The Effects of Infrastructure Development on Growth and Income Distribution

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Motivation

- Infrastructure is an essential ingredient for productivity and growth.
- Renewed attention to infrastructure development:
  (i) Retrenchment of public sector since mid-80s
  (ii) Opening up of infrastructure to private sector.
- Generalized access to infrastructure is key to help reduce income inequality.
- Pressures of fiscal consolidation → Lower public infrastructure spending → Insufficient provision of infrastructures → Adverse effects on growth and inequality
Motivation

• **Goal:** Comprehensive evaluation of the impact of infrastructure development on growth and income inequality.

• Data for over 100 countries for the years 1960-2000 (annual).

• Extend previous literature in the following dimensions:

  (i) Consider simultaneously transport, power, and telecoms. Some experiments involving water.

  (ii) Take into account quantity and quality

  (iii) Updated cross-country and time-series dataset of infrastructure indicators.
Empirical Strategy

• Unbalanced panel data set of 121 countries.
• Annual data spanning 1960-2000 period.
• Most empirical evidence focuses on a single infrastructure sector.
• Aggregation of infrastructure sectors via principal components analysis.
• Why? High correlation among various types of infrastructure.
• Construct synthetic indices that summarize various dimensions of infrastructure and its quality.
Empirical Strategy

- Index of Infrastructure Stocks:

\[ P_1(z)_{it} = 0.62 \cdot \ln \left( \frac{Z_1}{L} \right)_{it} + 0.61 \cdot \ln \left( \frac{Z_2}{L} \right)_{it} + 0.5 \cdot \ln \left( \frac{Z_3}{A} \right)_{it} \]

\((Z_1/L)\)=Telephone main lines (per 1000 workers)
\((Z_2/L)\)=Power Generating Capacity (GW per 1000 workers)
\((Z_3/L)\)=Total Roads (in km. per sq. km. of surface area)

- Index of Infrastructure Quality

\[ P_1(qz)_{it} = 0.59 \cdot (Q_1)_{it} + 0.58 \cdot (Q_2)_{it} + 0.56 \cdot (Q_3)_{it} \]

\(Q_1\)=Waiting time for installation of main lines
\(Q_2\)=Power transmission and distribution losses
\(Q_3\)=Share of paved roads in total roads
Infrastructure and Growth

• Empirical support for a (+) impact of infrastructure on aggregate output (Aschauer, 1989)

• Strands in the literature:

(1) *Output Contribution of Infrastructure*
- Telecommunications (Roller and Waverman, 2001)
- Roads (Fernald, 1999)

(2) *Long-term Growth Effects of Infrastructure*
- Summary measures of infrastructure have (+) association with growth (Sanchez-Robles, 1998).
- Telephones (Easterly, 2001; Loayza et al. 2003; Lopez, 2003)
Figure 1. Infrastructure Stocks vs. Economic Growth

y = 0.0056x + 0.0206
R² = 0.2547
Figure 2. Infrastructure Quality vs. Economic Growth

\[ y = 0.0081x + 0.0226 \]
\[ R^2 = 0.2027 \]
Infrastructure and Growth

• Growth Determinants:
  (a) Evidence of Transitional Convergence.
  (b) Growth enhanced by deeper financial systems, more human capital, more open economies, better governance, and positive terms of trade shocks.
  (c) Growth adversely affected by higher inflation, a larger government burden, and a high degree of RER overvaluation.

• A faster accumulation of infrastructure stocks leads to higher economic growth.

• In most specifications, quality of infrastructure services has no robust relationship with growth, except for our preferred estimate.

• Growth effects of infrastructure quality may be largely captured by the stock index.
Infrastructure and Growth

• Economic Implications of our estimates:
  i. ↑ 1 s.d. Infrastructure Stocks and Quality leads to higher growth by 3.6 pp. (2.9 pp attributed to higher quantity and 0.7 pp to higher quality).
  ii. Raising infrastructure development of Peru (25th percentile) to Chile (75th percentile in LAC), we increase growth by 2.2 pp. (1.7 pp due to larger stocks and 0.5 pp to better quality).

Growth Payoff from Infrastructure Development

• Growth gains by LAC countries relative to leader (CRI) range from 1.1 to 4.8 pp.
• Growth gains of LAC leader relative to EAP median (KOR) is 1.5 pp.
## Infrastructure and Growth

### Growth Improvement in LAC Countries due to Higher Infrastructure Development

*(in percentages)*

<table>
<thead>
<tr>
<th>Country</th>
<th>Improvement to levels of LAC Leader</th>
<th>Improvement to levels of EAP Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stocks</td>
<td>Quality</td>
</tr>
<tr>
<td>Argentina</td>
<td>1.3%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Bolivia</td>
<td>3.8%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Brazil</td>
<td>1.5%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Chile</td>
<td>1.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Colombia</td>
<td>1.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Ecuador</td>
<td>2.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Mexico</td>
<td>1.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Peru</td>
<td>3.0%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Uruguay</td>
<td>0.7%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>1.1%</td>
<td>0.4%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>2.0%</td>
<td>0.6%</td>
</tr>
</tbody>
</table>
Infrastructure and Inequality

• Infrastructure development can have a positive impact on income and welfare of the poor above its impact on average income (Lopez, 2003).

• Infrastructure helps under-developed areas to get connected to core economic activities and access to additional productive opportunities.

• Infrastructure has a disproportionate impact on the human capital of the poor (education and health), and hence on their job opportunities and income prospects.

• Distributive impact of private participation in infrastructure involves micro and macro linkages.
Figure 3. Infrastructure Stocks vs. Income Inequality

\[
y = -0.0303x + 0.403
\]

\[
R^2 = 0.2157
\]
Figure 4. Infrastructure Quality vs. Income Inequality

The scatter plot shows a negative correlation between infrastructure quality and income inequality. The equation of the regression line is:

\[ y = -0.0523x + 0.3887 \]

with an R-squared value of 0.2942.
Infrastructure and Inequality

- Determinants of the Gini coefficient:
  (a) Evidence in favor of the Kuznets curve.
  (b) Human capital (education and health) decreases inequality
  (c) The larger the size of the modern sector, the higher the level of inequality.

- Infrastructure stocks and the quality of their services have a negative and robust impact on inequality.

- Infrastructure development enhances the ability of the poor to access additional productive opportunities.

- Economic Implications:
  (a) ↑ 1 s.d. Infrastructure Stocks and Quality leads to a decline in Gini coefficient of 0.07 (0.06 attributed to higher stocks and 0.01 to better quality)
  (b) Infrastructure development raises from levels of Peru to Chile would reduce the Gini coefficient by 0.05 (0.04 due to higher stocks and 0.01 due to better quality).
Infrastructure and Inequality

• Infrastructure development affects income shares:
  (a) It reduces the ratio of income shares of top to bottom quintiles.
  (b) It increases the share of the middle income quintile.

Redistributive Benefits of Infrastructure Development

• Reduction of Gini coefficient by LAC countries relative to leader in infrastructure development (CRI) range from 0.02 (URY) to 0.10 (NIC).
• Reduction of Gini coefficient by LAC leader relative to EAP median (KOR) is 0.03. For countries like GTM, HND, NIC, PER the reduction is greater than 0.1.
# Infrastructure and Inequality

## Changes of Inequality in LAC Countries due to Higher Infrastructure Development

*(Changes in the Gini coefficient)*

<table>
<thead>
<tr>
<th>Country</th>
<th>Improvement to levels of LAC Leader</th>
<th>Improvement to levels of EAP Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stocks</td>
<td>Quality</td>
</tr>
<tr>
<td>Argentina</td>
<td>-0.03</td>
<td>-0.01</td>
</tr>
<tr>
<td>Bolivia</td>
<td>-0.08</td>
<td>-0.01</td>
</tr>
<tr>
<td>Brazil</td>
<td>-0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td>Chile</td>
<td>-0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Colombia</td>
<td>-0.04</td>
<td>-0.02</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Ecuador</td>
<td>-0.04</td>
<td>-0.02</td>
</tr>
<tr>
<td>Mexico</td>
<td>-0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Peru</td>
<td>-0.06</td>
<td>-0.01</td>
</tr>
<tr>
<td>Uruguay</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>Venezuela</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>-0.04</strong></td>
<td><strong>-0.01</strong></td>
</tr>
</tbody>
</table>
Water Development and Inequality

- Role of access to water and sanitation in reducing income inequality (Brenneman et al. 2002; Galiani et al. 2002).
- Population with access to safe water as another explanatory variable in inequality regression.
- Development of water network has a negative and significant impact on income inequality.
- ↑ 1 s.d. in access to safe water reduces Gini by 0.02. Analogous ↑ in infrastructure stocks and quality reduces Gini by 0.04. Total reduction is 0.06.
- Reduction of Gini coefficient by LAC countries relative to leader in infrastructure development (CRI) range from 0.02 (CHL, MEX, URY) to 0.09 (NIC).
# Water Development and Inequality

## Changes of Inequality in LAC Countries due to Higher Infrastructure Development and Access to Safe Water

*(in percentages)*

<table>
<thead>
<tr>
<th>Country</th>
<th>(A) Improvement to levels of LAC Leader</th>
<th>(B) Improvement to levels of EAP Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stocks</td>
<td>Quality</td>
</tr>
<tr>
<td>Argentina</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Bolivia</td>
<td>-0.03</td>
<td>-0.01</td>
</tr>
<tr>
<td>Brazil</td>
<td>-0.01</td>
<td>-0.03</td>
</tr>
<tr>
<td>Chile</td>
<td>-0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Colombia</td>
<td>-0.01</td>
<td>-0.03</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Ecuador</td>
<td>-0.01</td>
<td>-0.02</td>
</tr>
<tr>
<td>Mexico</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Peru</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>Uruguay</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Venezuela</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Average</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
</tbody>
</table>
Conclusions

• Our results reflect causal effects on infrastructure on growth and inequality.
• Volume of infrastructure stocks has a significant (+) effect on long-run economic growth.
• Link between infrastructure quality and growth is empirically less robust.
• Infrastructure quantity & quality have a robust (-) effect on income inequality.
• Access to safe water leads to a decline in inequality.
• Infrastructure can be a key win-win ingredient for poverty reduction: it raises growth and lower inequality.