

Using Satellite Imagery to Detect the Impacts of New Highways: An Application to India

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Overview

① Goal

- Provides a *framework* for studying the aggregate and highly local effects of infrastructure investments such as highway upgrades.
- *Context*: Conventional data sources are either not available or available at coarse spatial resolutions when in theory the impact and distributional consequences of investments are highly localized.

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② Approach

- Identify boundaries of local markets at 1 km resolution using *daytime* satellite imagery and measure minimum travel times between market pairs digitizing official road maps for India in 1996 and 2011.
- Compute market access in otherwise standard spatial model using data on market boundaries, nightlights, bilateral travel times, estimates of trade cost elasticity and elasticity of income to nightlights.

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③ Main Findings

- Improved market access (1996-2011) \uparrow NPV of Indian GDP (measured by nightlights) by 1.6%, mostly driven by the Golden Quadrilateral.
- GQ benefited the largest markets while national highway upgrades benefited smaller markets, with *within and across district* variations.

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First paper to disentangle the effects of the GQ and national highway!

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- What drives this difference? A decomposition of:
 - ① Market access effect: National Highways connect more remote areas (less market access) compared to GQ
 - ② Lane effect? GQ is 2-6 lanes, but NH is 2-4 lanes.
- Possible to answer by converting all national highways to 2-6 lanes, mimicking the GQ
- If most of the difference is driven by remoteness, would this mostly imply negative net (of costs) gains from connecting remote places?

Comment 2: Negative impact of National Highways

- Although the expansion of non-GQ national highways increased real GDP by 0.63%, this gain was offset by construction costs, leaving a small negative net impact.
- Compared to the GQ, the NH connected relatively smaller, more rural places where economic activity is not well captured by night-lights.
- Would this small negative impact change if we were to include possible improvements in agricultural outcomes using satellite based vegetative indices (NDVI and EVI) to proxy for village-level agricultural production? ([Asher and Novosad, 2020](#))

Comment 3: Time-lines of construction of GQ relative to National Highways

- The paper has two time periods: 1996 (pre) and 2011 (post).
- If the GQ preceded much of the NH expansion, can population re-allocation through migration change the welfare effects of NH expansion? i.e. if more people move to remote regions that were previously not connected.
- Complementarity between different types of highway expansions.
- This could be implemented by breaking the time periods into two blocks of pre-post years and adding migration costs to the model that can also change due to the GQ.

Comment 4: Aggregation Bias

- 42.6% of welfare variation due to road upgrades (GQ+NH) is within district.
- Naturally larger districts contain more heterogeneity, but are there aggregation biases from computing market access and welfare at larger levels of spatial aggregation? This is important even if interested only in aggregate welfare.
- It would be interesting to see the difference (aggregate effects when computed using district boundaries - aggregated effects at district-level computed from 1 km market) and if the difference correlates with district size.
- Since GQ and NH connect markets with different sizes, such aggregation biases could have significant welfare implications by type of highway construction.

Conclusion

- Impressive use of both day and night-time satellite imagery to define market boundaries and measure GDP.
- Big potential for applications in studying the effects of highway construction and improvements over a wide range of LMICs with scarce data.
- Combining nightlight based satellite data with data on agricultural yields predicted through satellite images has the potential to assess the general equilibrium effects of highways across rural and urban settings which are differentially affected by local versus national highways.