Measuring Inequality using Geospatial Data

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Abstract

The main challenge in studying economic inequality is limited data availability, which is particularly problematic in developing countries. We construct a measure of economic inequality for 234 countries/territories from 1992 to 2013 using satellite data on nightlights and gridded population data. We obtain a measure that is significantly correlated with cross-country variation in income inequality. We provide three applications of the data in the fields of health economics and international finance. The results suggest that the light-based inequality measure can capture more enduring features of economic activity that are not directly captured by income.

Motivation

Traditional measures of inequality tend to rely on national accounts and household survey data. Both sources are prone to design differences and scattered availability, which is especially true for survey data. Issues include under-sampling of richer households, tax evasion and other consistency issues. Finally, the informal sector and shadow economy transactions pose additional threats to the reliability of these data.

We construct an alternative measure by using worldwide satellite data on nighttime light emission and match them with data on geo-located population counts to construct Gini-coefficients. The greatest advantage of this approach is the consistent coverage provided by the geospatial source data across countries.

Data and Approach

Night Lights Data:
- Defense Meteorological Satellite Program (DMSP) data generated by the Earth Observation Group (EOG) at NOAA’s National Center for Environmental Information (NCEI). Available at annual frequency between 1992 and 2013.
- Full coverage of Earth’s surface along the longitudinal dimension between 75 degrees north and 65 degrees south in latitude.
- We use the average visible lights version of the DMSP data.

Population Data:
- LandScan (LSC) database by Oak Ridge National Laboratory: Disaggregated census counts within administrative boundaries with the support of ancillary data, such as land cover, roads, slope, urban areas, village locations, and high resolution imagery. Available on the pixel-level (see upper right map).

Economic Inequality:
- Calculation of census- and pixel-level Gini-coefficients using different parameters to map satellite data to actual economic numbers.
- Weighting of Gini-coefficients to maximize correlation with conventional income-based Gini-coefficients (SWIID⁵) → Light-based Economic Inequality

Applications

Applications show how light- and income-based inequality measures correlate with different determinants of inequality:
- Out-of-pocket health care expenditure
- Epidemics
- Financial liberalization

Empirical Approach:

\[ G_{LM} = \gamma \lambda_{LM} + \delta_L + \alpha_T + \epsilon_{LM} \]

where \( G_{LM} \) is the income- or light-based Gini-coefficient. \( \lambda_{LM} \) is the variable of interest from the applications. \( \delta_L \) and \( \alpha_T \) are time- and country-fixed effects.

Results: similar for light- and income-based inequality in the cross-section, however the results diverge in within-country estimations.

Interpretation: lights data are less prone to transitory income shocks while capturing additional aspects of the economy, such as informal economic activities, the distribution of productive means and household expenditures.

Conclusions

- Main Contribution: new measure of economic inequality based on geospatial data on nighttime light emissions and gridded population counts.
- Balanced sample of 234 countries and territories from 1992 to 2013.
- The measure is significantly correlated with conventional measures of income inequality across countries, but captures additional aspects, such as consumption, informal activities, infrastructure and wealth.

Cited References


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Data Access: