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The Macroeconomic Effects of Infrastructure Financing: A Tale of two countries

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Objectives

• Compare and contrast the experiences of PRC and India in financing infrastructure investment
• Quantify the macroeconomic impacts of public infrastructure investment
• Focus on the different modes of financing
### Infrastructure Financing in India & PRC

<table>
<thead>
<tr>
<th></th>
<th>PRC</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decentralized revenue raising</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Decentralized expenditure authority</td>
<td>Yes</td>
<td>In transition</td>
</tr>
<tr>
<td>Adequate retention of user fees</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Private sector involvement</td>
<td>Very little</td>
<td>Very little</td>
</tr>
<tr>
<td>Foreign investment allowed/encouraged</td>
<td>Yes, but difficult</td>
<td>Somewhat</td>
</tr>
</tbody>
</table>
The Model

  - 72 generations with uncertain life expectancy
  - Include public infrastructure as a factor of private production
  - Explicitly specified international trade in goods and services
Production sector

- Cobb-Douglas function
  - Decreasing returns to private inputs
  - An economic profit is distributed to the private firm.
- Age-specific labor productivity
- Convex adjustment costs of investment
- Maximize the present value of firm
  - Tobin’s $q$-type of investment behavior
Households sector

- 72 generations
  - corresponding to adult ages 18-89
- Intertemporal utility maximization
- CRRA within-period utility function
- Endogenous labor supply - labor-leisure choice
- Exogenous death possibility
- No annuity market
  - accident bequests are distributed as lump-sum transfers
Government

- Collect taxes, purchase goods and services, make investment and issue debt
- Provide infrastructure to firms
- Face no-Ponzi-game constraint

\[
\lim_{T \to \infty} \left( \frac{D_T}{\prod_{t=1}^{T} (1 + r_t)} \right) \leq 0
\]

- In the long run, government debt/GDP ratio is fixed, and tax rates or lump-sum transfer are endogenous to balance the budget constraint.
Foreign sector

- Following Armington structure to model international trade
- Exports in each region are demanded according to constant-elasticity demand curves
- Closed capital account
  - Net foreign capital flow is exogenous and it satisfies no-Ponzi-game constraint.
Dynamic Equilibrium

- All commodity and factor markets clear
- The first order conditions of households and firm’s decision problem are satisfied.

- The model is implemented in GAMS
- Assuming to reach steady state in 250 years
- Solving over 150K equations simultaneously

\[ r_t = (1 - \tau) \frac{\mathcal{F}(K_t, L_t, X_t)}{K_t} \]
Calibration

- Non-steady dynamic calibration
  - Assuming the economy in base year is a temporal equilibrium along a dynamic adjustment path
- Base year
  - PRC 2002
  - India 2003-4
## Calibration

### Extraneously specified parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PRC</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1/\gamma$ Intertemporal elasticity of substitution</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>$\rho$ Elas. of subs. between consumption and leisure</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>$1-\kappa-\theta$ Share parameter of public capital in production</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>$\sigma$ Elas. of subs. between imports and domestic goods</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>$\sigma^e$ Price elasticity of export demand</td>
<td>-6.00</td>
<td>-6.00</td>
</tr>
<tr>
<td>$\psi$ Capital adjustment cost parameter</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>$\delta$ Depreciation rate</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>$g$ Long-term growth rate of effective labor</td>
<td>0.025</td>
<td>0.025</td>
</tr>
</tbody>
</table>

### Endogenously calibrated parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PRC</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(1-\beta)/\beta$ Long-term time preference rate</td>
<td>-0.048</td>
<td>-0.045</td>
</tr>
<tr>
<td>Base year time preference rate</td>
<td>-0.107</td>
<td>-0.045</td>
</tr>
<tr>
<td>$\alpha$ Utility weight on leisure</td>
<td>1.83</td>
<td>2.57</td>
</tr>
<tr>
<td>$\kappa$ Private capital share parameter in production</td>
<td>0.355</td>
<td>0.38</td>
</tr>
<tr>
<td>$\theta$ Labor share parameter in production</td>
<td>0.575</td>
<td>0.55</td>
</tr>
<tr>
<td>$\tau_n$ Labor income tax rate (%)</td>
<td>1.8</td>
<td>2.7</td>
</tr>
<tr>
<td>$\tau_k$ Corporate income tax rate (%)</td>
<td>18.8</td>
<td>20.2</td>
</tr>
<tr>
<td>$\tau_c$ Consumption tax rate (%)</td>
<td>41.5</td>
<td>11.0</td>
</tr>
</tbody>
</table>
Policy Experiments

- Double the public investment in infrastructure
  - PRC: 2.55% -> 5.1%
  - India: 2.35% -> 4.7%

- Alternative financing modes
  - Consumption tax
  - Labor income tax
  - Use debt to finance additional investment for 10 years, then use consumption tax
Effects on Output - PRC (% change from baseline)

- Public infrastructure are important to long-term output
- The mode of financing does matter
Effects on Private Investment - PRC
(% change from baseline)

- Crowd out private investment initially
- But stimulate private investment in the long run
- Long run investment rises most under consumption tax financing mode
• Consumption tax financing redistributes wealth from the old to young, increasing total saving and restraining the rise of long term interest rate.

• Debt financing crowds out private investment initially, leading to higher long term interest rate.
Effects on Consumption - PRC (% change from baseline)

- Income effect associated with tax financing – reduce consumption initially
- Intertemporal subs. effect arising from higher interest rate - reduce consumption initially
- Intertemporal subs. effect arising from higher future price – increase consumption initially
Effects on Labor Supply - PRC (% change from baseline)

- Intratemporal subs. effects from higher tax reduce work efforts
- Under debt financing, intertemporal subs. effect dominates at the initial stage
Intergenerational Distribution Effects – PRC (EV as % lifetime wealth)

- Consumption tax financing redistributes the lifetime wealth from the older to younger generations

Years entering the adulthood before the base year
Is India different?

- The simulations for India show similar patterns about the effects of public infrastructure investment and the implications of alternative financing modes.
- But quantitative differences between the two countries’ results reveal their different underlying economic structure.
Steady state effects - India v.s. PRC (% change from the baseline)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption tax</td>
<td>7.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Labor income tax</td>
<td>6.9</td>
<td>7.0</td>
</tr>
<tr>
<td>Debt</td>
<td>6.2</td>
<td>5.8</td>
</tr>
<tr>
<td><strong>Consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption tax</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Labor income tax</td>
<td>3.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Debt</td>
<td>3.2</td>
<td>3.3</td>
</tr>
</tbody>
</table>
The long term gains are generally bigger in India

- Smaller infrastructure stock and public infrastructure investment
  - Doubling investment requires less resources
- Lower investment to GDP ratio
  - Lower capital adjustment costs
- Lower saving rate
  - Similar increases in interest rate lead to larger increase in saving in India.
But debt financing is more costly for India

- Higher government debt in India results in stronger initial crowding-out effects on private investment
- Higher debt ratio translates into higher consumption tax rate in the long run, which discourages labor supply
Conclusions

• Public infrastructure plays an important role in long term output and investment.
• But its effects depend on the particular financing mode of public infrastructure investment.
Conclusions

• Consumption tax financing is the best option in terms of prompting long term output growth, but it involves larger short term costs for existing older generations.

• Debt financing is favorable for intergenerational equality, but may have undesirable long term effects.
Conclusions

• In general, India can benefit more from public infrastructure investment given its relative scarcity of public infrastructure.
• Its high existing stock of government debt renders debt financing the least attractive.
Limitations

- Key parameters
- Public-private partnerships
- Debt and taxation policies