

Highway to Success: The Impact of Golden Quadrilateral Project on Indian Manufacturing

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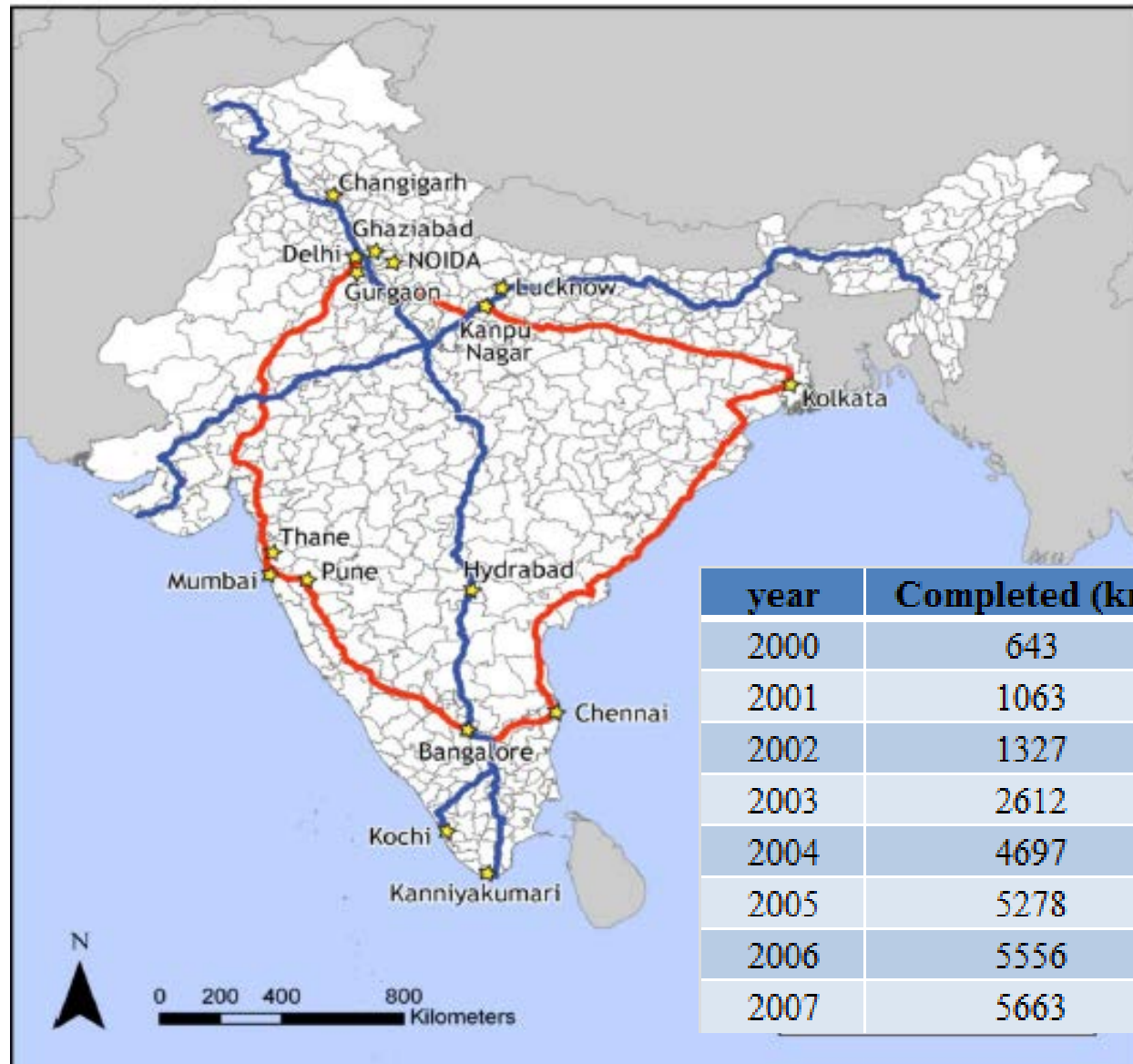
Highways in India, 2000 Snapshot



Highways in India, 2007 Snapshot



Highways in India: GQ and NS-EW



GQ and the Organization of Manufacturing

- Impact of proximity to GQ in non-nodal districts on organization of manufacturing activity: 1994-2009
- Impact measured in terms of: Establishment counts, employment and output levels, average labor productivity and TFP
- Compare the effects in urban versus rural portions
- Source of variation: Distance from GQ (e.g., 0-10 vs 10-50 km from network)

Our Contribution

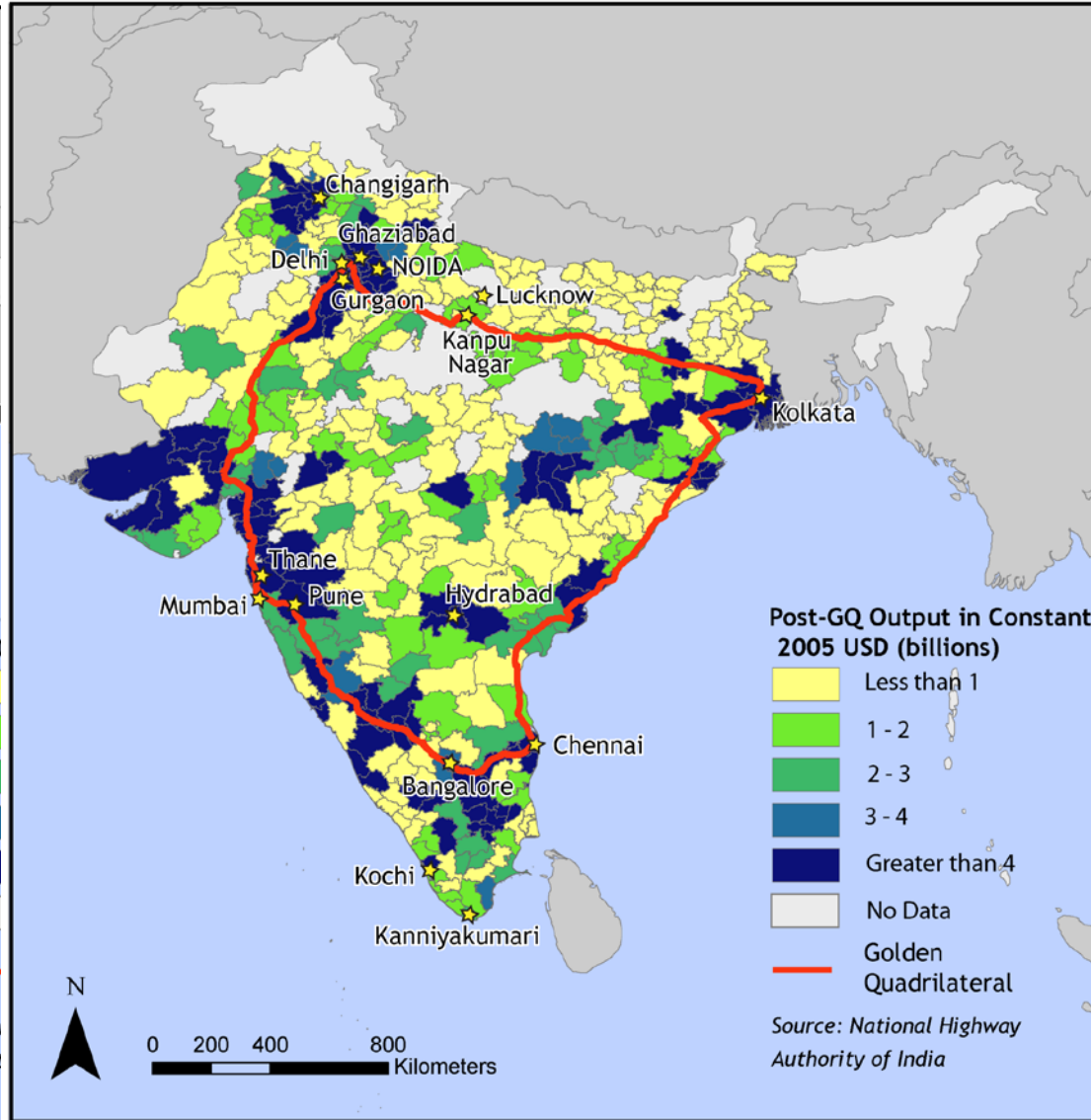
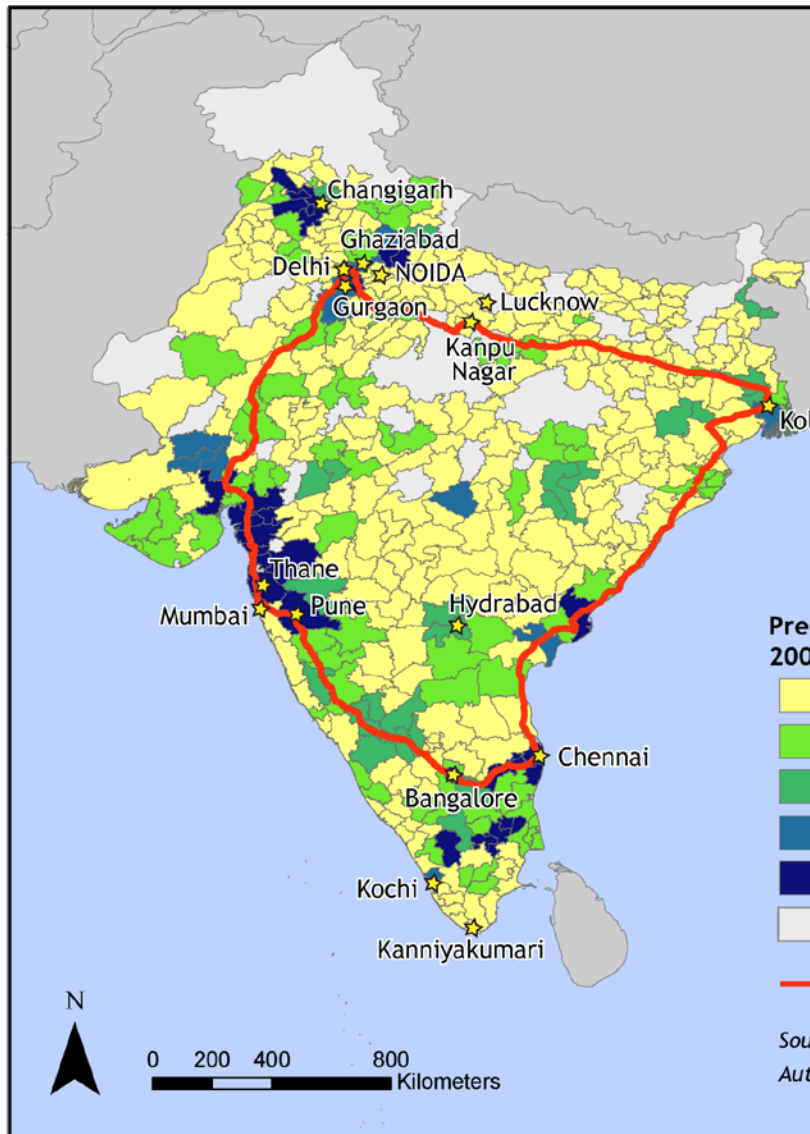
- Use plant-level data to analyze the impact of highways on:
 - Entry and exit outcomes
 - Productivity consequences
 - Entrant vs. incumbent growth
 - Allocative efficiency
 - Contribution to urbanization/de-urbanization

- Quantify the impact from investments into improving networks
 - [vs. the existence of transportation networks]
 - Comparison to the NS-EW placebo highway
 - Dynamics around upgrades
 - Comparison across urban and rural locations

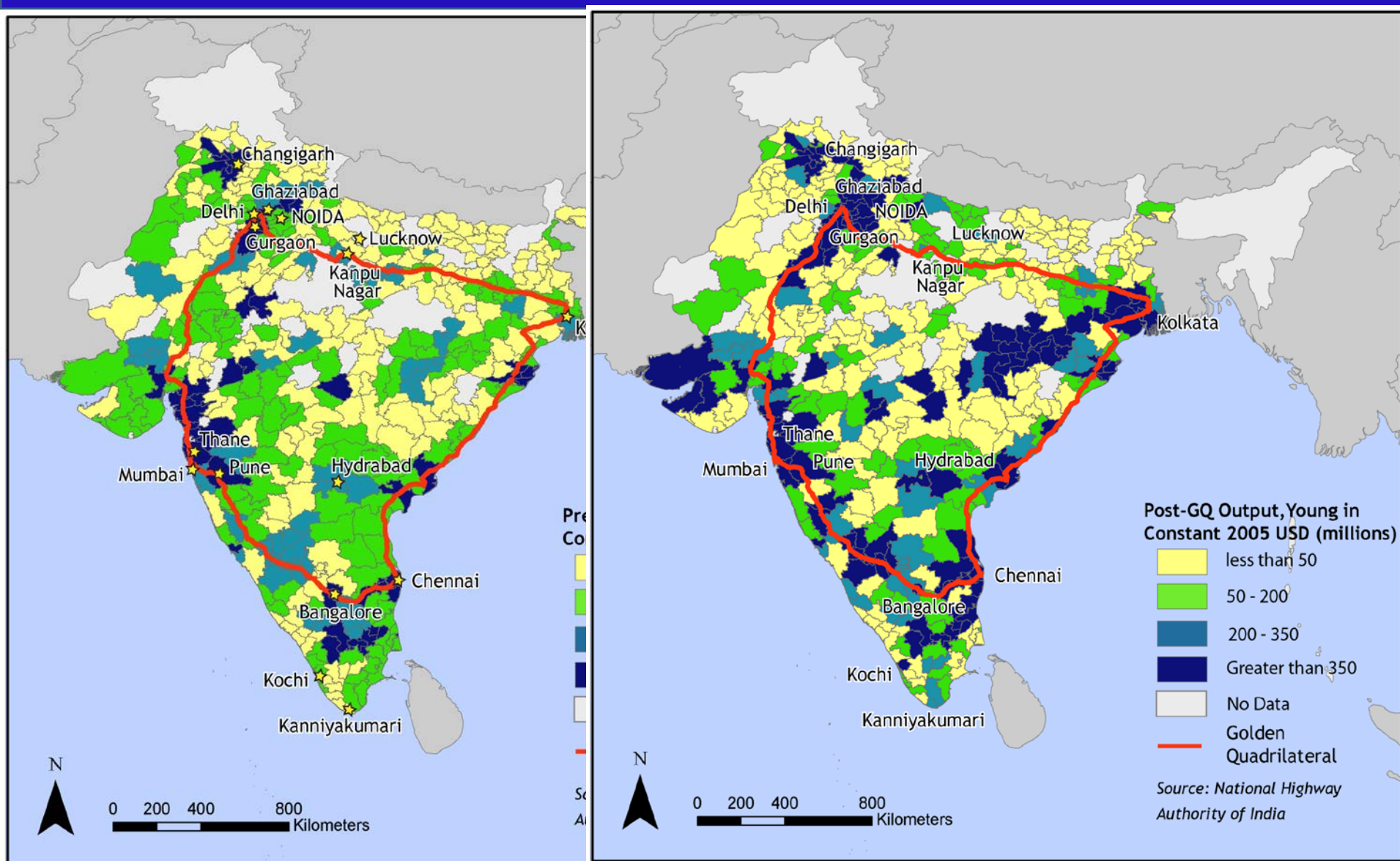
Data

- Annual Survey of Industries (ASI) for organized manufacturing and National Sample Survey (NSS) for unorganized
 - Repeated cross-sectional surveys
- Sample size: 311 districts for organized and 363 for unorganized
 - Consistent sample across survey years
 - Accounts for >90% of activity during period of study
 - About twice the size of a US county
- Distance from GQ Highway: ArcMap GIS software
 - Focus on distance to district edge

Output



Young Output



Methodology

- Non-parametric approach using Diff in Diff estimations

$$Y_{i,t} = \sum_{d \in D} \beta_d \cdot (0,1)GQDist_{i,d} \cdot PostGQ_t + \eta_i + \gamma_t + \varepsilon_{i,t}$$

- Treatment:
 - Indicator variables for distance ranges to the GQ network, with focus on non-nodal districts
 - Comparisons to districts farther away, with excluded group typically being 50+ km from the GQ network
 - Counts: 9 nodal, 76 0-10 km, 42 10-50 km, 236 50 km+
 - The 0-10 km groups accounts for ~40% of activity

Diff in Diff estimations: Entry Rates

	Total GQ organized sector effect,			Columns 1-3 in urban areas			Columns 1-3 in rural areas		
	Plants	Employment	Output	Plants	Employment	Output	Plants	Employment	Output
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Base spatial horizon measuring effects relative to districts 50+ km from the GQ network									
Post GQ upgrades *	0.702	1.167	1.647+	0.388	0.631	0.383	-0.165	0.202	0.723
Nodal district	(0.662)	(0.814)	(0.951)	(0.433)	(0.566)	(0.723)	(0.692)	(0.804)	(1.215)
Post GQ upgrades *	0.436++	0.471++	0.928+++	0.319+	0.221	0.443	0.442++	0.597++	1.059+++
District 0-10 km from GQ	(0.172)	(0.239)	(0.346)	(0.176)	(0.252)	(0.380)	(0.183)	(0.260)	(0.389)
Post GQ upgrades *	-0.012	-0.056	-0.263	-0.009	-0.056	-0.351	-0.015	0.006	-0.126
District 10-50 km from GQ	(0.240)	(0.357)	(0.537)	(0.225)	(0.312)	(0.427)	(0.261)	(0.380)	(0.620)
District and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1248	1248	1248	1112	1112	1112	1164	1164	1164

Sample counts by distance band: 9, 70, 42, and 196

Diff in Diff estimations: Entry Rates

	Total GQ organized sector effect,			Columns 1-3 in urban areas			Columns 1-3 in rural areas		
	Plants	Employment	Output	Plants	Employment	Output	Plants	Employment	Output
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Diff in Diff estimations: Entry Rates

	Total GQ organized sector effect,			Columns 1-3 in urban areas			Columns 1-3 in rural areas		
	Labor	TFP		Labor	TFP		Labor	TFP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Base spatial horizon measuring effects relative to districts 50+ km from the GQ network									
Post GQ upgrades *	0.084	-0.022		0.037	0.010		0.126	0.011	
Nodal district	(0.135)	(0.033)		(0.145)	(0.043)		(0.264)	(0.167)	
Post GQ upgrades *	0.177+	0.086++		0.165	0.098		0.198++	0.099+	
District 0-10 km from GQ	(0.093)	(0.042)		(0.139)	(0.066)		(0.099)	(0.056)	
Post GQ upgrades *	0.043	-0.005		-0.000	-0.021		0.115	0.068	
District 10-50 km from GQ	(0.132)	(0.074)		(0.186)	(0.085)		(0.175)	(0.099)	
District and year fixed effects	Yes	Yes		Yes	Yes		Yes	Yes	
Observations	1248	1244		1108	1100		1160	1160	

Sample counts by distance band: 9, 70, 42, and 196

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Methodology: Long differences

- Non-parametric approach using long-difference estimations

$$\Delta Y_i = \sum_{d \in D} \beta_d \cdot (0, 1)GQDist_{i,d} + \gamma \cdot X_i + \varepsilon_i.$$

- X_i controls include:
 - Measures of initial levels Y_i
 - Access to national highway, state highway, or railroad in terms of log distance
 - Traits from 2000 Census: population, age profile, female-male ratio, urbanization rate, SC/ST rate, literacy, and within-district infrastructure measure

Long Differences

DV: Change in manufacturing trait listed in column header	Log levels of total activity			Log levels of young firm activity			Log labor productivity	Total factor productivity	Log average wage	Log cost per employee
	Plants	Employment	Output	Plants	Employment	Output				
	(1)	(2)	(3)	(4)	(5)	(6)				
A. Base spatial horizon measuring effects relative to districts 50+ km from the GQ network										
(0,1) Nodal district	1.467+++ (0.496)	1.255+++ (0.464)	1.413+++ (0.480)	1.640+++ (0.499)	2.004+++ (0.543)	2.468+++ (0.621)	0.138 (0.111)	1.971+++ (0.195)	0.382+++ (0.065)	0.393+++ (0.069)
(0,1) District 0-10 km from GQ	0.364+++ (0.128)	0.235 (0.144)	0.443+++ (0.163)	0.815+++ (0.161)	0.882+++ (0.198)	1.069+++ (0.277)	0.199+++ (0.074)	0.163 (0.195)	0.121++ (0.055)	0.130++ (0.056)
(0,1) District 10-50 km from GQ	-0.199 (0.185)	-0.325 (0.222)	-0.175 (0.293)	-0.238 (0.237)	-0.087 (0.314)	-0.281 (0.455)	0.157 (0.126)	0.286 (0.280)	0.098 (0.091)	0.095 (0.094)
B. Panel A including covariates for initial district conditions and additional road and railroad traits										
(0,1) Nodal district	0.541 (0.591)	0.468 (0.657)	0.493 (0.677)	0.831 (0.718)	0.964 (0.858)	0.927 (0.957)	0.004 (0.151)	1.367+++ (0.280)	0.239++ (0.096)	0.249++ (0.100)
(0,1) District 0-10 km from GQ	0.312++ (0.124)	0.233+ (0.129)	0.427+++ (0.157)	0.616+++ (0.174)	0.555+++ (0.201)	0.680++ (0.286)	0.241+++ (0.085)	0.112 (0.215)	0.169+++ (0.060)	0.185+++ (0.062)
(0,1) District 10-50 km from GQ	-0.117 (0.161)	-0.202 (0.196)	-0.024 (0.271)	-0.115 (0.207)	-0.025 (0.279)	-0.194 (0.416)	0.177 (0.127)	0.403 (0.288)	0.151+ (0.087)	0.155+ (0.090)

Sample counts by distance band: 9, 70, 42, and 196

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B. Panel A including covariates for initial district conditions and additional road and railroad traits										
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Sample counts by distance band: 9, 70, 42, and 196

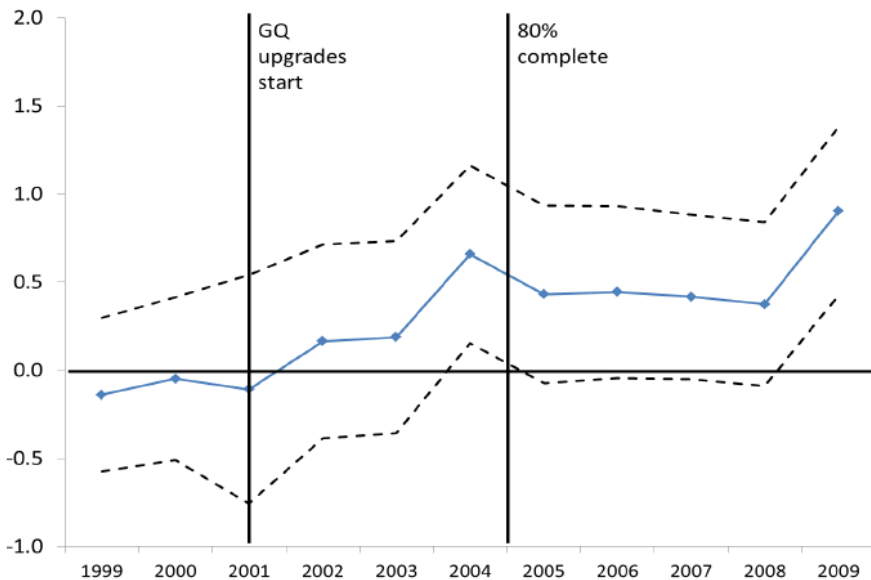
Robustness Checks

- Consider distance bands, new segments vs. upgrades, etc.
- Endogeneity can lead to an upwards or downwards bias
 - Infrastructure to growing places
 - Bridges to nowhere
- Approaches:
 - Placebo test: the portions of the NS-EW networks that were scheduled for Phase 1 upgrades but delayed
 - Straight line (with kink) IV based upon nodal districts
 - Dynamic estimations and completion dates

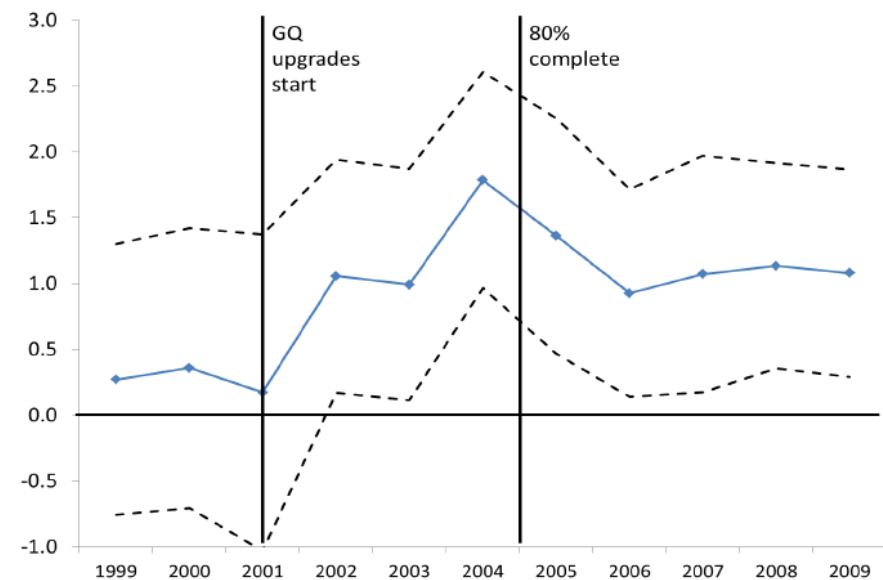
Dynamic Specifications: Young Activity

Figure 2: Dynamics of plant count and output growth around the GQ upgrades

A. Dynamics of log new plant growth



B. Dynamics of log new output growth



$$Y_{i,t} = \sum_{t \in T} \beta_t \cdot (0, 1)GQDist_{i,d < 10km} \cdot (0, 1)Year_t + \phi_i + \eta_t + \varepsilon_{i,t}.$$

Parallel work with average spread in states of completion times is 6.4 years

Diff in Diff: Unorganized Sector

	Log levels of total activity			Log levels of young firm activity		
	Plants	Employment	Output	Plants	Employment	Output
	(1)	(2)	(3)	(4)	(5)	(6)
A. Base spatial horizon measuring effects relative to districts 50+ km from the GQ network						
Post GQ upgrades *	0.184	0.259	0.126	0.376	0.370	0.031
Nodal district	(0.177)	(0.146)	(0.180)	(0.279)	(0.223)	(0.363)
Post GQ upgrades *	-0.086	-0.096	-0.077	0.059	0.093	0.038
District 0-10 km from GQ	(0.105)	(0.109)	(0.131)	(0.208)	(0.212)	(0.234)
Post GQ upgrades *	-0.031	0.006	0.112	-0.123	-0.102	-0.019
District 10-50 km from GQ	(0.116)	(0.122)	(0.186)	(0.247)	(0.246)	(0.295)
District and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1089	1089	1089	1089	1089	1089
B. Extended spatial horizon measuring effects relative to districts 200+ km from the GQ network						
Post GQ upgrades *	0.168	0.227	0.148	0.661	0.644	0.348
Nodal district	(0.185)	(0.157)	(0.188)	(0.297)	(0.247)	(0.386)
Post GQ upgrades *	-0.102	-0.127	-0.054	0.344	0.367	0.356
District 0-10 km from GQ	(0.117)	(0.124)	(0.141)	(0.232)	(0.237)	(0.266)
Post GQ upgrades *	-0.047	-0.026	0.134	0.160	0.170	0.295
District 10-50 km from GQ	(0.127)	(0.136)	(0.193)	(0.267)	(0.268)	(0.321)
Post GQ upgrades *	-0.074	-0.130	-0.112	0.392	0.293	0.127
District 50-125 km from GQ	(0.118)	(0.130)	(0.144)	(0.240)	(0.247)	(0.296)
Post GQ upgrades *	0.014	0.012	0.205	0.706	0.765	1.106
District 125-200 km from GQ	(0.126)	(0.132)	(0.170)	(0.256)	(0.270)	(0.333)
District and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1089	1089	1089	1089	1089	1089

GQ and Urban Rural transformation for Unorganized Sector

- Diff in diff for unorganized: non-nodal districts close to the GQ system behave similarly to those located farther away
- Diff in diff on urban shares: GQ accelerated spatial shift for organized sector but observe no changes in the urbanization rates for the unorganized sector.
- Limited effects for the unorganized sector, especially in comparison to the organized sector
- Given the informality, dependence on highways for connectivity with input and output market low.

Conclusions

- GQ upgrades connected to enhancements in organized sector activity
- Additionally, GQ helped increase allocative efficiency, facilitated a more natural spatial sorting of industries, and encouraged decentralization to intermediate cities
- Impact on organized sector is balanced between urban/rural settings, with the exception being that rural areas receive relatively more stimulus in terms of net output growth.
- Unorganized sector of manufacturing is not closely linked to the GQ developments in either location