

# The Impact of Highways on Urbanization in India: The Golden Quadrilateral Project

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## *Did you know?*

- By 2050, more than **50% of India's population** will live in urban areas.
- The Golden Quadrilateral Highway (GQ) connects India's four major cities.
- **Our Goal:** Understand how highways shape urbanization:
  - ① Urban population growth
  - ② Employment patterns
  - ③ Wages and housing prices

*"Infrastructure isn't just roads; it builds economies."*

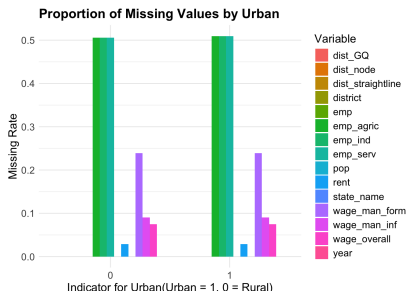
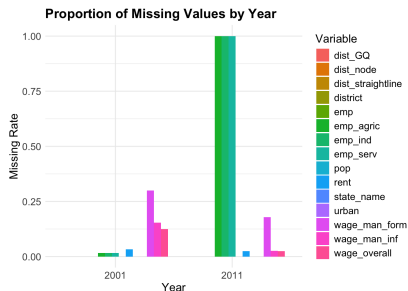
# Motivation and Context

- Highways promote economic growth but are often placed in areas with pre-existing advantages.
- **Challenge:** Causal inference becomes difficult due to selection bias.
- **Objective:** Examine the **causal impact** of the GQ project on:
  - Urban population growth
  - Industrial and services employment
  - Wages and housing prices

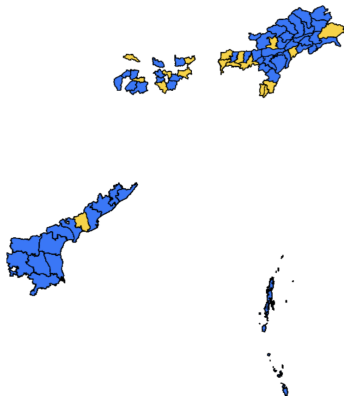
- **Dataset:** District-level data (2001 and 2011):
  - Urban population, employment, wages, and rental prices.
  - Highways mapped for proximity analysis.
- **Treatment:** Districts within  $<75$  km of GQ highway.
- **Control:** Districts  $>75$  km away.
- Sample size:
  - 608 treated districts
  - 1,700 control districts

# Missing Data Analysis

- Employment data had **50.8% missing values**, mostly in rural regions.
- Wages and rents were more reliable for analysis.
- **Impact:** Limits sectoral analysis conclusions.



## Treatment and Control Districts in Based on Distance to Highway



District Type ■ Control ■ Treatment

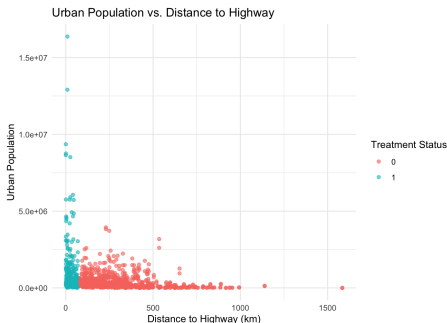
- Fixed-effects regression to compare treated and control districts over time:

$$Y_{it} = \beta_0 + \beta_1 \text{Treatment}_i + \beta_2 \text{Year Dummy}_t + \epsilon_{it}$$

- Where:
  - Y: Outcome variable (urban population, employment, wages, rent)
  - Treatment: Proximity to highway
  - Year dummies: Control for time trends.

# Results: Urban Population Growth

- **Continuous Treatment:** 1 km farther from GQ reduces urban population by **1,041 people** ( $p < 0.01$ ).
- **Dummy Treatment:** Treated districts see an increase of **495,782 people**.



```
##
## Impact of Highways on Urban Population (Clustered SEs)
## =====
##                               Dependent variable:
##                               -----
##                               Urban Population
##                               Continuous      Dummy
##                               (1)            (2)
## -----
## dist_GQ                               -1,041.585***
##                                       (153.359)
##
## treatment                               495,782.200***
##                                       (57,039.500)
##
## year_dummy                             142,740.500***
##                                       (54,017.680)
##
## Constant                             679,061.400***
##                                       (47,613.460)
##                                       (42,004.390)
## -----
## Observations                           1,154                1,154
## R2                                     0.044                0.067
## Adjusted R2                           0.042                0.065
## Residual Std. Error (df = 1151)      3,599,783.000          3,556,348.000
## F Statistic (df = 2; 1151)           26.556***             41.352***
## =====
## Note:                                *p<0.1; **p<0.05; ***p<0.01
##                               Standard errors clustered by district.
```



# Results: Sectoral Employment

- **Industrial Employment:** +40,224 jobs in treated districts.
- **Services Employment:** +82,752 jobs in treated districts.

```
##
## Impact of Highways on Urbanization(Employment)
## =====
##                               Dependent variable:
## -----
##               emp               emp_ind               emp_serv
##               (1)               (2)               (3)
## -----
## treatment          175,616.200***          40,223.680***          82,751.870***
##                   (21,472.650)          (6,847.846)          (14,716.730)
##
## year_dummy          66,506.810***
##                   (20,089.710)
##
## Constant            97,479.340***          24,806.380***          70,731.800***
##                   (15,812.650)          (3,884.179)          (8,347.505)
##
## -----
## Observations              1,154              566              566
## R2                        0.063              0.058              0.053
## Adjusted R2              0.062              0.056              0.051
## Residual Std. Error 1,338,795.000 (df = 1151) 299,913.000 (df = 564) 644,544.200 (df = 564)
## F Statistic          38.924*** (df = 2; 1151) 34.503*** (df = 1; 564) 31.618*** (df = 1; 564)
## =====
## Note:
##                               *p<0.1; **p<0.05; ***p<0.01
##                               Standard errors clustered by district.
```

# Results: Wages and Housing Prices

- **Wages:** No significant effects.
- **Rents:** Small but significant increase: **0.057 units** ( $p = 0.06$ ).

```
##
## Impact of Highways on Urbanization(Wages,House Prices)
## =====
##                               Dependent variable:
##                               -----
##                               wage_overall      rent
##                               (1)              (2)
## -----
## treatment                -6.163              0.057*
##                               (6.026)          (0.031)
##
## year_dummy                131.999***          0.409***
##                               (5.642)          (0.029)
##
## Constant                  129.302***          6.811***
##                               (4.528)          (0.023)
## -----
## Observations              1,068              1,121
## R2                        0.340              0.155
## Adjusted R2               0.339              0.153
## Residual Std. Error      364.046 (df = 1065)    1.904 (df = 1118)
## F Statistic              274.204*** (df = 2; 1065) 102.388*** (df = 2; 1118)
## =====
## Note:                      *p<0.1; **p<0.05; ***p<0.01
##                               Standard errors clustered by district.
```

- Highways boost urban population and employment.
- Recommendations:
  - Complementary policies to support wage growth.
  - Urban planning to address rising housing demand.

# Limitations and Future Work

- Address missing rural employment data.
- Explore regional and long-term effects.
- Investigate spillovers to smaller towns.

# Conclusion

- Golden Quadrilateral highways accelerated urbanization and employment growth.
- Limited impact on wages highlights need for policy support.

*"Infrastructure drives growth, but inclusive policies sustain it."*

# Questions?