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Abhiman Das
Arti Grover
Ramana Nanda
Ejaz Ghani
William Kerr

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Abhiman Das
IIM Ahmedabad

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Abstract

We use the construction of India's Golden Quadrangle (GQ) central highway network, together with comprehensive loan data drawn from the Reserve Bank of India, to investigate the interaction between infrastructure development and financial sector depth. We identify a disproportionate increase in loan count and average loan size in districts along the GQ highway network using stringent specifications with industry and district fixed effects. Our results hold in straight-line IV frameworks and are not present in 'placebo tests' with another highway that was planned to be upgraded at the same time as GQ but subsequently delayed. Importantly, however, results are concentrated in districts with stronger initial financial development, suggesting that while financing does respond to large infrastructure investments and help spur real economic outcomes, initial financial sector development might play an important role in determining *where* real activity will grow.

*Author institutions and contact details: Das: Indian Institute of Management Ahmedabad, abhiman@iima.ac.in; Ghani: World Bank, eghani@worldbank.org; Grover Goswami: World Bank, agrover1@worldbank.org; Kerr: Harvard University, Bank of Finland, and NBER, wkerr@hbs.edu; Nanda: Harvard University and NBER, RNanda@hbs.edu.

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1 Introduction

In recent years, there has been widespread acceptance of the view that finance plays a fundamental role in shaping the rate, direction and location of real economic activity (Levine, 1997). Financial development has also been shown to be a key driver of economic growth through its role in impacting entrepreneurship and firm dynamics (King and Levine 1993a,b; Kerr and Nanda, 2009), innovation (Kortum and Lerner, 2000; Hsu, Tian and Xu, 2014; Nanda and Nicholas, 2014) and reallocation towards more efficient firms (Jayaratne and Strahan 1996; Rajan and Zingales, 1998; Bertrand, Schoar and Thesmar 2007).

While this role of finance is well-established, a key policy question still remains: can one spur growth and development in areas with low financial development through other means such as infrastructure spending, or is finance a necessary condition for growth to occur? From both a theoretical and policy standpoint, this question is important for several reasons. First, infrastructure spending is increasingly seen as a key policy lever for governments to drive economic growth. Rapidly expanding countries like India and China face severe constraints on their transportation infrastructure, which has been described by academics and business leaders as a critical hurdle for further development. Even in advanced economies, continued urbanization, demographic trends, and climate change call for an acceleration of investment in infrastructure. However, there is a very limited understanding of the economic impact of those projects and their interaction with the financial sector.[1]

Second, the degree to which financial development is *necessary* for economic growth has important implications for models of development and policy. If infrastructure spending can overcome the limitations of weak financial development, this is an important insight for policy makers and nation builders as they can proceed with such projects in confidence that the complements of financial markets will work themselves out. Infrastructure investment can then also help with convergence of regions with less developed financial markets towards regions at the frontier. On the other hand, if a baseline level of financial development is necessary for growth, then the effects of such spending will be uneven. Moreover, a lack of attention to prior financial development could lead to a divergence

[1] Although existing literature emphasizes the importance of access to finance on firm-level investment it does not intersect with studies on investments in infrastructure (e.g., Chandra and Thompson, 2000; Duranton and Turner, 2011; Banerjee et al., 2012).

between regions that are above a threshold level of financial development compared to those that are not.

A key empirical challenge in addressing this questions is that large-scale infrastructure investment is typically endogenous, making it extremely difficult to causally identify whether a strong financial market needs to be in place first or whether financial development appropriately mirrors and develops alongside major investment efforts. We study this question using India's Golden Quadrilateral (GQ) highways investment as natural experiment, examining the spatial development of banking at the district level before and after. The GQ network connects the four major cities of Delhi, Mumbai, Chennai, and Kolkata and is the fifth-longest highway in the world. Conceived in 1999, the GQ upgrades began in 2001, with a target completion date of 2004, and 95% of the work was completed by the end of 2006.

Several studies have subsequently documented the importance of the GQ upgrades for Indian manufacturing development along the highway system but have not focused on the role of finance.[2] This project connects the GQ work to the financial sector and makes two main contributions: First, we use comprehensive and detailed data on bank lending across India over an extended period of time, drawn from the Reserve Bank of India. This database gives us detailed information on each outstanding loan above a small threshold, reported annually by every branch of every scheduled commercial bank in India. We have invested substantially over this project in accessing and preparing these data. They constitute a major new tool for the economic and financial development and growth literatures. Second, the context of the GQ infrastructure project allows us to generate strong causal results of the relationship between infrastructure investment and local financial development, using straight line IV analyses and comparing results to the planned, but not completed NS-EW corridor. To understand the interaction between infrastructure and finance, we examine how the results vary based on the pre-existing financial development of districts adjacent to the highway. This allows us to speak directly

[2] Using a very short time window, Datta (2011) finds almost immediate evidence of improved inventory efficiency and input sourcing for businesses situated along the GQ network. Ghani et al. (2016, 2017) demonstrate greater formal sector manufacturing growth and entrepreneurship in districts located within ten kilometers from the GQ network compared to those farther away. They further highlight urban-rural differences, changes in allocative efficiency, and causal assessments. In total organized manufacturing output increased by 15%-20% due to the highway system. Khanna (2014) examines changes in night-time luminosity around the GQ upgrades, finding evidence for a spreading-out of economic development.

to the question of whether financial development was necessary for the real effects to be manifested.

We find a strong response in lending activity in districts adjacent to the GQ highway network, manifested in terms of both loan counts and larger loan sizes. Our results are strongest in districts where there was new construction (as opposed to upgrades) and dynamic specifications support the effect taking hold shortly after construction. Moreover, our results hold in straight-line IV frameworks and are also not present in 'placebo tests' with a second highway that was planned to be upgraded at the same time as GQ but subsequently delayed. Our results point to bank lending responding to the increase in real activity that arose from improved transportation infrastructure. Importantly, however, we find our results are entirely concentrated in regions with strong initial financial development. Lending activity did not increase and in some specifications is seen to fall slightly in regions with initially low financial development, suggesting that while finance responded to help support increased real activity, the level of financial development played a critical role in determining where real economic activity grew. These results suggest that the initial level of financial development might be critical in shaping how (and where) infrastructure investment can jumpstart real economic activity.

Our study is the first to connect micro-level financial development with plausibly exogenous infrastructure development. This is not possible for the United States, where most research has traditionally focused, due to the older nature of the Eisenhower highway system. The later timing of the Indian investment and better collection of financial data over recent decades provide unprecedented platforms. Moreover, prior work mostly identifies how the existence of transportation networks impacts activity, but we can quantify the impact from investments into improving road networks compared to placebo networks that are not enhanced. This provides powerful empirical identification, and the comparisons are informative for the economic impact of road upgrade investments, which are very large and growing.[3]

This project also contributes to important questions facing India as it seeks to build

[3] Through 2006 and including the GQ upgrades, India invested USD 71 billion for the National Highways Development Program to upgrade, rehabilitate, and widen India's major highways to international standards. A recent Committee on Estimates report for the Ministry of Roads, Transport and Highways suggests an ongoing investment need for Indian highways of about USD 15 billion annually for the next 15 to 20 years (The Economic Times, April 29, 2012).

the infrastructure, ranging from highways to ports to cities to broadband, required to enable its continued growth and modernization. Beyond India, several recent studies find mixed evidence regarding economic effects for non-targeted locations due to transportation infrastructure in China or other developing economies.[4] These studies complement the larger literature on the United States and those undertaken in historical settings.[5]

Related literatures consider non-transportation infrastructure investments in developing economies (e.g., Duflo and Pande, 2007; Dinkelman, 2011) and the returns to public capital investment (e.g., Aschauer, 1989; Munell, 1990; Otto and Voss, 1994). Several studies evaluate the performance of Indian manufacturing, especially after the liberalization reforms (e.g., Ahluwalia, 2000; Besley and Burgess, 2004; Kochhar et al., 2006). Some authors argue that Indian manufacturing has been constrained by inadequate infrastructure and that industries that are dependent upon infrastructure have not been able to reap the maximum benefits of the liberalization's reforms (e.g., Mitra et al., 1998; Gupta et al., 2008; Gupta and Kumar, 2010).

2 India's Highways and the GQ Project[6]

Road transportation accounts for 65% of freight movement and 80% of passenger traffic in India. National highways constitute about 1.7% of this road network, carrying more than 40% of the total traffic volume.[7] To meet its transportation needs, India launched its National Highways Development Project (NHDP) in 2001. This project, the largest highway project ever undertaken by India, aimed at improving the GQ network, the North-South and East-West (NS-EW) Corridors, Port Connectivity, and other projects in several phases. The total length of national highways planned to be upgraded (i.e.,

[4]For example, Brown et al. (2008), Ulimwengu et al. (2009), Baum-Snow et al. (2012), Banerjee et al. (2012), Roberts et al. (2012), Baum-Snow and Turner (2013), Faber (2014), Xu and Nakajima (2017), Qin (2017), and Aggarwal (2018).

[5]For example, Fernald (1998), Chandra and Thompson (2000), Lahr et al. (2005), Baum-Snow (2007), Michaels (2008), Holl and Viladecans-Marsal (2011), Hsu and Zhang (2014), Duranton and Turner (2012), Fretz and Gorgas (2013), Holl (2013), Duranton et al. (2014), Donaldson and Hornbeck (2016), and Donaldson (2018).

[6]The first part of this section is taken from Ghani et al. (2016).

[7]Source: National Highway Authority of India website: http://www.nhai.org/. The Committee on Infrastructure continues to project that the growth in demand for road transport in India will be 1.5-2 times faster than that for other modes. Available at: http://www.infrastructure.gov.in. By comparison, highways constitute 5% of the road network in Brazil, Japan, and the United States and 13% in Korea and the United Kingdom (World Road Statistics, 2009).

strengthened and expanded to four lanes) under the NHDP was 13,494 km; the NHDP also sought to build 1,500 km of new expressways with six or more lanes and 1,000 km of other new national highways. In most cases, the NHDP sought to upgrade a basic infrastructure that existed, rather than build infrastructure where none previously existed.[8]

The NHDP evolved to include seven different phases, and we focus on the first two stages. NHDP Phase I was approved in December 2000 with an initial budget of Rs 30,300 crore (about USD 7 billion in 1999 prices). Phase I planned to improve 5,846 km of the GQ network (its total length), 981 km of the NS-EW highway, and 671 km of other national highways. Phase II was approved in December 2003 at an estimated cost of Rs 34,339 crore (2002 prices). This phase planned to improve 6,161 km of the NS-EW system and 486 km of other national highways. About 442 km of highway is common between the GQ and NS-EW networks.

The GQ network connects the four major cities of Delhi, Mumbai, Chennai, and Kolkata and is the fifth-longest highway in the world. Panel A of Figure 1 provides a map of the GQ network. The GQ upgrades began in 2001, with a target completion date of 2004. To complete the GQ upgrades, 128 separate contracts were awarded. In total, 23% of the work was completed by the end of 2002, 80% by the end of 2004, 95% by the end of 2006, and 98% by the end of 2010. Differences in completion points were due to initial delays in awarding contracts, land acquisition and zoning challenges, funding delays,[9] and related contractual problems. Some have also observed that India's construction sector was not fully prepared for a project of this scope. One government report in 2011 estimated the GQ upgrades to be within the original budget.

The NS-EW network, with an aggregate span of 7,300 km, is also shown in Figure 1. This network connects Srinagar in the north to Kanyakumari in the south, and Silchar in the east to Porbandar in the west. Upgrades equivalent to 13% of the NS-EW network were initially planned to begin in Phase I alongside the GQ upgrades, with the remainder scheduled to be completed by 2007. However, work on the NS-EW corridor was pushed into Phase II and later, due to issues with land acquisition, zoning permits, and similar.

[8] The GQ program in particular sought to upgrade highways to international standards of four- or six-laned, dual-carriageway highways with grade separators and access roads. This group represented 4% of India's highways in 2002, and the GQ work raised this share to 12% by the end of 2006.

[9] The initial two phases were about 90% publicly funded and focused on regional implementation. The NHDP allows for public-private partnerships, which it hopes will become a larger share of future development.

In total, 2% of the work was completed by the end of 2002, 4% by the end of 2004, and 10% by the end of 2006. These figures include the overlapping portions with the GQ network that represent about 40% of the NS-EW progress by 2006. As of January 2012, 5,945 of the 7,300 kilometers in the NS-EW project had been completed.

Ghani et al. (2016) quantify that the GQ work stimulated organized manufacturing expansion in the districts located along the highway network, even after excluding the four major cities that form the nodal points of the quadrangle and five other districts that are their contiguous suburbs. The nodal districts are excluded, in their work and in this project, because it is very hard to interpret results for nodal cities given that they were targeted by the reform. Estimations suggest manufacturing shipments in the affected districts grew by almost 50% over the ten years after the GQ construction commenced. This growth is not present in the districts farther away from the GQ network nor in districts alongside the NS-EW system. Ghani et al. (2016) further consider dynamic analyses and straight-line instrumental variables (IV) based upon minimal distances between nodal cities. As the affected districts contained about a third of India's initial manufacturing output, this was a major advancement for the country that would have covered the costs involved. They further find substantial evidence for heightened entrepreneurship, better industrial sorting, and stronger allocative efficiency for industries positioned on the network (e.g., Hsieh and Klenow, 2009).

In a companion paper, Ghani et al. (2017) also consider the unorganized sector and find a very limited response to the GQ upgrades. There is modest evidence for the replication of some results related to heightened entry rates and industry sorting, but the implied size of these effects is much smaller and rarely statistically significant. This is perhaps due to the greater incentive for larger plants that trade at a distance in the formal sector to pick their location more selectively. Another potential root cause, which we begin to explore in this paper, is differences in the initial level of financial development.

3 Data

Our platform combines financial loan data from RBI with evidence on GQ implementation.

3.1 Financial Banking Data

The essential ingredient for this project is a micro dataset that we built based upon the Basic Statistical Return (BSR)1A, maintained by the Central Bank (RBI). BSR-1A has details of each loan outstanding (above a threshold), reported annually by every branch of every scheduled commercial bank in India. The threshold over which individual account data is reported was Rs. 25,000 until 1998 and Rs. 2 lakh from 1999 onwards (the latter is about $4,000 using historical exchange rates). The universal and comprehensive nature of these financial data are substantially stronger than what can be assembled for most countries, including the United States for example. The BSR data has been used in recent research by Cole (2009), Das et al. (2016), Kumar (2016), and Das et al. (2018).

While the micro-data can only be accessed at the RBI by their staff, we were allowed to aggregate these data for external use. Our aggregations are at the level of the district x industry x year. Districts are administrative subdivisions of Indian states or union territories that provide more-granular distances from the various highway networks. We prepare our platform to resemble those used in prior studies on India's manufacturing sector to facilitate comparability.[10] Accordingly, the core sample contains 311 districts that account for over 90% of manufacturing activity in India. The excluded districts from the full set of 630 districts make very limited contributions to organized manufacturing.

Industry categories are 2-digit NIC for manufacturing and 1-digit for all other industry groups. We have invested substantial time to cleaning and validating the data and ensuring consistency across years. We explicitly designed our aggregations to avoid any kinks due to definitional changes across years. Our data span 1992 to 2013, with our analyses concentrated on the decade from 1999 to 2009 around the GQ reform.

3.2 GQ and NS-EW Mapping

We measure the spatial distance of Indian districts to the GQ or NS-EW highway system using official highway maps and ArcMap GIS software. We calculate distances using shortest straight-line metrics measured from the edge of each district. These results are robust to instead measuring distances from district centroids. The Empirical Appendix of Ghani et al. (2016) provides additional details on data sources and preparation, with

[10]See Ghani et al. (2016). For additional detail on the manufacturing survey data, see Fernandes and Pakes (2008), Hasan and Jandoc (2010), Kathuria et al. (2010), Nataraj (2011), and Ghani et al. (2014).

the most attention given to how GQ traits are developed using project-level records and then paired to district-level conditions.

Empirical specifications use a non-parametric approach with respect to distance to estimate treatment effects. We define indicator variables for the shortest distance of a district to the indicated highway network (GQ, NS-EW) being within a specified range. Most specifications use four distance bands: nodal districts, districts located 0-10 km from a highway, districts located 10-50 km from a highway, and districts over 50 km from a highway. Of our 311 districts, 9 districts are nodal for GQ, 69 districts fall within 0-10 km of GQ, 37 districts fall within 10-50 km, and 196 districts are 50 km or more from GQ.

Our focus is on the non-nodal districts of a highway. We measure and report effects for nodal districts, but the interpretation of these results is difficult as the highway projects are intended to improve the connectivity of the nodal districts. For the GQ network, we follow Datta (2011) in defining the nodal districts as Delhi, Mumbai, Chennai, and Kolkata. In addition, Datta (2011) describes several contiguous suburbs (Gurgaon, Faridabad, Ghaziabad, and NOIDA for Delhi; Thane for Mumbai) as being on the GQ network as 'a matter of design rather than fortuitousness.' We include these suburbs in the nodal districts. As discussed later when constructing our instrument variables, there is ambiguity evident in Figure 1 about whether Bangalore should also be considered a nodal city. The base analysis follows Datta (2011) and does not include Bangalore, but we return to this question. For the NS-EW network, we define Delhi, Chandigarh, NOIDA, Gurgaon, Faridabad, Ghaziabad, Hyderabad, and Bangalore to be the nodal districts using similar criteria to those applied to the GQ network.

4 Empirical Analysis of Highways' Impact on Loan Activity

4.1 Econometric Methodology

Long-differenced estimations compare district x industry loan activity in 1999, just prior to the start of the GQ upgrades, with loan activity in 2009. About 98% of the GQ upgrades were completed by the end of this time period. Indexing districts with d and industries with i, the specification takes the form:

$$\Delta Y_{d,i} = \sum_{j \in D} \beta_j \cdot (0,1) GQDist_{d,j} + \eta_i + \varepsilon_{d,i}. \tag{1}$$

The set D contains three distance bands with respect to the GQ network: a nodal district, 0-10 km from the GQ network, and 10-50 km from the GQ network. The excluded category includes districts more than 50 km from the GQ network. The β_j coefficients measure by distance band the average change in outcome $Y_{d,i}$ over the 1999-2009 period compared to the reference category.

We consider two outcome variables $Y_{d,i}$ expressed in logs: log loan counts and log average loan size. District x industry cells are only included if they have measured loan activity in both periods. All estimations control for industry fixed effects η_i, which is equivalent to including industry-x-year fixed effects in a panel regression. We thus control in our estimations for any industry-wide changes in loan activity, due for example to a growth or decline in sector activity or financial dependency. Regressions further control for the baseline level of financial development of each district to flexibly capture issues related to economic convergence across districts.

Estimations include 12,225 observations and are weighted by the log population of the district recorded in the 2001 population census, the year prior to the implementation of GQ. We cluster standard errors by district. We winsorize outcome variables at the 1%/99% level to guard against outliers.

4.2 Baseline Estimations

Table 1 reports the core results with specification (1). The dependent variable for Columns 1 and 2 is the change in log loan counts for a district-industry over the 10-year period; the dependent variable in Columns 3 and 4 is the change in log average loan size.

Regressions in Columns 2 and 4 further add state fixed effects, which is equivalent to including state-x-year fixed effects in a panel regression. This is a much more aggressive empirical approach than the baseline estimation as the augmented regression only considers variation within states (and thus we need to have districts located on the GQ network and those farther away together in individual states). By validating our results with the restricted variation, we can show that state policies, business cycles, and so forth are not responsible for the measured outcomes attributed to the highway development. Throughout the tables ahead, we find that our results are very stable to the inclusion or exclusion of the controls.

The first row shows enormous increases in loan counts and average loan size for nodal districts after the GQ development project. The higher standard errors of these estimates, compared to the rows beneath them, reflect the fact that there are only nine nodal districts. Yet, these changes in financing activity are so substantial in size that one can still reject statistically that the effect is zero. We do not emphasize these results much given that the upgrades were built with the explicit goal of improving the connectivity of the nodal cities. Because specification (1) measures the β_j coefficients for each band relative to districts more than 50 km from the GQ network, the inclusion or exclusion of the nodal districts does not impact results regarding non-nodal districts.

Our primary emphasis is on the second row, where we consider non-nodal districts that are 0-10 km from the GQ network. To some degree, the upgrades of the GQ network can be taken as exogenous for these districts. Both loan counts and average loan size also increase in this distant bands. The coefficients suggest a 20% or so increase in aggregate loan counts for districts within 10 km of the GQ network in 2009 compared to 1999, relative to districts more than 50 km from the GQ system. The increase in average loan size is 15%-18% greater for districts near the GQ system as well.

For comparison, the third row provides the interactions for the districts that are 10-50 km from the GQ network. None of the effects we measure for districts within 0-10 km of GQ are present for those in this next distance band.

These results, and in particular the contrast in growth for the 0-10 km versus the 10-50 km bands, closely resemble the differential development in organized manufacturing activity documented by Ghani et al. (2016). While the datasets and approaches are not exactly comparable, the differential growth towards non-nodal districts located along GQ in bank loan activity appears about half of the size of what was evident for organized manufacturing plant and output growth. As the follow-on work in Ghani et al. (2017) finds a very weak response for unorganized/informal manufacturing activity along the GQ network to the upgrades, the measured response in aggregate loan activity appears, perhaps intuitively, to sit in between the two prior studies.

4.3 Comparison of New Construction vs. Upgrades

Table 2 presents results about the differences in the types of GQ work undertaken. Prior to the GQ project, there existed some infrastructure linking these cities. In a minority of cases, the GQ project built highways where none existed before. In other cases, however, a basic highway existed that could be upgraded. Of the 70 districts lying near the GQ network, new highway stretches comprised some or all of the construction for 33 districts, while 37 districts experienced purely upgrade work. (One of these districts is excluded from our present analysis due to lack of loan activity in both periods.) We split the 0-10 km interaction variable for these two types of interventions.

Almost all of the measured finance response is in the new construction segments of the GQ project. As this result continues to hold after augmenting specification (1) to include state fixed effects, we can further conclude that the expansion in activity happens at a local level around new construction sites in addition to a regional one.

Comparing these findings to Ghani et al. (2016), one can speculate on how loans connected to changes in organized manufacturing sector activity. Ghani et al. (2016) find much of the manufacturing growth surrounding the upgrades of existing GQ roads came through productivity enhancements for existing large plants. It is possible that these expansions by incumbent plants did not require substantial growth in financial loans (or the loans could be taken out nationally by a parent organization), and this might also be a clue as to why organized sector output growth along the GQ network was differentially stronger than total loan growth. By contrast, Ghani et al. (2016) find new organized sector manufacturing entry was closely associated with places where new road construction took place, which may have required greater district-level loan provision.

4.4 Comparison of GQ Upgrades to NS-EW Highway

The stability of the results in Table 1 is encouraging, especially to the degree to which they suggest that proximity to the GQ network is not reflecting other traits of states that could have influenced their economic development. There remains some concern, however, that we may not observe all of the factors that policy makers would have known or used when choosing to upgrade the GQ network and designing the specific layout of the highway system. For example, policy makers might have known about the latent growth potential of local areas and attempted to aid that potential through highway development.

We examine this feature by comparing districts proximate to the GQ network to districts proximate to the NS-EW highway network that was not upgraded. The idea behind this comparison is that districts that are at some distance from the GQ network may not be a good control group if they have patterns of evolution that do not mirror what districts immediately on the GQ system would have experienced had the GQ upgrades not occurred. This comparison to the NS-EW corridor provides a stronger foundation in this regard, especially as its upgrades were planned to start close to those of the GQ network before being delayed. The identification assumption is that unobserved conditions such as regional growth potential along the GQ network were similar to those for the NS-EW system (conditional on covariates).

The upgrades scheduled for the NS-EW project were to start contemporaneous to and after the GQ project. To ensure that we are comparing apples to apples, we identified the segments of the NS-EW project that were to begin with the GQ upgrades and those that were to follow in the next phase. Of the 90 districts lying within 0-10 km of the NS-EW network, 40 districts were to be covered in the 48 NS-EW projects identified for Phase I. The empirical appendix of Ghani et al. (2016) provides greater detail on this division. Our analysis focuses on those scheduled for Phase I.

Table 3 augments specification (1) to include three additional indicator variables regarding proximity to the NS-EW system. Indicator variables are not mutually exclusive, in that some districts can lie within 50 km of both networks. In these estimations, the distance band coefficients are measured relative to districts more than 50 km from both networks.

The first three rows start by showing little quantitative change in our measured impact from GQ upgrades in the set of expanded regressions. The fourth row shows that nodal districts on NS-EW also experience some measure of loan growth, although these results are not precisely measured in the presence of state fixed effects. This confirms our earlier hesitation to infer too much from the coefficients for the nodal GQ districts. While the NS-EW upgrades did not occur, its nodal districts still show half or more of the response evident for the nodes of the GQ network.

By contrast, the estimates in the last two rows are very comforting for our primary results. None of the long-differenced loan outcomes evident for districts in close proximity to the GQ network are evident for districts in close proximity to the NS-EW network, even if these latter districts were scheduled for a contemporaneous upgrade. The placebo-like coefficients along the NS-EW highway are small and never statistically significant. The lack of precision is not due to too few districts along the NS-EW system, as the district counts are comparable to the distance bands along the GQ network and the standard errors are of very similar magnitude. Said differently, with the precision that we estimate the positive responses along the GQ network, we estimate a lack of change along the NS-EW corridor.

4.5 Straight-Line Instrumental Variables Estimations

Continuing with potential identification challenges, a related worry is that perhaps the GQ planners were better able to shape the layout of the network to touch upon India's growing regions (and maybe the NS-EW planners were not as good at this, had less discretion, or had a smaller set of good choices). More broadly, Duranton and Turner (2011) highlight endogenous placement could bias findings in either direction. Infrastructure investments may be made to encourage development of regions with high growth potential, which would upwardly bias measurements of economic effects that do not control for this underlying potential. However, there are many cases where infrastructure investments are made to try to turn around and preserve struggling regions. They may also be directed through the political process towards non-optimal locations (i.e., 'bridges to nowhere'). These latter scenarios would downward bias results.

Table 4 addresses these questions using IV techniques. Rather than use the actual layout of the GQ network, we instrument for being 0-10 km from the GQ network with being 0-10 km from a (mostly) straight line between the nodal districts of the GQ network. The identifying assumption in this IV approach is that endogenous placement choices in terms of weaving the highway towards promising districts (or struggling districts) can be overcome by focusing on what the layout would have been if the network was established based upon minimal distances only. This approach relies on the positions of the nodal cities not being established as a consequence of the transportation network, as the network may have then been developed due to the intervening districts. This is a reverse causality concern, and an intuitive example is the development of cities at low-cost points near to mineral reserves that are accessed by railroad lines. Similar to the straight-line IV used in

Banerjee et al. (2012), the four nodal cities of the GQ network were established hundreds or thousands of years ago, making this concern less worrisome in our context.[11]

The exclusion restriction embedded in the straight-line IV is that proximity to the minimum-distance line only affects districts in 1999-2009 period due to the likelihood of the district being on the GQ network and experiencing the highway upgrade. This restriction could be violated if the regions along these straight lines possessed characteristics or policies that are otherwise connected to financial growth during this period. To guard against these concerns, we focus on IV specifications with state fixed effects. We will thus only exploit variation within states in the likelihood that a district would have been on the GQ network. We also continue to control for initial financial development in the district.

Panel B of Figure 1 shows the implementation. IV Route 1 is the simplest approach, connecting the four nodal districts outlined in the original Datta (2011) study. We allow one kink in the segment between Chennai and Kolkata to keep the straight line on dry land. IV Route 1 overlaps with the GQ layout and is distinct in places. We earlier mentioned the question of Bangalore's treatment, which is not listed as a nodal city in the Datta (2011) work. Yet, as IV Route 2 shows, thinking of Bangalore as a nodal city is visually compelling. We thus test two versions of the IV specification, with and without the second kink for Bangalore.

Panel A of Table 4 provides a baseline OLS estimation. For these IV estimations, we exclude nodal districts (sample now contains 302 districts) and measure all effects relative to districts more than 10 km from the GQ network. This approach only requires us to instrument for a single variable—being within 10 km of the GQ network.

The first-stage relationships are quite strong. IV Route 1, which does not connect Bangalore directly, has a first-stage elasticity of 0.43 (0.05) and an associated F-statistic of 74.5. IV Route 2, which treats Bangalore as a connection point, has a first-stage elasticity of 0.54 (0.05) and an associated F-statistic of 138.1.

Panel B presents the second-stage results. The IV specifications generally confirm the

[11] Banerjee et al. (2012) provide an early application and discussion of the straight-line IV approach, and Khanna (2014) offers a recent application to India. Faber (2014) provides an important extension to this methodology. Faber (2014) uses data on local land characteristics and their impact on construction costs to define a minimum-cost way of connecting 54 key cities that were to be linked by the development of China's highway network.

OLS findings. Column 1 shows a modest growth in the estimated impact of proximity to the GQ network on loan counts for non-nodal districts. Column 2 finds a similar point estimate for growth in average loan sizes, but the larger standard errors result in these estimates not being statistically significant. In all cases, we do not statistically reject the null hypothesis that the OLS and IV results are the same.

On the whole, we find general confirmation of the OLS findings with these IV estimates, which help with particular concerns about the endogenous weaving of the network towards certain districts with promising potential. The IV estimates may be signalling some placement of the GQ network towards regions that could not benefit as much in the development of loan activity. An alternative is that the local average treatment effect of straight-line IVs can emphasize the experience of non-nodal districts close to the nodal points of the straight-line segments, and the loan response there may have been higher in districts more proximate to the big cities at the end of the GQ system.

4.6 Dynamic Estimations

Table 5 illustrates the dynamics of the increased financial development along the GQ network as the upgrades took place. Panel A presents specifications for changes in log loan counts, and Panel B considers changes in log average loan size. The first column on the left considers changes from 1999 to 2001. Each subsequent column increases the time period in the long-differenced regression by two years. The far right column documents our baseline specification covering the full sample period of 1999 to 2009. These estimations continue to include industry and state fixed effects and control for initial financial development in the district.

The GQ highway upgrades officially started in 2001, having been approved in 2000, and perhaps a third of the total loan response is evident by the end of 2001. The majority of the differential loan growth along the GQ network then emerges over the next four years, with the estimations examining the 1999-2005 span looking much like those that stretch across our full 1999-2009 sample period. To recall the GQ's rollout, 23% of the work was completed by the end of 2002, 80% by the end of 2004, and 95% by the end of 2006.

We thus observe a tight coupling of the GQ rollout with this expansion with loan activity. Interestingly, the dynamics of this loan expansions also fit well with the dynamics of output expansion for the organized manufacturing sector. Ghani et al. (2016) show that most of the growth in new plant contributions happens by 2005, and Datta (2011) also shows significant changes in plant inventory and input sourcing by this point. By contrast, the cumulative impact of the GQ upgrades for total manufacturing output continues to build through 2009 in the estimations of Ghani et al. (2016). The loan activity associated with these changes happens early in the process, and we earlier also noted the connections between districts that developed new highways, boosted loan activity, and witnessed the entry of new plants.

4.7 Level of Initial Financial Development

Table 6 uses a split sample to quantify how our results differ across the initial financial development of a district. While we have controlled for this development in all prior regressions, we have yet to analyze heterogeneity in these initial conditions. We split districts that are located 0-10 km from the GQ network into two equal-sized group for being above or below the median financial development of this set of districts. By introducing separate indicator variables, we can contrast their responses. Financial development is measured by the loan credit disbursed by the district in 2000.

The powerful result that emerges from this analysis is that all of the growth in loan activity is concentrated in districts along GQ that held above average initial financial development. Districts with below average seed conditions show no expansion, and their average loan sizes might even decrease somewhat. Table 7 shows that these results hold in dynamic specifications as well.

These results have important implications. A prominent question that this GQ episode sheds light on is whether financial development must precede large infrastructure projects for the investments to impact the real economy. In many ways, this project quantifies how responsive the financial sector can be. Loan activity and support increased quickly along the GQ network, providing financing within the first year of work and expanding rapidly over the five years when the upgrades mostly occurred. Moreover, many of our measurements closely align with settings where financing is thought to be more vital (e.g., new constructions, new firm entry). The NS-EW placebo and straight-line IV analyses further confirm the special response.

Yet, these final results suggest caution towards an expansive perspective of "build it and they will come." We see no differential expansion for districts that lacked initial financial development, even over a ten-year period. The growth in loan activity is thus much more prominent on the intensive margin among places with existing financial infrastructure, with the extensive margin of financing in new districts being much more subdued.

5 Conclusions

We have investigated the empirical linkage between a large-scale transportation infrastructure project and the development of the local financial sector in India. The GQ setting is a very powerful laboratory as the massive highway upgrades came after India began collecting high-quality data on loan activity, so we can quantify relationships in ways that are impossible for advanced economies where infrastructure work began long ago. These results are also very informative for policy makers evaluating infrastructure investments in other developing or emerging economy settings. Our work emphasizes the responsiveness of the financial sector to catalyze local economic activity, but with the twist that the initial banking sector needs to be sufficiently developed.

References

[1] Aggarwal, S. (2018). 'Do Rural Roads Create Pathways out of Poverty?: Evidence from India', *Journal of Development Economics*, vol. 133, pp. 375–95.

[2] Ahluwalia, M. (2000). 'Economic Performance of States in the Post Reforms Period', *Economic and Political Weekly*, vol. 35(19), pp. 1637–48.

[3] Ahsan, A. and Pages, C. (2009). 'Are All Labor Regulations Equal? Evidence from Indian Manufacturing', *Journal of Comparative Economics*, vol. 37(1), pp. 62–75.

[4] Aschauer, D.A. (1989). 'Is Public Expenditure Productive?', *Journal of Monetary Economics*, vol. 23(2), pp. 177–200.

[5] Banerjee, A., Duflo, E. and Qian, N. (2012). 'On the Road: Access to Transportation Infrastructure and Economic Growth in China', Working Paper No. 17897, NBER.

[6] Baum-Snow, N. (2007). 'Did Highways Cause Suburbanization?', *Quarterly Journal of Economics*, vol. 122(2), pp. 775–805.

[7] Baum-Snow, N., Brandt, L., Henderson, V., Turner, M. and Zhang, Q. (2012). 'Roads, Railroads and Decentralization of Chinese Cities', Working Paper.

[8] Baum-Snow, N. and Turner, M. (2013). 'Transportation and the Decentralization of Chinese Cities', Working Paper.

[9] Bertrand, M., Schoar, A. and Thesmar, D. (2007). 'Banking Deregulation and Industry Structure: Evidence from the French Banking Reforms of 1985', *Journal of Finance*, vol. 62(2), 597-628.

[10] Besley, T. and Burgess, R. (2004). 'Can Labor Regulation Hinder Economic Performance? Evidence from India', *Quarterly Journal of Economics*, vol. 119(1), pp. 91–134.

[11] Brown, D., Fay, M., Felkner, J., Lall, S. and Wang, H. (2008). 'The Death of Distance? Economic Implications of Infrastructure Improvement in Russia', *EIB Papers*, vol. 13(2), pp. 126–47.

[12] Chandra, A. and Thompson, E. (2000). 'Does Public Infrastructure Affect Economic Activity? Evidence from the Rural Interstate Highway System', *Regional Science and Urban Economics*, vol. 30(4), pp. 457–90.

[13] Cole, S. (2009). ‘Financial Development, Bank Ownership, and Growth. Or, Does Quantity Imply Quality?’, *Review of Economics and Statistics*, vol. 91(1), pp. 33–51.

[14] Das, A., Kulkarni, N., Mishra, P. and Prabhala, N.R. (2018). ‘Anatomy of a Banking Panic’, Robert H. Smith School of Business Working Paper.

[15] Das, A., Mishra, P. and Prabhala, N.R. (2016). ‘The Transmission of Monetary Policy Within Banks: Evidence from India’, CAFRAL Working Paper.

[16] Datta, S. (2011). ‘The Impact of Improved Highways on Indian Firms’, *Journal of Development Economics*, vol. 99(1), pp. 46–57.

[17] Desmet, K., Ghani, E., O’Connell, S. and Rossi-Hansberg, E. (2012). ‘The Spatial Development of India’, Policy Research Paper No. 6060, World Bank.

[18] Dinkelman, T. (2011). ‘The Effects of Rural Electrification on Employment: New Evidence from South Africa’, *American Economic Review*, vol. 101(7), pp. 3078–108.

[19] Donaldson, D. (2018). ‘Railroads of the Raj: Estimating the Impact of Transportation Infrastructure’, *American Economic Review*, vol. 108(4–5), pp. 899–934.

[20] Donaldson, D. and Hornbeck, R. (2016). ‘Railroads and American Economic Growth: New Data and Theory’, *Quarterly Journal of Economics*, vol. 131(2), pp. 799–858.

[21] Duflo, E. and Pande, R. (2007). ‘Dams’, *Quarterly Journal of Economics*, vol. 122(2), pp. 601–46.

[22] Duranton, G., Morrow, P. and Turner, M. (2014). ‘Roads and Trade: Evidence from the US’, *Review of Economic Studies*, vol. 81(2), pp. 681-724.

[23] Duranton, G. and Puga, D. (2001). ‘Nursery Cities: Urban Diversity, Process Innovation, and the Life Cycle of Products’, *American Economic Review*, vol. 91(5), pp. 1454–77.

[24] Duranton, G. and Puga, D. (2004). ‘Micro-Foundations of Urban Agglomeration Economies’, in (V. Henderson and J.F. Thisse, eds.), *Handbook of Regional and Urban Economics*, Volume 4, pp. 2063–117, Amsterdam: North-Holland.

[25] Duranton, G. and Turner, M. (2011). ‘The Fundamental Law of Road Congestion: Evidence from US Cities’, *American Economic Review*, vol. 101(6), pp. 2616–52.

[26] Duranton, G. and Turner, M. (2012). 'Urban Growth and Transportation', *Review of Economic Studies*, vol. 79, pp. 1407–40.

[27] Ellison, G., Glaeser, E. and Kerr, W. (2010). 'What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns', *American Economic Review*, vol. 100(3), pp. 1195–213.

[28] Faber, B. (2014). 'Trade Integration, Market Size, and Industrialization: Evidence from China's National Trunk Highway System', *Review of Economic Studies*, vol. 81(3), pp. 1046–70.

[29] Fernald, J.G. (1998). 'Roads to Prosperity? Assessing the Link between Public Capital and Productivity', *American Economic Review*, vol. 89(3), pp. 619–38.

[30] Fernandes, A. and Pakes, A. (2008). 'Factor Utilization in Indian Manufacturing: A Look at the World Bank Investment Climate Survey Data', Working Paper No. 14178, NBER.

[31] Foster, L., Haltiwanger, J. and Syverson, C. (2008). 'Reallocation, Firm Turnover and Efficiency: Selection on Productivity or Profitability?', *American Economic Review*, vol. 98, pp. 394–425.

[32] Fretz, S. and Gorgas, C. (2013). 'Regional Economic Effects of Transport Infrastructure Expansions: Evidence from the Swiss Highway Network', Working Paper.

[33] Ghani, E., Goswami, A. and Kerr, W. (2012). 'Is India's Manufacturing Sector Moving Away from Cities?, Working Paper No. 17992, NBER.

[34] Ghani, E., Goswami, A. and Kerr, W. (2016). 'Highway to Success: The Impact of the Golden Quadrilateral Project for the Location and Performance of Indian Manufacturing', *Economic Journal (Royal Economic Society)*, vol. 126(591), pp. 317–357.

[35] Ghani, E., Goswami, A. and Kerr, W. (2017). 'Highways and Spatial Location within Cities: Evidence from India', *World Bank Economic Review*, vol. 30(Suppl. 1), pp. S97–S108.

[36] Glaeser, E., Kerr, S. and Kerr, W. (2015). 'Entrepreneurship and Urban Growth: An Empirical Assessment with Historical Mines', *Review of Economics and Statistics*, vol. 97(2), pp. 498–520.

[37] Ghani, E., Kerr, W. and O'Connell, S. (2014). 'Spatial Determinants of Entrepreneurship in India', *Regional Studies*, vol. 48(6), pp. 1071-89.

[38] Gill, I. and Goh, C.-C. (2012). 'Scale Economies and Cities', *World Bank Research Observer*, vol. 25(2), pp. 235–62.

[39] Gupta, P., Hasan, R. and Kumar, U. (2008). 'What Constrains Indian Manufacturing?', Working Paper No. 211, ICRIER.

[40] Gupta, P. and Kumar, U. (2010). 'Performance of Indian Manufacturing in the Post Reform Period', Working Paper.

[41] Hasan, R. and Jandoc, K. (2010). 'The Distribution of Firm Size in India: What Can Survey Data Tell Us?', Working Paper No. 213, ADB Economics.

[42] Henderson, V. (2010). 'Cities and Development', *Journal of Regional Science*, vol. 50(1), pp. 515–40.

[43] Henderson, V., Lee, T., and Lee, Y.J. (2001). 'Scale Externalities in Korea', *Journal of Urban Economics*, vol. 49(3), pp. 479–504.

[44] Holl, A. (2013). 'Highways and Productivity in Urban and Rural Locations', Working Paper, Universitat de Barcelona-Institut d'Economia de Barcelona.

[45] Holl, A. and Viladecans-Marsal, E. (2011). 'Infrastructure and Cities: The Impact of New Highways on Urban Growth', Working Paper, Universitat de Barcelona-Institut d'Economia de Barcelona.

[46] Hsieh, C. and Klenow, P. (2009). 'Misallocation and Manufacturing TFP in China and India', *Quarterly Journal of Economics*, vol. 124(4), pp. 1403–48.

[47] Hsieh, C. and Klenow, P. (2014). 'The Life Cycle of Plants in India and Mexico', *Quarterly Journal of Economics*, vol. 129(3), pp. 1035–84.

[48] Hsu, W.-T. and Zhang, H. (2014). 'The Fundamental Law of Highway Congestion: Evidence from Japanese Expressways', *Journal of Urban Economics*, vol. 81, pp. 65–76.

[49] Jayaratne, J. and Strahan, P.E. (1996). 'The Finance-Growth Nexus: Evidence from Bank Branch Deregulation', *Quarterly Journal of Economics*.

[50] Kathuria, V., Natarajan, S., Raj, R. and Sen, K. (2010). 'Organized versus Unorganized Manufacturing Performance in India in the Post-Reform Period', Working Paper No. 20317, MPRA.

[51] Khanna, G. (2014). 'The Road Oft Taken: Highways to Spatial Development', Unpublished mimeo.

[52] King, R.G., and Levine, R. (1993a). 'Finance and Growth: Schumpeter Might be Right', *Quarterly Journal of Economics*, vol. 108(3), pp. 717–37.

[53] King, R.G., and Levine, R. (1993b). 'Finance, Entrepreneurship, and Growth: Theory and Evidence', *Journal of Monetary Economics*, vol. 32(3), pp. 513–42.

[54] Kochhar, K., Kumar, U., Rajan, R., Subramanian, A. and Tokatlidis, I. (2006). 'India's Pattern of Development: What Happened, What Follows?', Working Paper No. 06/22, IMF.

[55] Kortum, S. and Lerner, J. (2000). 'Assessing The Contribution Of Venture Capital To Innovation', *RAND Journal of Economics*, vol. 31(4), pp. 674–92.

[56] Kumar, N. (2016). 'Politics and Real Firm Activity: Evidence from Distortions in Bank Lending in India', University of Chicago Working Paper.

[57] Lahr, M., Duran, R. and Varughese, A. (2005). 'Estimating the Impact of Highways on Average Travel Velocities and Market Size', Unpublished mimeo.

[58] Levine, R. (1997). 'Financial Development and Economic Growth: Views and Agenda', *Journal of Economic Literature*, vol. 35, issue 2, 688-726.

[59] McKinsey Global Institute. (2010). 'India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth', McKinsey & Company Report.

[60] McKinsey Global Institute. (2012). 'The Shifting Urban Economic Landscape: What Does it Mean for Cities?', McKinsey & Company Report.

[61] Michaels, G. (2008). 'The Effect of Trade on the Demand for Skill: Evidence from the Interstate Highway System', *Review of Economics and Statistics*, vol. 90(4), pp. 683–701.

[62] Mitra, A., Varoudakis, A. and Véganzonès, M. (1998). 'State Infrastructure and Productive Performance in Indian Manufacturing', Working Paper No. 139, OECD.

[63] Munell, A. (1990). 'Why has Productivity Growth Declined? Productivity and Public Investment', *New England Economic Review*, January/February: 3–22.

[64] Nanda, R. and Nicholas, T. (2014). 'Did Bank Distress Stifle Innovation During the Great Depression?', *Journal of Financial Economics*, vol. 114(2), pp. 273–92.

[65] Nataraj, S. (2011). 'The Impact of Trade Liberalization on Productivity: Evidence from India's Formal and Informal Manufacturing Sectors', *Journal of International Economics*, vol. 85(2), pp. 292–301.

[66] Otto, G. and Voss, G. (1994). 'Public Capital and Private Sector Productivity', *The Economic Record*, vol. 70(209), pp. 121–32.

[67] Qin, Y. (2017). 'No County Left Behind? The Distributional Impact of High-Speed Rail Upgrade in China', *Journal of Economic Geography*, vol 17(3), pp. 489–520.

[68] Rajan, R. and Zingales, L. (1998). 'Financial Dependence and Growth', *American Economic Review*, vol. 88(3), pp. 559–86.

[69] Roberts, M., Deichmann, U., Fingleton, B. and Shi, T. (2012). 'Evaluating China's Road to Prosperity: A New Economic Geography Approach', *Regional Science and Urban Economics*, vol. 42(4), pp. 580–94.

[70] Rosenthal, S. and Strange, W. (2004). 'Evidence on the Nature and Sources of Agglomeration Economies', in (V. Henderson and J. F. Thisse, eds.), *Handbook of Regional and Urban Economics*, Volume 4, pp. 2119–71, Amsterdam: North-Holland.

[71] Subramanian, A. (2012a). 'The Ideas India Must Shed'. June 4th, 2012.

[72] Subramanian, A. (2012b). 'What is India's Real Growth Potential'. May 23, 2012.

[73] *The Economic Times*. (2012). 'Highway Development Requires Rs 200 cr Investment Every Day'. April 29, 2012.

[74] Ulimwengu, J., Funes, J., Headey, D. and You, L. (2009). 'Paving the Way for Development? The Impact of Transport Infrastructure on Agricultural Production and Poverty Reduction in the Democratic Republic of Congo', Discussion Paper No. 00944, IFPRI.

[75] World Bank. (2012). 'Planning, Connecting, and Financing Cities—Now'. Urbanization Review Flagship Report, The World Bank, Washington DC.

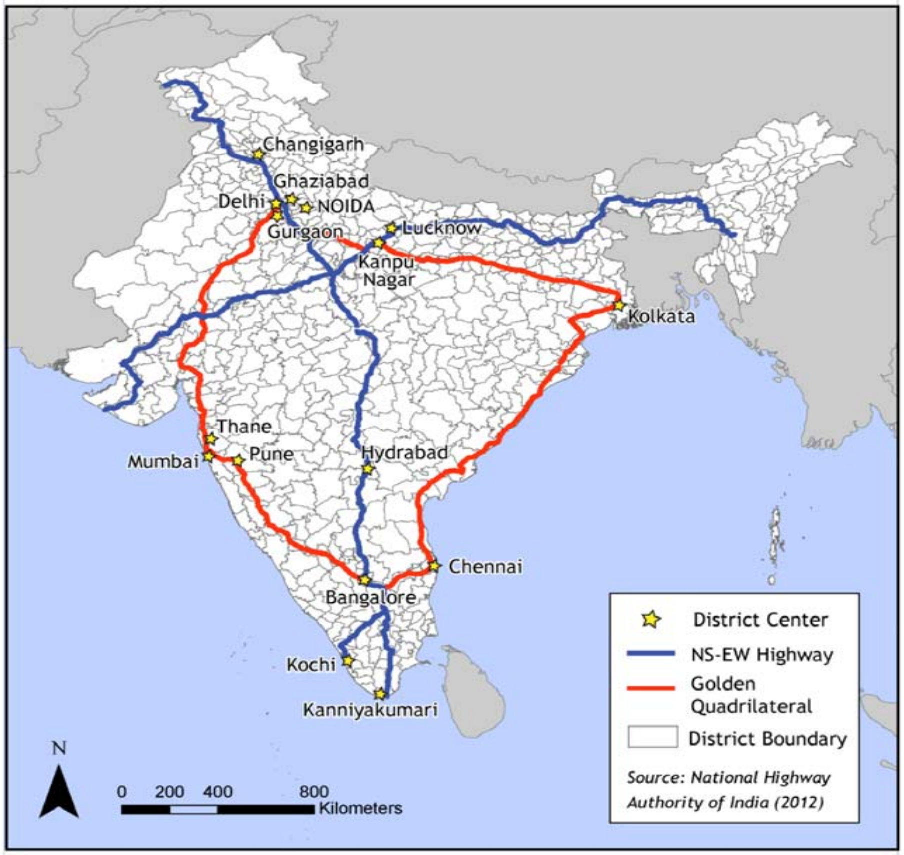
[76] World Development Report. (2009). Reshaping Economic Geography, The World Bank, Washington DC.

[77] World Road Statistics. (2009). World Road Statistics 2009: Data 2002-2007. International Road Federation, Geneva.

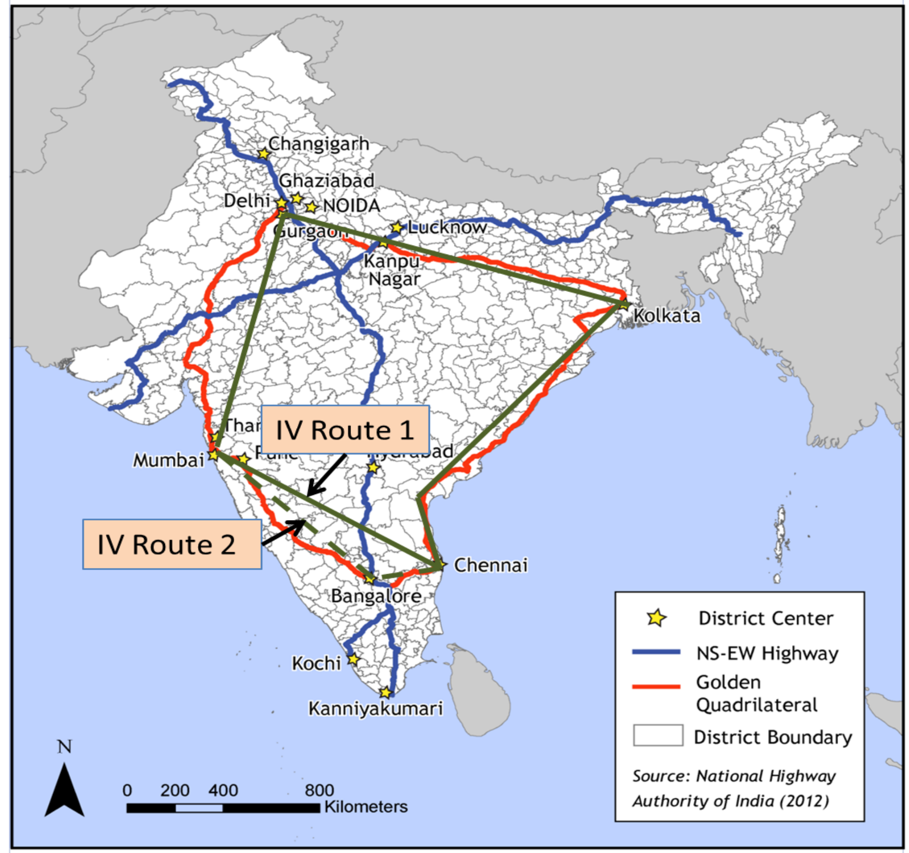
[78] Xu, H. and Nakajima, K. (2017). 'Highways and Development in the Peripheral Regions of China', *Papers in Regional Science* vol. 96(2), pp. 325–56.

Figure 1: Map of the Golden Quadrangle and North-South East-West Highway systems in India

A. Highway route structure



B. Overlay of straight-line IV strategy



Notes: Panel A plots the Golden Quadrangle and North-South East-West Highway systems. Panel B plots the instrumental variables route formed through the straight-line connection of the GQ network's nodal cities: Delhi, Mumbai, Kolkata, and Chennai. IV Route 2 also considers Bangalore as a fifth nodal city.

Table 1: Impact of GQ on Financial Development

This table reports the results of long-differenced estimations between 1999 and 2009. The dependent variable for Columns 1 and 2 is the log change in loan credit for a district-industry over the 10-year period; the dependent variable in Columns 3 and 4 is the log change in average loan size. The table reports changes in these values for three sets of districts (i) Nodal districts that the GQ highway network connects; (ii) Non-nodal districts that are 0-10 kilometers from the GQ highway network; and (iii) Non-nodal districts that are 10-50 kilometers from the GQ network. These coefficients are measured relative to districts more than 50 kilometers from the GQ network. Regressions include controls for baseline level of financial development and industry fixed effects, which is equivalent to including industry-x-year fixed effects in a panel regression. Regressions in Columns 2 and 4 include both state and industry fixed effects, which is equivalent to including state-x-year and industry-x-year fixed effects in a panel regression. Standard errors are clustered by district and reported below coefficients; +, ++, and +++ refer to statistical significance at the 10%, 5%, and 1% levels, respectively.

	Change in log loan count		Change in log average loan size	
	(1)	(2)	(3)	(4)
Nodal districts	0.988***	0.956***	1.429***	1.407***
	(0.161)	(0.191)	(0.149)	(0.165)
Districts 0-10 km from GQ highway	0.237***	0.204***	0.150**	0.177**
	(0.057)	(0.062)	(0.067)	(0.070)
Districts 10-50 km from GQ highway	-0.001	0.054	-0.147*	-0.101
	(0.072)	(0.070)	(0.083)	(0.076)
Industry Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes

Table 2: Impact of GQ on Financial Development - New Construction vs. Upgrades

See Table 1. This table reports results separating GQ work into new construction vs. upgrades of existing segments.

	Change in log loan count		Change in log average loan size	
	(1)	(2)	(3)	(4)
Nodal districts	1.001***	0.965***	1.441***	1.409***
	(0.161)	(0.192)	(0.150)	(0.165)
Districts 0-10 km from GQ highway	0.344***	0.356***	0.331***	0.299***
* New Construction	(0.069)	(0.078)	(0.098)	(0.102)
Districts 0-10 km from GQ highway	0.141*	0.077	-0.015	0.072
* Upgrades	(0.077)	(0.074)	(0.072)	(0.077)
Districts 10-50 km from GQ highway	-0.002	0.060	-0.147*	-0.097
	(0.073)	(0.071)	(0.084)	(0.076)
P Value for difference between construction - upgrades	0.029	0.002	0.002	0.049
Industry Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes

Table 3: Placebo with NS-EW Highway

See Table 1. This table contrasts distance from the GQ highway network with distance from the NS-EW highway network that was planned for partial upgrade at the same time as the GQ project but was then delayed. Coefficients are measured relative to districts more than 50 kilometers from both highway systems.

	Change in log loan count		Change in log average loan size	
	(1)	(2)	(3)	(4)
Nodal GQ districts	0.748***	0.747***	1.042***	1.117***
	(0.178)	(0.225)	(0.247)	(0.272)
Districts 0-10 km from GQ highway	0.237***	0.190***	0.150**	0.159**
	(0.057)	(0.061)	(0.063)	(0.067)
Districts 10-50 km from GQ highway	0.008	0.060	-0.132	-0.095
	(0.073)	(0.070)	(0.084)	(0.076)
Nodal NS-EW districts	0.467***	0.380	0.742***	0.534
	(0.160)	(0.231)	(0.281)	(0.370)
Districts 0-10 km from NS-EW highway	0.018	-0.022	0.029	-0.039
	(0.058)	(0.054)	(0.063)	(0.061)
Districts 10-50 km from NS-EW highway	-0.039	-0.125**	-0.060	-0.128**
	(0.066)	(0.057)	(0.062)	(0.058)
Industry Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes

Table 4: IV Estimates using Straight-Lines between District Nodes

See Table 1. Panel A modifies the base OLS estimation to exclude nodal districts and measure effects relative to districts 10+ km from the GQ network. Panel B reports IV estimations that instrument being within 10 km from the GQ network with being within 10 km of the straight line between nodal districts. Route 1 does not connect Bangalore directly, with the first-stage elasticity of 0.43 (0.05) and the associated F-statistic of 74.5. Route 2 treats Bangalore as a connection point, with the first-stage elasticity of 0.54 (0.05) and the associated F-statistic of 138.1. The null hypothesis in the exogeneity tests is that the instrumented regressor is exogenous.

	Change in log loan count	Change in log average loan size
	(1)	(2)
PANEL A: OLS ESTIMATES		
District 0-10 km from GQ highway	0.188***	0.204***
	(0.060)	(0.068)
PANEL B: IV ESTIMATES		
District 0-10 km from line ROUTE 1	0.224*	0.174
	(0.131)	(0.150)
Exogeneity test p value	0.767	0.825
District 0-10 km from line ROUTE 2	0.277***	0.183
	(0.101)	(0.119)
Exogeneity test p value	0.319	0.831
Industry Fixed Effects	Yes	Yes
State Fixed Effects	Yes	Yes

Table 5: Dynamics

See Table 1. Column headers indicate the span of time considered in dynamic long-differenced estimations.

PANEL A: CHANGE IN LOG LOAN COUNT					
	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
Nodal districts	0.450***	0.842***	0.916***	0.978***	0.956***
	(0.144)	(0.144)	(0.148)	(0.183)	(0.191)
Districts 0-10 km from GQ highway	0.075***	0.170***	0.192***	0.212***	0.204***
	(0.025)	(0.048)	(0.052)	(0.056)	(0.062)
Districts 10-50 km from GQ highway	0.024	0.071	0.069	0.077	0.054
	(0.031)	(0.046)	(0.055)	(0.059)	(0.070)
PANEL B: CHANGE IN LOG AVERAGE LOAN SIZE					
	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
Nodal districts	0.537***	1.064***	1.174***	1.316***	1.407***
	(0.140)	(0.192)	(0.177)	(0.184)	(0.165)
Districts 0-10 km from GQ highway	0.119***	0.172***	0.203***	0.201***	0.177**
	(0.037)	(0.053)	(0.060)	(0.063)	(0.070)
Districts 10-50 km from GQ highway	-0.025	0.038	0.020	-0.030	-0.101
	(0.041)	(0.055)	(0.059)	(0.061)	(0.076)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes

Table 6: Level of Initial Financial Development

See Table 1. This table reports results separating districts into above and below median financial development before the start of the GQ upgrades.

	Change in log loan count		Change in log average loan size	
	(1)	(2)	(3)	(4)
Nodal districts	1.040***	1.002***	1.463***	1.425***
	(0.163)	(0.194)	(0.151)	(0.168)
Districts 0-10 km from GQ highway	0.407***	0.398***	0.351***	0.361***
* above median financial development pre	(0.064)	(0.068)	(0.077)	(0.084)
Districts 0-10 km from GQ highway	-0.040	-0.091	-0.188**	-0.120*
* below median financial development pre	(0.079)	(0.075)	(0.080)	(0.071)
Districts 10-50 km from GQ highway	-0.003	0.056	-0.148*	-0.102
	(0.074)	(0.072)	(0.085)	(0.076)
Industry Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes

Table 7: Dynamics of Financial Development

See Table 1. Column headers indicate the span of time considered in dynamic long-differenced estimations.

	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
PANEL A: CHANGE IN LOG LOAN COUNT					
Nodal districts	0.466***	0.887***	0.960***	1.025***	1.002***
	(0.143)	(0.146)	(0.152)	(0.186)	(0.194)
Districts 0-10 km from GQ highway	0.146***	0.363***	0.383***	0.410***	0.398***
* above median financial development pre	(0.029)	(0.052)	(0.058)	(0.062)	(0.068)
Districts 0-10 km from GQ highway	-0.033	-0.123**	-0.097*	-0.088	-0.091
* below median financial development pre	(0.031)	(0.051)	(0.055)	(0.062)	(0.075)
Districts 10-50 km from GQ highway	0.024	0.072	0.070	0.078	0.056
	(0.032)	(0.048)	(0.057)	(0.062)	(0.072)
PANEL B: CHANGE IN LOG AVERAGE LOAN SIZE					
	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
Nodal districts	0.547***	1.079***	1.192***	1.334***	1.425***
	(0.142)	(0.198)	(0.182)	(0.189)	(0.168)
Districts 0-10 km from GQ highway	0.220***	0.324***	0.388***	0.376***	0.361***
* above median financial development pre	(0.040)	(0.061)	(0.070)	(0.075)	(0.084)
Districts 0-10 km from GQ highway	-0.043	-0.074	-0.096*	-0.081	-0.120*
* below median financial development pre	(0.046)	(0.053)	(0.052)	(0.063)	(0.071)
Districts 10-50 km from GQ highway	-0.026	0.038	0.019	-0.031	-0.102
	(0.041)	(0.056)	(0.059)	(0.062)	(0.076)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes