Novel estimation methods of local area economic activity and growth

Ayush Patnaik

XKDR Forum

December 11, 2024

{X}KDR

Why local area economic estimation matters

Policy applications

- Infrastructure project planning
- Resource allocation

Government scheme implementation

- Targeting of welfare programs
- Impact evaluation of interventions

Traditional measurement systems

Committee on Regional Accounts Established to develop regional accounts and measurement of economic activity at the state and district levels.[1]

NSSO Consumer Expenditure Survey Collects data on household consumption patterns, to understand living standards, poverty, and income distribution across regions.

[1] Deepak Sethia. "Regional Accounts of India: Methods, New Estimates, and Their Uses". In: *Review of Income and Wealth* 62.1 (2016), pp. 92–119.

Challenges of traditional measures

Informal sector In developing countries like India, a significant portion of economic activities occurs outside the formal economy, making it difficult to capture accurate data.

Price differences Different areas may have varying prices, affecting the accuracy of measuring value addition.

Statistical capacity Limited resources and expertise in statistical agencies can lead to inacurrate esimtates.

Political interference Political interference can affect the objectivity and reliability of economic data, leading to biased or manipulated results.[2]

[2] Luis R Martinez. "How much should we trust the dictator's GDP estimates". In: *Available at SSRN 3093296* (2018).

Alternative data

Alternative data sources can provide insights into local economic activity and growth, avoiding the challenges of traditional measures.

In India, the Consumer Pyramids Household Survey (CPHS) by Centre for Monitoring Indian Economy (CMIE) and VIIRS nighttime lights data are two such sources that are being used for economics research.
They have been used in 103[3] and 633 research papers, respectively[4].

[3] *Consumer pyramids dx*. URL: https://consumerpyramidsdx.cmie.com/kommon/bin/sr.php?kall=wrespaper&tab=105 (visited on 12/02/2024).

[4] As of December 7, 2024, a RePEc search indicates that 633 research papers have utilized the nighttime lights data.

Alternative data source: CPHS

Consumer Pyramids Household Survey (CPHS)

- Covers over 174,000 households across India.
- Conducted thrice a year, providing frequent and up-to-date data.
- Collects detailed information on income, expenses, savings, borrowings, and investments.

Usage as an alternative measurement source

- Offers granular insights into household economic activities.
- Helps in understanding consumption patterns, financial behavior, and economic well-being.

Alternative data sources: Nighttime lights

Nighttime Lights Data

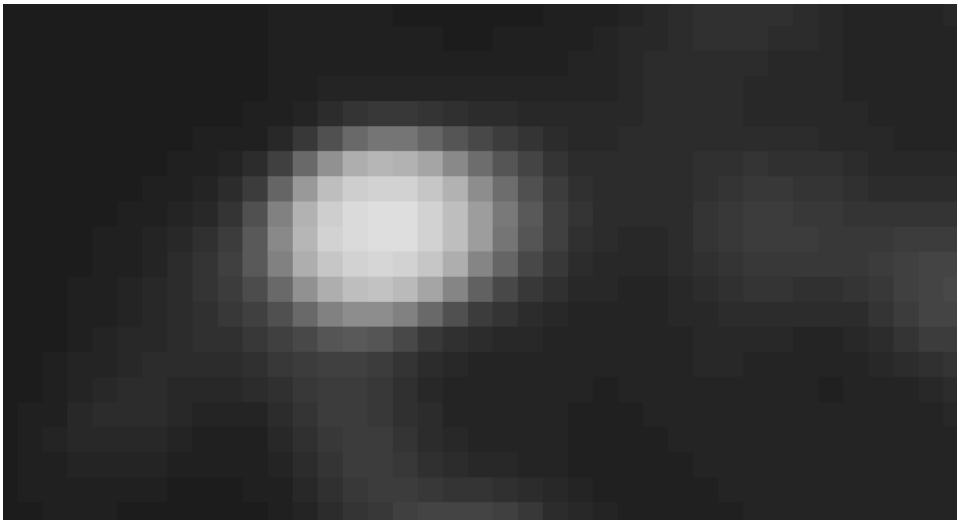
- Satellite imagery capturing the intensity and distribution of lights at night.
- Provides high-resolution (about 500m by 500m) data that can be used to analyze various economic activities.
- Provded for by NASA and NOAA.
- Free satellite data is often provided by NASA, the European Space Agency, and other organizations.

Nighttime lights around Hansalpur, Gujarat

2014

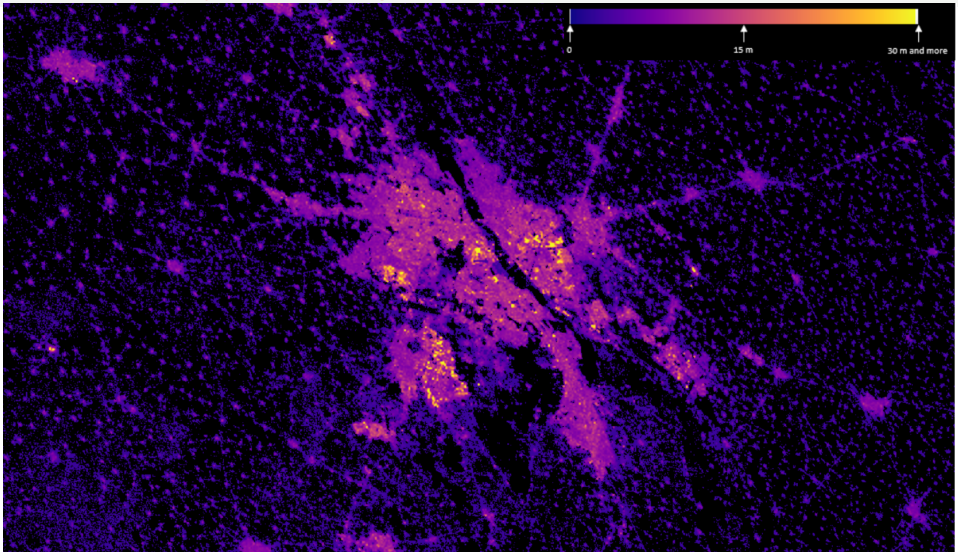
Nighttime lights around Hansalpur, Gujarat

2020



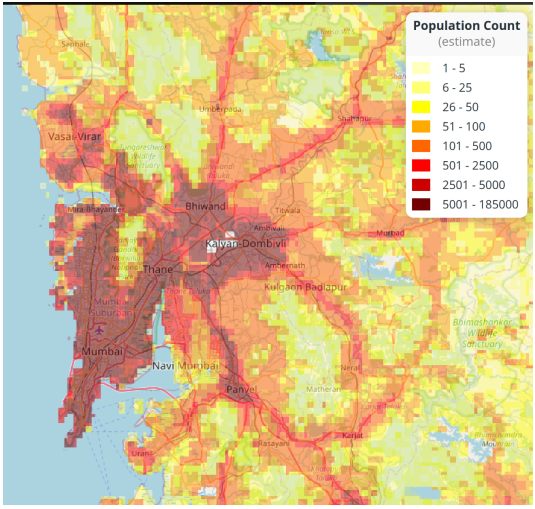
Other satellite data sources

Global Human Settlement Layer: Building height

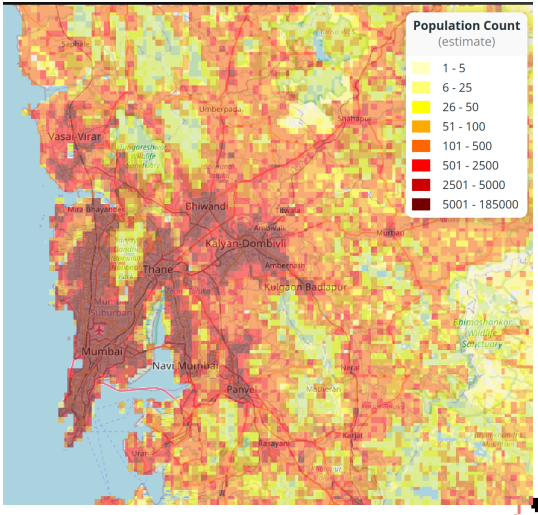


Other satellite data sources

LandScan: Population density



2000



2023

Challenges with alternative data sources

Each source of data has its own challenges. For example:

Nighttime lights Nighttime lights data can be biased due to factors like moonlight, LEDs, and sensor saturation, leading to inaccuracies in economic measurements. We discovered an attenuation in the intensity of nighttime lights in the presence of clouds[5].

Household surveys Household surveys can be affected by sampling errors, recall bias, and non-response rates, which can impact the accuracy of the data.

Using these datasets requires robust infrastructure for data storage, processing, and retrieval. This field demands cross-disciplinary expertise from computer science, physics, and economics. It requires sustained research and interdisciplinary skills, taking long years with continuous updates to ensure data relevance and accuracy.

[5] Ayush Patnaik et al. "But clouds got in my way: Bias and bias correction of VIIRS nighttime lights data in the presence of clouds". In: *Available at SSRN 3957319* (2021).

Frontier: combining multiple measures

Combining multiple alternative datasets provides a comprehensive understanding of economic activities.
For example, nighttime lights and CPHS have been used together to study COVID-19 containment policies[6] and evaluate demonetization[7].

[6] Robert CM Beyer, Tarun Jain, and Sonalika Sinha. "Lights out? COVID-19 containment policies and economic activity". In: *Journal of Asian Economics* 85 (2023), p. 101589.

[7] Areendam Chanda and C Justin Cook. "Was India's demonetization redistributive? Insights from satellites and surveys". In: *Journal of Macroeconomics* 73 (2022), p. 103438.

Karnataka Property Tax Study

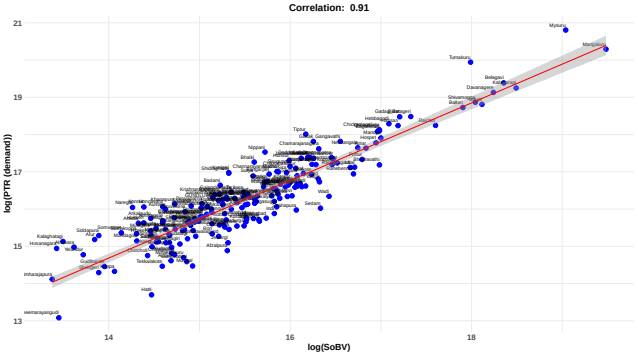


Figure: Log Property Tax Demand vs Building Volume

- We constructed a dataset of alternative economic indicators for 300 urban local bodies in Karnataka using nighttime lights, building volumes, and CPHS data.
- The primary application of this dataset was to analyze property tax collection in the state.
- Based on these alternative measures, we identified cities that should be collecting higher taxes but aren't, and vice versa. This highlights discrepancies in tax collection efficiency and potential areas for improvement.

Novel Dataset of Cities

Traditional Limitation Until now, understanding urban economic activities in India relied primarily on government data sources like the census, conducted only once every 10 years.

Our Novel Dataset

- Combines nighttime lights, building volumes, and CPHS data
- Covers 300 urban local bodies in Karnataka
- Provides granular and frequent economic indicators
- Offers insights previously unavailable through traditional sources

Future Applications While this study focuses on Karnataka, the methodology can be replicated across other regions, demonstrating how alternative data sources can complement traditional measurement systems.