Transportation Cost Reductions and the Distribution of Economic Activity: Evidence from Indian Cities and Villages

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Abstract

This study examines how reductions in transportation costs—driven by improvements in transportation infrastructure—have influenced the distribution of economic activity across villages, towns, and cities in India from 1998 to 2013. To address the potential endogeneity of infrastructure upgrades, I use a combination of propensity score matching and a difference-in-differences approach on the matched sample. The analysis focuses on the role of proximity to upgraded highways, assuming that areas closer to these highways benefit from greater reductions in transportation costs. Results show that regions near upgraded highways have employment rates that are 10% higher than those near non-upgraded highways. Importantly, the initial market size influences these outcomes: larger areas near upgraded highways tend to attract greater concentrations of economic activity, suggesting that reductions in transportation costs reinforce agglomeration economies, making larger regions even more economically attractive. Further, a heterogeneity analysis reveals patterns of industrial sorting. Manufacturing industries are more likely to cluster along upgraded highways, while land-intensive industries are located less in these areas compared to regions near other national highways.

Keywords— inter-regional transportation;labor market effects; agglomeration economies; industrial sorting

1 Introduction

Land transportation tends to be more expensive in developing countries than in developed countries due to inadequate transport infrastructure. For instance, trade costs rise four to five times faster with distance in countries like Ethiopia and Nigeria than in the United States (Atkin and Donaldson 2015). Improved transport infrastructure reduces these transportation costs (or frictions), facilitating the movement of people, goods, and economic activities across space. But does the reduction in transportation costs lead to concentration or dispersion of economic activity? Theoretically, the effects are ambiguous. On the one hand, lower transport costs can enable decentralisation by making peripheral regions more accessible. On the other hand, they can reinforce agglomeration by increasing the returns to clustering in already-productive areas. Empirical evidence reflects this ambiguity. Some studies document employment decentralisation following transport improvements, suggesting spatial dispersion of economic activity (Baum-Snow 2014). Conversely, others find that improved transportation networks can reinforce clustering, leading to greater spatial concentration (Faber 2014).

This study investigates how reductions in certain transportation costs, resulting from the upgrading of two major highway networks, affected the spatial distribution of economic activity across Indian villages, towns, and cities between 1998 and 2013 using a difference-in-difference framework. By the early 2000s, India's national highways carried around 40% of total traffic, despite accounting for only 2% of the road network. Recognising the critical role of highway infrastructure, the Indian government launched the National Highway Development Program (NHDP) in 2001, aiming to upgrade key highway segments to international standards. This study focuses on two of these upgraded corridors: the Golden Quadrilateral (GQ), which connects the four major metropolitan cities—Delhi, Mumbai, Chennai, and Kolkata—and the North-South and East-West (NS-EW) corridors, which span from Srinagar to Kanyakumari and from Porbandar to Silchar. While these projects primarily aimed to connect major urban centres, they also enhanced connectivity for numerous non-targeted cities, towns, and villages situated along the upgraded routes. This study examines whether and how the reduction in transport costs influenced the spatial distribution of economic activity in these non-targeted regions.

In this study, I compare regions located within 0–10 km of upgraded highways to regions within 0–10 km of other national highways that were not upgraded during the study period. The underlying assumption is that proximity to upgraded highways leads to a greater reduction in certain transportation costs post-upgrade as these improvements reduce some transport frictions, thereby facilitating the movement of people, resources, and activities across space. Since all regions in the comparison group were located near some national highway before the upgrades, we expect these regions to be similar not only in baseline characteristics but also in pre-treatment trends, addressing some key identification concerns.

To further address the potential endogeneity of highway placement, where pre-existing economic conditions might influence the selection of highways for upgrades—I employ propensity score matching (PSM). This method matches treated and control regions based on observable characteristics before the upgrades, within the specified distance band. After matching, I apply a difference-in-differences (DiD) approach to the matched sample to estimate the impact of reduced transportation costs on the spatial distribution of economic activity. As a robustness check, I assess the sensitivity of these results by comparing regions near upgraded highways to those at alternative distance thresholds.

Economic activities tend to cluster to exploit agglomeration economies: knowledge spillovers, input-output linkages, and labour pooling. However, such clustering also leads to congestion costs, competition, and higher factor prices (e.g., rent, wages). Thus, while centripetal (agglomeration) forces draw economic activity together, centrifugal (dispersion) forces—such as congestion and high land prices—encourage dispersion. Reductions in transportation costs influence the relative strength of these opposing forces. If better transport connectivity reduces commuting and shipping costs, firms and workers may increasingly locate in dense, economically active regions to benefit from economies of scale, reinforcing spatial concentration. However, as transport costs fall further, firms and households may relocate to peripheral areas to escape congestion and take advantage of lower land and labour costs, while still maintaining access to the benefits of agglomeration as transportation is cheaper. Therefore, as transportation costs decline, the net effect on the spatial distribution of activity—whether it leads to further concentration or increased dispersion—remains theoretically ambiguous and must be addressed empirically. In this context, I use distance to upgraded highways as a proxy for reductions in transport costs, as there is no direct measure of transport costs, and examine how these reductions shape the distribution of economic activity across a granular spatial scale in India.

The effect of large transportation investments on various demographic and economic outcomes has been studied in developing economies, including India (Datta 2012; Faber

2014; S. E. Ghani et al. 2013; E. Ghani et al. 2016; Alder 2016; Baum-Snow et al. 2017; Melecky et al. 2018; Asher and Novosad 2020; Amirapu et al. 2019; Chatterjee et al. 2022; Saxena et al. 2020; Dutta et al. 2021; Shekhawat et al. n.d.; Das et al. 2023). However, previous studies on India conducted a district-level analysis exclusively focusing on manufacturing activity. In this study, I include all non-farm economic activities, consisting of formal and informal manufacturing and services in villages, towns, and cities. This is important as the services sector has played a major role in driving economic growth in the last few decades, even though most of the New Economic Policy reforms have targeted the organised manufacturing sector. Thus, this study helps shed light on the distributive effect of transportation infrastructure in shaping economic development and industrial composition at granular spatial levels.

On the one hand, evidence from India suggests that transportation infrastructure led to the growth of organised manufacturing in districts along highways (E. Ghani et al. 2016). On the other hand, it suggests a dispersal of economic activity (Amirapu et al. 2019), although these findings do not always conflict with one another. This could be a reflection of differential responses of different economic activities to transportation cost reductions and agglomeration economies. Economic activities exhibit diversity due to differences in input-output linkages and factor intensities. The impact of reduced transportation costs can vary across industries (Duranton et al. 2014). Expanding on the existing literature that delves into the varied influence of transportation infrastructure on diverse economic activities (Chandra and Thompson 2000; Duranton et al. 2014; Liu et al. 2022), I examine how agglomeration forces differ between manufacturing and services industries as the manufacturing sector's engagement in producing tradable goods contrasts the non-tradable services sector. Additionally, I explore these dynamics across industries with varying levels of land intensity.

The differential response of economic activities to reductions in transportation costs can significantly reshape the industrial composition of a region. This transformation arises from heterogeneity in how agglomeration economies operate, both within and across industries. As a result, such changes may induce either greater specialisation in certain industries or increased diversification of economic activities across industries. To assess the impact of reduced transportation costs on the composition of non-farm economic activities, I construct a region-industry version of the Herfindahl–Hirschman Index (HHI). This index serves as a quantitative measure of industrial concentration (or conversely, diversification) within a region. I then use the HHI as the outcome variable to estimate the effect of highway-induced reductions in transportation costs on the spatial composition of economic activity.

The findings indicate an overall increase in non-farm economic activity across all studied regions following highway improvements, with the effects being more pronounced in areas proximate to the upgraded highways relative to others. These results support the hypothesis that reductions in transportation costs have heterogeneous effects.

Specifically, the impact is particularly strong in manufacturing industries, where further reductions in transport costs appear to reinforce agglomeration through input-output linkages—a key driver of industrial clustering in India. Moreover, the findings underscore the importance of transport cost reductions for land-intensive industries, which are more likely to relocate to peripheral areas to leverage on lower factor prices. In such cases, improved connectivity allows firms to benefit from agglomeration economies while avoiding the congestion and high costs associated with more central locations.

Investments in transportation infrastructure carry significant policy implications, as they can promote the agglomeration of economic activities. Industrial agglomeration enhances productivity, driving economic growth (Fujita et al. 2001 and Lall et al. 2004), and also improves consumer welfare. However, a more dispersed pattern of economic activity

can help mitigate spatial disparities and promote balanced regional development. Thus, examining the clustering of economic activities can provide valuable insights for shaping policies that support lagging regions. Such analysis can help policymakers understand how transportation improvements influence the distribution of activities, thereby guiding efforts to foster balanced regional development and reduce spatial inequalities.

This study focuses on the impact of reduced transportation costs on the distribution of non-farm economic activities across different locations at a fine spatial scale, where the interactions between firms and workers, central to agglomeration economies, are more pronounced. While the current analysis explores these spatial dynamics, the broader question of whether transportation improvements primarily drive productivity gains through concentration or help reduce spatial inequality remains outside the scope of this study.

2 Conceptual Framework

The interpretative framework utilised to analyse the empirical findings of the current study is rooted in the New Economic Geography literature, employing the core-periphery model elucidated by Krugman (Krugman 1991;Krugman and Venables 1995). In this context, the consequences of further reductions in transportation costs or the near elimination of transportation costs on the agglomeration of economic activities are ambiguous, as they can result in multiple equilibria. Puga 1999 delves into the relationship between agglomeration and transportation costs, considering factors such as increasing returns to scale (IRS), migration, and input-output linkages. Two cases are detailed by Puga 1999: regions with higher levels of economic activity will exhibit higher wages in the presence of increasing returns to scale. Mobile labour reacts to wage differences by migrating to larger regions, fostering higher agglomeration. With a reduction in trade barriers/transportation costs, production tends to concentrate in larger regions to benefit from economies of scale, leading to agglomeration. With increasing returns, migration, and customer access, profit-maximising firms find agglomeration advantageous (Puga 1999). Here, Marshallian externalities further encourage firms within an industry to establish stronger connections with upstream and downstream suppliers in the supply chain (Liu et al. 2022), encouraging activities to cluster together. Further, strong inter-industry linkages due to market size may encourage several industries to cluster.

However, excessive agglomeration in larger regions can bring negative externalities, characterised by high competition and increased factor prices (e.g., rent) that strengthen dispersal forces, prompting activities to move away. If labour is immobile, firms will respond more to cost differentials across regions. Consequently, with reduced transportation costs, firms may relocate to other peripheral areas with lower factor prices, leading to the dispersion of economic activity. With transportation costs that are low enough, activities located away from the congested regions may still benefit from agglomeration economies without facing high congestion costs. Thus, forces that hinder factor price equalisation across regions are likely to lead to dispersion.

The current study contributes to two key strands of literature. Firstly, it adds to the studies on the impact of transport cost reduction on economic activity [1]. Secondly, it adds to the growing body of research focused on evaluating the economic effects of transportation infrastructure in India (Datta 2012; Dutta et al. 2021; S. E. Ghani et al. 2013; Alder 2016; Melecky et al. 2018; Asher and Novosad 2020; Amirapu et al. 2019; Das et al. 2023).

While prior studies on highways in India often concentrate on the GQ network, focusing on a district-level analysis, the current research broadens the scope by considering

[1] Brülhart and Torstensson 1996; Teixeira 2006; Lopez et al. 2010; Meijers et al. 2012; Faber 2014; Yu et al. 2016; Coşar and Demir 2016; Baum-Snow 2020; Liu et al. 2022

all cities, towns, and villages along the GQ and NS-EW corridors. E. Ghani et al. 2016 observed that GQ upgrades led to the growth of organised manufacturing between 1994 and 2009 in districts along the GQ highway. Asturias et al. 2019 found that improvements to GQ resulted in a 2.7% increase in real income for the manufacturing sector between 2001 and 2016, with 7.4% attributed to allocative efficiency gains. Chatterjee et al. 2022 also emphasised the impact of public investment on GQ and NS-EW highways, showing productivity gains for formal manufacturing firms. Melecky et al. 2018 investigated the effect of GQ and NS-EW corridors on developmental outcomes between 1994 and 2011, highlighting structural transformation in districts closer to the highways. They focused on shifting employment from the farm to the non-farm sector.

The findings from the current study contribute to the existing literature by examining the effects of reduced transportation costs on the distribution of all non-farm economic activity, encompassing formal and informal manufacturing, as well as services, at finer spatial levels. It adds to the literature on the heterogeneous effects of transportation costs by focusing on industrial heterogeneity. I distinguish between non-farm economic activities at finer levels of industrial disaggregation and then broaden the analysis to investigate how transportation cost reductions influence the industrial composition within the region. This is important as the interaction of reduction in transportation costs with the agglomeration economies not only differs across manufacturing and services but also across different spatial scales.

3 Overview of Highways in India

Transportation infrastructure is essential for passenger and goods transport. By the early 2000s, about 65% of the freight transport in India was carried by a network of 228 national highways stretching over 66,000 km (Datta 2012). In contrast, the reliance on rail transport had reduced drastically. The non-bulk freight transport made up only 3% of the total rail transport, and bulk transport by rail was restricted to goods such as iron, steel, and cement (Asturias et al. 2019). Despite being reliant on national highways for the bulk of the transport, the poor condition of these highways posed a major hurdle to economic development. By 2000, most of India's national highways were limited to two lanes or fewer, with 32% comprising single-lane roads. The networks were not *access-controlled* and passed through busy towns and cities (Datta 2012), increasing congestion and affecting their carrying capacity.

Recognising the importance of improving highways, the government of India launched the National Highway Development Program (NHDP) in 2001. Enhancing the national highway network in the country at different stages was the primary goal of the program. In 2001, the program began its first phase, focusing on enhancing Golden Quadrilateral highways, which connected the four major metropolitan cities of Delhi, Mumbai, Chennai, and Kolkata, spanning a distance of 5834 km. This phase sought to upgrade the road quality of about 5000 km of highways. The aim was to upgrade some of the existing highways to international standards of 4 or 6 lanes with grade separators, over-bridges, bypasses, underpasses, and other access roads (Datta 2012). By 2006's end, approximately 95% of GQ's upgrade was finished and functioning. About 98% was completed by the end of 2010. By the end of 2011 and early 2012, the complete network was in operation.

As of today, the network has operated for nearly two decades. In April 2023, the Minister of Road Transport and Highways announced a further renovation of the Chandikhole-Bhadrak section of the Chennai-Kolkata corridor to upgrade the existing network to 6 lanes to carry more traffic. This network is considered crucial for economic development as it would facilitate the interstate transport of agricultural, industrial, and local mining traffic.

The North-South-East-West corridor, connecting Srinagar in the north to Kanyakumari in the South and Silchar in the East to Porbandar in the West, was the focus of the second phase of the NHDP. The goal was to improve 7142 km of national highways. The upgrade began in 2003, and about 5900 km was completed by 2012. As of 2017, 6568 km was completed on the highway, and the work was still in progress (Melecky et al. 2018). The project progressed slowly, with just 10% completion by 2006. I consider the part of the North-South East-West corridor completed as of 2012. Figure 1 presents the extent of highways studied here.

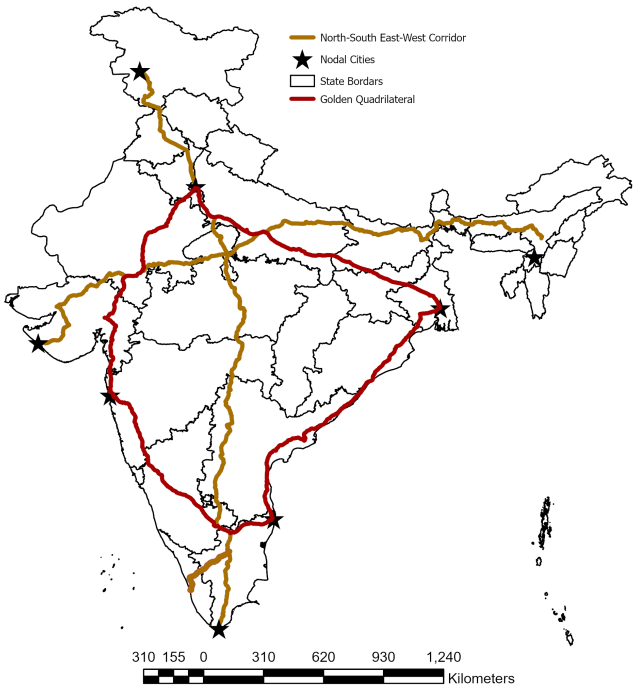


Figure 1: North-South and East-West corridor and the Golden Quadrilateral Highway network

4 Data and Methodology

4.1 Sources of Data

In this study, I use the village, town, and city-level panel data to examine the impact of highways on the distribution of non-farm economic activity. The outcome variable of interest is the economic activity measured in terms of total employment and the number of establishments from the Economic Census (1998 and 2013). The establishment-level data from the Economic Census (EC) is aggregated at the village/town/city level using the village/town/city keys from the Socioeconomic High-resolution Rural-Urban Geographic Platform for India (SHRUG)[2]. Using the Economic Census enables the differentiation of activities at granular industrial and spatial levels. In the current study, I identify all the non-farm activities at the 'shric ' [3] level.

I use distance to the upgraded highways as the proxy for a reduction in transportation costs, assuming that regions closer to the highways experience a larger reduction in transportation costs due to improved access that reduces transport frictions. Thus, I compare villages, towns, and cities within 0-10 km from the upgraded highways with villages, towns and cities within 0-10 km from other national highways not upgraded under the study period. The distance variable is obtained by creating the shapefile for GQ and NS-EW corridors using an open street map on Google Earth. This was combined with the village/town/city polygons from the SHRUG. The distance variable is obtained from the centroids of each village/town/city polygon to the nearest highway as geodesic distances on ArcGIS Pro. I also explore specifications by alternating the distance thresholds, and at increments of 10 km from the highways, to assess the robustness of the results.

The industries within manufacturing and services exhibit heterogeneity due to differences in input-output linkages, factor intensity, and consumer relationships. In this study, I address one such source of heterogeneity by classifying industries based on their land intensity at baseline (*pre-upgrade period*). Excess agglomeration often leads to negative externalities, such as high land prices in agglomerated areas that contribute to the strengthening of dispersal forces. With the reduction in transportation costs, land-intensive industries are likely to benefit by moving to low-cost peripherals without losing out on agglomeration economies, as transportation costs are cheaper.

The measure of land intensity is constructed as the ratio of the total value of land to the total output. The land intensity at the industry level is constructed by taking the weighted average of land intensity at the firm level, with outputs as the weights [4]. Here, I consider formal and informal non-farm economic activity using NSSO (55^{th} round), ASI (1999), and CMIE Prowess data. The ASI provides data on organised (formal) firms, and the NSSO (55^{th} round) covers informal non-agricultural enterprises; thus, I merge them to cover all manufacturing industries. CMIE Prowess (2000) covers data on manufacturing and service companies. The land intensity from CMIE data is computed from a sample of 626 manufacturing and 470 service companies.

Measure of the Composition of Economic Activity

The differential responses of economic activities within a region to a reduction in transportation costs may alter industrial composition. To measure the composition of economic activity within a region, I construct a variant of the HHI as follows:

[2] A comprehensive data compiled by Sam Asher, Tobias Lunt, Ryu Matsuura, and Paul Novosad (Asher et al. 2021)

[3] *Shric* is an industry identifier common across NIC 1987, 1998, 2004, and 2008, defined by SHRUG. At most, the activities are disaggregated at the 3-digit NIC level. The SHRUG identifies 90 unique activities across manufacturing and services. In this study, I cover 87 different non-farm activities.

[4] The study acknowledges that this is a crude measure of land intensity. However, due to limited data, I could not estimate the Land intensity through the production function.

$$HHI_{mt} = \sum_{i=1}^{n} s_{mit}^2 \tag{1}$$

Where HHI is the measure of the composition of economic activity of region *m* at time t; s_{mit} is the share of the industry *i*'s economic activity (*measured in terms of total employment*) in region *m*. I construct the index across all industries, as well as within manufacturing and services, to examine the extent of industry diversification within the region.

4.2 Empirical Strategy

To estimate the impact of reduced transportation costs on the distribution of economic activity in non-targeted villages, towns, and cities of India, a difference-in-difference estimation with region and time-fixed effects is employed. Here, I compare regions located 0–10 km from upgraded highways (treated group) with regions 0–10 km from other national highways that were not upgraded during the study period (control group). This approach helps control for potential pre-trends differences, as both groups were already situated near some national highways before the upgrades. However, some differences may persist.

Another major challenge in estimating the effect of infrastructure upgrades is the potential endogeneity of highway placement: economically stronger regions may have been more likely to receive upgrades, thereby biasing the estimates. While previous studies (Banerjee et al. 2020; Faber 2014; S. E. Ghani et al. 2013; Melecky et al. 2018; Asturias et al. 2019) have used the straight-line distance between nodal (targeted) points as an instrument, this is less applicable here. The highways studied here are part of an existing network that was upgraded, rather than newly constructed, making the straight-line IV less valid due to possible pre-existing differences between regions. Thus, I address selection bias and potential endogeneity in highway placement by applying propensity score matching (PSM) before implementing a difference-in-differences (DiD) estimation on the matched sample. This combined strategy ensures that treated and control regions are comparable in observable pre-treatment characteristics. Therefore, by comparing similarly situated regions near upgraded and non-upgraded highways and using PSM to ensure balance on covariates, I aim to reduce bias to estimate the impact of transportation cost reductions. In addition, I also present some robustness checks by comparing the regions closer to the upgraded highways with regions at different distance thresholds to test the effect of different levels of transportation cost reductions.

The study's main results focus on regions very close to the upgraded highways (within 10 km), which experienced larger reductions in transportation costs compared to regions closer to other national highways. The empirical specifications follow equation 2.

$$Y_{mt} = \alpha + \beta_1 Dist_{\text{HW}_m} + \beta_2 Dist_{\text{HW}_m} \times Post_{\text{t}} + \beta_3 Post_{\text{t}} + \gamma_{\text{m}} + \epsilon_{\text{mt}} \tag{2}$$

where $d \in D$ & D = (0-10)

$$\begin{aligned} Y_{mt} = \alpha + \beta_1 Dist_{\text{HW}_m} + \beta_2 Dist_{\text{HW}_m} \times Post_{\text{t}} + \beta_3 Post_{\text{t}} + \beta_4 Dist_{\text{HW}_m} \times share_{\text{m98}} \\ + \beta_5 Dist_{\text{HW}_m} \times Post_{\text{t}} \times share_{\text{m98}} + \beta_6 Post_{\text{t}} \times share_{\text{m98}} + \gamma_{\text{m}} + \epsilon_{\text{mt}} \end{aligned} \tag{3}$$

Where Y_{mt} is the outcome of interest in the region (village/town/city) m at time t; Dist_{HW}, is the binary indicator that equals 1 if the region belongs to the defined distance category ($\text{Dist}_{HW} \in$ 0-10 km from the upgraded highways and 0 if closer to other national highways); γ_m is the region fixed effect; Post is the time (year) indicator that captures the difference between the pre and post-upgrade period; ϵ is the error term. The inclusion of

region-fixed effects controls for region-specific time-invariant characteristics. Given this, β_2 is the coefficient of interest that captures the difference-in-difference effect. Additionally, to capture the differential effects of region size, I interact the proximity indicator with the region's initial level of economic activity[5] (share$_{m98}$) following equation 3.

Propensity Score Matching

To address the identification challenge, I employ propensity score matching (PSM) to compare regions located within 0–10 km of upgraded highways (treated group) to those located 0-10 km from other national highways (control group). Propensity scores are estimated using covariates from the 1991 Population Census, which capture pre-treatment regional characteristics. These covariates include population density, literacy rate, shares of Scheduled Castes and Scheduled Tribes, and employment shares in farming, manufacturing, and services. To identify the most relevant predictors of treatment assignment, I use a Lasso-logit model to select covariates for estimating the propensity scores.

To evaluate the quality of the matching, I present covariate balance before and after matching, along with standardised biases, in Table 1. Figure 3 shows the overlap of propensity scores between treated and control groups, both before and after matching. The results indicate improved balance across covariates post-matching. I use a 1-to-1 nearest-neighbour matching with a maximum calliper of 0.01 to ensure close matches. Overall, the matched sample demonstrates strong covariate balance, indicating that the treated and control regions are comparable based on observable characteristics before the highway upgrades.

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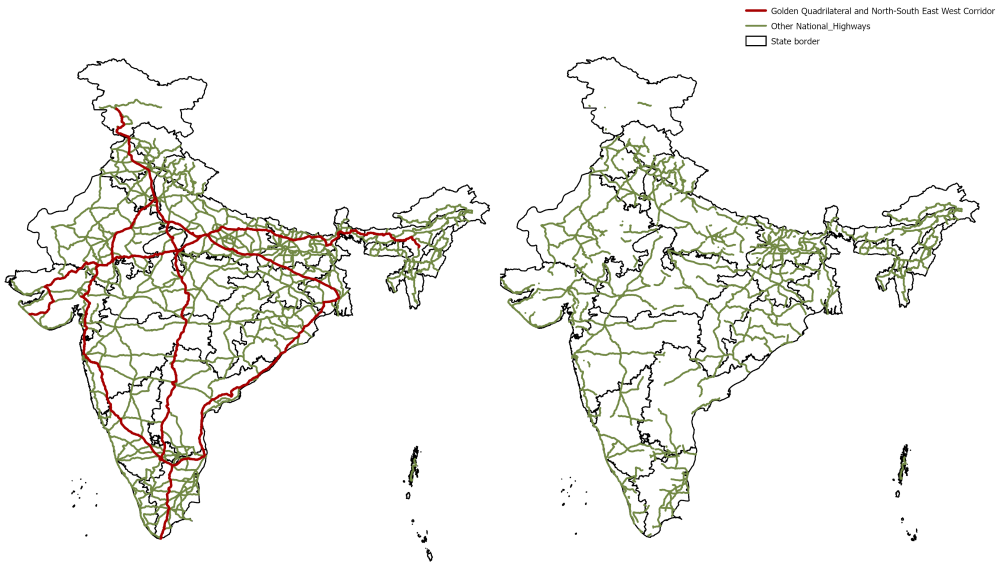
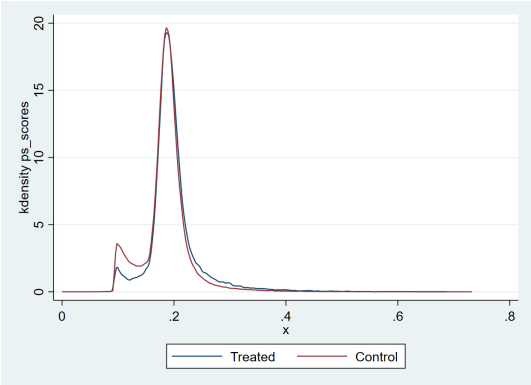
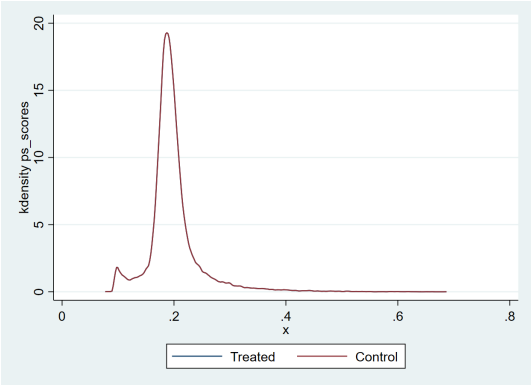


Figure 2: National Highway network in India

[5]It is measured as *m's* (region) share of non-farm economic activity (in the national non-farm economic activity) at baseline (1998).



(a) All Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and all other regions within 10 km of the other national highways that were not upgraded during the period as control. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991



(b) Matched Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and all other regions within 10 km of the other national highways that were not upgraded during the period as control. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991. This consists of a 1:1 nearest neighbourhood match with the maximum difference being 0.01.

Figure 3: Overlap Plots: Regions 0-10 km to and regions 0-10 km to non-upgraded highways

Table 1: Standardised mean differences (Standardised bias): 0-10 km (Baseline Year 1991)

	BEFORE MATCHING		
	Mean in 0-10 km from upgraded highways	Mean in 0-10 km from other national highway	Standardised diff.
Density of Population	47.76	51.61	-0.001
Share of Literates	0.36	0.34	0.123
Share of Scheduled Caste	0.2	0.18	0.088
Share of Scheduled Tribe	0.09	0.14	-0.191
Share of Farm Employment	0.82	0.85	-0.151
Share of Manufacturing	0.06	0.04	0.202
Share of Services	0.1	0.09	0.05
	AFTER MATCHING		
	Mean in 0-10 km from upgraded highways	Mean in 0-10 km from other national highway	Standardised diff.
Density of Population	47.76	49.94	-0.003
Share of Literates	0.36	0.36	0.002
Share of Scheduled Caste	0.2	0.2	-0.007
Share of Scheduled Tribe	0.09	0.08	0.036
Share of Farm Employment	0.82	0.82	-0.003
Share of Manufacturing	0.06	0.06	0.021
Share of Services	0.1	0.1	-0.01

Note: This table presents the results following standardised bias for the two distance categories - 0-10 km from the upgraded highways and 0-10 km from other non-upgraded national highways, following the 1991 population census data. Standard deviation in parentheses.

5 Empirical Results

5.1 Effect of highways on the distribution of non-farm economic activity

This section presents the results of the impact of highways on the distribution of non-farm economic activity in non-targeted cities, towns, and villages across India between 1998 and 2013. Additionally, following literature (Datta 2012; S. E. Ghani et al. 2013), other major cities situated along the highways—Gurgaon, Faridabad, Ghaziabad, Noida, Thane, Chandigarh, Hyderabad, and Bangalore—are also excluded from the analysis. These cities,

some of which are classified as large suburbs, were purposefully excluded from the study due to their significance as major economic centres. Datta 2012 argues that the decision to upgrade highways passing through these centres was intentional, emphasising the strategic importance of these areas in the country. Thus, I exclude these places in addition to the targeted cities and focus on only the non-targeted peripherals along the upgraded highway.

Table 2: Effect of Proximity to Highways on Economic Activity between 1998 and 2013

	Matched Sample		
	Employment	Establishment	Establishments with employment > 5
0-10 km	0.103^{***}	0.117^{***}	0.0521^{***}
	(0.0109)	(0.00992)	(0.00850)
Post=1	0.625^{***}	0.619^{***}	0.303^{***}
	(0.00764)	(0.00702)	(0.00589)
Constant	4.066^{***}	3.471^{***}	0.666^{***}
	(0.00272)	(0.00248)	(0.00213)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	118712	118712	118712
Adjusted R^2	0.207	0.241	0.092
Baseline Mean	3.842085	3.240377	0.5941337

Note: This table presents the results of estimating the differential effects of proximity to upgraded highways (which led to further reductions in transportation costs) on economic activity in villages, towns, and cities in India between 1998 and 2013. The results are presented for different measures of non-farm economic activity. Column 2 presents for all employment; columns 3 and 4 present the results for the number of all establishments, establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects.

Table 2 presents the results following specification 2. The analysis measures the impact on three indicators of economic activity: employment, the total number of establishments, and the number of large establishments employing more than 5 individuals. The findings suggest a positive effect of highway improvement on non-farm economic activity among all regions. However, a stronger impact was observed in regions closer to the upgraded highway network showing a 10% higher economic activity, measured in terms of the total employment and the total number of non-farm establishments, relative to other regions after the upgrade[6]. Additionally, when measured in terms of establishments with more than 5 employees, the regions closer to highways observed a 5% increase in economic activity compared to other regions.

After the upgrades, the average relative change in employment, the number of establishments, and the number of large establishments with employment greater than 5 was 8.6%, 13%, and 21%, respectively, in the regions closer to the highways. This shows that for every 100 workers, the regions closer to the upgraded highways employed 8 more people after the upgrades. These magnitudes are large as the spatial level at which these interactions are captured is often very small, wherein a majority of the regions studied (98%) are classified as rural at baseline (*2001 Population Census*) with very low non-farm activity.

The total investment in upgrading the GQ and NS-EW corridors between 2001 and 2012 was estimated at approximately 950 crores INR (9.5 billion). Following the upgrades, regions within 0-10 km from the upgraded highways experienced an average employment creation of 260 jobs. The total job creation post-upgrade was reported to be 488 jobs,

[6]The similarity in coefficients for total employment and the number of establishments may stem from their limited differentiation. This arises because the Economic Census treats a single-person unit as an enterprise and does not distinguish between establishments of different sizes. Figure 9 displays density plots of total employment and the total number of establishments in 1998 and 2013 for the matched sample, represented on an IHS scale, indicating a generally higher degree of overlap between them.

resulting in an estimated 0.514 jobs generated for every crore (INR) (0.01 billion) spent on the upgrades.

It is important to note that these figures are based on estimated values and assume that there is no relocation of economic activity. In this study, I am unable to differentiate between the effects of relocation and the actual growth of economic activity. Furthermore, my analysis focuses exclusively on the differential impacts across the specified distance categories and does not account for general equilibrium effects.

For the evaluation of the returns on investment, this analysis is constrained by the limited availability of data. Specifically, I do not have access to village, town, or city-level wage or output data, which are critical for a comprehensive assessment of economic returns. Consequently, the calculated returns on investment, represented as approximately 0.514 jobs per crore spent, must be interpreted with caution. This measure serves as a preliminary indicator of economic impact; however, a more detailed evaluation would require data on wages and output to accurately capture the full economic returns associated with large-scale investments, such as those in highway infrastructure. The findings suggest that regions closer to highways observe heightened economic activity, as substantial reductions in transportation costs experienced by these regions post-upgrades render these regions more attractive. These findings align with existing literature on India, which has demonstrated a growth of manufacturing activities along districts closer to highways (S. E. Ghani et al. 2013; Melecky et al. 2018). The results from the current study contribute by providing evidence for all non-farm economic activities at finer spatial levels where transport frictions are smaller and agglomeration effects are larger.

The main objective of this study is to examine the interaction between transportation costs and agglomeration economies at granular spatial scales in India. Figure 4 presents the coefficient plots where I measure the distance to the upgraded highways at incremental of 10 km to explore how distance to highways and economic activity behave after the upgrades. This argument is visually reinforced through coefficient plots for all the measures of economic activity, which showcase the diminishing levels of economic activity with increasing distance from highways (*decreasing transport costs*). Here, I compare regions at distance intervals of 10 km with regions beyond 300 km.

The region's initial level of economic activity plays an important role in determining whether reductions in transportation costs lead to further concentration of economic activities or not. With reductions in transportation costs, activities may move towards larger areas to pursue the cost advantage due to proximity to suppliers of intermediary goods (*forward linkage*) for firms that use those goods. If the reduced transportation costs interact with economies of scale, and strengthen agglomeration forces. It reinforces the attractiveness of large regions, leading to further concentration.

Table 3 presents the results following specification 3 to examine the effect of the region size that measures the strength of agglomeration economies (*defined as the region's initial size*). The results presented across three different measures of economic activity consistently highlight that regions closer to upgraded highways attract more economic activity compared to other regions. Specifically, a one-standard-deviation increase in the initial level of economic activity is associated with a 9% higher concentration of employment in regions closer to upgraded highways relative to other regions. These findings are robust when considering alternative measures of the region's initial size of economic activity, such as the share of large establishments and all establishments. The overall pattern suggests that areas closer to highways not only attract higher economic activity, but larger areas closer to highways experience a further concentration of economic activity relative to smaller areas closer to the upgraded highways. The larger coefficient on larger establishments reinforces the hypothesis that size matters for reaping the benefits of scale economies.

The interaction of economies of scale with reductions in transportation costs renders

proximate regions more attractive for economic activities by strengthening the agglomerative forces in those regions. This advantage of activities clustering in large regions may stem from stronger Marshallian externalities of input-output linkages, labour market pooling, and knowledge spillovers that are specific to the industry. Further, these agglomeration economies may also stem from Jacobian economies that arise due to stronger inter-industry interactions, due to the larger size of the regions. The evidence from India for this study period shows that industry linkages and labour pooling are strong drivers of industrial agglomeration at this geographical scale, as transport frictions are significantly reduced.

The main assumption in difference-in-difference estimation is that the treated and control groups exhibit similar trends before the treatment. Thus, in this study, I use propensity score matching to match the treated and control groups on a set of covariates before the upgrades. This matching ensures that the groups are similar in levels before the upgrades. However, they may or may not be similar in trends, thus raising identification concerns. To test for pre-trends among the matched sample, I conduct a placebo test. This test examines the impact of proximity to upgraded highways on economic activity between 1990 and 1998. The results presented in Table 16 show that before the upgrades, there was no statistically significant difference between regions closer to the GQ and NS-EW corridors and other national highways in India. Since all these regions were closer to some national highway, they were similar in trends as well at the levels before the upgrades. Given this, assuming that in the absence of upgrades the regions would continue to grow similarly, and any statistically significant difference observed above post-upgrades can be attributed to the upgrades, conditional on time and region fixed effects.

5.2 Heterogeneity Analysis

Industrial characteristics are heterogeneous, and transportation infrastructure improvements may have a differential effect on different industries (Liu et al. 2022). To explore the heterogeneous effect of highway improvements on the distribution of non-farm economic activity, I first classify the non-farm economic activities as manufacturing and services, followed by differentiating activities based on their land intensities.

Classification of non-farm activities as manufacturing and services

There are notable distinctions between manufacturing and services. Manufacturing industries produce goods that can be traded, whereas services are mostly non-tradable. Manufacturing industries heavily rely on transportation infrastructure and are likely to benefit more from reduced transportation costs due to strong inter-industry linkages. Consequently, the impact of highway improvements on industry agglomeration is likely to vary among different activities. Evidence from India (Mukim 2015; Dwivedi and Dubey 2022) suggests that input-output linkages play a crucial role in determining manufacturing agglomeration.

Table 4 presents the results illustrating the effect of proximity to upgraded highways on the distribution of manufacturing and services activities. The findings are presented for total employment and the number of establishments of various sizes, revealing interesting patterns of industrial sorting. Manufacturing activities are more closely located near highways compared to services, a consistent observation across various measures of economic activity. Manufacturing industries are more responsive to reductions in transportation costs compared to services, as agglomeration economies are stronger for manufacturing industries. Such cost reductions influence firms in their choice of optimal proximity to suppliers or consumers, thereby benefiting from economies of scale.

The findings presented in Table 10, based on specification 3, delve into the impact of the initial level of economic activity on distribution dynamics, treating it as an agglom-

Table 3: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Initial Level of Economic Activity

	Matched Sample		
	Employment	Establishment	Establishment > 5
0-10 km $\times$ Post=1	0.144***	0.141***	0.0818***
	(0.0110)	(0.00962)	(0.0116)
0-10 km $\times$ Post=1 $\times$ Initial economic activity Emp	0.956*		
	(0.453)		
0-10 km $\times$ Post=1 $\times$ Initial economic activity Est		0.171	
		(0.197)	
0-10 km $\times$ Post=1 $\times$ Initial economic activity L est			1.483*
			(0.731)
Post=1	0.457***	0.542***	0.0982***
	(0.00791)	(0.00689)	(0.00840)
Post=1 $\times$ Initial economic activity Emp	-15.84***		
	(0.334)		
Post=1 $\times$ Initial economic activity Est		-5.714***	
		(0.146)	
Post=1 $\times$ Initial economic activity L est			-21.68***
			(0.534)
Constant	4.066***	3.471***	0.666***
	(0.00264)	(0.00244)	(0.00202)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	118712	118712	118712
Adjusted R^2	0.253	0.268	0.177
Baseline Mean	3.842085	3.240377	0.5941337

Note: This table presents the results of estimating the differential effects of proximity to upgraded highways (which led to further reductions in transportation costs) on economic activity in villages, towns, and cities in India between 1998 and 2013. The results are presented for different measures of non-farm economic activity. Column 2 presents for all employment; columns 3 and 4 present the results for the number of all establishments, establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects. The measure of the initial level of economic activity is standardised with a mean of 0 and unit standard deviation.

erative force. A one-standard-deviation increase in the initial size of economic activity corresponds to a 17% higher concentration of manufacturing employment in regions along the upgraded highways. Similarly, for services, a one-standard-deviation increase in the initial size of economic activity results in a 10% reduction of employment in regions along the upgraded highways relative to manufacturing. T

In this study, I classify non-farm activities as only manufacturing and services. Services are a heterogeneous group. Much of India's rapid services sector expansion stems from consumers' access to final consumption. The impact of reduced transportation costs is likely to vary across these service subsectors, depending on consumer and firm demand. Following Fan et al. 2023, I disaggregate services into four subcategories, namely, wholesale and retail trade, finance and insurance (including real estate), transport and storage, and education and public administration. Further, I classify construction as a separate sector.

Table 19 presents the results of the effects of transportation cost reductions on manufacturing and disaggregated services. Findings indicate that a reduction in transportation costs leads to increased employment in finance and insurance services near upgraded highways. The increase in industrial activity prompts the development of additional services, leading to increased employment in these service sub-sectors. Conversely, there is a relative 18.2% reduction in employment in transport and storage, suggesting varied sectoral responses. This divergence may be attributed to firms' inclination to move from dense ar-

Table 4: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Manufacturing vs Services

	Matched Sample			
	Employment	Establishment	Establishment>5	Establishment>10
0-10 km $\times$ Post=1	0.144***	0.120***	0.0705***	-0.00412
	(0.0148)	(0.0118)	(0.00829)	(0.00284)
0-10 km $\times$ Services $\times$ Post=1	-0.0948***	-0.0421***	-0.0585***	0.00158
	(0.0152)	(0.0122)	(0.00988)	(0.00331)
Post=1	0.151***	0.233***	0.0502***	-0.00836***
	(0.0104)	(0.00836)	(0.00577)	(0.00181)
Services $\times$ Post=1	0.467***	0.301***	0.276***	0.0102***
	(0.0108)	(0.00868)	(0.00692)	(0.00215)
0-10 km $\times$ Services	0.0916***	0.122***	0.0269**	-0.0102***
	(0.0128)	(0.0103)	(0.00839)	(0.00271)
Services	0.838***	0.905***	0.253***	-0.00869***
	(0.00911)	(0.00732)	(0.00590)	(0.00178)
Constant	2.788***	2.187***	0.261***	0.0377***
	(0.00476)	(0.00383)	(0.00296)	(0.000968)
Year and Region Fixed Effects	Yes	Yes	Yes	Yes
Observations	205032	205032	205032	205032
Adjusted R^2	0.333	0.415	0.141	0.001
Baseline Mean (Manufacturing)	2.800	2.225	0.276	0.033
Baseline Mean (Services)	3.385	2.85	0.437	0.020

Note: This table presents the results of estimating the differential effects of proximity to upgraded highways (which led to further reductions in transportation costs) on economic activity in villages, towns, and cities in India between 1998 and 2013. The results are presented for different measures of non-farm economic activity. Column 2 presents for all employment; columns 3, 4 and 5 present the results for a number of – all establishments, establishments employing greater than 5 workers, and establishments employing workers >10 respectively. Standard errors in parentheses, clustered at the shrid level. * $p<0.05$, ** $p<0.01$, *** $p<0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects.

eas, potentially reducing the need for transport and storage services, which may be due to their altered inventory management.

Classification based on land-intensity

Improvements in transportation infrastructure reduce barriers to agglomeration, encouraging activities to cluster together. However, excessive agglomeration may also result in negative externalities such as high factor prices (e.g. rent) that strengthen dispersal forces. Land-intensive industries would likely benefit more from transportation cost reductions than less land-intensive industries, as the reductions in transport costs enable firms to access cheaper factors in the peripherals, allowing them to still benefit from the agglomeration economies of proximity by locating away as transportation is cheaper.

The reductions in transportation costs due to highway improvements become crucial in the presence of land-market frictions that would prevent factor price equalisation across regions. The Indian experience suggests that land markets are full of friction. On the one hand, land values are generally high along the transportation corridors as the latter adds to the attractiveness of the regions (Shivanand et al. 2013). On the other hand, land management policies are inefficient and may impede industrial agglomeration (Amirapu et al. 2019; Sridhar and Sridhar 2005) due to high costs, such as land rents, limited availability of commercial real estate, among others. Given this, with a reduction in transportation costs due to highway upgrades, one would expect land-intensive industries to cluster less in regions closer to upgraded highways relative to other regions. Land intensity measures the value of land and buildings relative to industry output. A higher land-to-output ratio

shows higher land intensity.

The classification of economic activities based on their land intensities allows for exploring the interaction between land intensity, transportation cost reductions, and the region's initial level of economic activity. Tables 17 and 18 provide computed land intensities for industries within manufacturing and across manufacturing and services for all non-farm industries studied.

Results from within manufacturing

Table 5 presents the outcomes regarding the impact of proximity to highways on economic activity, considering varying levels of land intensity within 29 manufacturing industries. The results indicate that a one-standard-deviation increase in land intensity is associated with a 2% and 1% reduction in manufacturing employment and establishments, respectively, in regions closer to upgraded highways relative to less land-intensive manufacturing activities in regions along the upgraded highways.

Table 6 following specification 3 shows that less land-intensive industries tend to concentrate more along regions closer to highways relative to more land-intensive industries. Interestingly, the region's size doesn't significantly impact employment and establishments when interacting with land intensity. Small establishments, often requiring smaller land units, do not exhibit strong market size dependencies as they are less likely to benefit from the agglomeration economies. In contrast to S. E. Ghani et al. 2013, where land-intensive organised manufacturing concentrates along districts closer to highways, the evidence from the current study explores distribution patterns of all manufacturing activities (formal and informal), contributing to the literature on industrial sorting at granular geographic levels.

Table 5: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Differentiating land-intensive industries within Manufacturing

	Matched Sample		
	Employment	Establishment	Establishment>5
0-10 km × Post=1	0.0641***	0.0437***	0.0215***
	(0.00985)	(0.00735)	(0.00470)
0-10 km × Post=1 × Land Intensity	-0.0242**	-0.0110	-0.0104**
	(0.00846)	(0.00657)	(0.00374)
Post=1	-0.0275***	0.0662***	0.00275
	(0.00697)	(0.00519)	(0.00344)
Post=1 × Land Intensity	0.0855***	0.0509***	0.0195***
	(0.00604)	(0.00481)	(0.00274)
Land Intensity	-0.147***	-0.0275***	-0.0632***
	(0.00505)	(0.00395)	(0.00235)
0-10 km × Land Intensity	0.0240***	0.00829	0.00688*
	(0.00704)	(0.00532)	(0.00327)
Constant	2.261***	1.675***	0.175***
	(0.00277)	(0.00208)	(0.00132)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	273717	273717	273717
Adjusted R^2	0.008	0.003	0.011
Baseline Mean	2.184	1.632	0.159

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013. The results examine the differential effects across land intensities within manufacturing. The results are presented for different measures of non-farm economic activity. Column 2 presents for all employment; columns 3, and 4 present the results for the number of all establishments, and establishments employing greater than 5 workers respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects. The measure of land intensity is standardised with a mean of 0 and a unit standard deviation.

Table 6: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Differentiating land-intensive and initial level of economic activity within Manufacturing

	Matched Sample		
	Employment	Establishment	Establishment>5
0-10 km × Post=1	0.0648***	0.0446***	0.0217***
	(0.00991)	(0.00732)	(0.00491)
0-10 km × Post=1 × Land Intensity	-0.0235**	-0.0108	-0.0101**
	(0.00842)	(0.00650)	(0.00367)
0-10 km × Post=1 × Initial economic activity Emp	0.0460		
	(0.0862)		
0-10 km × Post=1 × Land Intensity × Initial economic activity Emp	-0.0144		
	(0.0416)		
0-10 km × Post=1 × Initial economic activity Est		0.0745*	
		(0.0312)	
0-10 km × Post=1 × Land Intensity × Initial economic activity Est		-0.00342	
		(0.0287)	
0-10 km × Post=1 × Initial economic activity L est			-0.00269
			(0.111)
0-10 km × Post=1 × Land Intensity × Initial economic activity L est			0.0294
			(0.0457)
Post=1	-0.0276***	0.0657***	0.00271
	(0.00696)	(0.00516)	(0.00342)
Land Intensity	-0.148***	-0.0282***	-0.0628***
	(0.00501)	(0.00388)	(0.00230)
0-10 km × Land Intensity	0.0235***	0.00822	0.00653*
	(0.00698)	(0.00521)	(0.00319)
Land Intensity × Initial economic activity Emp	0.00227		
	(0.00959)		
0-10 km × Land Intensity × Initial economic activity Emp	0.0524		
	(0.0406)		
Post=1 × Land Intensity	0.0848***	0.0507***	0.0188***
	(0.00601)	(0.00477)	(0.00268)
Post=1 × Land Intensity × Initial economic activity Emp	0.0138**		
	(0.00467)		
Post=1 × Initial economic activity Emp	0.0125		
	(0.0104)		
Land Intensity × Initial economic activity Est		0.00611	
		(0.00759)	
0-10 km × Land Intensity × Initial economic activity Est		0.0264	
		(0.0278)	
Post=1 × Initial economic activity Est		0.0215***	
		(0.00241)	
Post=1 × Land Intensity × Initial economic activity Est		0.00407	
		(0.00269)	
Land Intensity × Initial economic activity L est			-0.0107*
			(0.00460)
0-10 km × Land Intensity × Initial economic activity L est			0.0000365
			(0.0478)
Post=1 × Initial economic activity L est			0.0136
			(0.0162)
Post=1 × Land Intensity × Initial economic activity L est			0.0190***
			(0.00386)
Constant	2.261***	1.675***	0.175***
	(0.00275)	(0.00205)	(0.00129)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	273717	273717	273717
Adjusted R^2	0.008	0.003	0.011
Baseline Mean	2.184	1.632	0.159

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013. The results examine the differential effects across land intensities and the initial level of economic activity within the manufacturing sector. The results are presented for different measures of non-farm economic activity. Column 2 presents all employment; columns 3 and 4 present the results for the number of all establishments and establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects. The measures of land intensity and initial level of economic activity are standardised with a mean of 0 and unit standard deviation.

Results across manufacturing and services

I present the results following specification 2 by interacting land intensity with the industry indicator for services to examine the differential effects across manufacturing and services activities. Table 7 presents the results from the study of 10 manufacturing and 11 services industries and reveals that less land-intensive manufacturing activities tend to concentrate

Table 7: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Differentiating land-intensive industries across Manufacturing and Services

	Matched Sample		
	Employment	Establishment	Establishment>5
0-10 km × Post=1	0.0318	0.0260	0.0304***
	(0.0188)	(0.0146)	(0.00857)
0-10 km × Post=1 × Land Intensity	0.0671***	0.0487***	0.0121
	(0.0157)	(0.0115)	(0.00792)
0-10 km × Post=1 × Services	-0.0793**	-0.0432*	-0.0400**
	(0.0266)	(0.0207)	(0.0124)
0-10 km × Post=1 × Services × Land Intensity	-0.171***	-0.145***	-0.00916
	(0.0274)	(0.0208)	(0.0143)
Post=1	-0.0146	0.0673***	0.0113
	(0.0134)	(0.0106)	(0.00640)
Post=1 × Land Intensity	-0.109***	-0.0915***	-0.0178**
	(0.0116)	(0.00854)	(0.00633)
Post=1 × Services × Land Intensity	0.0704***	0.00189	0.0265*
	(0.0204)	(0.0156)	(0.0112)
Post=1 × Services	0.0656***	0.0439**	-0.0102
	(0.0194)	(0.0152)	(0.00925)
Land Intensity	0.0634***	-0.0416***	0.0600***
	(0.00981)	(0.00713)	(0.00555)
0-10 km × Land Intensity	-0.103***	-0.0554***	-0.0456***
	(0.0130)	(0.00946)	(0.00683)
Services	-0.506***	-0.458***	-0.0426***
	(0.0164)	(0.0127)	(0.00849)
0-10 km × Services	0.0612**	0.0521**	0.0190
	(0.0226)	(0.0173)	(0.0113)
Services × Land Intensity	0.0631***	0.0916***	-0.0127
	(0.0172)	(0.0130)	(0.00987)
0-10 km × Services × Land Intensity	0.181***	0.134***	0.0363**
	(0.0228)	(0.0173)	(0.0125)
Constant	2.459***	1.838***	0.213***
	(0.00656)	(0.00511)	(0.00309)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	143510	143510	143510
Adjusted R^2	0.042	0.056	0.008
Baseline Mean (Manufacturing)	2.382	1.791	0.204
Baseline Mean (Services)	2.111	1.544	0.229

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013. The results examine the differential effects across land intensities between manufacturing and services. The results are presented for different measures of non-farm economic activity. Column 2 presents all employment; columns 3, and 4 present the results for the number of all establishments and establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects. The measure of land intensity is standardised with a mean of 0 and unit standard deviation.

more near upgraded highways than services. Land-intensive services industries are less likely to be located near highways than manufacturing. The findings indicate that there is no significant distinction between less land-intensive manufacturing and services across various measures of economic activity. Table 11 provides additional insights by presenting results that differentiate activities based on land intensity following specification 3. Interestingly, the analysis suggests that the region's size is not a significant factor in explaining the differential responses of different land-intensive activities across manufacturing and services. However, it is essential to note a potential limitation—the limited data availability for the sample of non-farm industries across manufacturing and services covered here. Further research with a larger and more diverse dataset could provide a more comprehensive understanding of the relationship between land intensity, region size, and economic activity across manufacturing and services.

Nevertheless, these results substantiate the hypothesis that reducing transportation costs

has heterogeneous effects on economic activities. The reduction matters more for manufacturing, particularly land-intensive industries involved in tradable goods production, as it incentivises these activities to leverage peripheral markets with lower factor prices.

5.3 Composition of Economic Activity

The results from the preceding section highlight the diverse effects of reducing transportation costs on different industries, thereby influencing the regional industrial composition. This section delves into the impact of reduced transportation costs on the composition of economic activity, measured by the Herfindahl-Hirschman Index (HHI) at the industry-region level. The choice of HHI as an index stems from its effectiveness in studying industrial distribution within the region.

Table 8: Effect of highways on the composition of economic activity between 1998 and 2013

	Matched Sample HHI
0-10 km	-0.0202*
	(0.00894)
Post=1	-0.240***
	(0.00644)
Constant	0.0606***
	(0.00224)
Year and Region Fixed effects	Yes
Observations	117506
Adjusted R^2	0.051

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on the composition of economic activity within the villages, towns and cities of India between 1998 and 2013 where the composition is measured in terms of the Herfindahl-Hirschman Index. The results examine the differential effects across manufacturing and services. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variable is standardised with a 0 mean and a unit standard deviation.

With a reduction in transportation costs, what happens to the distribution of industries within each region has not been explored much. Previous literature has focused on whether regions tend to specialise or diversify, revealing that specialisation alone does not necessarily drive growth (Glaeser 1999; Henderson et al. 1995). Strong inter-industry linkages encourage the diversification of regions and may increase the productivity of one or several industries. The evidence from Japan indicates that the development of high-speed railways (HSR) caused closer and distant regions to diversify and intermediaries to specialise, respectively (Wetwitoo 2019).

This pattern occurs because industries in nearby regions can easily access each other and take advantage of agglomeration benefits, leading to a variety of different activities or products being produced. Similarly, industries in distant regions may find it more cost-effective to produce and sell locally rather than incur high transportation costs. However, in intermediary regions, where transport costs have decreased but are not completely negligible, industries tend to specialise in activities that are less impacted by these reduced costs, as other industries may relocate to areas with even lower transport costs.

Table 9 further elucidates the impact of highways on economic activity composition. It indicates a 0.02 standard deviation decrease in the HHI for regions closer to upgraded highways relative to regions closer to other national highways, indicating that regions closer to upgraded highways are more diversified. Differentiating further within manufacturing and services along highways, the results presented in Table 9 suggest differing industrial

compositions, with services industries experiencing a 0.036 standard deviation increase in HHI compared to manufacturing, implying greater diversification in manufacturing due to stronger inter-industry linkages.

The composition of economic activity was impacted across all the regions studied, with a more pronounced effect in regions proximate to highways, where industrial composition became more diverse. These regions, benefiting from reduced transportation costs and scale economies, became attractive hubs for diverse economic activities to grow.

Table 9: Effect of highways on the composition of economic activity between 1998 and 2013: Composition across Manufacturing and Services

	Matched Sample
	HHI
0-10 km × Post=1	-0.0439***
	(0.0108)
0-10 km × Services × Post=1	0.0360**
	(0.0122)
Post=1	-0.184***
	(0.00769)
Services	-0.879***
	(0.00667)
0-10 km × Services	-0.00833
	(0.00933)
Services × Post=1	-0.0862***
	(0.00870)
Constant	0.569***
	(0.00334)
Year and Region fixed effects	Yes
Observations	205032
Adjusted R^2	0.358

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on the composition of economic activity within the villages, towns and cities of India between 1998 and 2013 where the composition is measured in terms of the Herfindahl-Hirschman Index. The results examine the differential effects across manufacturing and services. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variable is standardised with a 0 mean and a unit standard deviation.

5.4 Robustness check

The results from the study show that regions that experience a higher reduction in transportation costs benefit more from the strengthening of agglomeration economies and experience an additional increase in economic activity. To assess the robustness of these results, I investigate the impact of the reduction in transportation costs, measured as the distance to highways, on the spatial distribution of economic activity by alternating the distance categories to assess the effects of reductions in transportation costs. I present findings from four distinct distance categories to examine the sensitivity of observed treatment effects to different distance specifications. The results across various distance groups, as illustrated in Table 12-15, show the robustness of these results, where regions closer to the highways observe higher economic activity relative to regions farther away due to variations in transportation cost reductions. All the results follow specification 2, and the overlap plots for

the matched sample before and after propensity score matching are presented in Fig. 5-8. The results reinforce the earlier findings that upgrading of highways affects all regions studied, as it leads to reductions in transportation costs for all regions. However, a pronounced effect is found among regions closer to the upgraded highways relative to others, as proximate regions experience larger reductions in transportation costs, and this interacts with economies of scale, making these regions attractive for activities to locate.

6 Conclusion

Do reductions in transportation costs lead to the concentration or dispersion of economic activity? This study investigates this question by examining the effects of highway improvements on the spatial distribution of economic activity across villages, towns, and cities in India between 1998 and 2013. By exploiting variation in exposure to upgraded highways, the analysis provides evidence of how transportation costs interact with agglomeration forces at fine industrial and spatial scales. The results show that while reductions in transportation costs increase non-farm economic activity across all regions, the gains are higher in areas located closer to upgraded highways. These areas benefit from more substantial reductions in transportation costs, making them relatively more attractive for economic activity.

The magnitude of the effect varies with the initial market size. Larger regions close to improved highways experience a greater concentration of economic activity, suggesting that pre-existing agglomeration economies amplify the impact of transportation cost reductions. This is consistent with theories emphasising the role of economies of scale and self-reinforcing agglomeration effects in shaping spatial patterns of economic development. The study also identifies significant heterogeneity across sectors. Manufacturing activities respond more strongly to reductions in transportation costs than services, likely due to their greater traceability and sensitivity to input and output transportation costs. In particular, land-intensive manufacturing industries are more likely to relocate or expand in peripheral areas, attracted by lower land rents and improved connectivity. These shifts contribute to a diversification of non-farm economic activities along highway corridors, reshaping the local industrial composition.

Although highway improvements stimulate economic activity across the study area, the analysis covers all non-farm sectors, including both formal and informal manufacturing and services. By capturing this broad spectrum, the study contributes to the literature on the wider economic impacts of infrastructure investment. It highlights how reductions in transportation costs can contribute to spatial rebalancing and help mitigate regional inequalities in economic activity. However, assessing whether these shifts translate into long-term productivity gains remains outside the scope of this analysis.

The findings have important policy implications. Strategic investments in transportation infrastructure can yield transformative impacts on the spatial distribution and structure of economic activity. By influencing both where firms are located and what types of industries emerge, infrastructure improvements offer a powerful tool for regional development. Realising the full economic potential of such investments, however, requires careful planning and complementary policies that account for local market conditions and industrial characteristics.

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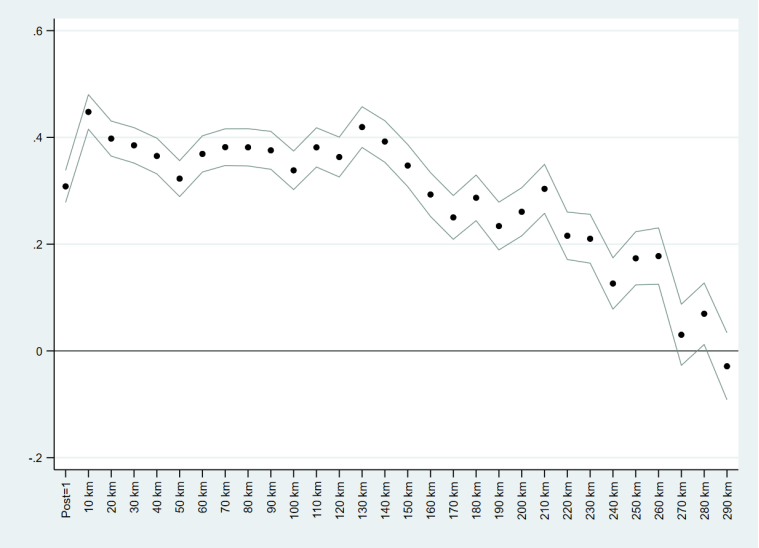
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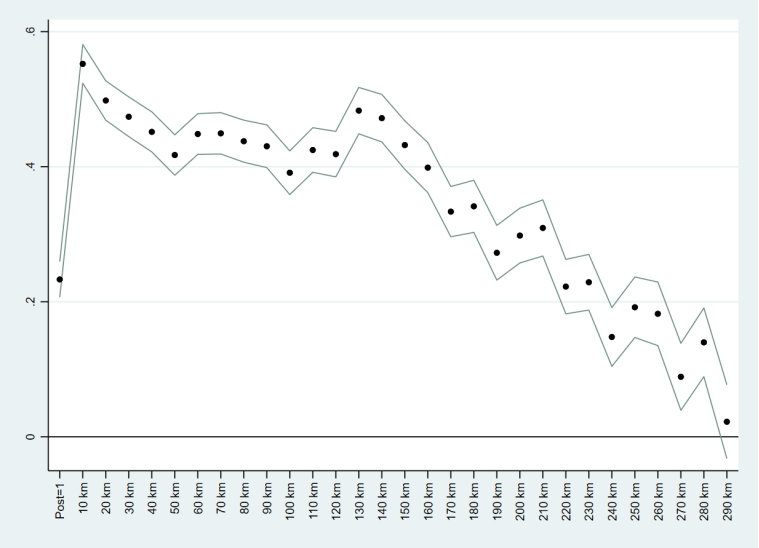
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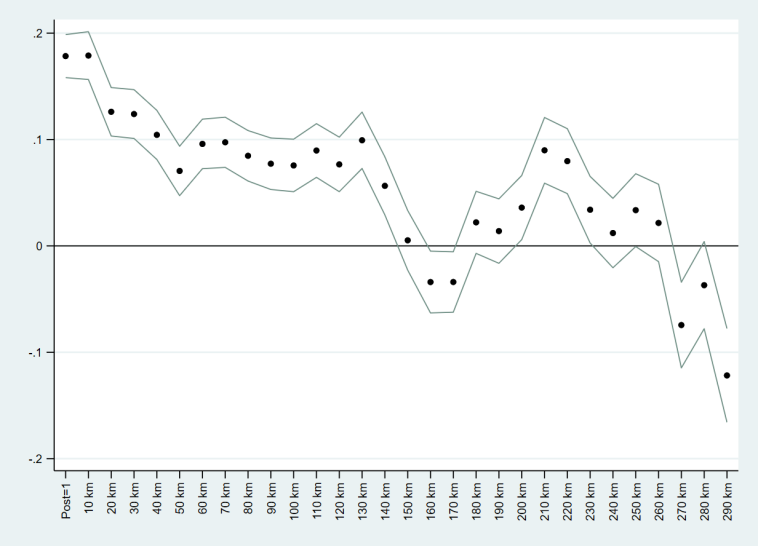
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(a) Total Employment



(b) Number of Establishment



(c) Number of Establishments with employment >5

Figure 4: Distance to highways and distribution of Economic Activity: Coefficient Plots

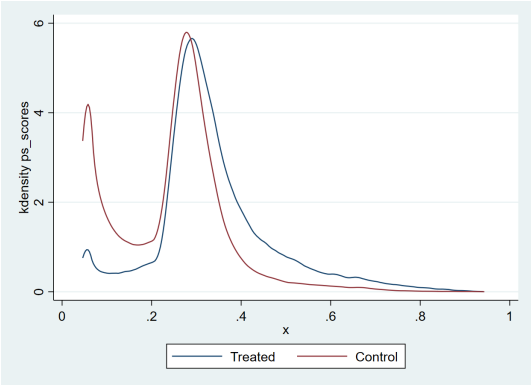
The plots present the coefficients of distance at increments of 10 km from the highway on different measures of economic activity, with the reference category being all regions beyond 300 km from the highway. All the specifications have region and time-fixed effects.

7 Appendix

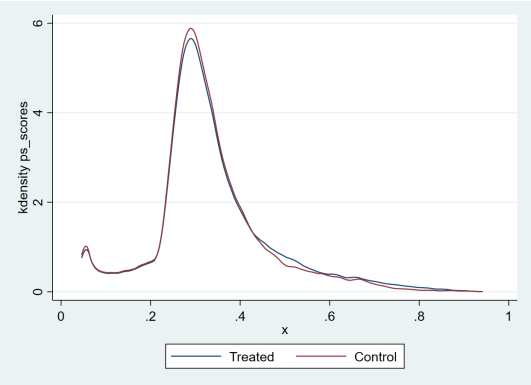
Table 10: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Differentiating across Manufacturing and Services Industries and the Initial Level of Economic Activity of the Region

	Matched Sample			
	Employment	Establishment	Establishment>5	Establishment>10
0-10 km × Post=1	0.171***	0.126***	0.0975***	-0.00918
	(0.0158)	(0.0120)	(0.0129)	(0.00503)
0-10 km × Post=1 × Initial economic activity Emp	1.725**			
	(0.634)			
0-10 km × Post=1 × Initial economic activity Est		0.672**		
		(0.246)		
0-10 km × Post=1 × Initial economic activity L.est			2.658**	-0.834*
			(0..823)	(0.339)
0-10 km × Services × Post=1	-0.0965***	-0.0247*	-0.103***	0.00336
	(0.0166)	(0.0121)	(0.0153)	(0.00675)
0-10 km × Services × Post=1 × Initial economic activity Emp	-1.088			
	(0.688)			
0-10 km × Services × Post=1 × Initial economic activity Est		-0.0773		
		(0.248)		
			(0.823)	(0.340)
0-10 km × Services × Post=1 × Initial economic activity L.est			-4.893***	0.453
			(0.937)	(0.458)
Post=1	0.0868***	0.220***	-0.0307**	-0.0254***
	(0.0112)	(0.00849)	(0.00948)	(0.00335)
Post=1 × Initial economic activity Emp	-6.937***			
	(0.445)			
Post=1 × Initial economic activity Est		-1.150***		
		(0.169)		
Post=1 × Initial economic activity L.est			-8.964***	-1.912***
			(0.609)	(0.225)
Services	0.841***	0.957***	0.360***	-0.000921
	(0.0116)	(0.00806)	(0.0120)	(0.00434)
0-10 km × Services	0.113***	0.116***	0.0277	-0.0198**
	(0.0157)	(0.0110)	(0.0162)	(0.00615)
Services × Post=1	0.411***	0.243***	0.279***	0.0181***
	(0.0120)	(0.00866)	(0.0110)	(0.00470)
Services × Initial economic activity Emp	-1.102*			
	(0.535)			
0-10 km × Services × Initial economic activity Emp	2.346**			
	(0.725)			
0-10 km × Services × Initial economic activity Est		1.176***		
		(0.271)		
Services × Post=1 × Initial economic activity Emp	-2.773***			
	(0.491)			
Services × Initial economic activity Est		3.528***		
		(0.205)		
Services × Post=1 × Initial economic activity Est		-3.263***		
		(0.171)		
Services × Initial economic activity L.est			10.72***	0.707*
			(0.799)	(0.305)
0-10 km × Services × Initial economic activity L.est			0.931	-1.156**
			(1.079)	(0.432)
Services × Post=1 × Initial economic activity L.est			1.509*	1.044**
			(0.671)	(0.318)
Constant	2.778***	2.192***	0.264***	0.0365***
	(0.00466)	(0.00380)	(0.00268)	(0.000825)
Year and Region Fixed Effects	Yes	Yes	Yes	Yes
Observations	205032	205032	205032	205032
Adjusted R^2	0.341	0.424	0.173	0.012
Baseline Mean (Manufacturing)	2.800	2.225	0.276	0.033
Baseline Mean (Services)	3.385	2.85	0.437	0.020

Note: This table presents the results of estimating the differential effects of proximity to upgraded highways (which led to further reductions in transportation costs) on economic activity in villages, towns, and cities in India between 1998 and 2013. The results are presented for different measures of non-farm economic activity. Column 2 presents all employment; columns 3 and 4 present the results for the number of all establishments, establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects. The measures of the initial level of economic activity are standardised with a mean of 0 and unit standard deviation.

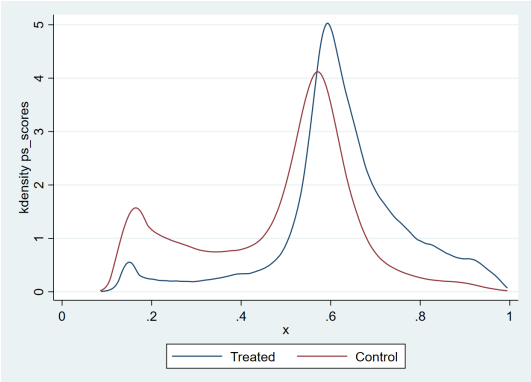


(a) All Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and those beyond 100km as the control group. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991

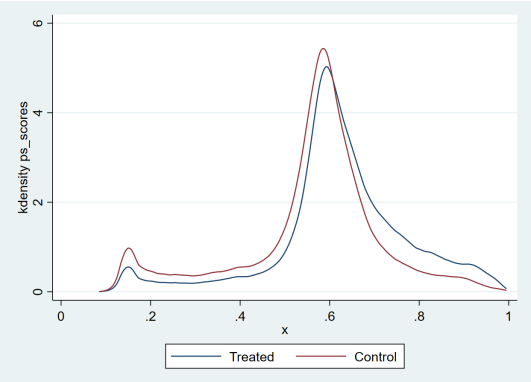


(b) Matched Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and those beyond 100km as the control group. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991. This consists of a 1:1 nearest neighbourhood match with the maximum difference being 0.01.

Figure 5: Overlap Plots: Regions 0-10 km and Beyond 100 km



(a) All Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and those beyond 200 km as the control group. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991



(b) Matched Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and those beyond 200 km as the control group. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991. This consists of a 1:1 nearest neighbourhood match with the maximum difference being 0.01.

Figure 6: Overlap Plots: Regions 0-10 km and Beyond 200 km

Table 11: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Differentiating land-intensive industries between Manufacturing and Services

	Matched Sample		
	Employment	Establishment	Establishment>5
0-10 km × Post=1	0.0325	0.0283	0.0311***
	(0.0188)	(0.0144)	(0.00862)
0-10 km × Post=1 × Land Intensity	0.0666***	0.0488***	0.0119
	(0.0157)	(0.0116)	(0.00799)
0-10 km × Post=1 × Initial economic activity Emp	0.0387		
	(0.0602)		
0-10 km × Post=1 × Services	-0.0794**	-0.0430*	-0.0413***
	(0.0266)	(0.0206)	(0.0124)
0-10 km × Post=1 × Services × Land Intensity	-0.168***	-0.143***	-0.00781
	(0.0274)	(0.0209)	(0.0141)
0-10 km × Post=1 × Services × Initial economic activity Emp	-0.00318		
	(0.0517)		
0-10 km × Post=1 × Services × Land Intensity × Initial economic activity Emp	-0.0194		
	(0.0426)		
0-10 km × Post=1 × Initial economic activity Est		0.0951***	
		(0.0272)	
0-10 km × Post=1 × Land Intensity × Initial economic activity Est		-0.0126	
		(0.0323)	
0-10 km × Post=1 × Services × Initial economic activity Est		-0.0755*	
		(0.0355)	
0-10 km × Post=1 × Initial economic activity L.est			0.0132
			(0.0431)
0-10 km × Post=1 × Services × Land Intensity × Initial economic activity Est		-0.0518	
		(0.0375)	
0-10 km × Post=1 × Land Intensity × Initial economic activity L.est			-0.00339
			(0.0161)
0-10 km × Post=1 × Services × Initial economic activity L.est			-0.00236
			(0.0296)
0-10 km × Post=1 × Services × Land Intensity × Initial economic activity L.est			-0.0243
			(0.0232)
Post=1	-0.0155	0.0657***	0.0109
	(0.0134)	(0.0105)	(0.00632)
Post=1 × Land Intensity	-0.108***	-0.0912***	-0.0177**
	(0.0116)	(0.00853)	(0.00633)
Post=1 × Initial economic activity Emp	0.0129		
	(0.000918)		
Post=1 × Land Intensity × Initial economic activity Emp	0.000577		
	(0.000479)		
	(0.000479)		
Post=1 × Services	0.0654***	0.0423**	-0.0106
	(0.0193)	(0.0152)	(0.00915)
Post=1 × Services × Initial economic activity Emp	-0.00196		
	(0.000816)		
Post=1 × Services × Land Intensity	0.0704***	0.00173	0.0285**
	(0.0204)	(0.0155)	(0.0111)
Post=1 × Services × Land Intensity × Initial economic activity Emp	0.00624		
	(0.000828)		
Post=1 × Initial economic activity Est		0.0261***	
		(0.00473)	
Post=1 × Land Intensity × Initial economic activity Est		-0.00396	
		(0.00232)	
Post=1 × Services × Initial economic activity Est		-0.000947	
		(0.00755)	
Post=1 × Services × Land Intensity × Initial economic activity Est		0.0122**	
		(0.00426)	
Post=1 × Initial economic activity L.est			0.0115
			(0.00998)
Post=1 × Services × Initial economic activity L.est			-0.00900
			(0.00617)
Post=1 × Services × Land Intensity × Initial economic activity L.est			-0.00348
			(0.0133)
			contd.

	Matched Sample		
	Employment	Establishment	Establishment>5
Land Intensity	0.0632***	-0.0419***	0.0599***
	(0.00979)	(0.00710)	(0.00554)
0-10 km × Land Intensity	-0.0993***	-0.0525***	-0.0448***
	(0.0131)	(0.00962)	(0.00694)
Land Intensity × Initial economic activity Emp	0.0146		
	(0.0123)		
0-10 km × Land Intensity × Initial economic activity Emp	0.0941*		
	(0.0436)		
0-10 km × Post=1 × Land Intensity × Initial economic activity Emp	-0.0304		
	(0.0300)		
Services	-0.507***	-0.458***	-0.0419***
	(0.0164)	(0.0126)	(0.00831)
0-10 km × Services	0.0631**	0.0532**	0.0198
	(0.0225)	(0.0170)	(0.0112)
Services × Land Intensity	0.0624***	0.0915***	-0.0159
	(0.0172)	(0.0130)	(0.00975)
0-10 km × Services × Land Intensity	0.177***	0.130***	0.0362**
	(0.0228)	(0.0174)	(0.0122)
Services × Initial economic activity Emp	0.0142		
	(0.0102)		
0-10 km × Services × Initial economic activity Emp	0.121*		
	(0.0545)		
0-10 km × Services × Land Intensity × Initial economic activity Emp	0.0140		
	(0.0326)		
Land Intensity × Initial economic activity Est		0.0184	
		(0.0152)	
0-10 km × Land Intensity × Initial economic activity Est		0.0764	
		(0.0479)	
Services × Initial economic activity Est		0.0124	
		(0.00807)	
0-10 km × Services × Initial economic activity Est		0.164***	
		(0.0368)	
Services × Land Intensity × Initial economic activity Est		-0.0165**	
		(0.00553)	
0-10 km × Services × Land Intensity × Initial economic activity Est		0.0182	
		(0.0339)	
Land Intensity × Initial economic activity L.est			0.0164
			(0.0102)
0-10 km × Land Intensity × Initial economic activity L.est			0.00309
			(0.0213)
		0.000450	
			(0.00748)
Services × Initial economic activity L.est			0.00161
			(0.00599)
0-10 km × Services × Initial economic activity L.est			0.00939
			(0.0300)
Services × Land Intensity × Initial economic activity L.est			0.0138
			(0.0138)
0-10 km × Services × Land Intensity × Initial economic activity L.est			0.0688*
			(0.0297)
Constant	2.459***	1.840***	0.213***
	(0.00648)	(0.00498)	(0.00304)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	143510	143510	143510
Adjusted R^2	0.043	0.058	0.011
Baseline Mean (Manufacturing)	2.382	1.791	0.204
Baseline Mean (Services)	2.111	1.544	0.229

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013. The results examine the differential effects across manufacturing and services and different land intensities. The results are presented for different measures of non-farm economic activity. The results follow the interaction of the proximity indicator with the initial level of regions' economic activity to examine the effect of agglomeration economies. Column 2 presents all employment; column 3 and 4 present the results for the number of all establishments, and establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variable is IHS transformed. The specification has shrid fixed effects. The initial level of economic activity and Land intensity are standardised with a mean of 0 and unit standard deviation.

Table 12: Robustness Checks: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Comparing 0-10 km with regions Beyond 100 km

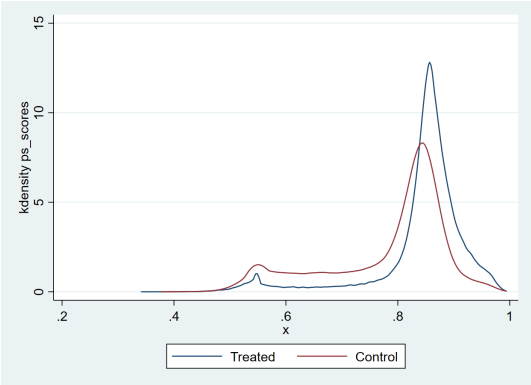
	Matched Sample				
	Employment	Establishment	Establishment>5	Establishments between 21-50	Establishments>51
0-10 km × Post=1	0.144***	0.144***	0.111***	0.00938**	0.00777***
	(0.00889)	(0.00813)	(0.00696)	(0.00313)	(0.00199)
Post=1	0.601***	0.601***	0.259***	0.0337***	0.00897***
	(0.00600)	(0.00554)	(0.00462)	(0.00209)	(0.00126)
Constant	4.095***	3.507***	0.691***	0.124***	0.0452***
	(0.00222)	(0.00203)	(0.00174)	(0.000782)	(0.000496)
Year and Region Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	169806	169806	169806	170234	170234
Adjusted R^2	0.215	0.246	0.090	0.007	0.002
Baseline Mean	4.0589	3.4854	0.69720	0.1271	0.04281

Note: This table presents the results of estimating the differential effects of proximity to upgraded highways (which led to further reductions in transportation costs) on economic activity in villages, towns, and cities in India between 1998 and 2013. The results are presented for different measures of non-farm economic activity. Column 2 presents for all employment; columns 3,4,5, and 6 present the results for a number of – all establishments, establishments employing greater than 5 workers, establishments employing 20-50 workers, and establishments employing 51 to 100 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variables are IHS transformed. The specification has shrid fixed effects.

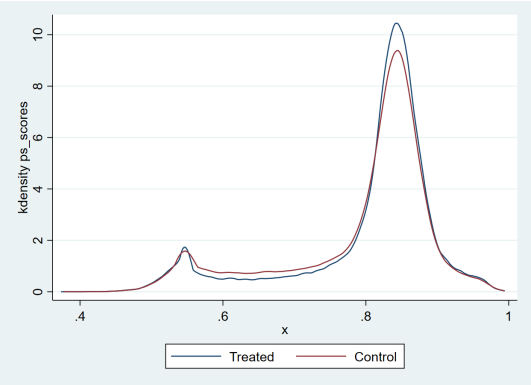
Table 13: Robustness Checks: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Comparing 0-10 km with regions Beyond 200 km

	Matched Sample		
	Employment	Establishment	Establishment> 5
0-10 km × Post=1	0.273***	0.330***	0.142***
	(0.0110)	(0.0101)	(0.00817)
Post=1	0.477***	0.416***	0.221***
	(0.00872)	(0.00796)	(0.00623)
Constant	3.991***	3.423***	0.606***
	(0.00268)	(0.00245)	(0.00205)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	116098	116098	116098
Adjusted R^2	0.213	0.237	0.097
Baseline Mean	3.8101	3.2918	0.52257

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013 comparing regions 0-10 km from the upgraded highways with regions beyond 200 km from them. Column 2 presents for all employment; columns 3, and 4 present the results for the number of – all establishments, and establishments employing greater than 5 workers respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The specification has shrid fixed effects. The dependent variable is IHS transformed.



(a) All Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-50 km of the GQ and NS-EW corridors treated and those beyond 200 km as the control group. Here, the Propensity scores are constructed as the function of a set of covariates observed in 1991



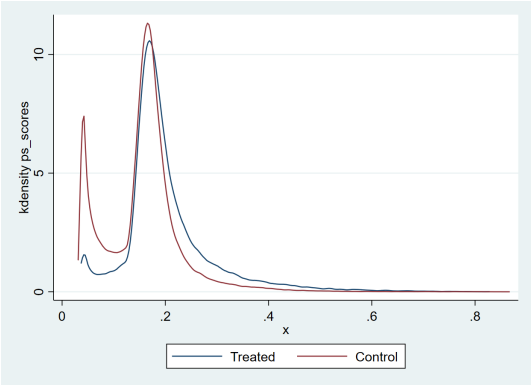
(b) Matched Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-50 km of the GQ and NS-EW corridors treated and those beyond 200 km as the control group. Here, the Propensity scores are constructed as the function of a set of covariates observed in 1991. This consists of a 1:1 nearest neighbourhood match with the maximum difference being 0.01.

Figure 7: Overlap Plots: Regions 0-50 km and Beyond 200 km

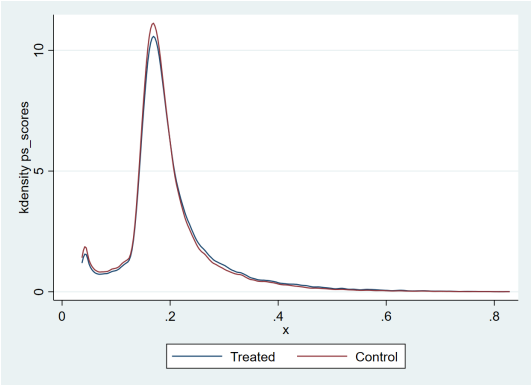
Table 14: Robustness Checks: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Comparing 0-50 km with regions Beyond 200 km

	Matched Sample		
	Employment	Establishment	Establishment>5
0-10 km $\times$ Post=1	0.214***	0.276***	0.0652***
	(0.00828)	(0.00758)	(0.00582)
Post=1	0.457***	0.383***	0.209***
	(0.00688)	(0.00629)	(0.00473)
Constant	3.779***	3.239***	0.482***
	(0.00192)	(0.00176)	(0.00139)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	230184	230184	230184
Adjusted R^2	0.184	0.200	0.069
Baseline Mean	3.6877	3.1802	0.4401

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013 comparing regions 0-50 km from the upgraded highways with regions beyond 200 km from them. Column 2 presents for all employment; columns 3, and 4 present the results for the number of – all establishments, and establishments employing greater than 5 workers respectively. Standard errors in parentheses, clustered at the shrid level. $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The specification has shrid fixed effects. The dependent variable is IHS transformed.



(a) All Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and those beyond 50 km as the control group. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991



(b) Matched Sample: The above plot presents the kdensity of propensity scores between the treated and the control group. Here, I consider all non-targeted regions between 0-10 km of the GQ and NS-EW corridors treated and those beyond 500 km as the control group. Here, the Propensity scores are constructed as a function of a set of covariates observed in 1991. This consists of a 1:1 nearest neighbourhood match with the maximum difference being 0.01.

Figure 8: Overlap Plots: Regions 0-10 km and Beyond 50 km

Table 15: Robustness Checks: Effect of Proximity to Highways on Economic Activity between 1998 and 2013: Comparing 0-10 km with regions Beyond 50 km

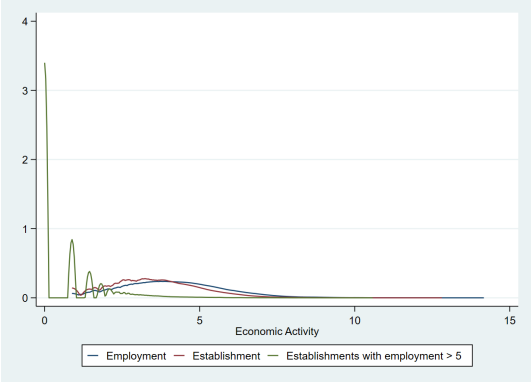
	Matched Sample		
	Employment	Establishment	Establishment>5
0-10 km $\times$ Post=1	0.105***	0.115***	0.0985***
	(0.00922)	(0.00843)	(0.00720)
Post=1	0.633***	0.629***	0.273***
	(0.00661)	(0.00609)	(0.00505)
Constant	4.096***	3.503***	0.691***
	(0.00231)	(0.00211)	(0.00181)
Year and Region Fixed Effects	Yes	Yes	Yes
Observations	161584	161584	161584
Adjusted R^2	0.218	0.251	0.093
Baseline Mean	3.9902	3.4224	0.64845

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013 comparing regions 0-10 km from the upgraded highways with regions beyond 50 km from them. Column 2 presents all employment; columns 3 and 4 present the results for the number of all establishments, and establishments employing greater than 5 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The specification has shrid fixed effects. The dependent variable is IHS transformed.

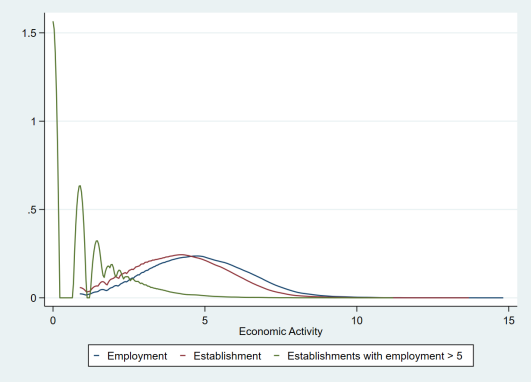
Table 16: Placebo Test Results: Effect of proximity to highways between 1990 and 1998

	Matched Sample Employment
0-10 km × Post=1	0.00512
	(0.0170)
Post=1	0.784***
	(0.0117)
Constant	3.040***
	(0.00424)
Year and Region Fixed Effects	Yes
Observations	118508
Adjusted R^2	0.127
Baseline Mean	2.957

Note: This table presents the placebo test results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on employment in the villages, towns and cities of India between 1990 and 1990 comparing Regions closer to upgraded highways with regions closer to other non-upgraded highways. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The specification has shrid fixed effects. The dependent variable is IHS transformed.



(a) presents the kernel density plots between total employment and establishment counts for the year 1998



(b) presents the kernel density plots between total employment and establishment counts for the year 2013.

Figure 9: Kernal density plots of employment and all establishments

Table 17: Land Intensity for Manufacturing Industries

Shric	Land Intensity	Manufacturing Industry Description
05	1.4283838	Processing of meat
06	.57862621	Manufacture of vegetable and animal oil and fats
07	1.0379512	Dairy
08	.83788073	Grain milling and grain products
09	.14534051	Animal feed
10	.75300417	Food product manufacturing
11	.14223071	Beverage manufacturing
12	1.1885606	Tobacco products
13	1.3018544	Manufacture of other textiles
14	1.6832555	Manufacturing of clothing
15	1.162249	Leather manufacturing
16	1.3365426	Footwear manufacturing
17	1.7695851	Sawmilling
18	2.03951	Printing and related services
19	3.7315442	Coke oven products
20	.00337705	Manufacture of refined petroleum products
21	.16044713	Pharmaceuticals
22	.09104207	Chemical products
23	.03816991	Manufacture of man-made fibers
24	.34647183	Stone and cement (non-metallic minerals)
26	.44091572	Manufacture of precious and non-ferrous metals
27	.05510495	Casting of metals
28	.42073893	Manufacture of domestic appliances
29	.08176831	Manufacture of consumer electronics
30	.26317719	Manufacture of transport equipment
31	1.4367106	Manufacture of furniture
32	2.0913171	Manufacture of sporting equipment
72	.35016687	Manufacturing of equipment and goods, some repair. Ships, machinery, instruments, electronics, paper, wood products, etc.

The land intensity here is constructed as the weighted average at the industry level from NSSO and ASI data.

Table 18: Land Intensity for Manufacturing and Services Industries

Shric	Land Intensity	Industry Description
		Manufacturing
05	0.14893754	Processing of meat
07	0.15809515	Dairy
10	1.0801282	Food product manufacturing
16	0.05902115	Footwear manufacturing
19	0.28151343	Coke oven products
26	0.29628866	Manufacture of precious and non-ferrous metals
27	0.09403637	Casting of metals
28	0.11140397	Manufacture of domestic appliances
29	0.49312976	Manufacture of consumer electronics
72	0.08227065	Manufacturing of equipment and goods, some repair. Ships, machinery, instruments, electronics, paper, wood products, etc.
		Services
35	0.21689793	Water collection, treatment, supply
36	0.02645116	Construction and civil engineering
37	0.15789475	Building completion and finishing
38	0.02514964	Construction installation and rentals
42	0.11213714	Wholesale on fee or contract basis
51	0.95372217	Hotels and accommodations
56	0.3864642	Coastal and seawater transport
57	0.22780651	Inland water transport
69	0.14715164	Real estate
74	0.06550258	Research and scientific services
89	0.11359365	Broadcasting, publishing, gambling, and sports

The land intensity here is constructed from the enterprise sample from CMIE Prowess data for the year 2000.

Table 19: Effect of Proximity to Highways on Economic Activity: Differentiating between Manufacturing and Disaggregated Services

	Employment	Establishments	Establishments >5	Establishments > 10
0-10 km × Post=1	0.133***	0.0699***	0.0869***	0.00641**
	(0.0119)	(0.00947)	(0.00663)	(0.00233)
0-10 km × Wholesale and Retail Trade × Post=1	0.000506	0.0670***	-0.0610***	-0.00616*
	(0.0126)	(0.0101)	(0.00729)	(0.00259)
0-10 km × Finance and Insurance × Post=1	0.0734***	0.162***	-0.0507***	-0.00314
	(0.0184)	(0.0145)	(0.00995)	(0.00409)
0-10 km × Transport and Storage × Post=1	-0.182***	-0.182***	-0.0942***	0.000282
	(0.0198)	(0.0175)	(0.00916)	(0.00378)
0-10 km × Education and Public Health × Post=1	-0.141***	-0.0725***	-0.0523***	0.000379
	(0.0137)	(0.0104)	(0.00830)	(0.00444)
0-10 km × Construction × Post=1	0.0886**	0.118***	-0.000139	-0.0176*
	(0.0320)	(0.0265)	(0.0171)	(0.00792)
Wholesale and Retail Trade	0.360***	0.587***	-0.0514***	-0.0182***
	(0.00723)	(0.00585)	(0.00401)	(0.00144)
Finance and Insurance	-1.310***	-1.290***	-0.258***	-0.0463***
	(0.0104)	(0.00838)	(0.00575)	(0.00226)
Transport and Storage	-1.449***	-1.291***	-0.447***	-0.0351***
	(0.0120)	(0.0106)	(0.00633)	(0.00233)
Education and Public Health	-0.409***	-0.943***	0.131***	0.118***
	(0.00786)	(0.00618)	(0.00466)	(0.00273)
Construction	-1.686***	-1.464***	-0.534***	-0.00336
	(0.0173)	(0.0146)	(0.0111)	(0.00437)
0-10 km × Wholesale and Retail Trade	0.133***	0.168***	0.0207***	-0.00103
	(0.0105)	(0.00841)	(0.00588)	(0.00217)
0-10 km × Finance and Insurance	-0.0166	0.00891	-0.0384***	0.00994**
	(0.0159)	(0.0125)	(0.00878)	(0.00350)
0-10 km × Transport and Storage	0.0842***	0.203***	0.0240**	-0.00138
	(0.0172)	(0.0150)	(0.00906)	(0.00327)
0-10 km × Education and Public Health	-0.00975	0.0681***	-0.0540***	-0.0239***
	(0.0116)	(0.00899)	(0.00678)	(0.00378)
0-10 km × Construction	-0.0145	0.0168	0.00718	0.0134
	(0.0275)	(0.0228)	(0.0173)	(0.00725)
Post=1	0.134***	0.254***	0.0191***	-0.0157***
	(0.00806)	(0.00647)	(0.00449)	(0.00153)
Wholesale and Retail Trade × Post=1	0.246***	0.101***	0.0888***	0.0168***
	(0.00849)	(0.00689)	(0.00489)	(0.00168)
Finance and Insurance × Post=1	0.283***	0.215***	0.0890***	0.0204***
	(0.0121)	(0.00964)	(0.00662)	(0.00261)
Transport and Storage × Post=1	0.538***	0.531***	0.103***	0.0106***
	(0.0136)	(0.0120)	(0.00632)	(0.00260)
Education and Public Health × Post=1	0.460***	0.155***	0.220***	0.0251***
	(0.00922)	(0.00712)	(0.00562)	(0.00308)
Construction × Post=1	0.0871***	-0.0601***	0.0665***	-0.0134**
	(0.0207)	(0.0173)	(0.0110)	(0.00507)
Constant	3.063***	2.463***	0.374***	0.0425***
	(0.00430)	(0.00330)	(0.00240)	(0.000920)
Year and Region Fixed Effects	Yes	Yes	Yes	
Observations	574048	574048	574048	574048
Adjusted R^2	0.343	0.477	0.133	0.057

Note: This table presents the results estimating the differential effects of proximity to the upgraded highways (that led to a further reduction in transportation costs) on economic activity in the villages, towns and cities of India between 1998 and 2013. The results examine the differential effects across manufacturing and services sub-sectors. The results are presented for different measures of non-farm economic activity. Column 2 presents for all employment; columns 2, 3, and 4 present the results for a number of – all establishments, establishments employing greater than 5 workers, and establishments employing greater than 10 workers, respectively. Standard errors in parentheses, clustered at the shrid level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The specification has shrid fixed effects. The dependent variable is IHS transformed.