcomes. For instance, Lipscomb et al. (2011) find that hydro-power plants in Brazil increased electricity access by 22 percentage points, and consequently, years of schooling by two years.

In conclusion, we would like to urge caution regarding the external validity of our findings. Our results relate to *elite* public colleges in India that garner substantial prestige. We find that elite public colleges successfully crowd-in large investments in public infrastructure services, and may be one mechanism driving our result. It is unlikely that other ('second-tier') public colleges would be able to facilitate a similar increase in access to public infrastructure. Although these concerns may constrain the broader implications of our results, elite public colleges are not unique to India.[39] More importantly, India's higher education system is the third largest in the world, next only to the US and China, and successive recent governments have pushed for a drastic and immediate increase in the number of elite public colleges in the country. In 2016-17, almost half of the budget for higher education was dedicated to elite public colleges (Budget, 2017). Since 2014, 25 new elite public colleges have been established across the country. To formulate an effective higher education policy in India, it is important to include any 'spillover' effects of elite public colleges in the calculation of the social returns to higher education investments.

Authors statement

The authors of this manuscript are Maulik Jagnani and Gaurav Khanna.

The authors have no competing conflicts of interest to declare.

The authors shared equal responsibility in the preparation of this manuscript. All non-proprietary data and code will be shared for reproducibility purposes.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jdeveco.2020.102512.

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[38] Muralidharan and Venkatesh (2015) show that although there exists little difference in output, private schools are more costs effective than public schools.

[39] In 1998, China launched a higher education modernization process, Project 985, that intends to establish elite or 'world-class' universities across the country.

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