A Bridge to Equality: How Investing in Infrastructure Affects the Distribution of Wealth

John Gibson\textsuperscript{1}  Felix Rioja\textsuperscript{2}

Georgia State University

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How does investing in infrastructure affect the distribution of wealth in a country?

- Could reduce inequality by boosting wages
- Could increase inequality by boosting interest rates
- Testing this requires a quantitative model

Infrastructure affects individual choice through many channels

- We consider two: production and utility
- Understanding which channel drives results is important
Infrastructure Investment and Growth:

Empirical literature generally finds a positive effect of infrastructure on economic growth


Theoretical literature supports this finding


Common Consensus: Infrastructure increases growth
Infrastructure Investment and Inequality:

- Empirical literature finds mixed results:

- Theoretical literature also finds mixed results:
  - No Effect: Glomm and Ravikumar (1994b)
  - Increase Inequality: Chatterjee and Turnovsky (2012)

No common consensus on infrastructure and inequality
Our Contribution

Modify Aiyagari (1994) to include:

- Endogenous labor supply decision
- Infrastructure impacts both production and utility

Our modeling strategy allows us to:

- Focus on ex post rather than ex ante heterogeneity
- Calibrate our model using income data
- Consider both quantitative as well as qualitative results

Determine which channel (production or utility) drives the distributional results
Preview of Results

**Increase infrastructure investment from 2% to 5% of GDP**

1. Large effects when both channels are operational
   - Aggregate output increases by 128% on average
   - Wealth concentration **falls by 13.4%** on average

2. Small effects when utility channel is shut down
   - Aggregate output increases by 18% on average
   - Wealth concentration **increases by 3%** on average

**Distributional effects transmitted through utility channel**
Model Setup

Extended version of Aiyagari (1994)

- Agents are ex ante identical
- Idiosyncratic shocks to labor productivity
- Partially insure against shocks by accumulating assets

Infrastructure affects choices through two channels:

- Production: Affects both output and factor prices
- Utility: Affects total and marginal utility
Role of Infrastructure

Infrastructure impacts the economy through the following channels:

1. Production
   
   \[ Y(K_G, K, N) = K_G^\phi K^\alpha N^{1-\alpha} \]
   
   Infrastructure directly affects output and factor prices

2. Utility
   
   \[ U(c, L) = \frac{1}{\gamma} [c^{-\xi} + \eta L^{-\xi}]^{\frac{\gamma}{\xi}} \]
   
   L denotes effective leisure, \( L = lK_G \)
   
   Infrastructure directly affects marginal utility of leisure
Household’s Problem

\[
V(a, \theta) = \max_{c,n,l,a'} \left[ \frac{1}{\gamma} \left( c^{-\xi} + \eta L^{-\xi} \right)^{-\frac{1}{\xi}} + \beta \sum_{\theta'} \pi(\theta'|\theta) V(a', \theta') \right]
\]

s.t.

\[
(1 + \tau_c)c + a' \leq \begin{cases} 
(1 + (1 - \tau_a)r)a + (1 - \tau_n) wn\theta & \text{if employed} \\
(1 + (1 - \tau_a)r)a + b & \text{if unemployed}
\end{cases}
\]

\[n + l \leq 1, \ a' \geq 0 \text{ and } L = lK_G\]

Solving this yields the following labor supply:

\[
n = \frac{1 + \tau_c + \left[ \frac{\eta (1+\tau_c)}{K_G^\xi (1-\tau_n) w \theta} \right]^{\frac{1}{1+\xi}} [g(a, \theta) - (1 + (1 - \tau_a)r)a]}{1 + \tau_c + \left[ \frac{\eta (1+\tau_c)}{K_G^\xi (1-\tau_n) w \theta} \right]^{\frac{1}{1+\xi}} (1 - \tau_n) w \theta}
\]
Household’s Problem (without utility channel)

\[
V(a, \theta) = \max_{c,n,l,a'} \left[ \frac{1}{\gamma} \left( c^{-\xi} + \eta l^{-\xi} \right)^{-\frac{\gamma}{\xi}} + \beta \sum_{\theta'} \pi(\theta'|\theta) V(a', \theta') \right]
\]

s.t.

\[
(1 + \tau_c)c + a' \leq \begin{cases} 
(1 + (1 - \tau_a)r)a + (1 - \tau_n)wn\theta & \text{if employed} \\
(1 + (1 - \tau_a)r)a + b & \text{if unemployed}
\end{cases}
\]

\[n + l \leq 1 \text{ and } a' \geq 0\]

Solving this yields the following labor supply:

\[
n = \frac{1 + \tau_c + \left[ \frac{\eta(1+\tau_c)}{(1-\tau_n)w\theta} \right]^{\frac{1}{1+\xi}} \left[ g(a, \theta) - (1 + (1 - \tau_a)r)a \right]}{1 + \tau_c + \left[ \frac{\eta(1+\tau_c)}{(1-\tau_n)w\theta} \right]^{\frac{1}{1+\xi}} (1 - \tau_n)w\theta}
\]
The representative firm solves a standard problem

- Choose aggregate capital, $K$, and aggregate labor, $N$, to maximize $\pi$

$$\pi = K^\phi_G K^\alpha N^{1-\alpha} - wN - (r + \delta)K$$

Solving the problem yields standard marginal conditions:

- $r = \alpha K^\phi_G \left(\frac{K}{N}\right)^{\alpha-1} - \delta$

- $w = (1 - \alpha) K^\phi_G \left(\frac{K}{N}\right)^\alpha$
Government Problem

The government is assumed to do the following:

1. Invest in infrastructure, $K_G$
   \[ \delta_G K_G = x K_G^\phi K^\alpha N^{1-\alpha} \]

2. Provide unemployment benefits, $B$
   \[ B = \int_0^{\bar{a}} bf(a, \theta = 0) da \]

3. Engage in government consumption, $G$

The government is assumed to run a balanced budget

\[ B + \delta_G K_G + G = \tau_c C + \tau_n wN + \tau_a rK \]
Calibration

Model is calibrated to an annual frequency

- Parameter values taken from literature

Income shock process is calibrated using survey data from Mexico

- Mexico National Institute of Statistics and Geography (INEGI)
- National Survey of Occupation and Employment (ENOE)
- Survey 100,000 households in 48 metropolitan and rural areas in Mexico every year
Calibration

Table 1: Model Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.96</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.75</td>
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<tr>
<td>$\gamma$</td>
<td>-1.50</td>
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<tr>
<td>$\xi$</td>
<td>1.50</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.36</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.15</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.06</td>
</tr>
<tr>
<td>$\delta_G$</td>
<td>0.04</td>
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</tbody>
</table>

Table 2: Productivity Shock Process

<table>
<thead>
<tr>
<th>Shock</th>
<th>$\theta_1$</th>
<th>$\theta_2$</th>
<th>$\theta_3$</th>
<th>$\theta_4$</th>
<th>$\theta_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_1$:</td>
<td>0.200</td>
<td>0.800</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>$\theta_2$:</td>
<td>0.032</td>
<td>0.551</td>
<td>0.247</td>
<td>0.115</td>
<td>0.055</td>
</tr>
<tr>
<td>$\theta_3$:</td>
<td>0.032</td>
<td>0.240</td>
<td>0.397</td>
<td>0.244</td>
<td>0.087</td>
</tr>
<tr>
<td>$\theta_4$:</td>
<td>0.032</td>
<td>0.113</td>
<td>0.235</td>
<td>0.402</td>
<td>0.218</td>
</tr>
<tr>
<td>$\theta_5$:</td>
<td>0.032</td>
<td>0.056</td>
<td>0.085</td>
<td>0.207</td>
<td>0.620</td>
</tr>
</tbody>
</table>
### Average Growth Results

<table>
<thead>
<tr>
<th></th>
<th>With Utility Channel</th>
<th>Without Utility Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>$\Delta \tau_a$</td>
</tr>
<tr>
<td>$x$</td>
<td>0.020</td>
<td>0.050</td>
</tr>
<tr>
<td>$N$</td>
<td>0.325</td>
<td>0.508</td>
</tr>
<tr>
<td>$K_G$</td>
<td>0.287</td>
<td>1.593</td>
</tr>
<tr>
<td>$Y$</td>
<td>0.574</td>
<td>1.275</td>
</tr>
<tr>
<td>$C$</td>
<td>0.324</td>
<td>0.714</td>
</tr>
<tr>
<td>$w$</td>
<td>1.132</td>
<td>1.605</td>
</tr>
<tr>
<td>$r$</td>
<td>0.018</td>
<td>0.025</td>
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<tr>
<td>$\tau_a$</td>
<td>0.100</td>
<td>0.364</td>
</tr>
<tr>
<td>$\tau_c$</td>
<td>0.150</td>
<td>0.150</td>
</tr>
<tr>
<td>$\tau_n$</td>
<td>0.100</td>
<td>0.100</td>
</tr>
</tbody>
</table>
Distributional Results

Asset Densities: With Utility Channel

Asset Densities: Without Utility Channel

Asset Distributions: With Utility Channel

Asset Distributions: Without Utility Channel

Gibson and Rioja

How Investing in Infrastructure Affects the Distribution of Wealth
### Distributional Results

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Baseline</th>
<th>$\Delta \tau_a$</th>
<th>$\Delta \tau_n$</th>
<th>$\Delta \tau_c$</th>
<th>$\Delta D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wealth Gini</td>
<td>0.380</td>
<td>0.368</td>
<td>0.363</td>
<td>0.364</td>
<td>0.364</td>
</tr>
<tr>
<td>Quintile 1</td>
<td>3.95</td>
<td>4.44</td>
<td>4.52</td>
<td>4.50</td>
<td>4.50</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>10.36</td>
<td>10.93</td>
<td>11.14</td>
<td>11.09</td>
<td>11.05</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>17.71</td>
<td>17.72</td>
<td>17.77</td>
<td>17.80</td>
<td>17.86</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>26.54</td>
<td>25.88</td>
<td>26.01</td>
<td>25.93</td>
<td>25.88</td>
</tr>
<tr>
<td>Quintile 5</td>
<td>41.43</td>
<td>41.03</td>
<td>40.57</td>
<td>40.68</td>
<td>40.72</td>
</tr>
<tr>
<td>Quintile 5 / Quintile 1</td>
<td>10.48</td>
<td>9.24</td>
<td>8.98</td>
<td>9.04</td>
<td>9.06</td>
</tr>
</tbody>
</table>

### With Utility Channel

### Without Utility Channel
Investing in infrastructure can increase growth and reduce inequality

- Wealth share of lower quintiles increases
- Wealth share of higher quintiles falls

Choice of financing method does not matter much

- Interest income tax performs the worst

Distributional effects operate through utility channel

- Wealth distribution barely changes when utility channel is shut down