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

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Motivation

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

Literature

Infrastructure Investment and Growth:

- Empirical literature generally finds a positive effect of infrastructure on economic growth
  - Aschauer (1989), Bom and Lighthart (2009) and Romp and Den Haan (2007)
- Theoretical literature supports this finding
  - Barro (1990), Glomm and Ravikumar (1994) and Rioja (1999, 2003)

Common Consensus: Infrastructure increases growth

Literature

Infrastructure Investment and Inequality:

- Empirical literature finds mixed results:
  - Reduce Inequality: Calderon and Severn (2004), Calderon and Chong (2004)
  - Increase Inequality: Khanderker and Koolwal (2010) and Artadi and Sala-i-Martin (2004)
- Theoretical literature also finds mixed results:
  - No Effect: Glomm and Ravikumar (1994b)
  - Reduce Inequality: Ferreira (1995) and Klenert et al (2014)
  - 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

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

s.t.

$$(1+\tau_c)c + a' \leq \left\{ \begin{array}{ll} (1+(1-\tau_a)r)a + (1-\tau_n)wn\theta & \text{if employed} \\ (1+(1-\tau_a)r)a + b & \text{if unemployed} \end{array} \right\}$$

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

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.

$$(1+\tau_c)c + a' \leq \left\{ \begin{array}{ll} (1+(1-\tau_a)r)a + (1-\tau_n)wn\theta & \text{if employed} \\ (1+(1-\tau_a)r)a + b & \text{if unemployed} \end{array} \right\}$$

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

Solving this yields the following labor supply:

$$n = \frac{1+\tau_c + \left[\frac{\eta(1+\tau_c)}{(1-\tau_n)w\theta}\right]^{\frac{1}{1+\xi}} [g(a,\theta) - (1+(1-\tau_a)r)a]}{1+\tau_c + \left[\frac{\eta(1+\tau_c)}{(1-\tau_n)w\theta}\right]^{\frac{1}{1+\xi}} (1-\tau_n)w\theta}$$

Firm's Problem

The representative firm solves a standard problem

- Choose aggregate capital, K, and aggregate labor, N, to maximize π
- $\pi = K_G^{\phi} K^{\alpha} N^{1-\alpha} - wN - (r + \delta)K$

Solving the problem yields standard marginal conditions:

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

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

$\beta = 0.96$	$\eta = 0.75$	$\gamma = -1.50$	$\xi = 1.50$
$\alpha = 0.36$	$\phi = 0.15$	$\delta = 0.06$	$\delta_G = 0.04$

Table 2: Productivity Shock Process

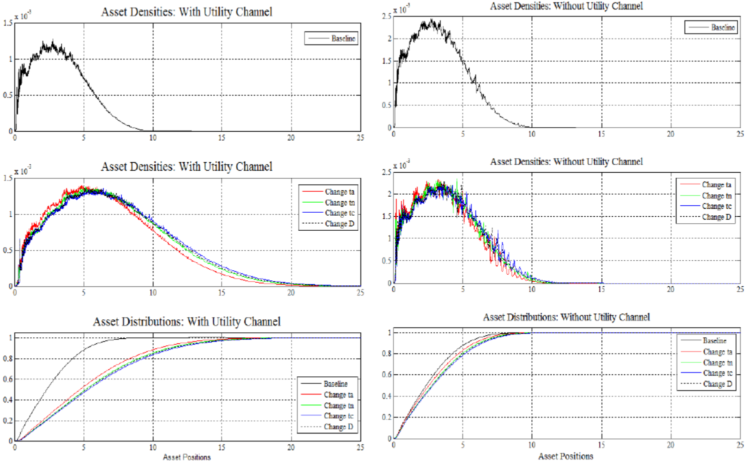
$\theta_1 = 0.000$	$\theta_2 = 0.331$	$\theta_3 = 0.588$	$\theta_4 = 0.878$	$\theta_5 = 2.203$

	θ_1	θ_2	θ_3	θ_4	θ_5
θ_1:	0.200	0.800	0.000	0.000	0.000
θ_2:	0.032	0.551	0.247	0.115	0.055
θ_3:	0.032	0.240	0.397	0.244	0.087
θ_4:	0.032	0.113	0.235	0.402	0.218
θ_5:	0.032	0.056	0.085	0.207	0.620

Average Growth Results

	With Utility Channel					Without Utility Channel				
	Baseline	$\Delta\tau_a$	$\Delta\tau_n$	$\Delta\tau_c$	ΔD	Baseline	$\Delta\tau_a$	$\Delta\tau_n$	$\Delta\tau_c$	ΔD
x	0.020	0.050	0.050	0.050	0.050	0.020	0.050	0.050	0.050	0.050
K	2.660	5.383	5.813	6.035	5.905	2.670	2.918	3.119	3.231	3.158
N	0.325	0.508	0.509	0.512	0.503	0.326	0.304	0.300	0.301	0.295
K_G	0.287	1.593	1.648	1.681	1.643	0.288	0.834	0.851	0.865	0.843
Y	0.574	1.275	1.318	1.345	1.314	0.576	0.667	0.681	0.692	0.675
C	0.324	0.714	0.724	0.732	0.752	0.326	0.367	0.366	0.368	0.380
w	1.132	1.605	1.658	1.682	1.674	1.133	1.407	1.451	1.472	1.465
r	0.018	0.025	0.022	0.020	0.020	0.018	0.022	0.019	0.017	0.017
τ_a	0.100	0.364	0.100	0.100	0.100	0.100	0.414	0.100	0.100	0.100
τ_c	0.150	0.150	0.150	0.209	0.150	0.150	0.150	0.150	0.216	0.150
τ_n	0.100	0.100	0.148	0.100	0.100	0.100	0.100	0.153	0.100	0.100

Distributional Results



Distributional Results

	With Utility Channel					Without Utility Channel				
	Baseline	$\Delta\tau_a$	$\Delta\tau_n$	$\Delta\tau_c$	ΔD	Baseline	$\Delta\tau_a$	$\Delta\tau_n$	$\Delta\tau_c$	ΔD
Wealth Gini	0.380	0.368	0.363	0.364	0.364	0.386	0.393	0.385	0.388	0.388
Quintile 1	3.95	4.44	4.52	4.50	4.50	3.94	3.79	3.89	3.84	3.81
Quintile 2	10.36	10.93	11.14	11.09	11.05	10.50	10.16	10.47	10.34	10.25
Quintile 3	17.71	17.72	17.77	17.80	17.86	17.70	17.65	17.91	17.72	17.85
Quintile 4	26.54	25.88	26.01	25.93	25.88	26.48	26.48	26.66	26.54	26.72
Quintile 5	41.43	41.03	40.57	40.68	40.72	41.37	41.91	41.06	41.56	41.37
$\frac{\text{Quintile 5}}{\text{Quintile 1}}$	10.48	9.24	8.98	9.04	9.06	10.50	11.06	10.56	10.81	10.85

Conclusions

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