Econ 5700 slides
Measurement

November 20, 2019

Standard way to measure levels of development: GDP/capita

Typical source for cross-country (macro): the PWT

Problems

- Many countries have poor data
- Comparisons hard; different goods, prices, currencies both across countries and over time
- Some economic activities not even captured by GDP, e.g. household production; potentially larger share in developing countries
- Even where data are good, GDP/capita is a crude measure of well-being

Hard to find better measures

Some candidates:

- Standard correlates of GDP/capita: mortality, fertility, education
- Survey data on happiness (see, e.g., Wolfers and Stevenson, NBER wp from 2008)
- Energy consumption
- Night lights (today's topic)

The case for using night lights

Henderson, Storeygaard, and Weil (2010) use night lights observed from satellites orbiting Earth to measure economic activity

Basic idea: all economic activity emits light

Many problems, but same holds for GDP data

Using both official GDP statistics and night lights can add precision if the two have different measurement errors

Another advantage compared to GDP data:

- Possible to measure lights at subnational level (smaller geographic units than countries)

- Some GDP (as well as GNP and population) data are available at subnational level from official sources in developed countries: e.g., US states, regions of Europe

- Less often in developing countries, in particular Sub-Saharan Africa

- New night lights data allow HSW to revisit earlier topics on development in Sub-Saharan Africa: access to the sea, malaria prevalence, city growth

Data

Lights measured from US satellites

Record the intensity of lights emitted from Earth by night

Maintained by the United States Air Force Defense Meteorological Satellite Program (DMSP)

Lights measured by a special sensor system called Operational Linescan System (OLS)

Original purpose: finding moonlit clouds

Used since the 1970s, but only data from 1992

Data distributed to the public through the National Geophysical Data Center (NGDC) at the National Oceanic and Atmospheric Administration's (NOAA)

http://ngdc.noaa.gov/eog/dmsp.html

To read the data: use a software called ArcGIS

Data organized by satellite/year (e.g., F15 2003, F15 being the satellite and 2003 the year).

Each satellite/year provides data on night lights for millions of "pixels"

Each pixel corresponds to about 0.86 square kilometers at the equator (exact size depends on distance from equator)

Sensors measure a “digital number” (DN) from 0 to 63; higher numbers = more lights

HSW drop pixels in the far north and far south: auroral activity; midnight sun; few people live there anyhow

For given pixel and year, HSW use average of all satellites’ DN across all days with data

Table 1 shows distribution across pixels of average DN 1992-2008 within each of eight countries

Some pixels unlit (most of Canada, very little of the Netherlands)

Some pixels "top-coded" with a DN=63; mostly in rich, densely populated countries

Some more geographically equal than others, as measured by Gini coefficient

Figure 1 shows night lights in 2008

Specific regions, examples

- Korean peninsula (Figure 2)
  - Both Seoul and Pyongyang visible; Seoul emits more lights
  - ROK and Seoul grew from 1992-2008; Pyongyang and DPRK did not

- Java (island of Indonesia): effects of economic recession (Figure 3)
  - Some decline in light emissions, but decline in GDP predicted by night lights smaller than in measured GDP

- Rwanda 1993-1996: effects of genocide (Figure 4)
  - Some decline in light emissions, but less than in measured GDP

Examples of Rwanda and Indonesia suggest night lights best suited for studying longer-term growth

Regression specification

- Dependent variable = log (total) GDP
- Main independent variable = log of night lights / area

Implicit assumption by HSW: total night lights (in some country and year) depend only on total GDP (for the same country and year)

Alternative assumption: night lights could depend separately on the number of people and the average person's income; e.g., if each person emits a fixed amount of light regardless of his/her income

Dividing by area should not matter if we have country fixed effects or look at growth rates

Fixed–effects regressions:

$$z_{j,t} = \psi x_{j,t} + c_j + d_t + \varepsilon_{j,t}$$

$z_{j,t}$ = level of log GDP for country j in year t

$x_{j,t}$ = level of log night lights for country j in year t

c_j = country fixed effect

d_t = year fixed effect

Growth regression:

$$z_j = \text{const} + \psi x_j + \varepsilon_j$$

z_j = growth or log difference in GDP for country j over some period

x_j = growth or log difference in night lights for country j over some period

Results

Table 2: FE regressions across 188 countries

Column (1): regressing log GDP on log lights/area, $\widehat{\psi} = .277$

Column (2): no indication of non-linear relationship; cf. Figure 6

Column (3): results not driven by cross-country variation in number of pixels with no lights, or top-coded lights (DN=63)

Column (4): results not driven by variation in how unequally countries' lights are distributed

Columns (5)-(7): results not driven by variation in energy consumption; note smaller sample, column (5) shows same regression as in column (1) but restricted sample

Column (8): results not driven by gas flares

Table 3: other regressions

Column (1): FE regression, same as in Table 2

Column (2): Add country specific time trends ($z_{j,t} = \psi x_{j,t} + \kappa_j t + c_j + d_t + \varepsilon_{j,t}$); smaller $\widehat{\psi}$

Column (3):

- Demean the data: log GDP and log lights are residuals net of year and country fixed effects

- Then take absolute values of negative light residuals

- Coefficients almost the same for positive and negative light residuals

- Little evidence of "ratchet effect"

Columns (4)-(5): growth in GDP regressed on growth in lights; column (5) similar to column (3) of Table 2

Tables 4-6: skip; about how to (optimally) correct existing GDP data

Subnational comparisons

Measuring night lights at subnational level in Sub-Saharan Africa

Want to compare growth in nights lights from 1992 to 2008 across different regions, call them A and B for now

Let $z_{A,1992}$, $z_{B,1992}$, $z_{A,2008}$, $z_{B,2008}$ denote log night lights in regions A and B in 1992 and 2008

If $z_{A,2008} - z_{A,1992} > z_{B,2008} - z_{B,1992}$, then faster growth in A than in B

Called difference-in-difference exercise

Findings:

- Coastal areas grew more slowly than interior ($>$100 km off sea or navigable rivers)
  - Surprising since this was in an era when world trade grew a lot
- Primary cities grew more slowly than hinterland
  - May suggest diminishing returns to city size

- Malaria infested areas grew more slowly than non-malarial areas
  - This happened against a backdrop of many anti-malaria efforts in this period
  - Thus little evidence that those campaigns increased lights growth

Some of these results contrasted with the existing literature up to then

Does not end discussion in any way, but goes to show what these new data can contribute