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INFRASTRUCTURE AND FINANCE:
EVIDENCE FROM INDIA'S GQ HIGHWAY NETWORK

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ABSTRACT

We use data from Reserve Bank of India to study the impact of India's Golden Quadrilateral (GQ) highway project on finance-dependent activity. Loan volumes increase by 20-30% in districts along GQ and are stronger in industries more dependent upon external finance. Loan growth begins with increases in average branch size and in places with more pre-GQ loan activity. New branch openings come later, consistent with short-run adjustment costs to expanding branch networks. These patterns are not evident in placebo tests using delayed investments in NS-EW highways. Results suggest the depth of initial financial infrastructure shapes how infrastructure investments impact localities.

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1 Introduction

Infrastructure spending is a key lever to promote economic growth. In addition to its role in stimulating demand, an important policy question is whether major infrastructure investments can reduce disparities in economic activity across regions by also unlocking complementary inputs, such as the greater availability of financial capital. Despite a rich literature examining the economic consequences of large-scale road construction (e.g., Chandra and Thompson, 2000; Duranton and Turner, 2011), the role of financial intermediaries in funding new activity remains underexplored.

We study this question using India's Golden Quadrilateral (GQ) highway investment as a natural experiment, examining the spatial development of bank lending at the district-industry level. The GQ network connects Delhi, Mumbai, Chennai, and Kolkata and is the fifth-longest highway in the world. Conceived in 1999, GQ upgrades began in 2001, with a target completion date of 2004, and 95% of the work was completed by the end of 2006. Prior studies show significant impact of GQ on the placement and operation of organized formal-sector manufacturing firms, trade flows, and deforestation, with weaker consequences for the informal sector and aggregate nighttime lights.

We contribute to this growing literature by using comprehensive data on bank lending drawn from the Reserve Bank of India (RBI). This database details each outstanding loan above a threshold of approximately $4,000, reported annually by every branch of all scheduled commercial banks in India. While limited to finance-dependent economic activity, RBI data have the unique advantage of enabling the study of economic activity at narrowly defined geographic and industry levels beyond manufacturing. The mandatory reporting across all private sectors of the economy makes lending among the most comprehensive metrics available, while maintaining industry differences not feasible with nighttime lights. While some businesses do not need loans, banking inputs are usually important for the bigger economic endeavors that policy makers seek to encourage with infrastructure projects. For example, about 85% of organized manufacturing firms in India report having a bank loan.

Beyond this comprehensive aspect of the RBI data, the availability of financing is often thought to also shape the rate, direction, and location of real economic activity (e.g., King and Levine, 1993a,b; Levine, 1997). This makes it important to also understand how finance adjusts to infrastructure investment. On one hand, finance follows real activity because infrastructure spending can enable business activity that leads to greater loan demand. New branches might also enable funding of investment opportunities through increased lending capacity. However, there are also reasons to believe that the supply of bank credit is not perfectly elastic, at least in the short run (e.g., von Lilenfeld-Toal et al., 2012). Given the importance of local knowledge and expertise to effectively screen loan applicants in the face of asymmetric information, banks would need, for example, to employ more loan officers, particularly in new regions, invest in new bank branch infrastructure, and potentially reorganize their operations as their client base changes. This takes time and can entail significant adjustment costs. How banks and their branch networks adjust to infrastructure investment therefore has the potential to impact the location, magnitude, and timing of economic activity stimulated. Our analysis of loan activity and bank branch expansions speaks to this question.

Our main estimates quantify loan development along the GQ network using econometric models comparable to prior studies. These models measure the net change in total loan activity, inclusive of supply and demand forces. This work contributes to the GQ literature through its universal data and cross-industry comparisons. We find stronger loan growth in districts adjacent to the GQ network compared to those further away, driven largely by an increase in the number of bank loans rather than larger loan sizes. Impacts are strongest in districts where there was new construction (as opposed to upgrades), and dynamic specifications suggest the effect took hold quickly after the upgrades commenced. Moreover, our results hold in IV estimates and are not present in a placebo test using planned, but subsequently delayed, upgrades to the North-South and East-West (NS-EW) highway system. Interaction estimations show that GQ's impact was largest in industries more dependent on external finance.

These results speak to an increase in finance-dependent economic activity arising from improved transportation infrastructure. Indeed, the dynamics of loan data around the reform lend new support for how one interprets the causal nature of prior GQ studies. In terms of magnitude, the growth of bank loans is less than some of the outcomes measured among large manufacturers due to GQ, but loan growth exceeds the impact seen with nighttime lights and the informal sector.

The final analyses of the paper attempt to make headway on how bank branch networks evolved across the GQ network, and the degree to which an inelastic potential supply of capital in the short run may have shaped the economic activity unlocked from GQ's infrastructure investment. We are limited in how much we can disentangle demand and supply because the natural experiment of GQ's construction is not coupled with a second natural experiment regarding the banking sector. Thus, while we are confident in claiming GQ leads causally to a growth in loan activity along the highway system, our results on the potential inelastic supply of capital shaping activity become more speculative.

We use the term 'supply' to capture GQ leading to an increase in lending capacity. This increase could come from the extensive margin (in terms of new branch openings) or the intensive margin (in terms of expansion at existing bank branches). Examining RBI data on bank branch counts and branch entry, we observe that the most significant growth in loans along GQ happens before a material growth in new bank branches. Moreover, GQ's impact was largest in areas with higher levels of pre-GQ lending per capita. Together, these results suggest that the supply of capital through new bank branches played a weaker role in the surge of loan activity, consistent with larger adjustment costs in setting up new branches compared to expanding capacity at existing banks.

Our results suggest that financing capacity and infrastructure development are complements in enabling economic activity. In areas with pre-existing bank activity, GQ infrastructure investment unlocked business activity faster, including activity that is more dependent on external finance. By contrast, there is less evidence for the road construction leading to loan demand being met by new bank branches. This could be, for example, because it is easier for banks to scale up on the intensive margin where they already had a presence, as opposed to having to grow at the extensive margin. While suggestive, these results highlight that adjustment costs can lead to differential elasticity of capital supply in response to improved infrastructure investment, shaping which industries and locations economic activity is most likely to enable.

Our study contributes to the literature on the economic impacts of infrastructure projects in developing economies. Studies of GQ upgrades document its importance for the operations and growth of organized manufacturing activity (Datta, 2011; Ghani et al., 2016, 2017; Chatterjee et al., 2021), with resulting stronger allocative efficiency for industries positioned on the network. Alder (2016), Khanna (2016), and Chanda and Kabiraj (2020) examine growth in nighttime luminosity due to GQ upgrades, and Allen and Atkin (2022), Asturias et al. (2019), and Abeberese and Chen (2022) quantify the intra-national trade implications. Naaraayanan and Wolfenzon (2023) examine differential impacts on business groups and stand alone firms, and we describe additional studies later.[1] Beyond India, recent studies find mixed evidence regarding economic effects for non-targeted locations due to transportation infrastructure in China or other developing economies.[2] These studies complement the larger literature on the United States and those undertaken in historical settings.[3] Our study is the first to consider in depth how these massive investments interact with the pre-existing financial conditions and the subsequent local development of loans.

Similar to Agrawal et al. (2023), we also contribute to the finance literature. Prior research documents the impact of local financial development[4] and explores firm dynamics (e.g., Robb and Robinson, 2014; Krishnan et al., 2015; Ayyagari et al., 2017; Akcigit et al., 2022). While these studies establish the causal link between the financial sector and the real economy, our study explores how initial financial conditions shape the impact of exogenous infrastructure spending.

2 India's Highways and the GQ Project

To meet its transportation needs, India launched its National Highways Development Project (NHDP) in 2001.[5] This project, the largest highway project ever undertaken by

[1] A broader literature also evaluates the performance of Indian manufacturing, with some authors noting the constraints of inadequate infrastructure (e.g., Mitra et al., 1998; Ahluwalia, 2000; Besley and Burgess, 2004; Kochhar et al., 2006; Gupta et al., 2008; Gupta and Kumar, 2010; Bloom et al., 2013; Desmet et al., 2015). See also Agarwal et al. (2022).

[2] For example, Brown et al. (2008), Ulimwengu et al. (2009), Roberts et al. (2012), Faber (2014), Baum-Snow et al. (2017), Baum-Snow and Turner (2017, 2020), Xu and Nakajima (2017), Qin (2017), Aggarwal (2018), Chauvin (2019), and Banerjee et al. (2020). 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).

[3] For example, Fernald (1998), Chandra and Thompson (2000), Lahr et al. (2005), Baum-Snow (2007), Michaels (2008), Duranton and Turner (2012), Fretz and Gorgas (2013), Hsu and Zhang (2014), Duranton et al. (2014), Garcia-Lopez et al. (2015), Donaldson and Hornbeck (2016), Holl (2016), Agrawal et al. (2017), Couture et al. (2018), and Donaldson (2018). Redding and Turner (2015) provide a broader review of transportation investments, and Rosenthal and Strange (2004) review agglomeration economies.

[4] For example, Jayaratne and Strahan (1996), Rajan and Zingales (1998), Black and Strahan (2002), Hasan and Marton (2003), Guiso et al., (2004), Burgess and Pande (2005), Paravisini (2008), Hasan et al. (2009), Nguyen (2019), and Greenstone et al. (2020).

[5] This section draws from Ghani et al. (2016).

India, aimed at improving the GQ network, the North-South and East-West (NS-EW) Corridors, Port Connectivity, and other projects. The NHDP evolved to include seven phases, and we focus on the first two. 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 GQ and NS-EW.

The GQ network connects Delhi, Mumbai, Chennai, and Kolkata. Appendix Figure 1 contains a map. The GQ upgrades began in 2001, with a target completion date of 2004, and 128 separate contracts were awarded. In total, 23% of the work was completed by the end of 2002, 80% by 2004, 95% by 2006, and 98% by 2009. Differences in completion were due to initial delays in awarding contracts, land acquisition and zoning challenges, and funding delays.

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

3 Data

We study how GQ impacted the financing of economic activity and how this varied by industry and the initial financial development of districts. To do so, we build a dataset based upon the Basic Statistical Return (BSR)1A, maintained by the Reserve Bank of India (RBI). BSR-1A details each loan outstanding (above a threshold), reported annually by every branch of every scheduled commercial bank in India. The data count each bank-borrower relationship separately. The threshold over which individual account data is reported was Rs. 25,000 until 1998 and Rs. 200,000 from 1999 onwards (the latter is about $4,000 using historical exchange rates). The universal, comprehensive nature of these financial data exceed most countries, including the United States, and features in research by Cole (2009), Das et al. (2016), Kumar (2016), and Das et al. (2018).

While the micro-data are confidential, the RBI allowed us to aggregate these data for external use. Our aggregations focus on borrowing by private non-financial corporations, sole proprietorships, and partnerships at the district x industry x year level. Districts are administrative subdivisions of Indian states or union territories. We prepare our platform to resemble studies of manufacturing for comparability.[6] Accordingly, the core sample contains 311 districts that account for over 80% of the population and 90% of manufacturing. Excluded districts have limited economic activity. Districts in our analysis average around 2.7 million in population with a land area of 10.1k km squared.[7]

Industry categories are two-digit NIC for manufacturing and one-digit for all other industry groups. Our analyses concentrate on 1999 to 2009 when almost all of the work was completed along the GQ highway and only a minority of work was completed on the NS-EW highway.

Through the RBI, we also obtained data on the opening and closures of bank branches by district via the Master Office File. The data include more than 151k branch openings, many of which predate 1999, and 5.8k branch closures. We match about 85% of the branch data to our focal districts and create an estimate of operating branches by district and year. The average district in our sample has 123 operating branches and 6.8 annual openings during 1999-2009.

[6] See Fernandes and Pakes (2008), Hsieh and Klenow (2009, 2014), Hasan and Jandoc (2010), Kathuria et al. (2010), Nataraj (2011), and Ghani et al. (2014, 2016).

[7] In the 2011 Census, India's 640 districts held an average population of 1.9m and land area of 4.9k km squared, about 19x and 1.8x the population and land area of a US county, respectively. The districts in our sample are larger. The 35 states of India average 6x and 0.57x the average population and land area of US states, respectively.

4 Analysis of Net Loan Activity

4.1 Baseline Estimations

We use long-differenced estimations, typical of studies where treatment is not a sharp event, and 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 upgrades were completed by 2009. Indexing districts with d and industries with i,

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

$\Delta Y_{d,i}$ is the change in the log loan volume in a district-industry from 1999 to 2009. We also decompose this change into the changes in the number of loans versus average loan size.

Our explanatory variables in the set D of distance bands comprise three bands with respect to GQ: a nodal district (9 districts), 0-10 km from GQ (69 districts), and 10-50 km from GQ (37 districts). Following Datta (2011), the 9 nodal districts include contiguous suburbs of Delhi, Mumbai, Chennai, and Kolkata placed on GQ by design. The excluded category includes 196 districts more than 50 km from the GQ network. The β_j coefficients thus measure the average change in outcome $Y_{d,i}$ for each distance band relative to the reference category. Our focus is on the non-nodal districts. We measure and report effects for nodal districts, but their interpretation is difficult as the highway projects were intended to improve their connectivity. The appendix describes the data further.

All estimations control for industry fixed effects η_i, which is equivalent to including industry-year fixed effects in a panel regression. These fixed effects control for different growth rates of industries that might be spatially correlated with distance to highways. Regressions further control for the baseline level of financial development of each district to flexibly capture economic convergence across districts. Observations are weighted by log district population in 2000.

Table 1 reports results with specification (1). Columns 1-4 consider the change in log loan volume for a district-industry over the 10-year period. Columns 5 and 6 separate out this overall change into the parts coming from the change in log number of loans and the change in log of the average loan size. Column 2 introduces state-industry fixed effects, which are equivalent to including state-industry-year fixed effects in a panel regression. Column 2 therefore controls for time-varying unobserved differences in state-industry cells such as state policies (in general or towards certain industries), business cycles and growth, and so forth that might be correlated with proximity to the GQ. Identification in these estimations comes solely from within-state-industry variation in the proximity of districts to GQ highways.

While we cannot include district fixed effects, Column 3 includes quartiles of district-level factors that might contribute to different growth rates and could be unevenly distributed spatially. These controls include district population, percentage of population in urban areas, shortest distance to a state or national highway, shortest distance to a railroad, a composite index of local infrastructure quality, and the share of households with bank accounts. Finally, our most stringent specifications in Columns 4-6 include all fixed effects together.

Panel A analyzes 9050 district-industries with loan activity in both 1999 and 2009. Looking across Table 1, the first row shows enormous increases in loan activity for nodal districts after GQ implementation. We do not emphasize these results as the upgrades were done with the explicit goal of improving the connectivity of nodal cities. The higher standard errors of these estimates, compared to the rows beneath them, reflect that there are only nine nodal districts. Yet, these changes in financing activity are substantial enough in size that one can reject statistically that the growth is zero.

Our primary emphasis is on the second row that considers non-nodal districts 0-10 km from GQ. To some degree, the upgrades of the GQ network are exogenous for these districts. Column 4 suggests a 20% increase in aggregate loan volume for these districts relative to districts more than 50 km from the GQ system over the 10-year period. Columns 5 and 6 show that this is mostly driven by increases in loan counts rather than changes in loan size. For comparison, the third row provides the results for districts that are 10-50 km from the GQ network. None of the effects that we measure for districts within 0-10 km of GQ are present in this next distance band.

We further report the linear difference between districts that are 0-10 versus 10-50 km from the GQ network. These differences are also sizable in economic magnitude, although we cannot reject at a 10% level that the patterns are the same in our most stringent specification in Column 4 (p-value = 0.106).

In Panel B, we examine the robustness of our focus on district-industries with positive loan volume. We now include 12,403 district-industries, recoding zero loan volume to 0.1 to enable the log transformation. We further winsorize changes in the dependent variable at their 0.1% and 99.9% levels. These estimates are even stronger, implying a nearly 30% increase in loan volume for districts within 10 km of the GQ network relative to districts more than 50 km away.[8]

While the techniques and sample periods vary across studies, Table 1's magnitudes sit intuitively in the middle of existing estimates of GQ's impact. Our most stringent specifications estimate a relative growth in loan activity of about 22% for district-industries along the GQ highway. Studies of the formal manufacturing sector find larger effects of GQ upgrades, with for example Ghani et al. (2016) estimating an output growth for 0-10 km districts of a bit less than 50% from the GQ's start until 2009. Asher et al. (2020) describe a large loss of forest cover. Yet, Ghani et al. (2017) and Chatterjee et al. (2021) measure that the large gains for formal manufacturing firms from the GQ upgrades are not evident in the informal manufacturing sector. Studies of luminosity also find smaller effects, closer to a 5% growth.[9]

Appendix Tables 1-8 show robustness checks and extensions: for example, using alternative weighting strategies, using Conley (1999, 2008) spatial errors as implemented by Fetzer (2014), using one-digit NIC codes, using alternative spatial bands, using different controls for initial conditions, and using Poisson pseudo-maximum likelihood regressions. We additionally report dynamic specifications showing most of the loan surge for 0-10 km districts happens by 2005, which is akin to the rapid plant inventory and input sourcing impact measured by Datta (2011) or the plant entry estimations of Ghani et al. (2016). Most of the new loan activity is also in the segments that experienced new construction vs. upgrades.

[8] The RBI data capture realized loans and cannot speak to the frequency of financing use by firms. Tabulations from the Annual Survey of Industries (ASI) provide suggestive evidence. Contemporaneous to the organized manufacturing growth documented in multiple studies, the share of ASI plants in 0-10 km districts that held a loan fell slightly from 92% in 2000 to 90% in 2010. For young plants, the share with loans rose slightly from 22% to 23%. This stability in loan shares suggest the financing growth likely followed more from differences in growth rates across industries, which we find evidence of in Section 5.

[9] Alder (2016) finds GQ Highways are associated with 5.1% change in luminosity in 2000-2009, corresponding to a 1.53 percent change in income. Khanna (2016) and Chanda and Kabiraj (2020) show the decline in luminosity with distance from GQ. Melecky et al. (2018) consider other social measures.

4.2 Comparison of GQ to NS-EW Highway System

The stability of the baseline results is reassuring, but we may not observe all of the factors that policy makers used when choosing to upgrade the GQ network and designing its layout. For example, policy makers might have known about the latent growth potential of districts and attempted to aid that development through highway investment.

We address this concern by comparing districts proximate to the GQ network to districts proximate to the NS-EW network that was not upgraded. This comparison to the NS-EW corridor provides a stronger potential reference group than districts further away from GQ, 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).

We identified the segments of the NS-EW project that were to begin with the GQ upgrades versus 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 are covered in the 48 NS-EW projects identified for Phase I. Appendix Table 9 compares characteristics of non-nodal districts along the GQ and NS-EW highways. While NS-EW districts have lower population on average, they are similar in terms of other district traits, including the level and growth of loan volumes in the pre-period. The log count of bank branches per capita in 2000 is very similar. The top of Figure 1 also shows parallel loan trends from 1996 to 2000, when GQ upgrades commenced.

Table 2 reports regressions that augment specification (1) to include three additional indicator variables regarding proximity to the NS-EW system. Indicator variables are not mutually exclusive, as some districts lie within 50 km of both networks, and coefficients are measured relative to districts more than 50 km from both networks. The first three rows show little quantitative change in our measured impact from GQ upgrades, implying that the baseline results are not sensitive to the change in reference group. The fourth row shows that nodal districts on NS-EW also experience robust loan growth, confirming our hesitation to infer much from coefficients for the nodal GQ districts.

By contrast, estimates in the last two rows are very comforting for our primary results. None of the loan growth evident for districts in close proximity to GQ are evident for districts lying on NS-EW, 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. With the precision that we estimate the positive responses along the GQ network, we estimate a lack of change along the NS-EW corridor. The bottom row further shows that in most specifications we reject that the 0-10 km bands are equal to each other. Appendix Table 10 shows similar findings when extending Panel B of Table 1 to model NS-EW proximity.

4.3 Straight-Line Instrumental Variables Estimations

Another check for the endogeneity of road placement comes through IV analyses. Such analyses address a concern that GQ planners were better able to shape the network layout to touch upon growing regions and that NS-EW planners were not as good at this, had less discretion, or had fewer good choices. Duranton and Turner (2011) highlight endogenous placement could bias findings in either direction. Infrastructure investments may target the development of regions with high growth potential, which would upwardly bias measurements of economic effects that do not control for this underlying potential. However, infrastructure investments that target struggling regions or non-optimal locations (i.e., 'bridges to nowhere') would bias results downward.

Rather than use the actual GQ layout, Appendix Table 11 instruments for a district being 0-10 km from GQ with it being near a straight line between the nodal districts of the GQ network. The idea behind 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 were 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. Similar to Banerjee et al. (2020), the four nodal cities of the GQ network were established hundreds or thousands of years ago, minimizing this concern. The IV estimates show strong first stages, with second stages somewhat larger than the OLS estimates. We do not, however, reject the hypothesis that the OLS and IV estimates are the same. These results provide confidence that the GQ investment impacted loan activity in a causal manner.

5 Industry Heterogeneity

Our estimations thus far have expanded the analysis of GQ beyond manufacturing and controlled for industry trends, but we can also characterize the differential growth rate across industries in loan development. Beginning with Rajan and Zingales (1998), many studies quantify whether growth in activity is strongest for the industries likely to be the most dependent upon financing. We adopt the spirit of this methodology and characterize whether loan activity growth during 1999-2009 is strongest in industries where the observed cost per establishment is highest. In many respects, our cost metric is indicative of the average scale of an establishment in an industry, with the assumption that external financing is more likely to be needed in higher average scale sectors.

We measure average cost per establishment by combining data from the National Sample Survey and the Annual Survey of Industries. These data are available for manufacturing and services industries (n=7549 district-industries), and thus we do not incorporate agriculture, fishing, mining, utility supply, and construction (NIC 1, 5, 13, 40, 45). We average values for the 2000-01 and 2009-10 end points of our sample. Our main interaction metric is the log average cost per establishment, with costs aggregating outlays for land, assets, labor, and raw materials. We demean these cost averages to keep main effects for district proximity to the GQ network similar to our baseline analysis.

Column 1 of Table 3 repeats our most stringent specification (Column 4 of Table 1) with the added interactions of the GQ variables and average cost per establishment in an industry. The state-industry fixed effects absorb the main effect of industry interactions. The main effects for the GQ network in the first three rows are similar to Table 1. Additionally, the interaction term on 0-10 km from GQ is well measured and suggests an industry with 10% higher costs has an additional 3% greater loan growth ($= 0.1 * 0.065/0.213$) when in close proximity to the GQ network during upgrades.

Columns 2-5 provide extensions. Columns 2 and 3 separate land and assets, which tend to be more fixed inputs, from the operating components of labor costs and raw materials. While the interaction term is stronger in the former, these differences are not substantial. Column 4 further includes interactions of the GQ variables with a measure of average industry cost per unit of output, which does not impact the results. Finally, Column 5 instead uses a dummy variable for industry cost per establishment being above the median, showing that most of the original main effect was concentrated in the upper half of the average cost distribution. Appendix Tables 12 and 13 show these industry interactions are also strongest in the initial years of GQ investment, similar to the main effects, and are not evident along the NS-EW system.

6 Complementarity of Finance and Infrastructure

Growth in loan volume following the GQ upgrades is likely to be shaped by both demand and supply factors. Demand for loans may rise with the entry and expansion of firms along the highway system, with financial capital following real activity. Loan growth can also occur if banks expand their lending capacity through the creation of new branches and expansion of existing ones. This greater lending capacity (e.g., loan officers) looking for local opportunities could feasibly also spur new real activity. As noted in the introduction, the GQ upgrades only allow us to make a causal assessment of the net effect as we do not have exogenous variation in the banking sector. However, this section provides additional data and analyses to shed some light on the distribution of lending activity across new versus existing branches, providing suggestive evidence that the distribution of bank activity in the pre-GQ period may have shaped post-GQ growth of loan activity.

We first consider new bank branches. As physical proximity helps overcome asymmetric information challenges, the development of new branches is an important lever for extending financial access to new regions. Panel B of Figure 1 reports the relative growth of loan and branch activity in the 0-10 km GQ districts relative to their NS-EW peers. To construct these measures, we first summed activity in districts along the two highways and measured their relative growth from 1999, as is shown for the credit series in Panel A of Figure 1. We then divided development along GQ by the development along NS-EW to provide a simple statistic on their divergence. Appendix Tables 14a-14d show each step in this tabulation and provide similar data on all distance bands.

Compared to the large surges in credit volumes and accounts as GQ starts, Panel B shows that growth in bank branches comes later and is more muted. Indeed, most or all of the relative loan differential occurs by 2005, while bank branch growth starts to pick up at this point. Consequently, the last two columns report that most of the initial loan growth is coming through an increase in credit and accounts per branch. While not definitive, this descriptive analysis is consistent with adjustment costs associated with expanding bank branch networks leading to a more inelastic supply of credit. The growth in average branch size suggests the more elastic response was coupled with existing branches proximate to GQ expansion.

Second, Table 4 repeats the industry estimations of Table 3 with a split based upon whether the district was more developed financially at the start of the GQ upgrade, measured as being above the district-level median in loans per capita. The industry differential is stronger in districts that had greater initial loan activity. Recognizing we should be cautious given the multiple uses of the RBI data, this pattern is again consistent with lending being easiest to scale in settings where established industries and banks faced lower adjustment costs.

7 Conclusions

Although our understanding of how infrastructure investment can facilitate real economic activity has advanced greatly in recent years, less is known about how complementary factors such as the availability of bank finance respond to increased infrastructure investment. Such an understanding is important, because the availability of finance has been shown to shape the rate, direction, and location of real economic activity. We overcome previous empirical barriers by combining unique data from the Reserve Bank of India with the upgrades of India's GQ network.

The GQ upgrades brought about substantial growth in finance-dependent economic activity for non-nodal districts located 0-10 km from the network, relative to those located further away. The results are strongest for areas where there was new construction and in industries most likely to benefit from bank finance; most of the growth came in the first few years after the upgrades commenced. Placebo tests using the NS-EW highway network, as well straight-line IV analyses, support a causal interpretation. These results using loans from many sectors, and controlling for aggregate industry trends, sit in-between studies of GQ that have mostly considered the extremes of organized manufacturing advancement and growth in nighttime lights.

While our causal assessment is limited to the net growth in loans, we also make forays to characterize how the disproportionate share of the response came from districts with existing bank branches and with greater pre-GQ lending. Entry of new bank branches lagged the GQ construction and appeared to play a more muted role, with most of the initial surge in loan supply coming through a growth in average bank branch size. Our results are consistent with larger adjustment costs associated with new branches relative to existing ones shaping the elasticity of credit supply and hence the locations where GQ-enabled opportunities were most able to get financed.

Motivated by the promise of using infrastructure to reduce disparity across regions, many policy makers ask a question along the lines of "build it and they will come?" Our analysis of the GQ experience suggests a nuanced answer. To begin, the very rapid and substantial response in loans in precisely the industries and locations predicted suggests a strong elasticity in the supply of credit to meet demand enabled by the GQ. However, we also find descriptive evidence that initial credit supply growth is tightly linked to places where banking loans were already happening before GQ. This suggests that understanding how finance responds to infrastructure may be key to understanding the distributional effects of infrastructure investments. If adjustment costs are substantial, the complementarity between finance and infrastructure can exacerbate, rather than attenuate, pre-existing differences in economic activity prior to infrastructure investment, at least in the short run.

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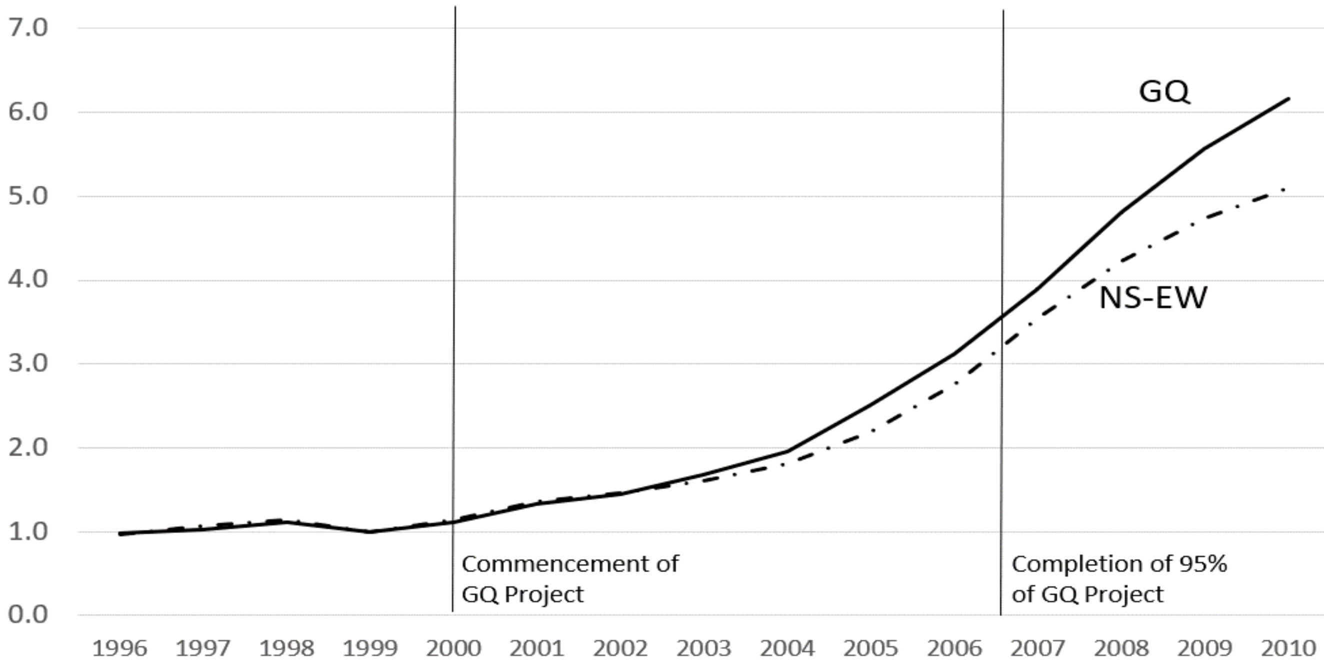
Figure 1: Banking Growth in non-Nodal Districts along Indian Highways

A. Credit in non-Nodal Districts on GQ and NS-EW Highways relative to 1999



B. Growth of non-Nodal Banking on GQ relative to NS-EW

	Credit	Accounts	Branches	Credit / Branch	Accounts / Branch
1999	1.00	1.00	1.00	1.00	1.00
2000	0.97	0.99	1.00	0.97	0.99
2001	0.98	1.03	1.00	0.97	1.02
2002	0.99	1.10	1.01	0.98	1.09
2003	1.05	1.14	1.00	1.05	1.14
2004	1.08	1.17	1.01	1.07	1.16
2005	1.15	1.25	1.04	1.11	1.21
2006	1.13	1.23	1.07	1.09	1.15
2007	1.10	1.21	1.13	1.01	1.07
2008	1.14	1.21	1.07	1.04	1.13
2009	1.18	1.24	1.08	1.10	1.14

Notes: Panel A plots credit volumes in non-Nodal districts along the two highway systems relative to year 1999, just prior to GQ project commencement. Panel B tabulates the relative growth of banking outcomes on GQ from 1999 compared to NS-EW. The appendix provides base values.

Table 1: Impact of GQ on Financial Development

This table reports the results of long-differenced estimations between 1999 and 2009. Panel A includes district-industries with positive loan activity in 1999 and 2009 (9050 observations). Panel B extends the sample to allow for entry or exit of lending by recoding zero loan activity to a value of 0.1 (12,403 observations). The dependent variable for Columns 1 - 4 is the log change in loan credit for a district-industry over the 10-year period; the dependent variable in Column 5 is the log change in loan counts and in Column 6 is the log change in average loan size. Panel B winsorizes these changes at their 0.1% and 99.9% levels. Regressions model 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, 4, 5, and 6 further include state-x-industry fixed effects, which is equivalent to including state-x-industry-x-year fixed effects in a panel regression. Columns 3-6 include fixed effects for quartiles of district-level covariates, all measured in year 2000: district population, percentage of population in urban areas, shortest distance to a state or national highway, shortest distance to a railroad, a composite index of local infrastructure quality, and share of households with bank accounts. Observations are weighted by log district population in 2000. 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 volume				Change in log count	Change in log av size
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending					
Nodal districts	1.792+++	1.705+++	1.372+++	1.398+++	0.567+++	0.976+++
	(0.307)	(0.343)	(0.323)	(0.360)	(0.185)	(0.202)
Districts 0-10 km from GQ highway	0.315+++	0.317+++	0.237++	0.196++	0.150+++	0.045
	(0.091)	(0.108)	(0.091)	(0.089)	(0.055)	(0.050)
Districts 10-50 km from GQ highway	-0.144	-0.079	-0.006	0.004	0.100	-0.095
	(0.128)	(0.126)	(0.108)	(0.105)	(0.062)	(0.061)
Linear difference of 0-10 to 10-50 km	0.459+++	0.396+++	0.243++	0.192	0.050	0.140+
	(0.141)	(0.141)	(0.123)	(0.119)	(0.070)	(0.071)
	B. Extended Sample Allowing Entry or Exit from District-Industries					
Nodal districts	3.083+++	3.009+++	1.919+++	1.965+++	0.651+++	1.134+++
	(0.355)	(0.417)	(0.372)	(0.431)	(0.194)	(0.237)
Districts 0-10 km from GQ highway	0.452+++	0.483+++	0.333+++	0.294++	0.153+++	0.112
	(0.152)	(0.175)	(0.126)	(0.123)	(0.052)	(0.074)
Districts 10-50 km from GQ highway	-0.216	-0.050	0.010	0.053	0.092	-0.050
	(0.193)	(0.197)	(0.164)	(0.163)	(0.061)	(0.103)
Linear difference of 0-10 to 10-50 km	0.668+++	0.533++	0.323+	0.241	0.062	0.162
	(0.221)	(0.226)	(0.178)	(0.174)	(0.066)	(0.112)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	No	Yes	No	Yes	Yes	Yes
Fixed Effects for District Traits	No	No	Yes	Yes	Yes	Yes

Table 2: Comparison with of GQ with NS-EW Highway System

See Table 1. Estimations include district-industries with positive loan activity in 1999 and 2009 (9050 observations). 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 volume				Change in log count	Change in log av size
	(1)	(2)	(3)	(4)	(5)	(6)
Nodal GQ districts	1.311+++	1.309+++	0.966+++	1.113+++	0.425++	0.840+++
	(0.297)	(0.358)	(0.326)	(0.379)	(0.211)	(0.235)
Districts 0-10 km from GQ highway	0.325+++	0.296+++	0.233+++	0.193++	0.141++	0.046
	(0.087)	(0.102)	(0.088)	(0.085)	(0.056)	(0.048)
Districts 10-50 km from GQ highway	-0.115	-0.056	0.003	0.017	0.104+	-0.088
	(0.130)	(0.125)	(0.107)	(0.103)	(0.061)	(0.061)
Nodal NS-EW districts	1.018+++	0.797+	0.885+++	0.684++	0.304+	0.344
	(0.281)	(0.406)	(0.287)	(0.347)	(0.178)	(0.251)
Districts 0-10 km from NS-EW highway	0.070	-0.028	0.027	0.023	-0.014	0.020
	(0.093)	(0.095)	(0.085)	(0.082)	(0.049)	(0.051)
Districts 10-50 km from NS-EW highway	-0.079	-0.228++	-0.024	-0.065	-0.080	0.003
	(0.107)	(0.101)	(0.093)	(0.091)	(0.054)	(0.053)
P Value: GQ 0-10 = NS-EW 0-10	0.038	0.013	0.071	0.111	0.014	0.679
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	No	Yes	No	Yes	Yes	Yes
Fixed Effects for District Traits	No	No	Yes	Yes	Yes	Yes

Table 3: Industry Heterogeneity

See Table 1. Estimations include district-industries with positive loan activity in 1999 and 2009 that are also mapped to industry level cost share data. Estimations further interact regressors with industry-level cost shares as described by column headers. Cost shares are demeaned prior to interaction to restore main effects.

	Baseline model with industry interactions	Focus on land and asset inputs	Focus on labor and raw material inputs	Column 1 with a control for cost shares of output	Column 1 using dummy variable for above median
	(1)	(2)	(3)	(4)	(5)
Nodal GQ districts	1.476+++	1.481+++	1.474+++	1.473+++	1.256+++
	(0.356)	(0.357)	(0.356)	(0.357)	(0.362)
Districts 0-10 km from GQ highway	0.213++	0.216++	0.211++	0.213++	0.124
	(0.097)	(0.098)	(0.096)	(0.097)	(0.087)
Districts 10-50 km from GQ highway	-0.002	-0.002	-0.002	-0.002	-0.027
	(0.113)	(0.114)	(0.112)	(0.112)	(0.104)
<u>Interacted with Industry Cost per Establishment</u>					
Nodal GQ districts	0.227+++	0.301+++	0.134+++	0.300+++	0.463+++
	(0.055)	(0.064)	(0.039)	(0.061)	(0.166)
Districts 0-10 km from GQ highway	0.065++	0.076++	0.045+	0.072++	0.185++
	(0.032)	(0.037)	(0.025)	(0.035)	(0.085)
Districts 10-50 km from GQ highway	-0.008	-0.004	-0.002	-0.015	0.059
	(0.039)	(0.046)	(0.029)	(0.046)	(0.096)
P Value: GQ 0-10 = GQ 10-50 main effects	0.092	0.091	0.095	0.092	0.189
P Value: GQ 0-10 = GQ 10-50 interactions	0.096	0.109	0.138	0.303	0.239
Observations	7549	7549	7549	7549	7549
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes

Table 4: Industry Analysis with Initial District Financial Development

See Tables 1 and 3. This table separates GQ 0-10 km districts by median financial development before the start of the GQ upgrades. Financial development is measured by loan volume per capita.

	Baseline model with industry interactions	Focus on land and asset inputs	Focus on labor and raw material inputs	Column 1 with a control for cost shares of output	Column 1 using dummy variable for above median
	(1)	(2)	(3)	(4)	(5)
Nodal districts	1.490+++	1.495+++	1.488+++	1.487+++	1.272+++
	(0.358)	(0.358)	(0.357)	(0.358)	(0.363)
Districts 0-10 km from GQ highway * above median financial dev. pre GQ	0.250+	0.252+	0.248+	0.249+	0.123
	(0.133)	(0.134)	(0.133)	(0.133)	(0.122)
Districts 0-10 km from GQ highway * below median financial dev. pre GQ	0.137	0.135	0.137	0.137	0.138
	(0.111)	(0.113)	(0.109)	(0.111)	(0.103)
Districts 10-50 km from GQ highway	-0.004	-0.003	-0.004	-0.004	-0.029
	(0.113)	(0.114)	(0.112)	(0.113)	(0.104)
<u>Interacted with Industry Cost per Establishment</u>					
Nodal districts	0.225+++	0.300+++	0.133+++	0.299+++	0.460+++
	(0.054)	(0.063)	(0.039)	(0.061)	(0.165)
Districts 0-10 km from GQ highway * above median financial dev. pre GQ	0.097+++	0.115+++	0.069+++	0.105+++	0.268+++
	(0.033)	(0.038)	(0.026)	(0.035)	(0.095)
Districts 0-10 km from GQ highway * below median financial dev. pre GQ	-0.009	-0.015	-0.007	-0.004	0.001
	(0.050)	(0.057)	(0.038)	(0.054)	(0.119)
Districts 10-50 km from GQ highway	-0.008	-0.005	-0.002	-0.015	0.059
	(0.039)	(0.046)	(0.029)	(0.046)	(0.096)
Observations	7549	7549	7549	7549	7549
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Onlines Appendixes

August 2023

1 Data Notes: GQ and NS-EW

Appendix Figure 1 maps the GQ and NS-EW networks. Road transportation accounts for 65% of freight movement and 80% of passenger traffic in India. National highways constitute about 1.7% of this network, carrying more than 40% of traffic volume. Percentages are from National Highway Authority of India. 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).

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, there is ambiguity evident in Appendix Figure 1 about whether Bangalore should also be considered a nodal city. For the NS-EW network, we define Delhi, Chandigarh, NOIDA, Gurgaon, Faridabad, Ghaziabad, Hyderabad, and Bangalore to be the nodal districts using similar criteria.

We measure distance using official highway maps and ArcMap GIS software, focusing on the shortest straight-line from the edge of each district. Results are robust to measuring distances from district centroids.

2 Data Notes: Loans

Our main dataset is based upon the Basic Statistical Return (BSR)1A, maintained by the Reserve Bank of India (RBI). BSR-1A details 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. 200,000 from 1999 onwards (the latter is about $4,000 using historical exchange rates).

The data count each bank-borrower relationship separately. Thus, a firm borrowing from multiple banks will be counted separately each time. If the firm increased the amount of borrowing from the same bank, it would show up as growth in loan size. We lack the base data to separate these cases, and thus should not overly interpret an increase in loan count to necessary indicate new firm formation. Studies with manufacturing plant data find both incumbent expansion and new entry occurred, likely resulting in both playing a role for increased loan counts.

In 2009, levels of credit per capita at the district level in our sample have a 0.3-0.4 correlation with formal manufacturing activity per capita and a 0.1 correlation with average luminosity for pixels across the district. Total loan activity for districts has a 0.5 correlation with district population, a 0.7-0.8 correlation with aggregated formal manufacturing activity, and a 0.4 with aggregated luminosity (all measures in logs). The RBI loan threshold, along with the industry heterogeneity analysis, suggest our estimations are not capturing a crowd-out of informal loans.

The RBI also has a directory of commercial banks in the form of Master Office File (MOF). The MOF provides the record of birth, death, relocation, survival, and amalgamation of bank branches. The MOF also maintains a unique code of the branch, as assigned by the RBI. The RBI makes the data on directory of commercial banks publicly available. Records show sizable counts of branch openings from one year to the next in some districts; many district-year observations do not record an opening. We sum branch openings minus closures for a district to estimate the count of operating branches. The average district in our sample has 123 operating branches and 6.8 annual openings during 1999-2009. The distribution along GQ: nodal district (581 branches, 34 openings), 0-10 km (158, 9.2), 10-50 km (92, 5.7), and 50+ km (97, 5.0). The distribution along NS-EW: nodal district (423 branches, 27 openings), 0-10 km (114, 5.7), 10-50 km (88, 5.3), and 50+ km (123, 6.8). The difference of 158 to 114 in average branch counts for districts 0-10 km districts from GQ and NS-EW is mostly due to differences in district size; Appendix Table 9 shows they have very similar log levels of branches per capita in 2000.

Some measure of loans in manufacturing are available with the ASI and NSS. The ASI contains large plants in the organized sector. Consistently, about 77% of plants report loan information in the raw data. Excluding non-responses, 89% of plants held loans during the 1989-2009 period. The share of plants with loans is about 85% when the denominator is those that completed some part of the financing section. Use of sample weights does not change these shares much given the ASI sampling. A smaller share, about two-thirds, report using other features like overdraft, cash credit, etc. These shares rise to about 75% when excluding non-responses.

The NSS contains smaller plants in the unorganized (informal) sector. These data are trickier to handle. If one looks at just the firms that completed the financing section (i.e., the firm answered one or more question in the financing section), about 22% have a loan from a bank-like entity tracked by the RBI during the 1989-2009 period (25% if weighting plants). This share grew from 14% to 31% during the sample period. The NSS shares are much lower at 1-3% if one instead assumes that respondents who skipped the financing section entirely did not have loans. This non-response to the whole section is difficult to interpret.

3 Baseline Robustness Analysis and Extensions

Appendix Table 1 shows Table 1 without observation weights and using Conley (1999, 2008) spatial errors as implemented by Fetzer (2014). Coefficient values are very similar. Spatial standard errors are smaller than clustered standard errors, making differences across spatial bands even more statistically different from each other, including Column 4's estimation. We keep to clustered standard errors for the main paper to be conservative.

Appendix Table 2 reports results with one-digit NIC industries. The higher aggregation reduces measurement error and zero-valued cells. These results are of very similar magnitude and more precisely estimated than Table 1.

Appendix Tables 3a and 3b show results using alternative demarcations for non-nodal districts ranging from 5 km to 15 km. The results do not display a knife-edge dependency on distance measured from GQ.

Appendix Tables 4a and 4b show variations on controls for initial financial development. Estimations of the intensive margin, where we observe loans at start and end of sample period, are quite robust to excluding initial controls or using variants. In fact, differences between 0-10 and 10-50 km bands become more precisely measured in some alternative variants. We nonetheless prefer the inclusion of the initial controls because they have been commonly used in this literature and help control for conditional convergence. In estimations of the extensive margin, where no loans were observed at the start of the sample, the initial control is capturing the coding of the zero-value to a minimum baseline. Here, the results lose their power without initial controls and when saturating the model with fixed effects.

Appendix Tables 5 and 6 analyze the dynamics of increased financial development along GQ as the upgrades took place, using the baseline and one-digit NIC samples respectively. Repeating Column 4's model in Table 1, we model changes in loan volumes from 1999-2001 (the first year of GQ upgrades) to 1999-2009 (our full sample). To recall the GQ's rollout, 23% of the work was completed by the end of 2002, 80% by 2004, and 95% by 2006. The strongest differences of 0-10 km districts in comparison to districts 50 km or more away happen during the 1999-2005 surge in work, while differences to districts 10-50 km emerge more gradually over the sample period. Figure 1 also shows the difference between GQ and NS-EW accumulates gradually.

The text notes that loan activity, which incorporates non-manufacturing sectors but also captures mostly formal activity from larger firms, sits in the middle of estimated GQ impacts. The tight localization of effects along the highway network is very similar to other outcomes, regardless of magnitudes estimated. These estimations suggest loan effects tended to happen quickly, akin to the plant inventory and input sourcing impact measured by Datta (2011) or the plant entry estimations of Ghani et al. (2016). Other effects like luminosity or total manufacturing output growth appear to accumulate more gradually.

Appendix Tables 5 and 6 also report results with the sample split for 0-10 km districts by whether they are above or below median loan volume per capita in 2000. These estimations show ambiguous results. On the one hand, the strongest impact is measured in districts along GQ that held above average initial financial development, while districts below median initially show diminished outcomes. Yet, we are unable to make strong conclusions as the differences between the two types are not themselves precisely estimated.

Appendix Table 7 considers Poisson pseudo-maximum likelihood regressions with multi-way fixed effects using the routine of Correia et al. (2020). Estimations model (non-log) loan volumes and counts in district-industry cells annually for 1999-2009. This routine is designed as a panel model, and we include high-dimensional fixed effects for district-industry, industry-year or state-industry-year, and district traits by year. Mirroring the dynamic analysis, the most precisely estimated differences in loan activity are measured for 2003-2005 relative to the early period of 1999-2002.

Appendix Table 8 compares new construction versus upgrades. 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 analysis due to lack of loan activity in both periods. Almost all of the increased financing of economic activity is in the new construction segments of the GQ project.

Appendix Tables 9, 10, 12, and 13 are described in the text.

4 Straight-Line Instrumental Variables Estimations

Another check for the endogeneity for road placement comes through IV analyses. Rather than use the actual GQ layout, we instrument for a district being 0-10 km from GQ with it being within 15 km from a straight line between the nodal districts of the GQ network. The exclusion restriction of 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-industry fixed effects. We thus only exploit variation within states in the likelihood that a district would have been on the GQ network.

Panel B of Appendix Figure 1 shows the implementation. IV Route 1 connects the four nodal districts outlined in Datta (2011). We model 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. Bangalore is not listed as a nodal city in Datta (2011), yet IV Route 2 shows that thinking of Bangalore as a nodal city is visually compelling. We thus test IV specifications with and without the second kink for Bangalore. For these IV estimations, we exclude nodal districts (sample now contains 302 districts) and measure effects relative to districts more than 10 km from GQ. This approach only requires us to instrument for a single variable—being within 10 km of the GQ network.

Panel A of Appendix Table 11 provides a OLS baseline. Panels B and C report IV estimates using Route 1 and Route 2 respectively. First-stage relationships are quite strong. IV Route 1 has a first-stage estimate of 0.51 (0.07) and an associated F-statistic of over 50. IV Route 2, which treats Bangalore as a connection point, has a first-stage elasticity of 0.61 (0.06) and an associated F-statistic closer to 100.

Columns 1-3 report results for district-industry cells with positive loan volume in both 1999 and 2009, while Columns 4-6 report results for all district-industry cells. IV specifications generally confirm the OLS findings. The point estimates for the IV specifications in Columns 1-3 remain very similar to those in Panel A. In Columns 4-6 the IV estimates are somewhat larger than the OLS estimates, but we do not reject the hypothesis that they are the same.

One concern with the straight line IV is that explanatory power may be coming from districts that are close to the nodes. When a nodal city grows, surrounding areas are likely to grow as well, potentially confounding the IV estimates. Column 2 and 4 thus exclude from the sample any district within 50 km of nodal cities, finding reassurance that OLS and IV estimates do not change much. Columns 3 and 6 further include district controls. As with the OLS estimates, these controls attenuate the coefficients, but the magnitudes remain economically large. On the whole, IV estimates generally confirm the OLS findings, which helps with concerns about endogenous placement. The IV magnitudes, particularly in Columns 4-6, may be signalling some placement of the GQ network towards regions that could not benefit as much in the development of loan activity.

5 Figure 1 Tabulations

Appendix Tables 14a-14d show the construction of the series presented in Figure 1, with extension to all distance bands.

Appendix Table 14b shows the focal 0-10 km band. Panel A aggregates loan and branch activity for the non-nodal 0-10 km districts along GQ. Column headers describe variables being analyzed, and the rows provide levels of variables compared to their 1999 value. Columns 1 and 2 describe the large growth in credit volumes and accounts. Branch growth, in Column 3, is slower to develop in absolute and relative terms. The most substantial growth period for branches commences in 2004, whereas most of the initial loan growth is coming through larger average branch sizes.

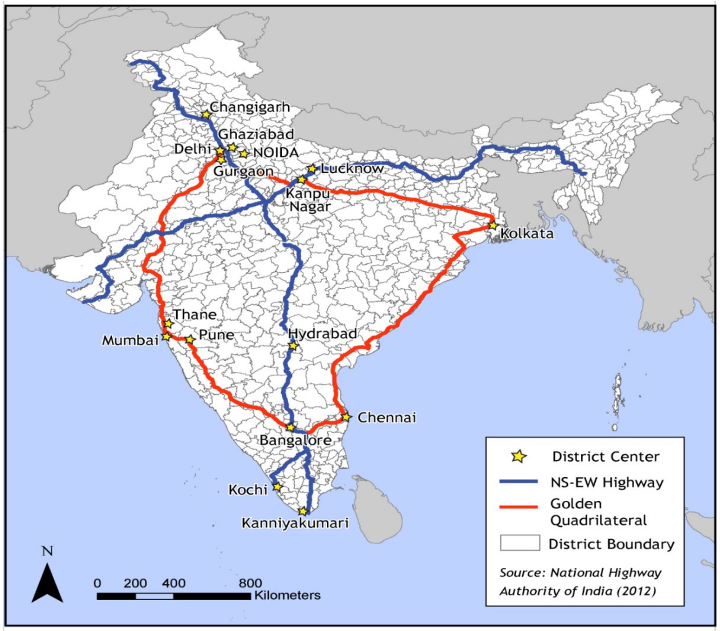
Panel B plots the same series for districts within 10 km of NS-EW, and Panel C provides the ratio of GQ's expansion to NS-EW's. Panel C continues to show a pattern consistent with growth in average branch size, especially in terms of accounts, coming first. Growth in bank branches comes later and is weaker.[1]

The other three tables provide comparable tabulations for other distance bands, showing the effect we are highlighting in the 0-10 km comparison is not evident in other bands.

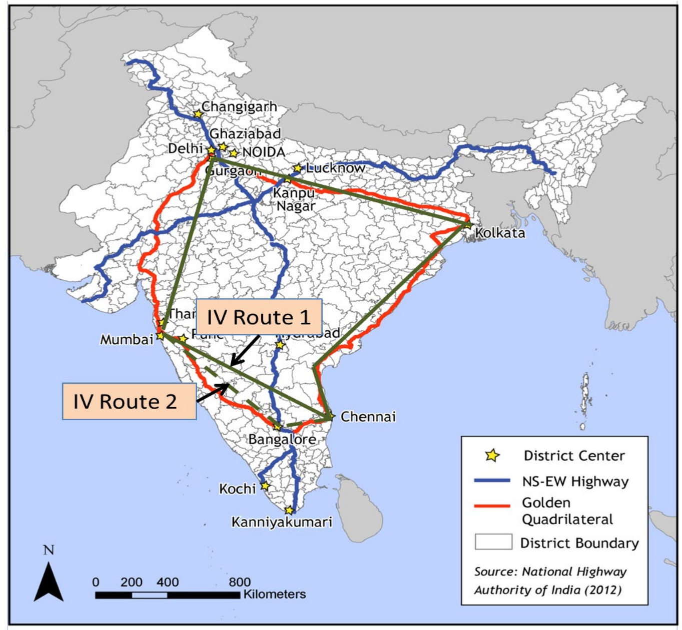
[1] To benchmark the rate of branch openings, we obtained data on annual firm registrations from the Ministry of Company Affairs. The registration of companies in India is a legal requirement under the Companies Act. Through registration, firms obtain legal entity status, although most firms remain informal. From 1999 to 2003, the rate of branch openings is declining compared to the rate of annual firm registrations; after 2004, branch openings begin to increase in relative terms. Complications with the registrations data lead us to note this pattern but not emphasize it.

Appendix Figure 1: Map of the Golden Quadrilateral and North-South East-West Highways

A. Highway route structure



B. Overlay of straight-line IV strategy



Notes: Panel A plots the Golden Quadrilateral 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.

Appendix Table 1: Table 1 with Spatial Standard Errors and Unweighted Estimations

See Table 1. Estimations are unweighted and use Conley (1999, 2008) spatial errors as implemented by Fetzer (2014).

	Change in log loan volume				Change in log count	Change in log av size
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending					
Nodal districts	1.806+++	1.714+++	1.378+++	1.401+++	0.498+++	0.903+++
	(0.177)	(0.143)	(0.208)	(0.155)	(0.069)	(0.116)
Districts 0-10 km from GQ highway	0.309++	0.313+++	0.232++	0.192++	0.106+	0.086+
	(0.130)	(0.090)	(0.104)	(0.081)	(0.061)	(0.047)
Districts 10-50 km from GQ highway	-0.154	-0.086	-0.011	0.002	0.072	-0.070
	(0.141)	(0.124)	(0.115)	(0.101)	(0.057)	(0.068)
Linear difference of 0-10 to 10-50 km	0.463+++	0.399+++	0.243+++	0.191++	0.035	0.156++
	(0.123)	(0.113)	(0.092)	(0.096)	(0.045)	(0.074)
	B. Extended Sample Allowing Entry or Exit from District-Industries					
Nodal districts	3.082+++	3.003+++	1.910+++	1.953+++	0.645+++	1.130+++
	(0.249)	(0.362)	(0.219)	(0.229)	(0.082)	(0.116)
Districts 0-10 km from GQ highway	0.439+	0.473+++	0.326++	0.288++	0.150++	0.110
	(0.234)	(0.182)	(0.142)	(0.122)	(0.059)	(0.069)
Districts 10-50 km from GQ highway	-0.225	-0.057	0.009	0.054	0.090	-0.047
	(0.211)	(0.199)	(0.158)	(0.148)	(0.059)	(0.092)
Linear difference of 0-10 to 10-50 km	0.664+++	0.530++	0.317+++	0.233+	0.060	0.157+
	(0.209)	(0.207)	(0.122)	(0.129)	(0.043)	(0.083)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	No	Yes	No	Yes	Yes	Yes
Fixed Effects for District Traits	No	No	Yes	Yes	Yes	Yes

Appendix Table 2: Table 1 using One-Digit NIC Industry Sectors

See Table 1. Estimations use one-digit NIC industry sectors. Sample count is 3065 and 3110 in Panels A and B, respectively.

	Change in log loan volume				Change in log count	Change in log av size
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending					
Nodal districts	1.352+++	1.311+++	1.149+++	1.175+++	0.454++	0.842+++
	(0.290)	(0.335)	(0.290)	(0.334)	(0.191)	(0.175)
Districts 0-10 km from GQ highway	0.290+++	0.251+++	0.238+++	0.200+++	0.133++	0.066
	(0.067)	(0.077)	(0.075)	(0.070)	(0.053)	(0.042)
Districts 10-50 km from GQ highway	-0.092	-0.066	-0.003	-0.014	0.102+	-0.120++
	(0.095)	(0.089)	(0.085)	(0.078)	(0.057)	(0.048)
Linear difference of 0-10 to 10-50 km	0.382+++	0.317+++	0.242++	0.214++	0.031	0.185+++
	(0.105)	(0.101)	(0.095)	(0.089)	(0.064)	(0.058)
	B. Extended Sample Allowing Entry or Exit from District-Industries					
Nodal districts	1.460+++	1.398+++	1.208+++	1.236+++	0.452++	0.863+++
	(0.282)	(0.329)	(0.289)	(0.334)	(0.184)	(0.174)
Districts 0-10 km from GQ highway	0.300+++	0.264+++	0.248+++	0.211+++	0.137++	0.067
	(0.071)	(0.080)	(0.079)	(0.072)	(0.053)	(0.042)
Districts 10-50 km from GQ highway	-0.100	-0.066	-0.004	-0.011	0.105+	-0.124++
	(0.098)	(0.093)	(0.088)	(0.082)	(0.060)	(0.049)
Linear difference of 0-10 to 10-50 km	0.400+++	0.331+++	0.252++	0.223++	0.033	0.191+++
	(0.110)	(0.106)	(0.100)	(0.093)	(0.066)	(0.059)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	No	Yes	No	Yes	Yes	Yes
Fixed Effects for District Traits	No	No	Yes	Yes	Yes	Yes

Appendix Table 3a: Table 1 Column 1 with Alternative Spatial Bands

See Table 1. Column headers show distance from GQ highway used to separate bands.

	5 km band	7.5 km band	10 km band (baseline)	12.5 km band	15 km band
	(1)	(2)	(3)	(4)	(5)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending				
Nodal districts	1.808+++	1.811+++	1.792+++	1.786+++	1.779+++
	(0.310)	(0.311)	(0.307)	(0.307)	(0.307)
Districts up to specified km from GQ highway	0.347+++	0.337+++	0.315+++	0.279+++	0.241+++
	(0.096)	(0.092)	(0.091)	(0.089)	(0.088)
Districts from specified km to 50 km from GQ highway	-0.048	-0.077	-0.144	-0.135	-0.083
	(0.119)	(0.128)	(0.128)	(0.144)	(0.158)
<u>Linear difference</u>	0.428+++	0.452+++	0.459+++	0.414+++	0.323+
	(0.134)	(0.139)	(0.141)	(0.154)	(0.167)
	B. Extended Sample Allowing Entry or Exit from District-Industries				
Nodal districts	3.111+++	3.112+++	3.083+++	3.076+++	3.069+++
	(0.358)	(0.358)	(0.355)	(0.354)	(0.354)
Districts up to specified km from GQ highway	0.517+++	0.485+++	0.452+++	0.386+++	0.325++
	(0.162)	(0.156)	(0.152)	(0.147)	(0.144)
Districts from specified km to 50 km from GQ highway	-0.147	-0.177	-0.216	-0.188	-0.112
	(0.171)	(0.180)	(0.193)	(0.216)	(0.243)
<u>Linear difference</u>	0.678+++	0.680+++	0.668+++	0.573++	0.437+
	(0.212)	(0.215)	(0.221)	(0.238)	(0.261)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 3b: Table 1 Column 4 with Alternative Spatial Bands

See Table 1. Column headers show distance from GQ highway used to separate bands.

	5 km band	7.5 km band	10 km band (baseline)	12.5 km band	15 km band
	(1)	(2)	(3)	(4)	(5)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending				
Nodal districts	1.388+++	1.401+++	1.398+++	1.391+++	1.389+++
	(0.354)	(0.357)	(0.360)	(0.361)	(0.360)
Districts up to specified km from GQ highway	0.172+	0.205++	0.196++	0.179++	0.165+
	(0.093)	(0.090)	(0.089)	(0.088)	(0.087)
Districts from specified km to 50 km from GQ highway	0.121	0.064	0.004	0.009	0.025
	(0.103)	(0.108)	(0.105)	(0.102)	(0.111)
Linear difference	0.078	0.170	0.192	0.170	0.140
	(0.120)	(0.121)	(0.119)	(0.114)	(0.124)
	B. Extended Sample Allowing Entry or Exit from District-Industries				
Nodal districts	1.942+++	1.958+++	1.965+++	1.955+++	1.951+++
	(0.423)	(0.425)	(0.431)	(0.431)	(0.431)
Districts up to specified km from GQ highway	0.258++	0.298++	0.294++	0.260++	0.238+
	(0.130)	(0.126)	(0.123)	(0.124)	(0.121)
Districts from specified km to 50 km from GQ highway	0.170	0.106	0.053	0.078	0.114
	(0.146)	(0.151)	(0.163)	(0.159)	(0.176)
Linear difference	0.105	0.212	0.241	0.182	0.124
	(0.167)	(0.169)	(0.174)	(0.167)	(0.183)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes

Appendix Table 4a: Table 1 Column 1 with Alternative Initial Controls

See Table 1. Column headers describe initial control used. Panel B includes an indicator variable for an initial zero-valued cell.

	1999 loan volume (baseline)	No control	1996-1998 loan volume	1996-1998 loan counts	1995 bank branches
	(1)	(2)	(3)	(4)	(5)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending				
Nodal districts	1.792+++	0.714+	1.271+++	0.996++	0.785+
	(0.307)	(0.388)	(0.381)	(0.422)	(0.405)
Districts 0-10 km from GQ highway	0.315+++	0.184+++	0.272+++	0.239+++	0.207+++
	(0.091)	(0.065)	(0.075)	(0.068)	(0.066)
Districts 10-50 km from GQ highway	-0.144	-0.099	-0.097	-0.084	-0.102
	(0.128)	(0.094)	(0.107)	(0.100)	(0.095)
Linear difference	0.459+++	0.283+++	0.369+++	0.323+++	0.309+++
	(0.141)	(0.100)	(0.116)	(0.107)	(0.102)
	B. Extended Sample Allowing Entry or Exit from District-Industries				
Nodal districts	3.387+++	1.274+++	1.717+++	1.384+++	1.133++
	(0.421)	(0.413)	(0.411)	(0.459)	(0.468)
Districts 0-10 km from GQ highway	0.453+++	0.224++	0.324+++	0.293+++	0.179+
	(0.161)	(0.095)	(0.099)	(0.094)	(0.096)
Districts 10-50 km from GQ highway	-0.218	-0.172	-0.151	-0.140	-0.169
	(0.197)	(0.141)	(0.147)	(0.143)	(0.141)
Linear difference	0.671+++	0.396+++	0.475+++	0.433+++	0.348++
	(0.229)	(0.149)	(0.156)	(0.150)	(0.152)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 4b: Table 1 Column 4 with Alternative Initial Controls

See Table 1 and Appendix Table 4a.

	1999 loan volume (baseline)	No control	1996-1998 loan volume	1996-1998 loan counts	1995 bank branches
	(1)	(2)	(3)	(4)	(5)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending				
Nodal districts	1.398+++	0.405	0.809++	0.557	0.451
	(0.360)	(0.408)	(0.391)	(0.437)	(0.406)
Districts 0-10 km from GQ highway	0.196++	0.088	0.151+	0.130+	0.127+
	(0.089)	(0.075)	(0.078)	(0.075)	(0.075)
Districts 10-50 km from GQ highway	0.004	-0.079	-0.018	-0.028	-0.060
	(0.105)	(0.082)	(0.087)	(0.083)	(0.082)
Linear difference	0.192	0.167+	0.169+	0.158+	0.187++
	(0.119)	(0.090)	(0.098)	(0.091)	(0.090)
	B. Extended Sample Allowing Entry or Exit from District-Industries				
Nodal districts	2.324+++	0.666	1.070++	0.773	0.685
	(0.490)	(0.495)	(0.466)	(0.527)	(0.494)
Districts 0-10 km from GQ highway	0.301++	0.094	0.183+	0.153	0.110
	(0.133)	(0.101)	(0.105)	(0.103)	(0.103)
Districts 10-50 km from GQ highway	0.060	-0.088	-0.035	-0.050	-0.081
	(0.166)	(0.123)	(0.131)	(0.127)	(0.122)
Linear difference	0.241	0.182	0.218	0.203	0.191
	(0.182)	(0.133)	(0.137)	(0.132)	(0.134)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes

Appendix Table 5: Dynamic Analysis and Initial Financial Development

Panel A repeats Column 4 of Panel A in Table 1 for different time spans as indicated by column header. Panel B separate GQ 0-10 km districts by median financial development before the start of the GQ upgrades. Financial development is measured by loan volume per capita.

	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
	(1)	(2)	(3)	(4)	(5)
			A. Base Specification		
Nodal districts	0.693+++	1.075+++	1.236+++	1.362+++	1.398+++
	(0.232)	(0.270)	(0.287)	(0.358)	(0.360)
Districts 0-10 km from GQ highway	0.068	0.128+	0.214+++	0.184++	0.196++
	(0.048)	(0.066)	(0.071)	(0.083)	(0.089)
Districts 10-50 km from GQ highway	0.075	0.098	0.122	0.065	0.004
	(0.053)	(0.080)	(0.081)	(0.099)	(0.105)
Linear difference of 0-10 to 10-50 km	-0.007	0.030	0.092	0.118	0.192
	(0.062)	(0.094)	(0.091)	(0.108)	(0.119)
			B. Separating by Initial Level of Financial Development		
Nodal districts	0.703+++	1.095+++	1.258+++	1.374+++	1.412+++
	(0.232)	(0.270)	(0.287)	(0.359)	(0.361)
Districts 0-10 km from GQ highway	0.095	0.182++	0.275+++	0.216+	0.234+
* above median financial dev. pre GQ	(0.060)	(0.084)	(0.097)	(0.114)	(0.124)
Districts 0-10 km from GQ highway	0.023	0.034	0.110	0.130	0.134
* below median financial dev. pre GQ	(0.069)	(0.085)	(0.079)	(0.091)	(0.101)
Districts 10-50 km from GQ highway	0.074	0.094	0.119	0.064	0.002
	(0.053)	(0.079)	(0.081)	(0.099)	(0.105)
Linear difference of 0-10 to 10-50 km	0.022	0.088	0.156	0.153	0.232
Above median financial dev. pre GQ	(0.071)	(0.109)	(0.112)	(0.135)	(0.150)
Below median financial dev. pre GQ	-0.050	-0.060	-0.008	0.066	0.132
	(0.078)	(0.105)	(0.097)	(0.112)	(0.124)
Observations	9058	8663	8885	8978	9050
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 6: Dynamic Analysis using One-Digit NIC Industry Sectors

See Appendix Table 5.

	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
	(1)	(2)	(3)	(4)	(5)
			A. Base Specification		
Nodal districts	0.492++	0.923+++	1.070+++	1.195+++	1.175+++
	(0.215)	(0.230)	(0.269)	(0.293)	(0.334)
Districts 0-10 km from GQ highway	0.031	0.052	0.112+	0.141++	0.200+++
	(0.036)	(0.055)	(0.057)	(0.062)	(0.070)
Districts 10-50 km from GQ highway	0.046	0.047	0.040	0.015	-0.014
	(0.044)	(0.061)	(0.064)	(0.065)	(0.078)
Linear difference over bands	-0.016	0.005	0.072	0.126+	0.214++
	(0.049)	(0.071)	(0.073)	(0.076)	(0.089)
			B. Separating by Initial Level of Financial Development		
Nodal districts	0.507++	0.941+++	1.087+++	1.205+++	1.179+++
	(0.215)	(0.230)	(0.270)	(0.294)	(0.334)
Districts 0-10 km from GQ highway	0.091++	0.126+	0.180++	0.182++	0.217++
* above median financial dev. pre GQ	(0.046)	(0.072)	(0.083)	(0.089)	(0.097)
Districts 0-10 km from GQ highway	-0.048	-0.043	0.025	0.088	0.177+
* below median financial dev. pre GQ	(0.051)	(0.078)	(0.073)	(0.080)	(0.093)
Districts 10-50 km from GQ highway	0.044	0.044	0.037	0.013	-0.015
	(0.044)	(0.061)	(0.063)	(0.065)	(0.078)
Linear difference of 0-10 to 10-50 km	0.048	0.082	0.142	0.169+	0.232++
Above median financial dev. pre GQ	(0.057)	(0.086)	(0.094)	(0.100)	(0.114)
Below median financial dev. pre GQ	-0.091	-0.087	-0.013	0.075	0.192+
	(0.061)	(0.087)	(0.085)	(0.088)	(0.105)
Observations	3045	3059	3064	3065	3065
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 7: Analysis of GQ on Financial Development using PPML Estimator

See Table 1. This table reports the results of Poisson pseudo-maximum likelihood regressions with multi-way fixed effects using the routine of Correia et al. (2020). Estimation models district-industry cells annually for 1999-2009. Estimations include 132,866 observations. The dependent variable for Columns 1 - 4 is the loan credit for a district-industry; the dependent variable for Columns 5 - 8 is the loan count. Regressions include high-dimensional fixed effects as indicated for each column. Standard errors are clustered by district and reported below coefficients; *, **, and *** refer to statistical significance at the 10%, 5%, and 1% levels, respectively.

	Loan volume				Loan count			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nodal districts x (2003-2005)	0.099+++	0.069	0.038	0.038	0.140	0.103	0.079	0.121+
	(0.022)	(0.048)	(0.027)	(0.057)	(0.104)	(0.083)	(0.072)	(0.062)
Nodal districts x (2006-2009)	0.052	0.009	-0.059	-0.024	0.302	0.221+	0.213+	0.251++
	(0.046)	(0.070)	(0.080)	(0.093)	(0.189)	(0.130)	(0.129)	(0.099)
Districts 0-10 km from GQ highway x (2003-2005)	0.069+	0.090+	0.044	0.087++	0.072+++	0.073++	0.065++	0.065++
	(0.042)	(0.047)	(0.035)	(0.040)	(0.025)	(0.033)	(0.026)	(0.028)
Districts 0-10 km from GQ highway x (2006-2009)	0.103+	0.105	0.027	0.103	0.093+++	0.073	0.107+++	0.091++
	(0.056)	(0.070)	(0.061)	(0.064)	(0.033)	(0.049)	(0.038)	(0.045)
Districts 10-50 km from GQ highway x (2003-2005)	-0.015	-0.088+	-0.019	-0.059	0.013	-0.025	-0.004	-0.016
	(0.047)	(0.048)	(0.058)	(0.042)	(0.059)	(0.051)	(0.048)	(0.044)
Districts 10-50 km from GQ highway x (2006-2009)	-0.033	-0.197+++	-0.070	-0.156++	0.045	-0.016	0.049	0.010
	(0.086)	(0.073)	(0.091)	(0.067)	(0.078)	(0.067)	(0.067)	(0.057)
District x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year Fixed Effects	Yes	No	Yes	No	Yes	No	Yes	No
State x Industry x Year Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes
Fixed Effects for District Traits x Year	No	No	Yes	Yes	No	No	Yes	Yes

Appendix Table 8: Impact of GQ by Type of Construction Activity

See Table 1. This table breaks down the 0-10 km districts into those that had new construction vs. those that had upgrades to existing highways.

	Change in log loan volume				Change in log count	Change in log av size
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive Margin for District-Industries with 1999 and 2009 Lending					
Nodal districts	1.814+++	1.717+++	1.392+++	1.408+++	0.581+++	0.972+++
	(0.306)	(0.343)	(0.324)	(0.360)	(0.185)	(0.202)
Districts 0-10 km from GQ highway	0.491+++	0.501+++	0.311++	0.240+	0.206+++	0.027
* New Construction	(0.118)	(0.144)	(0.130)	(0.134)	(0.073)	(0.082)
Districts 0-10 km from GQ highway	0.128	0.135	0.163	0.154	0.097	0.062
* Upgrades	(0.117)	(0.130)	(0.108)	(0.105)	(0.069)	(0.058)
Districts 10-50 km from GQ highway	-0.145	-0.072	-0.004	0.005	0.101	-0.096
	(0.129)	(0.127)	(0.108)	(0.105)	(0.062)	(0.061)
Linear difference of 0-10 to 10-50 km	0.636+++	0.573+++	0.316++	0.235	0.105	0.123
New Construction	(0.160)	(0.170)	(0.151)	(0.152)	(0.082)	(0.095)
Upgrades	0.273+	0.207	0.167	0.150	-0.005	0.158++
	(0.159)	(0.159)	(0.137)	(0.135)	(0.083)	(0.079)
	B. Extended Sample Allowing Entry or Exit from District-Industries					
Nodal districts	3.118+++	3.022+++	1.949+++	1.983+++	0.665+++	1.136+++
	(0.358)	(0.420)	(0.373)	(0.430)	(0.193)	(0.237)
Districts 0-10 km from GQ highway	0.847+++	0.866+++	0.453++	0.370+	0.210+++	0.119
* New Construction	(0.204)	(0.242)	(0.189)	(0.196)	(0.074)	(0.115)
Districts 0-10 km from GQ highway	0.099	0.160	0.232	0.232	0.107+	0.106
* Upgrades	(0.182)	(0.197)	(0.142)	(0.141)	(0.063)	(0.089)
Districts 10-50 km from GQ highway	-0.217	-0.038	0.011	0.055	0.093	-0.050
	(0.195)	(0.199)	(0.164)	(0.163)	(0.061)	(0.103)
Linear difference of 0-10 to 10-50 km	1.064+++	0.904+++	0.442++	0.316	0.117	0.170
New Construction	(0.260)	(0.274)	(0.220)	(0.219)	(0.081)	(0.135)
Upgrades	0.316	0.198	0.221	0.177	0.014	0.156
	(0.243)	(0.252)	(0.197)	(0.198)	(0.077)	(0.129)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	No	Yes	No	Yes	Yes	Yes
Fixed Effects for District Traits	No	No	Yes	Yes	Yes	Yes

Appendix Table 9: Comparison of Traits in 2000 for non-Nodal Districts on GQ and NS-EW Highway Systems

Comparison excludes 10 districts within 10 km of both highways.

	GQ	NS-EW	t-test	Significance
	(1)	(2)	(3)	(4)
N	59	65		
Log total population	15.036	14.674	-3.9362	***
Percent urban	0.266	0.278	0.3987	
Distance to nearest highway	7.831	6.656	-0.9258	
Distance to nearest railroad	13.282	9.511	-1.7788	*
Composite index of local infrastructure	3.017	3.202	1.4993	
Share of households with banking	0.362	0.355	-0.3173	
Log lending level 1999	12.015	11.732	-1.0743	
Log lending level 1999 per capita	-3.021	-2.942	0.3204	
Log lending growth 1996 to 2000	-0.278	-0.259	0.2881	
Log average loan size 1999	4.283	4.191	-0.9939	
Share above median in fin development	0.576	0.523	-0.5905	
Log estimated bank branches per capita	-10.361	-10.303	0.4581	

Appendix Table 10: NS-EW Highway Estimations Allowing for Entry and Exit

See Table 2. Table extends the sample to allow for entry or exit of lending by recoding zero loan activity to a value of 0.1 (12,403 observations).

	Change in log loan volume				Change in log count	Change in log av size
	(1)	(2)	(3)	(4)	(5)	(6)
Nodal GQ districts	2.350+++	2.457+++	1.380+++	1.602+++	0.500++	0.922+++
	(0.555)	(0.653)	(0.471)	(0.531)	(0.214)	(0.281)
Districts 0-10 km from GQ highway	0.456+++	0.445+++	0.321+++	0.283++	0.147+++	0.106
	(0.147)	(0.171)	(0.123)	(0.120)	(0.052)	(0.073)
Districts 10-50 km from GQ highway	-0.188	-0.040	0.011	0.057	0.094	-0.049
	(0.194)	(0.198)	(0.161)	(0.159)	(0.060)	(0.101)
Nodal NS-EW districts	1.421++	0.999	1.070++	0.793	0.318+	0.468
	(0.579)	(0.824)	(0.443)	(0.529)	(0.188)	(0.303)
Districts 0-10 km from NS-EW highway	0.055	-0.082	-0.022	-0.013	-0.005	-0.015
	(0.151)	(0.152)	(0.132)	(0.122)	(0.048)	(0.076)
Districts 10-50 km from NS-EW highway	-0.084	-0.286+	-0.015	-0.043	-0.054	0.011
	(0.157)	(0.151)	(0.133)	(0.123)	(0.050)	(0.075)
P Value: GQ 0-10 = NS-EW 0-10	0.049	0.012	0.046	0.061	0.016	0.207
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	No	Yes	No	Yes	Yes	Yes
Fixed Effects for District Traits	No	No	Yes	Yes	Yes	Yes

Appendix Table 11: IV Estimates using Straight-Lines between District Nodes

See Table 1. Panel A modifies the base OLS estimation to exclude nodal districts and also Bangalore. Estimations measure effects relative to districts 10+ km from the GQ network. Panel B reports IV estimations that instrument proximity to the GQ network with being within 15 km of the straight line between nodal districts. Route 1 does not connect Bangalore directly, while Route 2 treats Bangalore as a connection point. The null hypothesis in the exogeneity tests is that the instrumented regressor is exogenous.

	Intensive Margin Only			Allowing Entry and Exit		
	(1)	(2)	(3)	(4)	(5)	(6)
				A. OLS Specification		
Districts 0-10 km from GQ highway	0.301+++	0.298+++	0.178++	0.453+++	0.463+++	0.262++
	(0.103)	(0.108)	(0.086)	(0.167)	(0.174)	(0.117)
				B. Second-Stage Estimates with IV Route 1		
Districts 0-10 km from GQ highway	0.340+	0.334+	0.061	0.638++	0.624++	0.156
	(0.196)	(0.195)	(0.166)	(0.308)	(0.308)	(0.238)
First stage F statistic	55.6	56.8	52.7	53.3	54.5	52.5
Exogeneity test p value	0.832	0.846	0.476	0.525	0.584	0.634
				B. Second-Stage Estimates with IV Route 2		
Districts 0-10 km from GQ highway	0.308++	0.324++	0.182	0.577++	0.648++	0.329+
	(0.153)	(0.162)	(0.133)	(0.247)	(0.261)	(0.194)
First stage F statistic	101.5	93.1	101.6	89.7	81.8	95.5
Exogeneity test p value	0.961	0.864	0.970	0.589	0.450	0.701
Observations	8,687	8,484	8,687	12,003	11,763	12,003
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Exclude Districts within 50km of Node	No	Yes	No	No	Yes	No
Fixed Effects for District Traits	No	No	Yes	No	No	Yes

Appendix Table 12: Industry Analysis with Dynamic Time Horizon

See Table 3. This table repeats Column 1 of Table 3 for different time periods as indicated by column headers.

	1999-2001	1999-2003	1999-2005	1999-2007	1999-2009
	(1)	(2)	(3)	(4)	(5)
Nodal districts	0.761+++	1.134+++	1.298+++	1.420+++	1.476+++
	(0.235)	(0.279)	(0.284)	(0.373)	(0.356)
Districts 0-10 km from GQ highway	0.067	0.146++	0.229+++	0.196++	0.213++
	(0.051)	(0.072)	(0.075)	(0.091)	(0.097)
Districts 10-50 km from GQ highway	0.075	0.089	0.115	0.073	-0.002
	(0.059)	(0.084)	(0.089)	(0.107)	(0.113)
Interacted with Industry Cost per Establishment					
Nodal districts	0.111++	0.131+++	0.118++	0.177+++	0.227+++
	(0.055)	(0.050)	(0.051)	(0.060)	(0.055)
Districts 0-10 km from GQ highway	0.058+++	0.083+++	0.093+++	0.054+	0.065++
	(0.021)	(0.027)	(0.028)	(0.031)	(0.032)
Districts 10-50 km from GQ highway	0.033	-0.003	0.011	0.018	-0.008
	(0.026)	(0.035)	(0.034)	(0.034)	(0.039)
Observations	7632	7206	7417	7491	7549
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 13: Industry Analysis with NS-EW Comparison

See Tables 2 and 3. 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.

	Baseline model with industry interactions	Focus on land and asset inputs	Focus on labor and raw material inputs	Column 1 with a control for cost shares of output	Column 1 using dummy variable for above median
	(1)	(2)	(3)	(4)	(5)
Nodal GQ districts	1.179+++	1.184+++	1.177+++	1.175+++	0.969++
	(0.375)	(0.375)	(0.374)	(0.375)	(0.380)
Districts 0-10 km from GQ highway	0.208++	0.212++	0.206++	0.208++	0.117
	(0.093)	(0.094)	(0.092)	(0.093)	(0.082)
Districts 10-50 km from GQ highway	0.011	0.012	0.011	0.011	-0.013
	(0.110)	(0.111)	(0.109)	(0.110)	(0.100)
Nodal NS-EW districts	0.704+	0.707+	0.702+	0.707+	0.670+
	(0.369)	(0.369)	(0.368)	(0.367)	(0.370)
Districts 0-10 km from NS-EW highway	0.019	0.020	0.018	0.020	0.027
	(0.089)	(0.090)	(0.089)	(0.089)	(0.082)
Districts 10-50 km from NS-EW highway	-0.069	-0.069	-0.069	-0.069	-0.122
	(0.096)	(0.097)	(0.096)	(0.096)	(0.092)
Interacted with Industry Cost per Establishment					
Nodal GQ districts	0.226+++	0.294+++	0.135+++	0.295+++	0.442+++
	(0.064)	(0.073)	(0.048)	(0.069)	(0.165)
Districts 0-10 km from GQ highway	0.067++	0.079++	0.046+	0.075++	0.188++
	(0.033)	(0.038)	(0.025)	(0.035)	(0.088)
Districts 10-50 km from GQ highway	-0.007	-0.002	-0.002	-0.013	0.056
	(0.039)	(0.046)	(0.029)	(0.046)	(0.096)
Nodal NS-EW districts	0.018	0.037	0.005	0.030	0.067
	(0.084)	(0.098)	(0.062)	(0.094)	(0.220)
Districts 0-10 km from NS-EW highway	0.003	0.005	-0.001	0.006	-0.023
	(0.030)	(0.035)	(0.023)	(0.034)	(0.078)
Districts 10-50 km from NS-EW highway	0.027	0.026	0.022	0.023	0.114
	(0.037)	(0.042)	(0.029)	(0.040)	(0.093)
Observations	7549	7549	7549	7549	7549
State x Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Fixed Effects for District Traits	Yes	Yes	Yes	Yes	Yes

Appendix Table 14a: Credit and Branch Growth - Nodal

Table documents levels compared to 1999 values. Panel C divides values in Panel A by those in Panel B.

	Credit	Accounts	Branches	Credit / Branch	Accounts / Branch
	(1)	(2)	(3)	(4)	(5)
			A. Summed values for nodal districts of GQ network		
1999	1.00	1.00	1.00	1.00	1.00
2000	1.22	0.98	1.03	1.18	0.95
2001	1.42	1.41	1.05	1.36	1.35
2002	1.75	1.54	1.08	1.59	1.43
2003	1.94	1.92	1.12	1.72	1.72
2004	2.10	3.82	1.19	1.74	3.21
2005	2.64	5.36	1.26	2.04	4.26
2006	3.28	7.66	1.36	2.37	5.65
2007	3.99	8.24	1.48	2.65	5.55
2008	4.51	12.05	1.66	2.67	7.26
2009	4.92	12.69	1.79	2.71	7.08
			B. Summed values for nodal districts of NS-EW network		
1999	1.00	1.00	1.00	1.00	1.00
2000	1.13	1.00	1.03	1.09	0.97
2001	1.41	1.38	1.06	1.34	1.30
2002	1.58	1.68	1.08	1.46	1.55
2003	1.78	2.28	1.13	1.65	2.02
2004	2.04	3.00	1.21	1.67	2.48
2005	2.50	4.28	1.29	1.96	3.31
2006	3.06	5.81	1.39	2.18	4.18
2007	3.85	7.07	1.54	2.51	4.58
2008	4.47	8.04	1.73	2.53	4.64
2009	5.39	8.75	1.89	2.86	4.64
			C: Nodal districts from GQ network relative to NS-EW network		
1999	1.00	1.00	1.00	1.00	1.00
2000	1.08	0.98	1.00	1.08	0.98
2001	1.01	1.02	0.99	1.02	1.03
2002	1.11	0.92	0.99	1.09	0.92
2003	1.09	0.84	0.99	1.05	0.85
2004	1.03	1.27	0.98	1.04	1.30
2005	1.06	1.25	0.97	1.04	1.29
2006	1.07	1.32	0.97	1.09	1.35
2007	1.04	1.17	0.96	1.05	1.21
2008	1.01	1.50	0.96	1.05	1.57
2009	0.91	1.45	0.95	0.95	1.53

Appendix Table 14b: Credit and Branch Growth - 0-10 km

Table documents levels compared to 1999 values. Panel C divides values in Panel A by those in Panel B.

	Credit	Accounts	Branches	Credit / Branch	Accounts / Branch
	(1)	(2)	(3)	(4)	(5)
	A. Summed values for non-nodal districts 0-10 km from GQ network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.11	1.20	1.01	1.10	1.18
2001	1.33	1.46	1.02	1.30	1.43
2002	1.45	1.83	1.04	1.40	1.77
2003	1.69	2.51	1.05	1.60	2.38
2004	1.95	3.48	1.09	1.80	3.20
2005	2.51	4.68	1.17	2.14	4.00
2006	3.12	6.21	1.32	2.45	4.71
2007	3.91	7.94	1.48	2.73	5.36
2008	4.81	9.04	1.63	2.98	5.56
2009	5.58	10.96	1.77	3.19	6.20
	B. Summed values for non-nodal districts 0-10 km from NS-EW network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.14	1.21	1.01	1.13	1.20
2001	1.36	1.42	1.02	1.33	1.40
2002	1.46	1.67	1.03	1.42	1.62
2003	1.61	2.20	1.06	1.53	2.09
2004	1.81	2.97	1.08	1.67	2.75
2005	2.19	3.74	1.13	1.94	3.32
2006	2.75	5.03	1.23	2.24	4.10
2007	3.54	6.57	1.32	2.69	4.99
2008	4.22	7.46	1.52	2.87	4.92
2009	4.72	8.86	1.63	2.91	5.43
	C: Districts 0-10 km from GQ network relative to NS-EW network				
1999	1.00	1.00	1.00	1.00	1.00
2000	0.97	0.99	1.00	0.97	0.99
2001	0.98	1.03	1.00	0.97	1.02
2002	0.99	1.10	1.01	0.98	1.09
2003	1.05	1.14	1.00	1.05	1.14
2004	1.08	1.17	1.01	1.07	1.16
2005	1.15	1.25	1.04	1.11	1.21
2006	1.13	1.23	1.07	1.09	1.15
2007	1.10	1.21	1.13	1.01	1.07
2008	1.14	1.21	1.07	1.04	1.13
2009	1.18	1.24	1.08	1.10	1.14

Appendix Table 14c: Credit and Branch Growth - 10-50 km

Table documents levels compared to 1999 values. Panel C divides values in Panel A by those in Panel B.

	Credit	Accounts	Branches	Credit / Branch	Accounts / Branch
	(1)	(2)	(3)	(4)	(5)
	A. Summed values for non-nodal districts 10-50 km from GQ network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.19	1.23	1.01	1.18	1.22
2001	1.41	1.50	1.02	1.39	1.48
2002	1.47	1.81	1.03	1.43	1.75
2003	1.70	2.36	1.05	1.62	2.25
2004	1.99	3.29	1.07	1.85	3.06
2005	2.68	4.32	1.23	2.18	3.52
2006	3.17	5.88	1.40	2.26	4.20
2007	4.09	7.75	1.53	2.67	5.06
2008	4.81	9.12	1.72	2.80	5.31
2009	5.73	10.56	1.86	3.08	5.68
	B. Summed values for non-nodal districts 10-50 km from NS-EW network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.16	1.26	1.01	1.15	1.25
2001	1.38	1.53	1.02	1.36	1.51
2002	1.56	1.87	1.03	1.52	1.82
2003	1.84	2.52	1.06	1.75	2.39
2004	2.16	3.45	1.08	2.00	3.19
2005	2.80	4.60	1.14	2.45	4.03
2006	3.33	6.35	1.26	2.64	5.04
2007	4.07	8.08	1.41	2.90	5.75
2008	4.82	9.30	1.64	2.94	5.67
2009	5.42	11.12	1.79	3.02	6.20
	C: Districts 10-50 km from GQ network relative to NS-EW network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.03	0.98	1.00	1.03	0.98
2001	1.02	0.98	1.00	1.02	0.98
2002	0.94	0.97	1.01	0.94	0.96
2003	0.92	0.94	0.99	0.93	0.94
2004	0.92	0.95	1.00	0.92	0.96
2005	0.96	0.94	1.08	0.89	0.87
2006	0.95	0.93	1.11	0.85	0.83
2007	1.00	0.96	1.09	0.92	0.88
2008	1.00	0.98	1.05	0.95	0.94
2009	1.06	0.95	1.04	1.02	0.92

Appendix Table 14d: Credit and Branch Growth - 50+ km

Table documents levels compared to 1999 values. Panel C divides values in Panel A by those in Panel B.

	Credit	Accounts	Branches	Credit / Branch	Accounts / Branch
	(1)	(2)	(3)	(4)	(5)
	A. Summed values for non-nodal districts 50+ km from GQ network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.13	1.23	1.01	1.12	1.22
2001	1.35	1.47	1.02	1.32	1.44
2002	1.47	1.75	1.03	1.43	1.69
2003	1.63	2.30	1.06	1.54	2.17
2004	1.87	3.13	1.09	1.74	2.88
2005	2.28	4.02	1.14	1.97	3.54
2006	2.82	5.51	1.22	2.25	4.50
2007	3.57	7.03	1.34	2.70	5.26
2008	4.29	7.99	1.52	2.82	5.25
2009	4.99	9.38	1.67	2.99	5.63
	B. Summed values for non-nodal districts 50+ km from NS-EW network				
1999	1.00	1.00	1.00	1.00	1.00
2000	1.21	1.16	1.01	1.19	1.15
2001	1.39	1.47	1.02	1.30	1.44
2002	1.68	1.71	1.04	1.61	1.65
2003	1.87	2.20	1.06	1.70	2.08
2004	2.04	3.68	1.09	1.83	3.37
2005	2.59	4.93	1.17	2.16	4.21
2006	3.22	6.88	1.29	2.43	5.33
2007	3.94	8.08	1.43	2.70	5.63
2008	4.56	10.57	1.58	2.83	6.70
2009	4.97	11.91	1.73	2.82	6.90
	C: Districts 50+ km from GQ network relative to NS-EW network				
1999	1.00	1.00	1.00	1.00	1.00
2000	0.93	1.06	1.00	0.94	1.06
2001	0.97	1.00	1.00	1.02	1.00
2002	0.88	1.02	0.99	0.89	1.03
2003	0.87	1.05	1.00	0.91	1.05
2004	0.92	0.85	0.99	0.95	0.86
2005	0.88	0.82	0.97	0.91	0.84
2006	0.88	0.80	0.95	0.93	0.85
2007	0.91	0.87	0.93	1.00	0.93
2008	0.94	0.76	0.96	1.00	0.78
2009	1.00	0.79	0.97	1.06	0.82