Infrastructure Maintenance: Evidence from India

Paper by Ritam Chaurey & Duong Trung Le
Presented by Zach Winship

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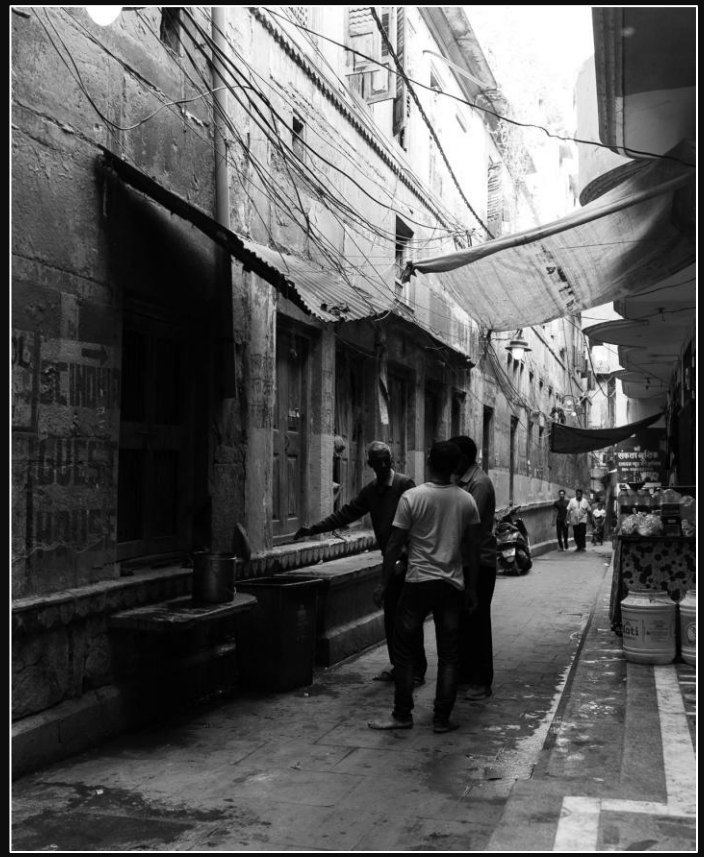


01

Motivation

The Global Maintenance Crisis

The Scale:

- Infrastructure disruptions cost households $390 billion/year (World Bank, 2021).

The Policy Bias:

- Political incentives favor "New Ribbons" (construction) over "Old Potholes" (maintenance) (World Bank, 1994).

Research Gap:

- Prior literature focuses almost exclusively on new infrastructure (e.g., Donaldson, 2018; Datta, 2012).

Theoretical Ambiguity (Positive Evidence)

Established Gains: Strong evidence that new roads/electricity boost development:

Roads

Aggarwal (2018), Donaldson (2018), Jensen & Miller (2018).

Electricity

Dinkelman (2011), Rud (2012a), Lipscomb et al. (2013).

Telecom

Jensen (2007), Hjort & Poulsen (2019).

Theoretical Ambiguity (Null Evidence)

Recent Skepticism: Several major studies find minimal village-level transformation:

Roads

Asher & Novosad (2020) [PMGSY], Burlig & Preonas (2016).

Electricity

Lee, Miguel, & Wolfram (2020), Aklin et al. (2017).

Greenfield vs. Brownfield Investments

The “Greenfield” Focus

Prior studies (Asher & Novosad, 2020; Lee et al., 2020) examine new infrastructure in unserved areas.

The “Brownfield” Opportunity

This program targets areas where infrastructure and firms already exist!

The Maintenance Gap

We know how to connect a village; we don't know the return on improving that connection.

Hypothesis: The Reliability Dividend

Variable vs. Fixed Costs:

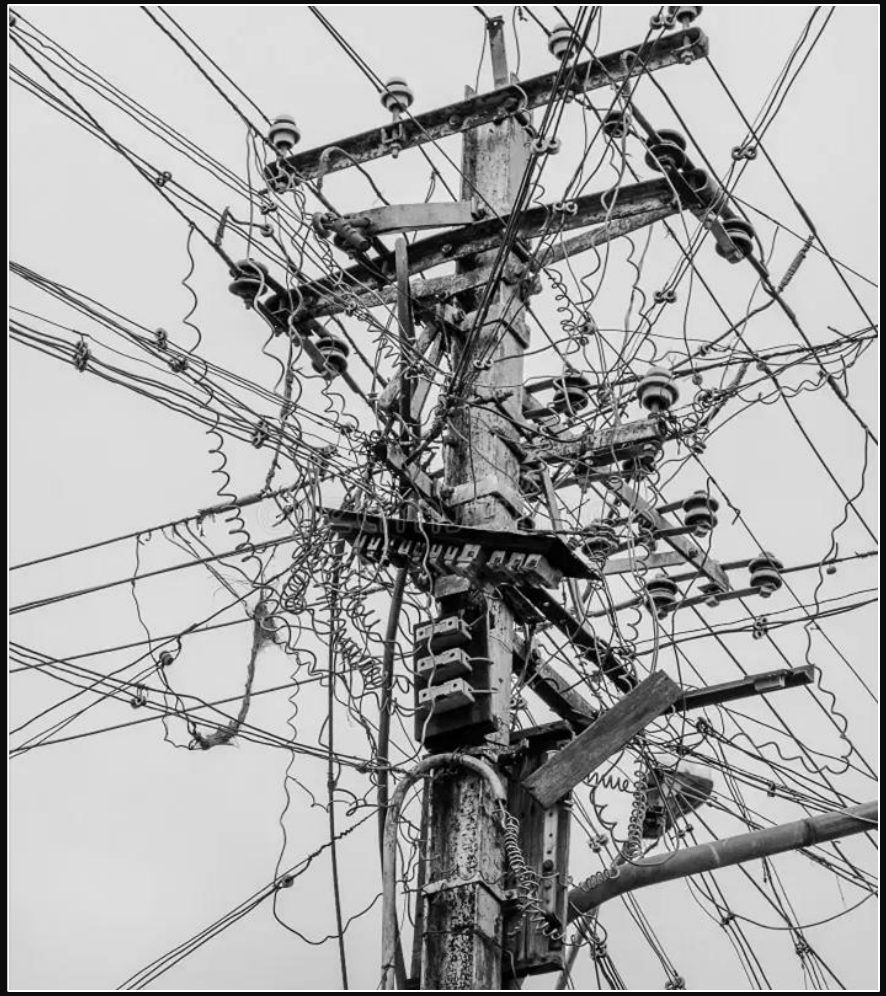
- Maintenance (pothole repair, grid stability) reduces the daily variable costs of production for existing firms.

The Marginal Firm:

- In "Brownfield" areas, firms are already at the threshold of viability.

Research Goal:

- Does fixing existing "pipes and wires" catalyze local structural transformation more effectively than new construction?



02

Background & Data

The RSVY Program (2003-2007)

Target:
- 147 “Backward Districts” identified by the Planning Commission.

Funding:
- Rs. 450 million (~$10M USD) per district.

The “No-New-Build” Rule:
- Explicitly restricted to maintenance and improvement of existing assets (Program Evaluation Organization, 2010).

Infrastructure Scope & Maintenance Mandate

Roads:
- Widening and strengthening existing roads; repairing bridges and culverts.

Power:
- Strengthening transmission and distribution (T&D) networks to reduce outages.

The Mechanism:
- Unlike PMGSY, RSVY could not be used to connect previously unconnected villages.

Data Sources

Economic Census (1998, 2005)

Full enumeration of all village establishments.

NSS Manufacturing (Round 56, 62)

Detailed survey of "unorganized" firms.

NSS Employment (Round 55, 62)

Individual wages and labor supply.

DMSP-OLS

Satellite night-lights as a proxy for electrification quality.

Defining the Village Economy

Microenterprises/Informal Firms

Defined as firms with
< 10 workers (power) or < 20 (no power).

The Reality

99% of all rural establishments are micro-firms; average size is 1.69 workers.

Baseline:

88% of rural non-farm employment is in these small-scale "unorganized" firms.

03

Methodology

Methodology

Regression Discontinuity: Functional Form Variants

04

Results

Result: Village-Level Employment

Finding

Total non-farm employment increases by 13.7% to 16%.

Sectoral Split

Effect driven entirely by Microenterprises

Formal Firms

Zero significant impact on large firms (consistent with Rud, 2012b).

Result: Firm Entry (Extensive Margin)

New Firms

+7.0 to +9.3 new microenterprises per village.

Average Size

No change in workers per firm (~1.69).

Firm Conclusions

Maintenance facilitates entry rather than expansion.

Result: Employment & Firms

Table 2
Village-level employment, number of firms, and average firm size.

	Linear (1)	Quadratic (2)	Linear (3)	Quadratic (4)	Linear (5)	Quadratic (6)
Panel A: Village employment						
1. Total Employment	0.159*	0.137	0.141	0.150*	0.153*	0.160*
S.E.	(0.0953)	(0.0922)	(0.0911)	(0.0894)	(0.0881)	(0.0857)
2. Formal Employment	0.0578	0.0179	0.0239	0.0358	0.0217	0.0232
S.E.	(0.0848)	(0.0850)	(0.0781)	(0.0743)	(0.0753)	(0.0747)
3. Informal Employment	0.169*	0.150*	0.153*	0.161*	0.167*	0.176**
S.E.	(0.0934)	(0.0898)	(0.0880)	(0.0870)	(0.0862)	(0.0837)
Panel B: Number of firms						
1. All Firms	0.150	0.130	0.153*	0.156*	0.170**	0.176**
S.E.	(0.0967)	(0.0915)	(0.0854)	(0.0863)	(0.0856)	(0.0845)
2. Formal Firms	0.0119	0.00078	0.00216	0.00572	0.00255	0.00283
S.E.	(0.0243)	(0.0246)	(0.0223)	(0.0212)	(0.0218)	(0.0216)
3. Informal Firms	0.151	0.133	0.155*	0.158*	0.173**	0.178**
S.E.	(0.0969)	(0.0917)	(0.0855)	(0.0864)	(0.0858)	(0.0847)
Panel C: Average firm size						
1. All Firms	0.00666	0.00432	-0.0124	-0.00755	-0.0176	-0.0158
S.E.	(0.0341)	(0.0349)	(0.0334)	(0.0302)	(0.0302)	(0.0299)
Bandwidth	0.02		0.025		0.03	
State FE & Village Controls	Yes	Yes	Yes	Yes	Yes	Yes

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Result: Individual Welfare

Wages

Weekly earnings rose by 11% to 15%.

Days Worked

Total days worked in the last 7 days increased by 2% to 3%.

Consumption

Household expenditure (MHCE) increased by 4% to 8%.

Result: Individual Welfare

Table 3

Wages, days worked, and monthly household consumption expenditure.

	Linear (5)	Quadratic (6)	Linear (3)	Quadratic (4)	Linear (1)	Quadratic (2)
Panel A: Wages						
RD Estimate	0.157**	0.155**	0.149***	0.139**	0.123***	0.110**
S.E.	(0.0607)	(0.0616)	(0.0554)	(0.0560)	(0.0467)	(0.0469)
Panel B: Days worked						
RD Estimate	0.0310***	0.0306***	0.0286**	0.0277**	0.0233**	0.0231**
S.E.	(0.0101)	(0.0104)	(0.0111)	(0.0109)	(0.00989)	(0.00995)
Panel C: MHCE						
RD Estimate	0.0428	0.0487	0.0803**	0.0776**	0.0765*	0.0761*
S.E.	(0.0388)	(0.0438)	(0.0383)	(0.0390)	(0.0401)	(0.0405)
Bandwidth	0.02		0.025		0.03	
State FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes

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Bandwidth	0.02		0.025		0.03	
State FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes

Result: Structural Reallocation

The Shift

Significant move out of agricultural wage work (-2.5% to -4.4%).

Destination

Direct entry into local manufacturing, retail, and transport services.

Transformation

Local structural change without the need for migration.

Result: Structural Reallocation

Table 4

Labor force participation, unemployment, migration, agricultural and non-agricultural workers.

	Linear (1)	Quadratic (2)	Linear (3)	Quadratic (4)	Linear (5)	Quadratic (6)
Panel A: Labor force, etc.						
[A1] Labor force participation	-0.0160	-0.00934	-0.00709	-0.00807	0.00423	0.00461
S.E.	(0.0210)	(0.0206)	(0.0191)	(0.0185)	(0.0175)	(0.0176)
[A2] Unemployment	0.00719	0.00590	0.00371	0.00425	0.00505	0.00527
S.E.	(0.00591)	(0.00668)	(0.00500)	(0.00495)	(0.00641)	(0.00641)
[A3] Internal migration	-0.000176	-0.00582	0.000900	0.00274	-0.00909	-0.00914
S.E.	(0.0226)	(0.0218)	(0.0202)	(0.0197)	(0.0184)	(0.0183)
[A4] External migration	-0.00575	-0.00670	-0.00482	-0.00417	-0.00441	-0.00444
S.E.	(0.0158)	(0.0169)	(0.0144)	(0.0139)	(0.0134)	(0.0134)
Panel B: Sectoral reallocation						
[B1] Agricultural workers	-0.0259*	-0.0253*	-0.0303*	-0.0312**	-0.0442***	-0.0374**
S.E.	(0.0149)	(0.0147)	(0.0167)	(0.0157)	(0.0165)	(0.0161)
[B2] Non-agricultural workers	0.0246*	0.0239*	0.0269*	0.0273*	0.0240*	0.0242*
S.E.	(0.0137)	(0.0140)	(0.0140)	(0.0141)	(0.0124)	(0.0123)
Bandwidth	0.02		0.025		0.03	
State FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes

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S.E.	(0.0210)	(0.0206)	(0.0191)	(0.0185)	(0.0175)	(0.0176)
[A2] Unemployment	0.00719	0.00590	0.00371	0.00425	0.00505	0.00527
S.E.	(0.00591)	(0.00668)	(0.00500)	(0.00495)	(0.00641)	(0.00641)
[A3] Internal migration	-0.000176	-0.00582	0.000900	0.00274	-0.00909	-0.00914
S.E.	(0.0226)	(0.0218)	(0.0202)	(0.0197)	(0.0184)	(0.0183)
[A4] External migration	-0.00575	-0.00670	-0.00482	-0.00417	-0.00441	-0.00444
S.E.	(0.0158)	(0.0169)	(0.0144)	(0.0139)	(0.0134)	(0.0134)
Panel B: Sectoral reallocation						
[B1] Agricultural workers	-0.0259*	-0.0253*	-0.0303*	-0.0312**	-0.0442***	-0.0374**
S.E.	(0.0149)	(0.0147)	(0.0167)	(0.0157)	(0.0165)	(0.0161)
[B2] Non-agricultural workers	0.0246*	0.0239*	0.0269*	0.0273*	0.0240*	0.0242*
S.E.	(0.0137)	(0.0140)	(0.0140)	(0.0141)	(0.0124)	(0.0123)
Bandwidth	0.02		0.025		0.03	
State FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes

Evidence of Direct Infrastructure Impacts (Tables 5 & 6)

Firms Reported Fewer Bottlenecks (Table 5):

- Power: 10.5%–17.7% reduction in frequent outages.
- Roads: Significant drop in raw material access problems.
- Falsification: Zero change in credit or corruption issues.

Gains Matched Industry Needs (Table 6):

- Electricity Intensity: Jobs (+19%) and new firms (+11%) grew only in power-heavy sectors.
- Road Intensity: Highest response in transport-dependent trade.

Heterogeneity by Baseline Infrastructure

Table 6

Microenterprises – Heterogeneous effects in electricity and road-intensive industries.

	(1)	(2)	(3)
Panel A: Electricity-intensive industries			
[A1] Microenterprise employment	0.193**	0.0565	0.0515
S.E.	(0.0745)	(0.0440)	(0.0956)
[A2] Established < 3 years ago (%)	0.115***	0.0604***	-0.00793
S.E.	(0.0253)	(0.0192)	(0.0298)
[A3] Problem: power cut (%)	-0.217***	-0.116**	-0.173
S.E.	(0.0754)	(0.0471)	(0.106)
Degree of electricity dependency (tercile)	>66th	33th to 66th	<33th
Panel B: Road-intensive industries			
[B1] Microenterprise employment	0.183**	0.0376	-0.0473
S.E.	(0.0761)	(0.0562)	(0.0383)
[B2] Established < 3 years ago (%)	0.0973***	0.0352	0.0429
S.E.	(0.0266)	(0.0230)	(0.0359)
[B3] Problem: raw materials (%)	-0.190**	0.0751	-0.0682
S.E.	(0.0855)	(0.0987)	(0.0860)
Degree of road dependency (tercile)	>66th	33th to 66th	<33th
State, Industry FE & Controls	Yes	Yes	Yes

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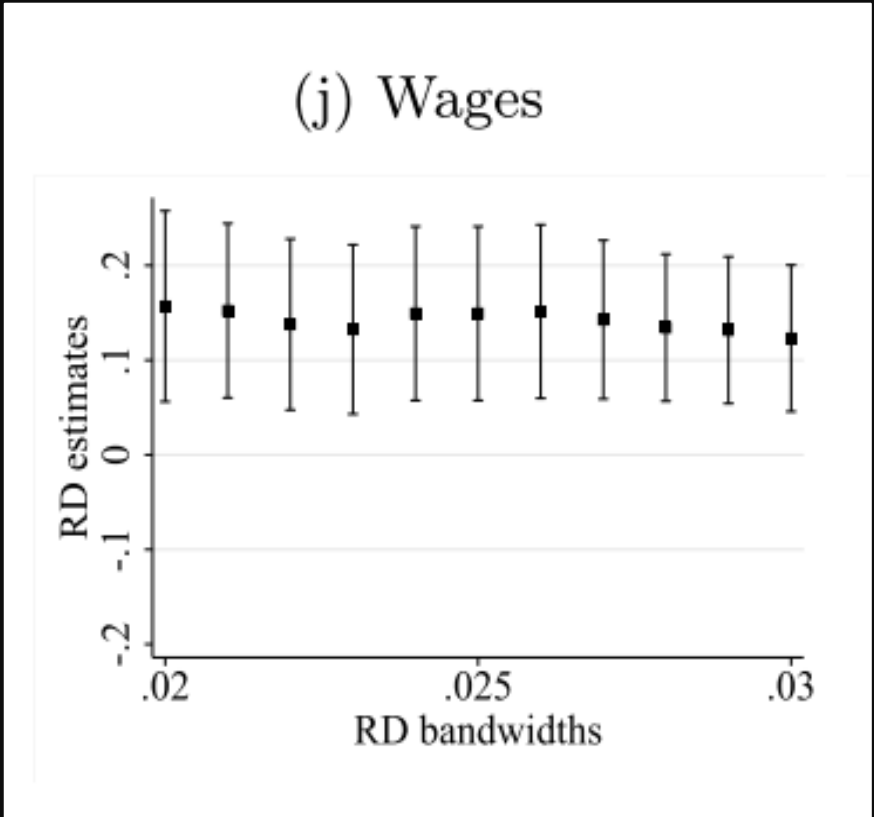
State, Industry FE & Controls	Yes	Yes	Yes

05

Robustness

Results are Not Sensitive to Model Choices



Bandwidth Consistency

Estimates remain stable and statistically significant across all bandwidths from 0.02 to 0.03.

Optimal Bandwidth

Results hold using Calonico et al. (2014) data-driven optimal selection.

Falsification 1: No “Pre-Program” Effects

The Test

Did these districts already have higher growth before RSVY existed?

The Method

Run the RD model on 1998 Economic Census and 2000 NSS data.

The Result

RD estimates are statistically indistinguishable from zero for all main outcomes.

The Verdict

The economic effects only began after the maintenance grants were distributed.

Falsification 2: Placebo Cutoffs and Satellite Proof

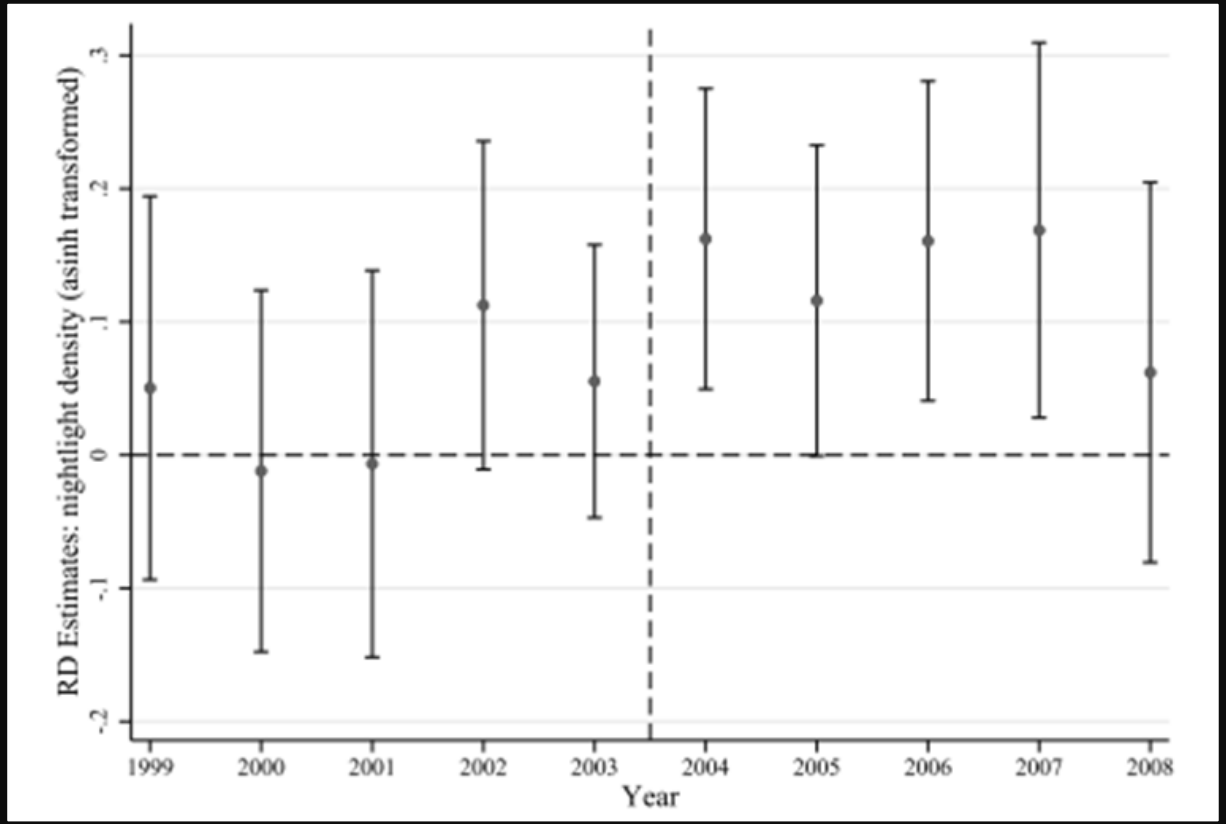
Hypothetical Cutoffs

Testing "fake" thresholds on untreated districts yields zero effect.

Night-Lights

Satellite imagery shows a sharp increase in luminosity that peaks exactly during the RSVY implementation years.

Falsification 2: Satellite Proof



Difference-in-Discontinuities

Difference-in-Discontinuities

Microenterprises

The model confirms a 13.7% to 16% increase in village-level employment.

Informal Sector

Gains are entirely driven by small, unorganized workshops and shops.

Formal Sector

No statistically significant effect on large, formal firms (consistent with the main RDD).

The Verdict

Even with the most conservative econometric controls, the "Maintenance Dividend" is real and robust.

(Grembi et al., 2016)

06

Conclusions

Summary of the Maintenance Dividend

Structural Transformation

A massive shift away from farm employment:

- Agricultural employment: -4.4%.
- Village non-farm jobs: +14% to +16%.

The “Micro” Firm Boom:

- +7 to +9 new firms per village (almost entirely from informal firms).
- No change in average firm size; this is about new entrepreneurs, not scaling existing ones.

Main Takeaway

Maintenance creates a "functional" local economy that keeps workers in the village.

Limitations

Data Opacity

- The RSVY guidelines allowed for roads, power, and water.
- District-level records don't specify the exact split (e.g., 60% roads / 40% power).

The Infrastructure Floor

- Effect = Zero in villages with no baseline roads or electricity.
- You cannot "maintain" a network that doesn't exist yet.

The “Micro” Ceiling

Massive gains for informal shops, but zero impact on large, formal firms. Maintenance stabilizes the "floor" for the rural poor; it doesn’t necessarily attract industrial plants.

Question of Survival

The study captures a 5-year window. We don't know if these new micro-firms are "subsistence traps" or the seeds of future growth.

Are There Any Missing Limitations?

The “Index Problem”: Measurement Error in Backwardness

Main Takeaways

Political Bias

We over-invest in Construction because it's visible (Novosad, 2020).

The Economic Reality

Maintenance is the actual multiplier for existing clusters.

Final Takeaway

Reliability is the invisible engine of the rural economy.

Thank you