Assessing the Impact of Delhi Meerut Expressway on Regional Development in India Using DiD

Ishaan Gupta (2430148) under Prof. Somesh K. Mathur

Special Mention - Prof. Rajiv Sinha (Dept. of Earth Sciences) and Bhanu Pratap Singh

Introduction :

Infrastructure projects are essential for influencing urban growth and promoting regional development. As a major infrastructure project, the Delhi-Meerut Expressway provides an interesting case study to comprehend its enormous influence on the neighboring areas. Using information from the World Bank Enterprise Survey, among other sources, this research aims to carefully measure and examine changes in Delhi, Ghaziabad, and Meerut's urban environments. In addition to improving connectivity, the Delhi-Meerut Expressway's construction has sparked urban growth and economic activity along its path.

By examining these multifaceted impacts, this study intends to provide empirical evidence of how strategic infrastructure investments like the Delhi-Meerut Expressway contribute to sustainable urbanization, economic development, and regional integration. Understanding these dynamics is crucial for policymakers and urban planners to make informed decisions for future infrastructure investments and sustainable development initiatives in similar contexts globally.

Research Objective :

This study evaluates the impact of the Delhi-Meerut Expressway on firms and regions close to the infrastructure compared to those located further away. The assessment focuses on firm-level variables such as efficiency, total annual sales for the fiscal year, days of inventory held, years of relationship with the main input supplier, and the perception of transportation as an obstacle. Additionally, regional development will be analysed through remote sensing techniques.

By incorporating both firm-level and regional analyses, the study aims to provide a comprehensive understanding of the expressway's influence. The enhancement of the tourism and cargo sectors due to improved infrastructure will also be closely examined. This multifaceted approach ensures a thorough evaluation of the expressway's economic and developmental impacts on various stakeholders.

Literature Review :

- **Saugato Datta's paper, "The Impact of Improved Highways on Indian Firms,"** explores the effects of enhanced highway infrastructure on firm performance in India. The study draws on theories of agglomeration economies and market access, suggesting that improved highways reduce transportation costs, increase market reach, and enhance productivity. Empirical evidence is drawn from firm-level data, comparing regions with and without highway improvements. Findings indicate positive impacts on firm productivity, sales, and employment, alongside a spatial redistribution of firms closer to highways. This work contributes to understanding infrastructure's role in economic development, particularly in emerging markets like India.

- **Ghani, Ejaz, et al. "Highway to Success: The Impact of the Golden Quadrilateral Project for the Location and Performance of Indian Manufacturing." (2016)** This paper, appearing in The Economic Journal, investigates the impact of the Golden Quadrilateral Highway project on the efficiency of manufacturing firms in India. This paper on the impact of the Golden Quadrilateral (GQ) highway project in India reveals significant positive effects on manufacturing in non-nodal districts within 10 km of the GQ network. The study highlights increased entry rates of new plants, improved labor productivity, and efficient industry sorting towards land-intensive sectors in non-nodal areas. The GQ upgrades contributed to the decentralization of economic activities, fostering growth in intermediate cities. In contrast, similar benefits were not observed along the delayed North-South East-West corridor upgrades, underscoring the importance of timely infrastructure development for regional economic growth.

- **Rao and Vinod's (2023) study on the economic and financial performance of Indian IT services export firms** offers a detailed analysis of the sector's growth determinants. Building on prior literature that highlights the sector's expansion due to skilled labor, cost advantages, and supportive policies (Kumar & Joseph, 2005; Athreye, 2005), the authors provide an empirical analysis of firm-level data, revealing significant correlations between export performance and factors like innovation capacity, strategic alliances, and financial management practices. These findings align with earlier research by Arora et al. (2001) and Dossani and Kenney (2007), emphasizing innovation and strategic positioning in maintaining competitive advantages. Additionally, the study examines the influence of external economic conditions and internal efficiencies on financial outcomes, echoing themes from NASSCOM (2020) and McKinsey Global Institute (2014). By employing a robust methodological framework, Rao and Vinod offer granular insights into the operational and economic dynamics of Indian IT firms, contributing valuable knowledge to the discourse on emerging market economies.

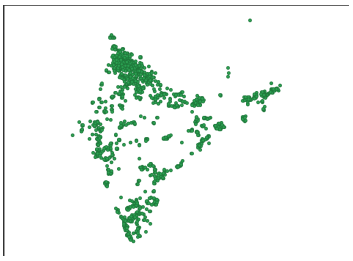
Model and Methodology :

This section outlines the comprehensive range of models and techniques utilized in the study, detailing the specific steps taken throughout the research process. It encompasses both the methodological approaches and the sequential actions followed to ensure a thorough and accurate analysis.

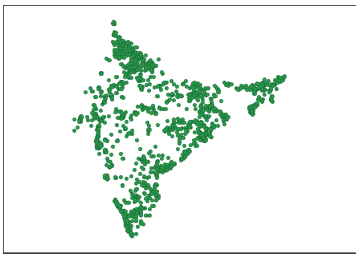
1. Data Collection

The major data source used in this study is the World Bank Enterprise Survey Data for the years 2014 and 2022 which provides detailed information on business environments and firm performance. This dataset would provide us with our dependent variables for running the models.

One major obstruction with the Dataset was the lack of mention of the city names in which the firm was operating. This was countered by actively working with the World Bank which later agreed to share the geographical coordinates where the firms were located.



2022



2014

2. Converting Coordinates to City Names

The conversion of latitude and longitude coordinates into city names was facilitated using Python's Pandas and Geopy libraries. Geopy provides a robust method to accurately translate geographic coordinates into identifiable city names, a crucial step in geographical data analysis. T

his transformation was systematically applied across the entire dataset, comprising 16,000 data points, ensuring that each location was precisely mapped to its corresponding city.

3. Difference-in-Difference Model

The Difference-in-Difference (DiD) model is a statistical technique used to evaluate the causal impact of a treatment or intervention by comparing the changes in outcomes over time between a treatment group and a control group. This method controls for time-invariant differences between the groups and common trends affecting both groups. By analyzing data before and after the intervention, the DiD

model isolates the effect of the intervention, providing a robust estimation of its impact on the dependent variable.

The DiD model can be expressed as follows:

$$Y_{it} = \alpha + \beta \cdot Treatment_i + \gamma \cdot Post_t + \delta \cdot Treatment_i \cdot Post_t + \Omega \cdot X + \varepsilon_{it}$$

Where:

- Y_{it}: Outcome variable for firm *i* at time *t* (2014 or 2022)
- $Treatment_i$: Dummy variable indicating whether firm *i* is part of the treatment group
- $Post_t$: Dummy variable indicating the post-treatment period (2022)
- X: Independent Variables
- ε_{it}: Error term

4. Specific Models Used

- **Total Annual Sales in Fiscal Year**

  A simple OLS regression was utilized for this.

  To address the scale of the total sales variable, we standardized it by converting it to z-values. This transformation allowed for a more meaningful comparison and analysis within our regression model.

- **Perception of Transport as an Obstacle**

  This variable is in the form of a categorical variable which takes only integer values from 0 to 4 (both included).

	No obstacle	Minor obstacle	Moderate obstacle	Major obstacle	Very Severe Obstacle
Transport **d30a**	0	1	2	3	4

- Tobit Model

The Tobit model is a statistical regression model designed to estimate relationships between variables when the dependent variable is censored.

$$\begin{cases} 0 & \text{if } y_i^* \leq 0 \\ y_i^* & \text{if } 0 < y_i^* < 4 \\ 4 & \text{if } y_i^* \geq 4 \end{cases}$$

- Multinomial Logit

The Multinomial Logit Model is a statistical technique used to model and analyze categorical outcomes with more than two categories. It estimates the probability of each category relative to a base category, utilizing maximum likelihood estimation to determine the coefficients associated with each independent variable.

Results:

- ## Total Annual Sales

	Dependent variable:
	d2 (Total Annual Sales in a Fiscal Year)
Treatment	-0.060
	(0.079)
Post	0.072***
	(0.015)
Treatment:Post	0.365***
	(0.117)
Constant	-0.165***
	(0.011)
Observations	16,937
R2	0.118
Adjusted R2	0.118
Residual Std. Error	0.939 (df = 16932)
F Statistic	568.482*** (df = 4; 16932)
Note:	*p<0.1; **p<0.05; ***p<0.01

The first model reveals that firms situated along the Expressway, after undergoing the treatment, have experienced an increase of 0.365 standard deviations above the mean. This finding is not only substantial but also statistically significant at the 1% level, indicating a strong and reliable impact of the infrastructure project on the economic performance of these firms.

- **Perception of Transport as an Obstacle**
  - **Tobit Model**

	Dependent variable:
	d30a (Perception of Transport as an obstacle)
Treatment	-0.173
	(0.162)
Post	-0.424***
	(0.030)
Treatment:Post	-0.822***
	(0.255)
logSigma	0.596***
	(0.008)
Constant	0.713***
	(0.022)
Observations	16,830
Log Likelihood	-24,892.500
Akaike Inf. Crit.	49,794.990
Bayesian Inf. Crit.	49,833.640

Note: *p<0.1; **p<0.05; ***p<0.01

The Tobit model demonstrates that firms situated on the expressway, following the treatment, perceive transportation as 0.82 points less of an obstacle than firms that did not receive the treatment. This reduction in perceived transportation barriers is both notable and statistically significant at the 1% level, underscoring the positive impact of the infrastructure improvements on the operational efficiency of these firms.

  - **Multinomial Logit Model**

	Dependent variable:			
	1	2	3	4
	(1)	(2)	(3)	(4)
Treatment	0.383*	0.047	-1.332**	-9.998
	(0.197)	(0.241)	(0.598)	(81.658)
Post	-0.816***	-0.706***	-0.466***	0.278***

	(0.039)	(0.044)	(0.059)	(0.098)
Treatment:Post	-0.360	-1.455***	-1.219	-2.601
	(0.283)	(0.488)	(1.172)	(13.946)
Constant	0.007	-0.464***	-1.354***	-2.807***
	(0.027)	(0.031)	(0.042)	(0.080)
Akaike Inf. Crit.	44,565.440	44,565.440	44,565.440	44,565.440

*p<0.1; **p<0.05; ***p<0.01

The chosen base category is No obstacle (0).

Odds Ratios for the Treatment*Post coefficients

	Odds Ratio
1	**0.69770488**
2	**0.23328783**
3	**0.29562079**
4	**0.07418364**

This can be inferred as if a firm is on the expressway then after treatment its odds of transportation being a minor obstacle decreases by 30.23%, a moderate obstacle decreases by 76.67%, a major obstacle decreases by 70.44%, and a severe obstacle by 92.58%.

Conclusion:

Firms located in closer proximity to the highway have experienced significant increases in sales, paralleled by a perceptible decrease in the perceived challenges associated with transportation logistics. This dual effect underscores the strategic advantage of proximity to infrastructure developments like the highway, enhancing operational efficiency and economic performance.

Government spending initiatives should prioritize local economic benefits and provide transparent reporting on outcomes to ensure taxpayer funds are effectively utilized. This could act as a guide for them to assess how the previous projects impacted the surrounding regions and could be useful for coming up with more targeted projects in the future.

Future Works:

- The low R^2 value can be improved by incorporating more robust independent variables, such as those from the Center for Monitoring Indian Economy (CMIE) Prowess dataset.
- The study can be expanded from firm-level analysis to regional analysis by utilizing satellite imagery data. This approach allows for a broader assessment of infrastructure impacts, capturing changes in regional development, land use, and urbanization patterns over time.
- By collaborating with the Department of Earth Sciences, this study can become interdisciplinary, leveraging Geographic Information Systems(GIS) to extract and analyze our dependent variables.
- In the future, this study can be expanded to include additional infrastructure projects such as inland waterways, freight corridors, and high-speed rail networks. This broader scope will allow for the analysis of their respective impacts on economic growth, urban development, and regional connectivity.

References:

- Datta, S., 2012. The impact of improved highways on Indian firms. Journal of Development Economics, 99(1), pp.46-57.
- Ghani, E., Goswami, A.G. and Kerr, W.R., 2016. Highway to success: The impact of the Golden Quadrilateral project for the location and performance of Indian manufacturing. The Economic Journal, 126(591), pp.317- 357.
- Rao, P.M. and Vinod, H.D., 2023. Economic and financial performance of Indian IT services export firms. Telecommunications Policy, 47(3), p.102507.
- World Bank. (2024). Enterprise Surveys. - https://www.enterprisesurveys.org

Appendix:

All codes and Combined Dataset with city names - Appendix

World Bank Questionnaire - India 2022_ES_Questionnaire_Services.pdf