Investment Opportunities and Financing Externalities : Evidence from the Golden Quadrilateral in India*

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ABSTRACT

Do business groups impose financing externalities on standalone firms in the local economy? We examine this question in the context of Indian business groups, specifically, using a recent large-scale highway development project as a shock to local investment opportunity. We find that business group affiliated firms invest more than standalone firms in response to upgraded highway connectivity. We show that the investment behavior of standalone firms is affected by the density of business groups in the local area. On the financing side, we find that the presence of business groups makes it harder for other standalone firms in the local economy to raise external finance. This business group externality works through the banking sector, when the banks associated with standalone firms share lending relationships with, and have large exposure to, firms affiliated with business groups. Overall, our study sheds light on a negative externality in the economy and documents the costs of conglomeration wherein business groups inhibit the growth of standalone firms due to lack of finance.

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I. Introduction

A vast literature on conglomerates and business groups compares resource allocation in these organizations relative to standalone firms.[1] The objective of this comparison is to understand the role played by internal labor or capital markets within conglomerates/business groups.[2] While extant research has focused on understanding the functioning and efficiency of internal markets, there is limited empirical evidence on the effects of conglomeration on other firms in the local economy. For example, conglomerates might make it harder for small independent firms to raise external financing. This can have implications for the allocative efficiency of external capital markets. To this end, we study whether and how business groups impose externalities on other standalone firms in the economy.

Multi-segment firms (or Conglomerates) as an organizational form are common in the United States.[3] However, there is a considerable decline in importance of internal reallocation within conglomerates in the United States as a result of financial development. In contrast, many emerging markets are characterized by weak legal environments and ineffectual investor protection. This, in turn, makes it difficult for firms to raise external financing (La Porta, Lopez-de Silanes, Shleifer, and Vishny (1997)). In such environments, firms are often organized as business groups - "a group of legally independent firms under common ownership" which share significant operational and financial inter-linkages (Gopalan, Nanda, and Seru (2007)). Given the prevalence of this organizational form, measuring the welfare consequences of business groups in a convincing way is important in emerging markets.

Theoretically, models have identified a cost of conglomeration and have shown adverse effects that presence of conglomerates might have on standalone firms in the economy. For example, Almeida and Wolfenzon (2006) argue that financial market imperfections such as low investor protection generate equilibrium costs of conglomeration. Specifically, too much capital is "trapped"

[1] See, Khanna and Palepu (2000), and Almeida, Kim, and Kim (2015). For a review of the literature on conglomerates, see, Stein (2003) and cites therein.

[2] Most papers examine the role of internal labor/capital markets in times of distress (Cestone, Fumagalli, Kramarz, and Pica (2016); Kuppuswamy and Villalonga (2015); Gopalan and Xie (2011)) and market turmoil (Matvos and Seru (2014)).

[3] We use the terms "conglomerate" and "business group" interchangeably. These organizational forms are different in many aspects but have active internal capital markets which function in a similar manner. For example, business group allocate capital among member firms while conglomerates allocate capital among divisions.

inside the business groups, and while the allocation of this capital might be efficient for the business group itself, standalone firms deserving of capital are left starving.

To test the predictions of their model, we use a recent large-scale highway development project (called Golden Quadrilateral, henceforth GQ) in India as a shock to *local* investment opportunity of the firms located in those areas. Particularly, we exploit the upgrade of GQ road network as a shock to local investment opportunity for firms located along the network as it increases those firms' access to other regional markets. The GQ program offers an opportunity to study the changes in investment opportunities of firms, which contemporaneously do not affect their financing capacity thereby allowing us to study business group externality. These effects may be different compared to situations when financial constraints are binding and can be informative of broader implications of capital allocation by business groups.

We hypothesize that the presence of business groups makes it harder for other standalone firms in the economy to raise capital. This effect would be particularly strong when standalone firms are in locations surrounded by a large number of group-affiliated firms, and when banks associated with standalone firms share lending relationships with and have large exposure to, firms affiliated with business groups.

We employ a difference-in-differences specification that exploits the staggered commencement of construction of highway stretches connecting various cities across Indian states. It involved upgradation of the 5,800-kilometer highway system that connects the four major cities of Delhi, Mumbai, Chennai, and Kolkata, making it the fifth-longest highway in the world.[4] This program involved significant investments by the government and represented a major infrastructure improvement for India.[5]

As the first step, we start by establishing direct evidence that investment increases for firms located in areas in which the roads are upgraded. We find a significant increase in the total investments in the two years following the commencement of road upgrades. The magnitude of this increase is substantial. For example, an average firm which benefits from this road network upgrade increased its investments by 3% of total assets. This represents an increase of two-thirds relative

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

[5]See section II for background details.

to the mean level of investment. Relatedly, we also show that the firms' total factor productivity increased after the road upgrade, as they benefited from enhanced access to the road network. Thus, the evidence suggests that we have a *plausible* investment opportunity shock.

Next, we analyze whether firms respond differentially to the road upgrades owing to differences in their organizational structure. Prior work argues that group affiliated firms benefit from the transfer of resources within the group, enabling them to capitalize on profitable new investment opportunities. Such internal transfers can economize costs of external finance thus allowing firms to allocate capital to the right project (Stein (2003)). However, standalone firms by definition do not have access to such internal resource transfers. Thus, we expect differences in investment behavior between group-affiliated firms and standalone firms.

Our results confirm that business group affiliated firms invest more than standalone firms. We show that group-affiliated firms increase their total investment rather than merely reallocating capital within the group. Our empirical strategy allows us to control for substantial heterogeneity by way of high dimensional fixed effects and hence rule out concerns about location and industry specific supply/demand effects that may differentially affect group-affiliated firms following the GQ upgrades. Additionally, we do not find differences in investment behavior of group-affiliated firms before the upgrade, ruling out concerns about reverse causality. In sum, group-affiliated firms significantly increased their investments while standalone firms were unable to increase their investments after the GQ road upgrade.

Furthermore, we examine whether standalone firms face financing externalities in the presence of conglomerates, which renders them unable to capitalize on the investment opportunity afforded by GQ upgrades. Our methodology compares *standalone* firms around the investment opportunity shock as a function of the degree of conglomeration in the local market. We hypothesize that the presence of business groups makes it harder for other standalone firms in the economy to raise capital. Consistent with this hypothesis, our results suggest that the investment behavior of standalone firms around an investment opportunity shock is affected by the density of business groups in the local area. This effect is particularly stronger when standalone firms are in locations surrounded by a large number of group-affiliated firms. We document that standalone firms are unable to invest when the density of business groups in the local area is very high.

We also consider an alternative interpretation for our results. The investment opportunity

afforded by GQ upgrades might be mutually exclusionary. To put it differently, if group-affiliated firms utilize all investment opportunities available locally by investing heavily, then standalone firms will be unable to invest because of lack of locally available investment opportunity. Contrary to this explanation, we find that in heavily export oriented industries, standalone firms in locations surrounded by a large number of group-affiliated firms are severely financially constrained which renders them unable to invest. This is consistent with the financing channel i.e. business group externality is driving our results.

Next, we examine the factors driving such financial externalities. We present evidence that the channel through which the business group externality works is the banking sector. We show that the financial constraints for standalone firms are severe when banks associated with them have large exposure to group-affiliated firms. Additionally, we find that standalone firms are unable to borrow if they are associated with a critical lender who shares lending relationship with group-affiliated firms.

Overall, our study sheds light on a negative externality in the economy and documents the presence of costs of conglomeration wherein business groups inhibit the growth of standalone firms due to lack of finance. Our paper is relevant to the large literature on business groups and conglomerates on several fronts. First, prior literature has often focused on examining conglomerates in isolation and ignored their impact on other firms in the economy (Hoshi, Kashyap, and Scharfstein (1991); Gopalan, Nanda, and Seru (2007); Almeida, Kim, and Kim (2015)).[6] These studies provide convincing evidence on the functioning and efficiency of internal capital markets. However, there is limited empirical evidence on the effects of conglomeration on other firms in the economy. Our paper provides such evidence.

Second, we provide empirical support for predictions from Almeida and Wolfenzon (2006). In their model, they show that financial market imperfections such as low investor protection generate equilibrium costs of conglomeration. Differences in pledgability of projects between conglomerates and standalone firms make it optimal for standalone firms to supply the project's capital to external capital market. Therefore, high degree of conglomeration is associated with smaller supply of capital

[6]Recent work by Boutin, Cestone, Fumagalli, Pica, and Serrano-Velarde (2013) is the closest study which investigates whether and how business groups exert influence on other sectors of the economy. They examine the effect of business groups' financial strength on product market competition and show that groups with deep-pockets significantly affect the entry and exit decisions of firms in industries. However, they do not have much to say on whether groups impose externalities on other firms.

in the external market for standalone firms thereby affecting the efficiency of aggregate investment.

Lastly, our paper is also related to literature examining the impact of highway infrastructure on local economic activity. Chandra and Thompson (2000) study the impact of U.S interstate highways and show that they have differential impact on non-metropolitan areas, across industries and affect the spatial allocation of economic activity. In the context of GQ, Datta (2012) finds that firms in cities that lay along the routes of the four upgraded highways benefited significantly from the improved highways. They find that firms had increased inventory efficiency due to lower transportation obstacles to production and access to efficient suppliers. Ghani, Goswami, and Kerr (2014) show that the upgraded GQ network had a strong impact on the growth of manufacturing activity. While our findings are highly complementary in nature, we document significant differences in response across firms which imposes externality on standalone firms.

The rest of the paper is organized as follows. The next section describes background about the golden quadrilateral and discusses the main features of the network. Section III describes the data with a special focus empirical methodology employed. Section IV contains the main empirical results and section V concludes.

II. Background about the Golden Quadrilateral

India has second largest road network in the world.[7] National highways are critical to this road network and play a significant role in interstate trade while carrying nearly half of the total road traffic volume. At the end of 1990s, India's highway network was in a state of disarray marked by poor connectivity, sub-par road conditions and congestion with limited lane capacity. Poor road surface conditions, frequent stops at state borders for tax collection and increased demand from growing traffic all contributed to congestion with 25% of roads categorized as congested (World-Bank (2002)).

To tackle these issues, Government of India (GoI) launched the National Highways Development Project (NHDP) in 1998 with the aim to improve the performance of the highway network. We study the *upgrade* of the 5,800 kilometer highway system called the Golden Quadrilateral (GQ) which connects the four major cities of Delhi, Mumbai, Chennai, and Kolkata, making it the fifth-

[7] It consists of expressways, national highways, state highways, major district and rural roads. Taken together, these roads carry close to 65 percent of freight in terms of weight.

longest highway in the world.[8] The project was initially approved in 1998, but many stretches of the project started only as late as 2001. These delays in the start of construction led to differences in completion.[9] Construction was complete for a significant portion of the stretches by the end of 2006, but minor work on additional phases of the project continued even as late as 2009.

To complete the GQ upgrades, 128 separate contracts were awarded.[10] The cost of the project was envisaged at 600 billion rupees (around US$ 9 billion) while actual cost incurred totaled to 250 billion rupees (around US$ 3.75 billion).[11] Most of the construction involved public-private partnerships and cost was to be recovered by levying a cess of INR 1 on petrol and diesel. Significant portion of the funding came from federal government while the remainder from multi-lateral financing agencies such as Asian Development Bank (ADB), and World Bank (WB).[12] Therefore, the road construction by itself didn't impose constraints on the banking system.

The most direct benefit from upgraded connectivity is a significant reduction in transportation costs and improved market access for firms to other regional markets (Asturias, García-Santana, and Magdaleno (2016)).[13]Datta (2012) finds that immediately after the upgrades *commenced* there is improved inventory efficiency and input sourcing by manufacturing firms located along the GQ road network.[14] Ghani, Goswami, and Kerr (2014) find significant differential response by organized manufacturing firms within 10km of the highway but find no significant response among firms located 50km away from the highway. As evident, firms respond differentially based on their location along the network which suggests that *upgrade* of GQ is a significant investment opportunity for firms that lay along the upgraded road network.

[8]The GQ work involved upgrading highways to international standards by incorporating features of high-quality highway systems such as expanded lane capacities, dual-carriageway highways with grade separators, over-bridges,bypasses and access roads. This upgrade raised the share of highways to 12% of the road network by the end of 2006. In comparison, highways constitute about 5% of the road network in developed economies such as US and Japan and 13% in United Kingdom (World-Road-Statistics (2009))

[9]The junior Highways Minister, Tushar Chaudhary told the Parliament that "Projects have been delayed mainly due to problems associated with land acquisition, shifting of utilities, obtaining environment and forest clearance, approval for road over bridges, poor performance of some contractors due to cash flow constraints and law and order problems in some states."

[10]The majority of construction began in 2001, with a target completion date of 2004.

[11]1 US$ is approximately equivalent to 67 INR

[12]The federal government contributed about 60% of financing, while the multi-lateral agencies contributed 20% and rest was raised through a variety of new public-private initiatives such as BOT, Equity sharing concessionaire agreements etc. For financing, the federal government created Central Road Fund through the Central Road Fund Ordinance, 2000 in November, 2000. The revenue accrued through levies would form part of the fund which was used to finance the upgrade of highways. In addition, the government increased allocation by 42% over the preceding year. Such increases allocation to infrastructure was unprecedented (Source: NHAI Annual Reports).

[13]For other work related to market access, see Alder (2014)

[14]For evidence on significant long-term economic benefits , see Khanna (2014)

Or identification strategy exploits variation in the *commencement* of road construction for cities located on the GQ road network to study the spillover effects of group-affiliated firms on standalone firms in the local economy. We compare outcomes for firms located along GQ to firms located away from GQ. This methodology has been used in a number of papers to study the economic impacts of US inter-state highways (see Chandra and Thompson (2000) and Michaels (2008)). It is, however, crucial to remember that a highway network already existed between these four cities, and the project merely *upgraded* the system thereby reducing congestion and travel times.

III. Data and Empirical Methodology

A. Data

Financial data are from *Prowess*, a database maintained by CMIE, Center for Monitoring the Indian Economy. This data set has been used by a number of prior studies on Indian firms, including Bertrand, Mehta, and Mullainathan (2002), Gopalan, Nanda, and Seru (2007), Lilienfeld-Toal, Mookherjee, and Visaria (2012) and Gopalan, Mukherjee, and Singh (2016). *Prowess* contains annual financial data sourced from balance sheets and income statements for about 34,000 publicly listed and private Indian firms. The data is of panel nature covering about 2000 to 6000 firms every year with assets plus sales of over INR 40 million. It contains additional descriptive information on the location of the registered office, industry classification, year of incorporation and group affiliation. We adopt Prowess' group classification to identify whether a firm is affiliated to a business group or not.[15] This group affiliation has been most notably used in Khanna and Palepu (2000) and Bertrand, Mehta, and Mullainathan (2002). We assign firms to treatment group which is defined as receiving an *upgraded* road based on the location of the registered office (see Appendix A for details).[16] We extract data from the latest vintage of *Prowess* which is free from survivorship bias as highlighted by Siegel and Choudhury (2012).

[15] According to Gopalan, Nanda, and Seru (2007), Prowess' broad-based classification is more representative of group affiliation than a narrow equity based classification. However, we note that the very few firms change their group affiliation in the data.

[16] We do not observe changes in registered office location. We believe many firms are unlikely to change their location in response to upgrade. Ghani, Goswami, and Kerr (2014) find that incumbent firms along the GQ network facilitated output growth and increase in allocative efficiency. Also, there are significant costs involved in relocation especially for larger and national firms (e.g. group affiliated firms). We address this concern by focusing on relatively larger firms. However, we cannot completely rule out that firms respond by changing their location.

In our analyses "year" refers to financial year as opposed to calendar year because the financial year in India runs from April 1 to March 31. Thus, we refer to the financial year starting on Apri1 l, 2014 and ending on March 31, 2015 as year 2014-15. All dates are adjusted to reflect financial year rather than the calendar year. From the overall Prowess sample of 1989 to 2016, we exclude all financial firms (NIC code: 641-663), firms owned by central and state governments, firms with less than three years of data with positive values of total assets and sales, firms with leverage outside the [0,1] range, and observations with ratio of investment to lagged total assets greater than 1.[17] We exclude all firms in other manufacturing industries (NIC code: 321-329), coke and refined petroleum products (NIC code: 191-199), and construction firms (NIC code: 420-439).

To better capture the subsample of firms capable of investing, we restrict the sample to firms with a book value of total assets greater than INR 10 million (around US$ 0.15 million). We exclude firms with sales growth exceeding 100% to avoid potential business discontinuities caused by mergers and acquisitions. To mitigate outliers, we require that the firm's capital, book assets, and sales be at least INR 2.5 million (around US$ 0.03 million) in the previous year. Finally, we also require firms to have a minimum of three observations within panel.

B. Descriptive Firm Statistics

Table I reports statistics for our sample of firms. Panel A reports descriptive statistics for all firms in our sample while Panel B reports information on group affiliated firms' characteristics. In Panel A, Columns (1) and (2) present summary statistics for group affiliated firms and Columns (3) and (4) report information for standalone firms in our sample. Columns (5) and (6) presents descriptive statistics for all the firms in our sample. In Panel B, Columns (1) and (2) presents statistics for Indian business groups.

Panel A of the table shows that, on average, group firms are larger, and more profitable. Investments to total assets ratio is similar to an average firm in the sample. In addition, debt to total assets ratio is slightly lower than an average sample firm while they have higher cash flow relative to standalone firms. Our sample has 51,575 firm-year observations with 40,850 standalone firm-year observations and 10,725 group firm-year observations. Panel B suggests that an average

[17] Firms with leverage greater than 1 are considered to be bankrupt in India and hence we exclude such firms from our analyses.

Indian business group has about 6 subsidiaries, operates across 4 industries and 2 states.[18] The number of observations for the different tests vary because of missing data and dropping of singleton observations in high-dimensional fixed effects estimation.

C. Empirical Methodology

Upgraded connectivity reduces transportation costs significantly and increases access to regional markets for firms located along the road network. This benefits firms along the road network due to access to an enhanced highway system. To examine the effect of this treatment, we estimate a difference-in-differences specification. We assign firms to treatment group based on the location of their registered office. To identify the firms that are affected by the *commencement* of GQ *upgrades*, we define treatment as the start year of construction of a particular highway stretch connecting two cities. We assign firms located at either end of a particular stretch to be treated as they both benefit from this connection.This definition of treatment assumes that firms' operation is concentrated in the city of registered office. We follow Datta (2012) in defining nodal cities and districts which include Delhi, Mumbai, Kolkata, Chennai, and Bangalore and their contiguous suburbs (Gurgaon, Faridabad, Ghaziabad, and NOIDA for Delhi; Thane for Mumbai). Hence, we also assign firms located in these nodal areas to treatment group.

To perform the analyses, we estimate a difference-in-differences (DID) model of the following form for firm i in year t:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{5} \beta_{-k} Start_{it}^{-k} + \sum_{k=1}^{6} \beta_k Start_{it}^{+k} + \kappa X_{it-1} + \omega_{jt} + \theta_{st} + \delta_{rt} + \epsilon_{it} \quad (1)$$

subscripts i refers to firm ,j to industry, r to treated,s to state, and t to time. We include all firms even those that do not help to identify β_k i.e. firms not affected by the construction of GQ network because they help to identify the secular trends in firms' financial and investment policies. We choose a window size of twelve years (five years in pre-period and six years in post-period) and define Start^{-5} (Start^{+6}) equals one if it is five (six) or more years before(after) the commencement of the GQ *upgrade* work. The model is fully saturated with the immediate start year of construction

[18] States here refer to the state of registered office. For a sample of firms for which we can observe both headquarters and registered office location, we find that 83% of the firms report same address for both locations.

as the excluded category. Therefore, the coefficients on Start^{-k} (Start^{+k}) compare the level of the dependent variable 'k' years before (after) the start of construction of GQ network. The inclusion of firm fixed effects, α_i, ensures that each dummy variable is estimated using only within firm variation in the dependent variable, and time dummies, α_t, control for national-level trends. We recognize that treated firms along the GQ network may have secular time trends that differ from Non-GQ firms. To control for this, we include interaction between the time and treatment dummies (δ_{rt}) for all firms. The identification at firm-level aids in absorbing time-varying industry and state-level heterogeneity. We also include control variables (X_{it-1}) such as *Size*, *Sales Growth*, *Age*, *Cash flow* and *Profitability* in our regressions. Inclusion of control variables improves the efficiency of the estimates.

Our main dependent variables are firm-level investment and borrowings. Investment is capital expenditures divided by lagged total assets. Borrowings is total outstanding debt from banks and financial institutions divided by lagged total assets. All the nominal values are deflated using Wholesale Price Index (WPI) values at 2010 constant prices. To mitigate the effect of outliers, we winsorise all the ratios at 1% tails of their empirical distributions. Standard errors are corrected for heteroscedasticity and auto-correlation, and they are clustered at registered city level to account for correlations within cities (Bertrand, Duflo, and Mullainathan (2004)).

While we focus on investment and borrowing, we also estimate the effect on firm productivity. We use a measure of total factor productivity (TFP). TFP is the difference in actual output and predicted output. To compute this, we follow the literature and use a log-linear Cobb-Douglas production function (Syverson (2004) and Foster, Haltiwanger, and Syverson (2008)). We estimate the residual at firm-level from the following regression model:

$$y_{i,t} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \epsilon_{it} \tag{2}$$

where y is the logarithm of output and k,l, and m are logarithms of capital,labor and material inputs, respectively(see Appendix B for further details).[19] To allow varying intensities for factors of production across industries, we run this estimation for each 2-digit NIC industry separately. Thus, we measure TFP for each firm relative to other firms *within* the same industry.

[19]We estimate this using structural method developed by Levinsohn and Petrin (2003). We find qualitatively similar results when computing TFP using either OLS or Olley and Pakes (1996).

Our main focus is on understanding differential response of firms based on their organizational structure. We use the specification in Equation 1 but interact $Start^{+k}$ with *Group (Standalone)* which is a dummy variable that identifies whether the firm is affiliated to a business group(or not). We also test whether the coefficients estimated are significantly different for group affiliated firms relative to standalone firms. To allow for differences in organizational forms, we interact *Group (Standalone)* with the fixed effects and controls. Thus, we are able to control for substantial heterogeneity owing to differences in organization structures which helps strengthen our interpretation. While we present results using just the location of *upgrade*, the magnitude and interpretation of these results is *understated* as other nearby cities indirectly benefit from *upgraded* connectivity to GQ.

IV. Main Results

A. Investment and Total Factor Productivity

We begin our empirical analysis by documenting that *upgraded* connectivity was indeed a shock to investment opportunity for treated firms. Table II shows the effect of GQ *upgrade* on investment and total factor productivity around the *commencement* of construction for treated firms. As shown in column (1), investment at treated firms increases by 0.029 percentage points which corresponds to an increase of 59% (0.029 versus sample average of 0.049). Economic magnitude of the estimates are quantitatively similar when we use controls in our regressions. These estimates are reported in column (2). We find that this significant effect occurs in the second year after the *commencement* of upgrade work. The median completion time for a particular stretch is around 2.3 years and firms significantly increase their investments around the completion time. Given the large economic magnitude of investments, we also note that the coefficient on dummies decrease for other years which bolsters our conjecture that firms invested heavily in response to the investment opportunity afforded by construction of road network.

A key identifying assumption of our DID strategy is the parallel-trends assumption i.e. in the absence of treatment the behaviour of treated and control firms are similar. We document absence of any pre-trends in investment decision of firms. The coefficients on Start^{-k} are economically and statistically insignificant suggesting no pre-existing differential trends. This validates a key

identifying assumption of our analyses thereby lending credence to the estimation strategy. In columns (3) and (4) we control for non-linear effects of size on investment decision by using 100 dummy variables - one for each percentile of size distribution. In all our regressions, we are able to control for substantial heterogeneity by inclusion of industry-year fixed effects to control for time-varying industry unobservables i.e demand/supply conditions, state-year fixed effects to control for time-varying state-level unobservables and treated-year fixed effects to control for differential trends for treated and control firms.

In columns (5) and (6), we show the effect on productivity which we measure using TFP. We find significant increase in productivity at treated firms, consistent with the idea that completion of road upgrade significantly raised the marginal product of capital and labor. This effect is observed around the third and fourth year of after after the *commencement* of the work. Thus, we document significant improvements in productivity of treated firms. Overall, we establish that GQ *upgrade* was a significant investment opportunity shock for firms that lay along the road network. Such firms invested heavily and saw significant improvements in their overall productivity.

B. Differential response: Group vs. Standalone firms

Next, we analyze whether firms respond differentially owing to differences in their organizational structure. Prior literature argues that group affiliated firms benefit from the transfer of resources within the group thus enabling them to capitalize on profitable new investment opportunities. In the case of diversified, multi-division firms such internal transfers can economize costs of external finance thus allowing firms to allocate capital to the right project (Stein (2003)). Thus, we expect differences (owing to differences in resources) in investment behaviour of firms based on their affiliation to business groups.

1. Investments

Table III shows the effect on investment by organizational structure. For these tests, to conserve space, we collapse the pre-event dummies into one variable called *Pre* and report the coefficients in the tables. In addition, for these tests, we are able control for substantial heterogeneity with the use of high-dimensional fixed effects.

Column (1) suggests that treated group firms along the GQ network on average increased

their investments. There is a 7.1 percentage point increase in investment which translates to a substantial increase of 147% (7.1 versus average for group firms of 4.8). Column (2) suggests that standalone treated firms in the same areas as group firms on average have no statistically discernible change in their investments. The timing of these investments corresponds to the overall investment documented in Table II suggesting that the increase in investments is entirely driven by group firms.

Results in columns (3) and (4) includes controls variables and estimates are similar to when we exclude controls. We test whether the coefficients estimated are significantly different for group firms relative to standalone firms. In column titled *Diff*, we report the estimate difference with standard errors in parentheses. There is a differential investment of 6 percentage points between group and standalone firms which is statistically significant at the conventional levels of significance in either of the specifications. The coefficients on *Pre* are economically and statistically insignificant suggesting no pre-existing differential trends between group and standalone firms. Thus, evidence from Table III suggests that group firms invests differentially relative to standalone firms in response to the investment opportunity shock.

2. Shifts in Investment?

In the preceding subsection, we document significant investments by treated group firms in response to the investment opportunity shock afforded by GQ upgrade. A plausible concern with this evidence relates to reallocation of investment *within* groups. Group headquarters may choose to shift their investments from one location to another in response to new investment opportunities (Giroud (2013) and Giroud and Mueller (2015)). Thus, treated groups merely reallocate capital in response to the investment opportunity without any overall increase in investment. To rule out concerns that reallocation maybe driving our results, we present evidence on investments at the group-level. Table IV presents results to address these concerns.

For these tests we focus only on group affiliated firms and estimate the specification as in Equation 1. We begin with a firm-fixed effects specification and report results in column (1). We note that there is a significant increase in investment *among* treated group firms. The increase in investment is 0.059 percentage points which is slighly lower than what we document in our tests in Table III. Next, we use owner-group fixed effect rather than firm fixed effects specification. The

inclusion of these fixed effects, ensures that each dummy variable is estimated using only *within* group variation in the dependent variable. Thus, if reallocation is driving our results, we should not expect changes in investment *within* groups. However, results in column (2) seem to suggest otherwise. We find that estimates remain unchanged in magnitude and significance.

In columns (3) and (4), we control for non-linear effects of size on investment decision by using a set of 10 dummy variables that identify firm size deciles based on $Size_{t-1}$. Controlling for such size effects, sharpens our estimates and leaves our interpretation unchanged. Two points are worth mentioning based on the evidence from this table. First, lower magnitudes than baseline results suggest some reallocation but on average there is an increase in group-level investments. Second, there are no pre-existing trends in investment decision by firms either at the firm-level or at the group-level. Thus, evidence from this table bolsters our conjecture that group firms responded by increasing overall investment rather than shifting investment across locations.

3. External Financing

Evidence from preceding subsections, establish a significant increase in investment by treated group firms which is not driven just mere reallocation *within* group firms. Here, we attempt to understand financing behaviour of treated firms. Our focus is on external financing behaviour as we intend to characterize financing externalities on standalone firms.[20] We focus on total outstanding debt from banks and financial institutions. Table V reports the results on external borrowings for group and standalone firms.

We document that treated group firms predominantly borrow from banks and financial institutions in response to access to *upgraded* GQ network. These effects are significant and persistent. The difference in borrowings between group and standalone firms is statistically significant and entirely driven by group affiliated firms. The coefficient estimates suggest that group affiliated firms on average borrow 7.5% of total assets from external sources which is almost twice as large when compared to the magnitude of the average investment. The increase in external borrowings is persistent and continues until five years after the *commencement* of the upgrade work.

[20] Group firms can rely on intra-group equity and loans, external borrowing, external equity, or internal cash they generate. It is important to note that in India corporate debt market is underdeveloped and bank lending is one of the major sources of corporate borrowing. Therefore, we focus on external borrowing from banks and financial institutions. In unreported results, we find significant intra-group equity and loan transfer to treated firms and no change in cash holdings for treated firms.

The large magnitude and opposite sign on the coefficients is suggestive of crowding-out effect at play. The large magnitude of external borrowing more than what was invested coupled with opposite signs on borrowing raises suspicion whether group affiliated firms impose financing constraints on standalone firms which are unable to raise external capital. This explanation seems plausible and is consistent with predictions in Almeida and Wolfenzon (2006). They show that efficient reallocation of capital inside groups may increase financial constraints on independent firms and be harmful to economy-wide capital allocation.[21] Overall, we document significant increase in external borrowings from group affiliated firms.

C. Effect on Standalone firms

In this subsection, we attempt to establish whether standalone firms face financing externalities in the presence of conglomerates which renders them unable to capitalize on the investment opportunity afforded by GQ upgrade. Our methodology compares *standalone* firms around the investment opportunity shock as a function of the degree of conglomeration in the local market. We hypothesize that presence of business groups make it harder for other standalone firms in the economy to raise capital.

1. Group concentration

We begin by exploring the effect of group affiliated firms' concentration on investment behaviour of standalone firms. Given our identification strategy relies on location of upgrade, we create a location based measure to capture this effect. We create a *new* measure of group concentration at the city level which is the basis of our treatment. For each city, we create a concentration measure based on median sales in the period before GQ *upgrade* was announced i.e. 1989 to 1997. We then define *High Conc(Low Conc)* as a dummy variable equal to 1 if sales concentration in the city is above(below) the 75^{th} percentile of the median group sales across the years before the announcement. Thus, this measure captures concentration of groups firms around standalone firms

[21] Alternatively, the crowding out might be exacerbated as a result of financing being used up for GQ *upgrade* itself in the form of project financing. Thus, the effects we present here have downward bias and are understated. However, this is likely not the case as a substantial amount of financing was borne by international agencies (such as World Bank, Asian Development Bank etc) and federal government.

at each location.[22] Thus, our measure indicates that if *High Conc(Low Conc)* equals 1, then the group concentration in that location is Dense(Sparse).

Table VI reports results of the effects of group concentration at each location on standalone firms in the same location. We restrict our sample to standalone firms for these tests and estimate a similar specification as in Equation 1 where we interact $Start^{+k}$ with *High Conc (Low Conc)*. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, state-year, industry-year and treated-year fixed effects. Control variables include *Size*, *Age*, *Cash flow* and *Profitability*. All control variables are interacted with *High Conc (Low Conc)* to allow for differential trends.

Results in column (1) presents investment behaviour of standalone firms *within* high concentration locations along GQ network. We find that in high concentration areas there is significant reduction in investment by standalone firms. The decline in investment is significant in magnitude and much larger than the increase in investment by group affiliated firms. In contrast, we do not find any statistically discernible change in investments for standalone firms in sparsely concentrated areas. These estimates remain stable in sign and magnitude even after inclusion of controls. Noticeably, in the pre-event period there are no pre-existing differential trends between investment by these firms across these locations. If anything, we find that standalones invested more in highly concentrated areas but the effect is statistcally insignificant.

Results in panel B for external financing mirror those in panel A. column (1) presents borrowings for standalone firms *within* high concentration locations along GQ network. We find that in high concentration areas there is significant reduction in borrowings by standalone firms. The decline in borrowings is significant in magnitude and similar to increase in borrowings by group affiliated firms in our baseline tests. In contrast, we find that there is a substantial increase in borrowings for standalone firms in sparsely concentrated areas. These estimates remain stable in sign and magnitude even after inclusion of controls but become statistically insignificant. Similar to earlier results, we find no evidence of pre-existing differential trends by these firms across these locations.

Hence, the evidence presented here suggests that standalone firms seem to face financing externality as a function of degree of conglomeration in the local area.

[22]For the purpose of our analyses, we restrict the our sales measure to GQ network. The idea behind this is that group firms with greater ex-ante exposure will respond significantly to these upgrades than firms with low exposure. The results remain qualitatively similar if we use a sales measure across all locations.

2. Mutually exclusive investment opportunities?

An alternative interpretation for the evidence in preceding section might be that the investment opportunity afforded by GQ *upgrade* is mutually exclusive. To put it differently, if group affiliated firms utilize all investment opportunities available locally by investing heavily then standalone firms will be unable to invest because of lack of locally available investment opportunity. This could explain what we find above.

To rule out this concern, we repeat the tests in Table VI for high exporting industries. Our underlying assumption is that GQ *upgrade* afforded a *local* investment opportunity shock by improving access to regional and local markets. By focusing on exporting industries (i.e. both group affiliated and standalone firms operating in heavily export oriented industries), we alleviate concerns that mutually exclusive local investment opportunities may be driving our results.

We measure High exporting industry in the following manner. For each firm, we observe export earnings to sales each year and we measure the median ratio for each industry in the period before GQ *upgrade* was announced i.e. 1989 to 1997. We keep industries if export earnings to sales in each industry is above(below) the 75^{th} percentile of the median export earnings to sales across the years before the announcement of the GQ road network upgrade. Our group concentration measure remains the as in Table VI.

Table VII presents results on the effects of group concentration in high exporting industries. Results in column (1) presents investment behaviour of standalone firms *within* high concentration locations along GQ network. We find there is significant reduction in investment by standalone firms. The decline in investment is significant in magnitude and much larger than the increase in investment by group affiliated firms. This effect is larger and persistent in comparison to Table VI. In contrast, we find weakly statistically discernible change in investments for standalone firms in sparsely concentrated areas. These estimates remain stable in sign and magnitude even after inclusion of controls.

Results in panel B for external financing mirror those in panel A. column (1) presents borrowings for standalone firms *within* high concentration locations along GQ network. We find that in high concentration areas there is significant reduction in external borrowings by standalone firms. The decline in borrowings is significant in magnitude and similar to increase in borrowings by group

affiliated firms in our baseline tests. In contrast, we find that there is a substantial increase in borrowings for standalone firms in sparsely concentrated areas. These estimates remain stable in sign and magnitude even after inclusion of controls but become statistically insignificant.

In sum, we find suggestive evidence that standalone firms face externalities when surrounded by group firms and are able to rule out concerns of mutually exclusive local investment opportunity.

D. Financing Externalities

While the results so far are informative about the quantitative importance of organizational structure in driving financial externalities, they are silent about the precise mechanisms that engender such externalities. In this subsection, we explore the role of banking sector in driving business group externalities.

1. Shared Lenders

If the supply of capital is limited, standalone firms may face significant financing externalities when they borrow from lenders with lending relationships to group affiliated firms. This effect is likely exacerbated when the standalone firms borrow from only one external source. To explore such effects, we exploit lending relationships of standalone firms.

We create a measure of whether standalone firms borrowed from the same lender as a group affiliated firm.[23] For each standalone firm, we match the lender's name to lending relationships of group affiliated firms. We then create a dummy variable *One Shared (Others)* which equals 1 if standalone firm shares atleast one lender with the group firm in the five years preceding GQ *upgrade*.[24] To better capture externalities and quantify the importance of a specific lender to the firm, we restrict this classification to standalone firms borrowing from only one external bank/financial institution. Thus, our measure indicates that when *One Shared* equals 1, the standalone firm borrows from only one external source and this lender has exposure to group affiliated firms. We present the effect on external borrowings of standalone firms with shared lenders in Table VIII.

[23] We observe lending relationships between banks, financial institutions and firms in our sample. These lending relationships are used in Gopalan, Mukherjee, and Singh (2016)

[24] In *Others*, we have three types of lending relationships with standalone firms, (1) borrow from multiple external source(s) and *share* lending relationships, (2) borrow from multiple external sources but *don't share* lending relationships, and (3) no external source(s).

In column (1), we examine borrowings by standalone firms *with* shared lenders. We document a significant reduction in borrowings around the commencement of GQ upgrade. The decline in borrowings is significant in magnitude and similar to increase in borrowings by group affiliated firms in our baseline tests. In contrast, we find that there is a substantial increase in borrowings for standalone firms when they are associated with multiple shared lenders. The difference between the two groups is statistically significant indicating the differential borrowing behaviour of standalone firms in relation to their exposure to shared lenders. We obtain similar estimates after inclusion of controls.

These results are consistent with the negative externality argument, according to which business group firms impose external financing constraints on standalone firms through the shared lending relationships and rationing by banks.

2. Lenders' Group Exposure

In the previous subsections, we show that group firms impose externality on standalone firms which renders them unable to capitalize on investment opportunity. Furthermore, these effects are stronger for high exporting industries, where we are able to rule out concerns of mutually exclusive investment opportunities. In addition, standalone firms are unable to borrow if they are associated with a critical lender who also shares lending relationships with group-affiliated firms. In this subsection, we study the effect from supply side i.e banks' lending exposure.

While we do not observe lending amounts by banks, we do observe lending relationships between banks, financial institutions and firms. Using these lending relationships we are able to create a exposure measure for each bank and financial institution. We create a *new* measure of lending exposure to group firms in the following manner. In the period before GQ *upgrade* was announced, for each firm, we divide the total outstanding debt by banks and financial institutions equally among all lenders. For each lender, we then define *High(Low)* as a dummy variable equal to 1 if their lending amount is above(below) the median across the years before the announcement. We then assign each lender to standalone firms in our sample. Thus, the measure captures standalones' association with lenders having varying degree of exposure to group firms.[25] Thus, our measure

[25]For the purpose of our analyses, we restrict our measure to GQ network. Lenders with greater ex-ante exposure to group firms will respond significantly to these upgrades than lenders with low exposure. The results remain qualitatively similar if we use a measure across all locations.

indicates that if *High Exp(Low Exp)* equals 1, then the lender associated with the standalone has High(Low) lending exposure to group firms.

Table IX presents results on the effects of lenders' group exposure on standalone firms. Results in column (1) presents borrowing behaviour of standalone firms *within* different exposure measure along GQ network. We find that there is no change in borrowings by standalone firms when they are associated with lenders with high group exposure. Next, we examine the effect in low exposure groups. From column (2), it is evident that there is significant increase in borrowing. The decline in borrowings is significant in magnitude and similar to increase in borrowings by standalone firms when they are associated with banks having low exposure to groups. We interpret this as evidence of banks supplying available capital to group affiliated firms than to standalone firms thereby possibly exacerbating the differential wedge in investment. These estimates remain stable in sign and magnitude even after inclusion of controls.

Overall, we find evidence that standalone firms indeed face financing externality when surrounded by group firms and are unable to borrow funds if they are associated with lenders having greater lending exposure to group affiliated firms.

V. Conclusion

In this paper, we study whether and how business groups influence standalone firms in the local economy. We use a recent large-scale highway development project in India as a shock to local investment opportunity for firms located in those areas. We show that investment behavior of standalone firms around an investment opportunity shock is affected by the density of business groups in the local area. Our evidence shows that the channel through which the business group externality works is through the banking sector. Taken together, the evidence is consistent with the predication that business group affiliated firms impose financial externalities on standalone firms, leaving them worse-off. Our results suggest that capital rationing by banks propagates and amplifies the negative externality to other firms. This has important implications as financial intermediaries could adversely affect capital allocation when external capital markets are less developed especially in the case of emerging markets.

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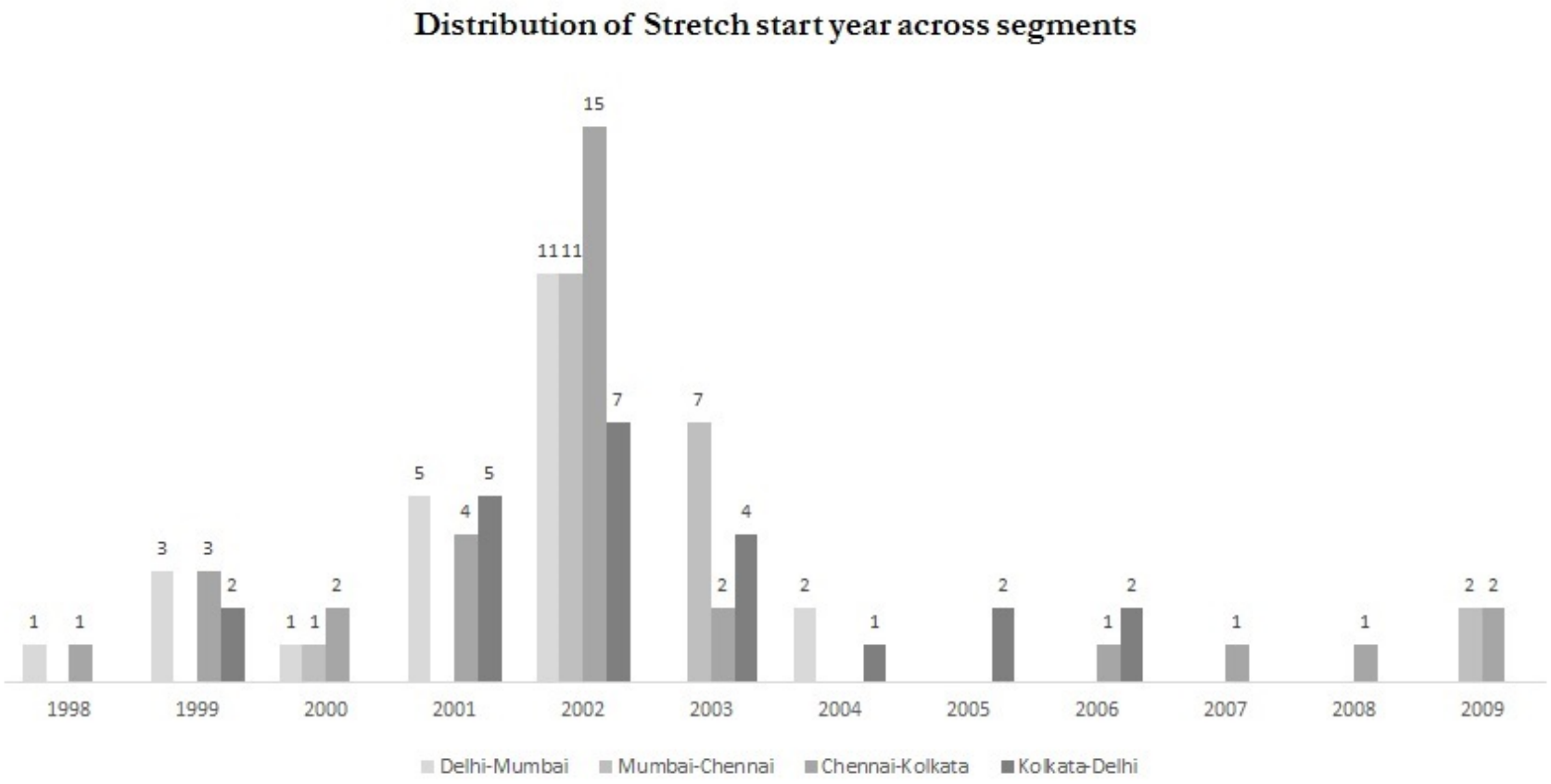
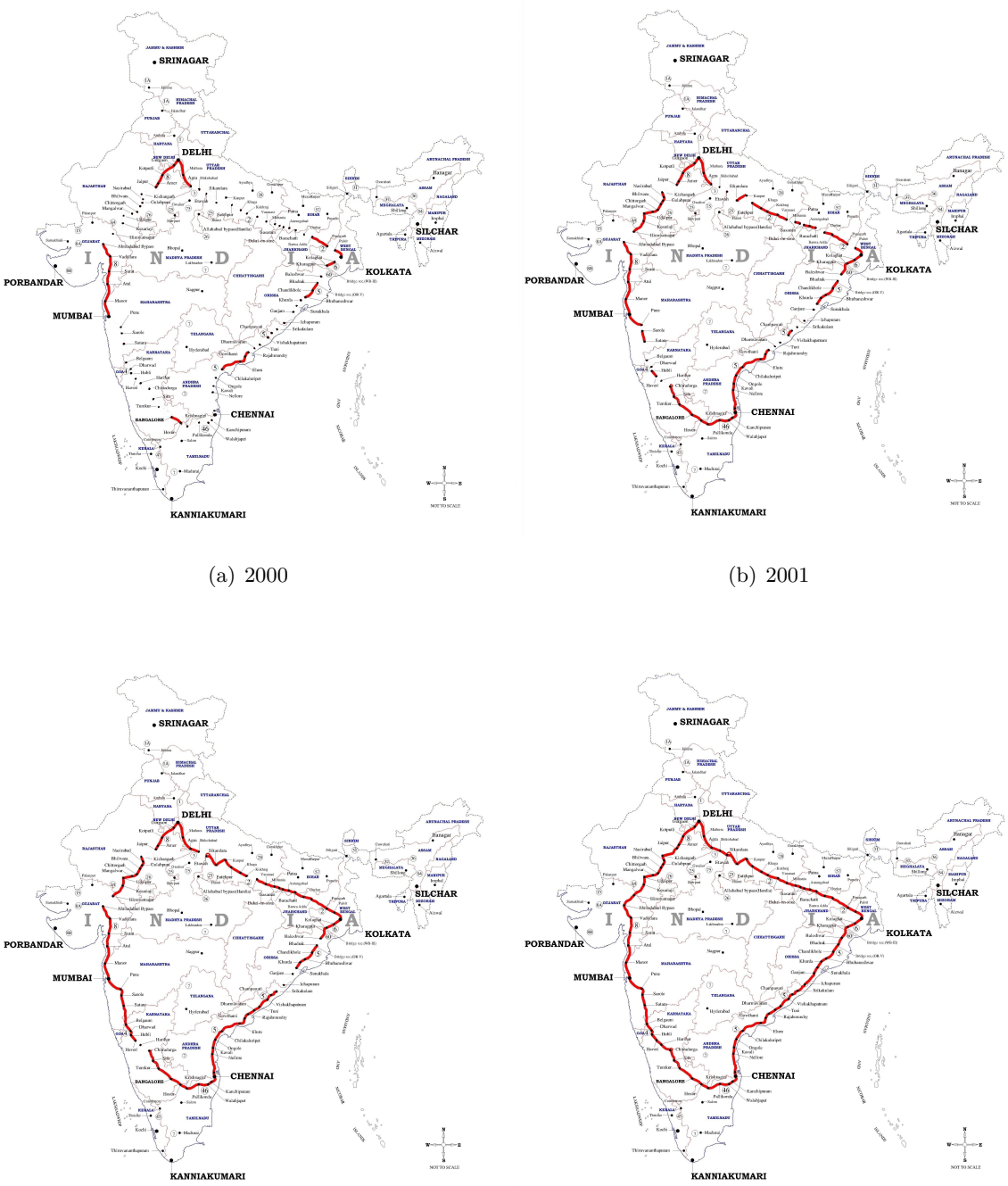


Figure 1. Construction start year distribution along GQ network

This figure shows the distribution of start year of construction of the four important stretches forming part of the golden quadrilateral which connects the four nodal cities of Delhi, Mumbai, Chennai and Kolkata.



(a) 2000

(b) 2001

(c) 2002

(d) 2004

Figure 2. Spatial distribution of stretches along GQ network

This figure shows the spatial distribution of various stretches over start year of construction that form part of the 5,846 km stretch of golden quadrilateral connecting four nodal cities of Delhi, Mumbai, Chennai and Kolkata. Map source: National Highway Authority of India.

Table I. Summary Statistics

This table reports mean, median values for our sample. Panel A reports descriptive statistics for all firms in our sample while Panel B reports information on group affiliated firms' characteristics. All variables are defined in Appendix Table 1. From the overall Prowess sample of 1989 to 2016, we exclude all financial firms (NIC code: 641-663), firms owned by central and state governments, firms with less than three years of data with positive values of total assets and sales, firms with leverage outside the [0,1] range, and drop observations with ratio of investment to lagged total assets greater than 1.For group affiliation, we rely on CMIE Prowess' classification. We use 2-digit National Industrial Classification (NIC) to classify industries. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices. We also correct for changes in financial reporting year by adjusting values for number of months. To mitigate the effect of outliers, we winsorise all the ratios at 1% tails.

Panel A: Firm Characteristics

	Group firms		Standalone		All firms	
	Mean	Median	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)	(5)	(6)
Total Assets (INR millions)	13586	2180	1629	390	4115	514
EBITDA (INR millions)	1646	214	180	38	485	50
Age (in years)	36	29	24	20	27	21
Investment/Total assets	0.048	0.019	0.050	0.016	0.049	0.017
Debt/Total assets	0.243	0.215	0.261	0.241	0.257	0.236
Profitability/Total assets	0.117	0.114	0.109	0.107	0.110	0.108
Cash flow/Total assets	0.073	0.069	0.055	0.054	0.059	0.058
Number of firm years	10,725		40,850		51,575	

Panel B: Business Group Characteristics

	Mean	Median
	(1)	(2)
Number of Subsidiaries	5.8	4
Number of Industries	3.6	3
Number of States	2.2	2

Table II. Effect of Golden Quadrilateral on Investment and Total Factor Productivity

This table presents the estimates from difference-in-differences regression for firms located along the golden quadrilateral at the start of construction of a stretch. The dependent variable in columns (1) through (4) is *Investment* while in columns (5) and (6) is *Total factor productivity*. Appendix B outlines the estimation procedure for total factor productivity using Levinsohn and Petrin (2003). All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices. We also correct for changes in financial reporting year by adjusting values for number of months. To mitigate the effect of outliers, we winsorise all the ratios at 1% tails and drop observations with ratio of investment to lagged total assets greater than 1. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects and state-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Size*, *Age*, *Cash flow* and *Profitability*. We also include a set of 100 dummy variables that identify firm size percentiles based on $Size_{t-1}$. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.The sample includes all non-missing observations for non-government, non-foreign, non-financial and non-utility firms from *Prowess*.

Dependent variable:	$\frac{I}{AT_{t-1}}$				Total Factor Productivity	
	(1)	(2)	(3)	(4)	(5)	(6)
$Start^{-5}$	0.036	0.016	0.027	-0.013	-2.670	-2.653
	(0.048)	(0.045)	(0.053)	(0.037)	(1.861)	(1.860)
$Start^{-4}$	0.020	0.012	0.010	-0.017	-0.774	-0.793
	(0.024)	(0.025)	(0.021)	(0.024)	(0.531)	(0.541)
$Start^{-3}$	-0.005	-0.012	-0.017	-0.035	-0.077	-0.070
	(0.025)	(0.025)	(0.027)	(0.027)	(0.448)	(0.456)
$Start^{-2}$	0.011	0.011	-0.002	-0.003	-0.249	-0.226
	(0.010)	(0.011)	(0.011)	(0.013)	(0.327)	(0.315)
$Start^{-1}$	0.017	0.017	0.016	0.007	-0.188	-0.205
	(0.018)	(0.018)	(0.020)	(0.017)	(0.218)	(0.213)
$Start^{+1}$	0.009	0.009	0.011	0.010	-0.135	-0.131
	(0.018)	(0.017)	(0.019)	(0.015)	(0.160)	(0.159)
$Start^{+2}$	0.029	0.027	0.034	0.030	0.070	0.083
	$(0.012)^{**}$	$(0.011)^{**}$	$(0.012)^{***}$	$(0.010)^{***}$	(0.168)	(0.164)
$Start^{+3}$	-0.002	-0.004	0.007	0.009	0.304	0.308
	(0.016)	(0.015)	(0.018)	(0.015)	(0.188)	$(0.186)^{*}$
$Start^{+4}$	0.008	0.007	0.019	0.029	0.305	0.310
	(0.015)	(0.014)	(0.016)	$(0.013)^{**}$	$(0.185)^{*}$	$(0.182)^{*}$
$Start^{+5}$	-0.003	-0.004	0.008	0.019	0.256	0.244
	(0.015)	(0.016)	(0.015)	(0.014)	(0.251)	(0.249)
$Start^{+6}$	-0.010	-0.010	0.001	0.019	0.434	0.414
	(0.016)	(0.017)	(0.016)	(0.016)	(0.267)	(0.264)
Controls	No	Yes	No	Yes	No	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Industry*Year	Yes	Yes	Yes	Yes	No	No
State*Year	Yes	Yes	Yes	Yes	Yes	Yes
Treated*Year	Yes	Yes	Yes	Yes	No	No
Size dummies	No	No	Yes	Yes	No	No
Adj.-R^2	0.097	0.114	0.110	0.283	0.774	0.775
Observations	37240	37240	35039	35039	25389	25389

Table III. Effect of Golden Quadrilateral on Investment: Group vs Standalone firms

This table reports the results of regressions estimating the differential response of firms based on whether they are affiliated to business group along the golden quadrilateral road network. We interact $Start^{+k}$ with *Group (Standalone)* a dummy variable that identifies whether the firm is affiliated to a business group(or not). In the column titled *Diff*, we test whether the coefficients estimated are significantly different for group affiliated firms relative to standalone firms. This column reports the estimate difference with standard errors in parentheses. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, group-state-year, group-industry-year and group-treated-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Age*, *Cash flow* and *Profitability*. All control variables are interacted with *Group (Standalone)* to allow for differential trends. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

	Dependent variable: I/AT_{t-1}					
	Group	Standalone	Diff	Group	Standalone	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	0.016	0.011	0.006	0.015	0.011	0.004
	(0.021)	(0.022)	(0.030)	(0.020)	(0.023)	(0.030)
$Start^{+1}$	0.009	0.015	-0.005	0.008	0.014	-0.007
	(0.032)	(0.020)	(0.032)	(0.031)	(0.020)	(0.032)
$Start^{+2}$	0.071	0.011	0.060	0.070	0.010	0.059
	$(0.018)^{***}$	(0.015)	$(0.023)^{***}$	$(0.018)^{***}$	(0.015)	$(0.023)^{**}$
$Start^{+3}$	0.021	-0.011	0.032	0.021	-0.011	0.033
	(0.022)	(0.019)	(0.026)	(0.022)	(0.019)	(0.026)
$Start^{+4}$	0.030	0.008	0.023	0.031	0.007	0.023
	(0.022)	(0.017)	(0.023)	(0.022)	(0.017)	(0.023)
$Start^{+5}$	0.013	-0.007	0.020	0.012	-0.007	0.019
	(0.021)	(0.019)	(0.026)	(0.022)	(0.019)	(0.027)
$Start^{+6}$	0.012	-0.015	0.027	0.012	-0.016	0.028
	(0.026)	(0.020)	(0.034)	(0.026)	(0.020)	(0.034)
Controls		No			Yes	
Firm		Yes			Yes	
Group*Industry*Year		Yes			Yes	
Group*State*Year		Yes			Yes	
Group*Treated*Year		Yes			Yes	
Adj-R^2		0.099			0.101	
Observations		34756			34756	

Table IV. Effect of Golden Quadrilateral on Investments at group level

This table presents the estimates from difference-in-differences regression for group-affiliated firms located along the golden quadrilateral. The dependent variable in columns (1) through (4) is *Investment*. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, state-year, industry-year and treated-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Age*, *Cash flow* and *Profitability*. We also include a set of 10 dummy variables that identify firm size deciles based on $Size_{t-1}$. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

	Dependent variable: I/AT_{t-1}			
	(1)	(2)	(3)	(4)
$Start^{-5}$	-0.080	-0.030	-0.093	-0.021
	(0.025)***	(0.029)	(0.029)***	(0.026)
$Start^{-4}$	0.027	-0.000	0.031	0.015
	(0.035)	(0.039)	(0.038)	(0.040)
$Start^{-3}$	-0.063	-0.074	-0.056	-0.069
	(0.066)	(0.072)	(0.078)	(0.074)
$Start^{-2}$	0.020	0.027	0.014	0.024
	(0.025)	(0.021)	(0.028)	(0.023)
$Start^{-1}$	0.023	0.022	0.005	0.002
	(0.024)	(0.026)	(0.023)	(0.025)
$Start^{+1}$	-0.004	0.004	0.003	-0.000
	(0.030)	(0.030)	(0.028)	(0.029)
$Start^{+2}$	0.059	0.059	0.067	0.057
	(0.018)***	(0.017)***	(0.020)***	(0.018)***
$Start^{+3}$	0.006	0.009	0.018	0.009
	(0.024)	(0.023)	(0.025)	(0.023)
$Start^{+4}$	0.014	0.013	0.023	0.011
	(0.024)	(0.025)	(0.022)	(0.024)
$Start^{+5}$	-0.009	-0.013	0.011	-0.008
	(0.023)	(0.023)	(0.022)	(0.023)
$Start^{+6}$	-0.003	-0.004	0.004	-0.010
	(0.027)	(0.026)	(0.027)	(0.027)
Controls	No	Yes	No	Yes
Firm	Yes	No	Yes	No
Owner-Group	No	Yes	No	Yes
Industry*Year	Yes	Yes	Yes	Yes
State*Year	Yes	Yes	Yes	Yes
Treated*Year	Yes	Yes	Yes	Yes
Size dummies	No	No	Yes	Yes
Adj.-R^2	0.086	0.108	0.088	0.115
Observations	8840	8899	8059	8126

Table V. Effect of Golden Quadrilateral on External Financing: Group vs Standalone firms

This table reports the results on external financing response for firms along the golden quadrilateral road network. We interact $Start^{+k}$ with *Group (Standalone)* a dummy variable that identifies whether the firm is affiliated to a business group(or not). In the column titled *Diff*, we test whether the coefficients estimated are significantly different for group affiliated firms relative to standalone firms. This column reports the estimate difference with standard errors in parentheses. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, group-state-year, group-industry-year and group-treated-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Size*, *Sales Growth* and *Profitability*. All control variables are interacted with *Group (Standalone)* to allow for differential trends. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

	Dependent variable: Debt/AT$_{t-1}$					
	Group	Standalone	Diff	Group	Standalone	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	0.025	-0.017	0.041	0.015	-0.011	0.026
	(0.020)	(0.029)	(0.029)	(0.018)	(0.029)	(0.029)
Start^{+1}	0.042	-0.002	0.044	0.032	-0.002	0.033
	(0.021)**	(0.017)	(0.029)	(0.020)	(0.016)	(0.027)
Start^{+2}	0.086	0.011	0.075	0.080	-0.000	0.080
	(0.020)***	(0.021)	(0.026)***	(0.020)***	(0.020)	(0.025)***
Start^{+3}	0.110	0.011	0.098	0.105	-0.000	0.105
	(0.026)***	(0.024)	(0.035)***	(0.025)***	(0.025)	(0.033)***
Start^{+4}	0.123	-0.003	0.125	0.122	-0.018	0.140
	(0.030)***	(0.029)	(0.047)***	(0.027)***	(0.027)	(0.041)***
Start^{+5}	0.111	0.001	0.109	0.107	-0.013	0.120
	(0.034)***	(0.033)	(0.052)**	(0.031)***	(0.031)	(0.046)***
Start^{+6}	0.142	-0.022	0.163	0.149	-0.038	0.187
	(0.041)***	(0.038)	(0.062)***	(0.037)***	(0.035)	(0.055)***
Controls		No			Yes	
Firm		Yes			Yes	
Group*Industry*Year		Yes			Yes	
Group*State*Year		Yes			Yes	
Group*Treated*Year		Yes			Yes	
Adj-R^2		0.610			0.640	
Observations		34756			34756	

Table VI. Effect of Group concentration on Standalones

This table presents estimates from triple-differences regressions relating the effect of group firms' concentration on Standalone firms. Panel A presents results for *Investments* whereas panel B presents results for *Debt*. *High Conc(Low Conc)* is a dummy variable equal to 1 if sales concentration in the city is above(below) the 75^{th} percentile of the median group sales across the years before the announcement of the GQ road network upgrade. In the column titled *Diff*, we test whether the coefficients estimated are significantly different for group affiliated firms relative to standalone firms. This column reports the estimate difference with standard errors in parentheses. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, group-state-year, group-industry-year and group-treated-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Size*, *Age*, *Cash flow* and *Profitability*. All control variables are interacted with *High(Low)* to allow for differential trends. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

Panel A: Investments

	Dependent variable: I/AT_{t-1}					
	High Conc	Low Conc	Diff	High Conc	Low Conc	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	0.044	0.031	0.013	0.045	0.031	0.015
	(0.056)	(0.026)	(0.059)	(0.055)	(0.026)	(0.058)
$Start^{+1}$	-0.074	0.029	-0.103	-0.081	0.029	-0.110
	$(0.043)^{*}$	(0.023)	$(0.046)^{**}$	$(0.044)^{*}$	(0.023)	$(0.046)^{**}$
$Start^{+2}$	-0.049	0.013	-0.062	-0.053	0.012	-0.065
	(0.046)	(0.018)	(0.046)	(0.046)	(0.018)	(0.046)
$Start^{+3}$	-0.082	-0.008	-0.074	-0.086	-0.009	-0.077
	$(0.048)^{*}$	(0.019)	(0.048)	$(0.048)^{*}$	(0.019)	(0.048)
$Start^{+4}$	-0.099	0.011	-0.110	-0.104	0.009	-0.113
	$(0.051)^{*}$	(0.020)	$(0.050)^{**}$	$(0.051)^{**}$	(0.020)	$(0.050)^{**}$
$Start^{+5}$	-0.092	-0.014	-0.078	-0.097	-0.015	-0.083
	$(0.048)^{*}$	(0.023)	(0.048)	$(0.048)^{**}$	(0.023)	$(0.048)^{*}$
$Start^{+6}$	-0.115	-0.027	-0.088	-0.122	-0.029	-0.094
	$(0.043)^{***}$	(0.025)	$(0.043)^{**}$	$(0.044)^{***}$	(0.025)	$(0.044)^{**}$
Controls		No			Yes	
Firm		Yes			Yes	
Industry*Year		Yes			Yes	
State*Year		Yes			Yes	
Treated*Year		Yes			Yes	
Adj-R^2		0.101			0.102	
Observations		21066			21066	

Panel B: External Financing

	Dependent variable: Debt/AT$_{t-1}$					
	High Conc	Low Conc	Diff	High Conc	Low Conc	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	0.036	-0.009	0.045	0.095	-0.001	0.096
	(0.119)	(0.028)	(0.122)	(0.112)	(0.030)	(0.116)
Start^{+1}	-0.105	0.010	-0.116	-0.072	0.006	-0.078
	(0.051)**	(0.014)	(0.051)**	(0.047)	(0.014)	(0.048)
Start^{+2}	0.018	0.042	-0.024	0.028	0.023	0.006
	(0.080)	(0.021)**	(0.080)	(0.080)	(0.022)	(0.081)
Start^{+3}	0.024	0.062	-0.038	0.028	0.042	-0.013
	(0.085)	(0.024)***	(0.087)	(0.089)	(0.026)	(0.088)
Start^{+4}	0.042	0.034	0.009	0.038	0.010	0.029
	(0.092)	(0.030)	(0.091)	(0.095)	(0.034)	(0.093)
Start^{+5}	0.033	0.053	-0.020	0.034	0.023	0.010
	(0.092)	(0.035)	(0.091)	(0.095)	(0.037)	(0.091)
Start^{+6}	0.041	0.037	0.004	0.043	0.003	0.041
	(0.094)	(0.036)	(0.090)	(0.098)	(0.041)	(0.093)
Controls		No			Yes	
Firm		Yes			Yes	
Industry*Year		Yes			Yes	
State*Year		Yes			Yes	
Treated*Year		Yes			Yes	
Adj-R^2		0.101			0.102	
Observations		21066			21066	

Table VII. Effect of Group Concentration on Standalones: High Exporting Industries

This table presents estimates from triple-differences regressions relating the effect of group firms' concentration on Standalone firms in high exporting industries. Panel A presents results for *Investments* whereas panel B presents results for *Debt*. We keep industries if export earnings to sales in each industry is above(below) the 75^{th} percentile of the median export earnings to sales across the years before the announcement of the GQ road network upgrade. *High Conc(Low Conc)* is a dummy variable equal to 1 if sales concentration in the city is above(below) the 75^{th} percentile of the median group sales across the years before the announcement of the GQ road network upgrade. In the column titled *Diff*, we test whether the coefficients estimated are significantly different for group affiliated firms relative to standalone firms. This column reports the estimate difference with standard errors in parentheses. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, group-state-year, group-industry-year and group-treated-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Size*, *Age*, *Cash flow* and *Profitability*. All control variables are interacted with *High(Low)* to allow for differential trends. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

Panel A: Investments

	Dependent variable: I/AT_{t-1}					
	High Conc	Low Conc	Diff	High Conc	Low Conc	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	0.103	0.051	0.051	0.087	0.053	0.034
	(0.103)	(0.020)**	(0.105)	(0.099)	(0.020)***	(0.101)
$Start^{+1}$	-0.093	0.012	-0.106	-0.100	0.012	-0.112
	(0.041)**	(0.016)	(0.044)**	(0.042)**	(0.017)	(0.045)**
$Start^{+2}$	-0.086	0.033	-0.119	-0.098	0.031	-0.129
	(0.059)	(0.015)**	(0.061)*	(0.059)*	(0.015)**	(0.060)**
$Start^{+3}$	-0.112	0.004	-0.116	-0.125	0.002	-0.127
	(0.057)*	(0.020)	(0.063)*	(0.057)**	(0.020)	(0.062)**
$Start^{+4}$	-0.133	0.027	-0.159	-0.148	0.024	-0.172
	(0.061)**	(0.021)	(0.058)***	(0.061)**	(0.021)	(0.057)***
$Start^{+5}$	-0.117	-0.004	-0.113	-0.133	-0.007	-0.127
	(0.069)*	(0.022)	(0.066)*	(0.068)*	(0.022)	(0.064)**
$Start^{+6}$	-0.134	0.005	-0.139	-0.156	0.004	-0.160
	(0.059)**	(0.025)	(0.058)**	(0.059)***	(0.025)	(0.058)***
Controls		No			Yes	
Firm		Yes			Yes	
Industry*Year		Yes			Yes	
State*Year		Yes			Yes	
Treated*Year		Yes			Yes	
Adj-R^2		0.102			0.102	
Observations		12266			12266	

Panel B: External Financing

	Dependent variable: Debt/AT$_{t-1}$					
	High Conc	Low Conc	Diff	High Conc	Low Conc	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	-0.352	0.015	-0.367	-0.098	0.020	-0.118
	(0.128)***	(0.024)	(0.133)***	(0.125)	(0.026)	(0.132)
Start^{+1}	-0.122	0.020	-0.142	-0.088	0.016	-0.103
	(0.056)**	(0.017)	(0.061)**	(0.043)**	(0.017)	(0.048)**
Start^{+2}	0.088	0.037	0.052	0.104	0.015	0.089
	(0.099)	(0.023)	(0.106)	(0.093)	(0.024)	(0.102)
Start^{+3}	0.101	0.058	0.042	0.119	0.041	0.078
	(0.112)	(0.026)**	(0.118)	(0.110)	(0.027)	(0.113)
Start^{+4}	0.104	0.028	0.076	0.112	0.007	0.105
	(0.110)	(0.029)	(0.113)	(0.107)	(0.031)	(0.111)
Start^{+5}	0.093	0.063	0.031	0.111	0.036	0.075
	(0.108)	(0.036)*	(0.115)	(0.106)	(0.037)	(0.110)
Start^{+6}	0.111	0.043	0.068	0.130	0.012	0.118
	(0.110)	(0.040)	(0.114)	(0.109)	(0.045)	(0.112)
Controls		No			Yes	
Firm		Yes			Yes	
Industry*Year		Yes			Yes	
State*Year		Yes			Yes	
Treated*Year		Yes			Yes	
Adj-R^2		0.610			0.640	
Observations		12266			12266	

Table VIII. Effect of Shared Lenders on Standalones' Borrowings

This table presents estimates from triple-differences regressions relating the effect of shared lenders on Standalones' external borrowings. *One Shared (Others)* is a dummy variable equal to 1 if group affiliated firms and standalone firms have only one common lender in the five years before the announcement of the GQ road network upgrade. To better capture externalities and quantify the importance of a specific lender to the firm, we restrict this classification to standalone firms borrowing from only one external bank/financial institution. In the column titled *Diff*, we test whether the coefficients estimated are significantly different for these groups. This column reports the estimate difference with standard errors in parentheses. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, state-year, and industry-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Size*, *Age*, *Cash flow* and *Profitability*. All control variables are interacted with *One Shared (Others)* to allow for differential trends. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

	Dependent variable: Debt/AT$_{t-1}$					
	One Shared	Others	Diff	One Shared	Others	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	0.166	-0.005	0.171	0.168	0.003	0.164
	(0.065)**	(0.025)	(0.073)**	(0.073)**	(0.024)	(0.079)**
Start^{+1}	-0.006	0.005	-0.011	-0.023	0.009	-0.032
	(0.048)	(0.013)	(0.048)	(0.058)	(0.011)	(0.057)
Start^{+2}	-0.074	0.036	-0.110	-0.102	0.028	-0.130
	(0.051)	(0.016)**	(0.045)**	(0.070)	(0.016)*	(0.065)**
Start^{+3}	-0.049	0.055	-0.104	-0.065	0.049	-0.114
	(0.080)	(0.017)***	(0.079)	(0.086)	(0.016)***	(0.083)
Start^{+4}	-0.044	0.033	-0.077	-0.061	0.028	-0.089
	(0.074)	(0.016)**	(0.073)	(0.083)	(0.017)*	(0.081)
Start^{+5}	-0.103	0.046	-0.149	-0.124	0.041	-0.166
	(0.058)*	(0.020)**	(0.059)**	(0.070)*	(0.019)**	(0.068)**
Start^{+6}	-0.085	0.042	-0.128	-0.097	0.040	-0.137
	(0.054)	(0.020)**	(0.056)**	(0.062)	(0.020)**	(0.059)**
Controls		No			Yes	
Firm		Yes			Yes	
Industry*Year		Yes			Yes	
State*Year		Yes			Yes	
Adj-R^2		0.614			0.641	
Observations		21066			21066	

Table IX. Effect of Lenders' Group Exposure on Standalones' Borrowings

This table presents estimates from triple-differences regressions relating the effect of lenders' group exposure on Standalone firms. *High Exp(Low Exp)* is a dummy variable equal to 1 if banks' group exposure is above(below) the 75^{th} percentile of the median group debt across the years before the announcement of the GQ road network upgrade. In the column titled *Diff*, we test whether the coefficients estimated are significantly different for group affiliated firms relative to standalone firms. This column reports the estimate difference with standard errors in parentheses. All the financial variables are adjusted for inflation using Wholesale Price Index (WPI) at 2010 constant prices.To mitigate the effect of outliers, we winsorise all the ratios at 1% tails. Data period spans from beginning of the financial year 1989 to end of financial year 2016. The model is fully saturated with the start year of construction as the excluded category. All regressions include firm fixed effects, group-state-year, group-industry-year and group-treated-year fixed effects. We use 2-digit National Industrial Classification (NIC) in our fixed effects. Other control variables include *Size*, *Age*, *Cash flow* and *Profitability*. All control variables are interacted with *High(Low)* to allow for differential trends. Standard errors are corrected for heteroscedasticity and auto correlation, and clustered at the registered city level. Standard errors are reported in parentheses.*,**, and *** indicate significance at 10%,5% and 1% respectively.

	Dependent variable: Debt/AT$_{t-1}$					
	High Exp	Low Exp	Diff	High Exp	Low Exp	Diff
	(1)	(2)	(1)-(2)	(3)	(4)	(3)-(4)
Pre	-0.012	-0.022	0.010	-0.014	-0.009	-0.004
	(0.031)	(0.033)	(0.038)	(0.032)	(0.031)	(0.037)
Start^{+1}	0.005	0.015	-0.010	0.001	0.016	-0.014
	(0.020)	(0.018)	(0.024)	(0.022)	(0.018)	(0.025)
Start^{+2}	0.001	0.034	-0.033	-0.013	0.022	-0.035
	(0.026)	(0.025)	(0.022)	(0.027)	(0.026)	(0.024)
Start^{+3}	0.030	0.074	-0.045	0.010	0.058	-0.048
	(0.029)	(0.027)***	(0.020)**	(0.031)	(0.029)**	(0.020)**
Start^{+4}	0.018	0.042	-0.024	-0.001	0.025	-0.026
	(0.037)	(0.032)	(0.018)	(0.039)	(0.036)	(0.020)
Start^{+5}	0.033	0.063	-0.030	0.010	0.043	-0.033
	(0.041)	(0.039)	(0.009)***	(0.044)	(0.041)	(0.014)**
Start^{+6}	0.029	0.038	-0.009	0.009	0.018	-0.009
	(0.041)	(0.040)	(0.008)	(0.043)	(0.043)	(0.012)
Controls		No			Yes	
Firm		Yes			Yes	
Industry*Year		Yes			Yes	
State*Year		Yes			Yes	
Treated*Year		Yes			Yes	
Adj-R^2		0.601			0.626	
Observations		12353			12353	

Appendix Table I. Variable Definitions

Variable	Definition
$\text{Age}_{i,t}$	Firm i's age since incorporation in year t.
$\text{Cash flow}_{i,t}$	Ratio of cash flow from operations relative to book value of assets in year t.
$\text{Debt}_{i,t}$	Total outstanding debt from bank and institutions of firm i in year t relative to book value of assets in year t.
$\text{EBITDA}_{i,t}$	Earnings before interest, depreciation, taxes, and amortization of firm i in year t.
Group_{g}	A dummy variable which takes a value of one if firm i is a group firm and zero otherwise.
$\text{Investments}_{i,t}/\text{TA}_{i,t}$	Ratio of gross plant of firm i in year t relative to book value of assets in year t.
$\text{Profitability}_{i,t}$	Earnings before interest, depreciation, taxes, and amortization relative to book value of assets in year t.
$\text{Return on Assets}_{i,t}$	Profit after tax of firm i in year t relative to book value of assets in year t.
$\text{Sales Growth}_{i,t}$	Measured as the annual growth rate of sales of firm i in year t.
$\text{Size}_{i,t}$	Measured as the log of book value of assets in year t.
$\text{Total Assets}_{i,t}$	Total book value assets of firm i in year t.

Appendix A.

Empirical Appendix

Data Source on GQ Details: According to National Highway Authority of India (NHAI), the GQ highway was a collection of 128 contracts which was implemented all over the country starting in 1998. By Feb 2015, all of these contracts had been executed and the project completed. We compile information on each of these 128 projects from the annual reports of NHAI from 1998-99 to 2013-2014 as well as from the Ministry of Roads, Transport and Highways (MORTH). These annual reports identified the project name for the highway stretch, the length of the highway stretch, the national highway number, the start date for the project, cost of the stretch, financiers of the stretch and target and actual completion dates.

Mapping GQ Projects to cities: In most cases, the name of the project indicated the start and end towns on a highway stretch along with highway number. This information was used to identify city names in CMIE Prowess to identify location along these cities. In some cases, the project name was not clear or the town name could not be located. In such cases, we used information on the NHAI website for the highway project chainage and mapped to the preceding or succeeding highway stretch.

Implementation Date: We assign the start year of construction of a stretch and adjust for differences in financial year. We then match city names to individual highway project stretches and their start dates. In doing so, we allow firms atleast six months to respond to any such treatment. Several cities touch two or more stretches of highway. For such cities, we allocated them to the latest start date as they had access to some connectivity before other cities did. However, we did not allocate the start year as an earlier year if the earlier GQ project was River Over Bridge (ROB), a bridge section, or a short bypass, as most of these constructions were small in terms of kilometers of length.

Appendix B.

Total Factor Productivity: Estimation Procedure

Output is measured by the value of total sales that includes income earned by the company from the sale of industrial goods as well as their raw materials, byproducts, stores and waste.

Capital is measured by gross fixed assets of a firm that includes both tangible assets, such as land, building, plant, and machinery, and intangible assets, such as goodwill assets, software, etc.

Labor, which is a freely moving variable in the estimation of the production function, is measured by compensation to employees that includes all cash and payments in kind made by a company to its employees.

Intermediate inputs, is the combined value of raw materials, power and fuel consumptions. Raw materials are the sum of expenses on raw materials, stores, spares and tools used up by firms in the production process. Power and fuel include expenses made by the firms on power, fuel and water. The sum of these three variables is used as the proxy in the estimation of the production function.

In estimating firm-level TFP, we include firm size as a control variable.