Quality Ladders, Competition, Growth and Misallocation

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Democracy and Growth
Limited Experience with Stable Democratic Institutions

- US, UK, Canada, Australia, New Zealand: 100 years ("universal suffrage" 1918-28)
- Western Europe, Japan, India: 70 years

Growth in India versus China, versus catastrophes in India and China

Role of ideology?

Post WWII was particularly bad: ideas such as socialism, central planning, government control of industry, trade protectionism, stimulus spending were fashionable everywhere
Purpose of the Talk

What can endogenous growth theory tell us about:

1. Catch up?
2. Static frictions such as misallocation?
Consumption Sector

utility of the representative consumer

\[ U = \int_0^\infty e^{-\rho t} \log c_t \, dt \]

subjective interest rate \( \rho \)

quality ladder:

good of different qualities \( j = 1, 2, \ldots, \infty \), consumption of \( j \) is \( d_j \)

constant increase \( \lambda > 1 \) in quality as we move one step up the ladder

aggregate consumption is \( c_t = \sum_j \lambda^j d_{jt} \)
Grossman-Helpman Production Ladder

- one unit of output of each quality requires one unit of labor to obtain
- first firm to reach step $j$ on the quality ladder achieves a short-term monopoly over that technology.
- monopoly ends with new innovation $j+1$ at which time all firms have access to technology $j$
- hence limit pricing: price of $j+1$ relative to $j$ is $p = \lambda$
- intensity of R&D for a firm is denoted by $\tilde{i}$,
- probability of next step during a period of length $dt$ is $\tilde{\alpha} dt$ at a cost of $\tilde{i}a_idt$
- endowment: $L$ units of labor
Steady State Research Intensity

\[ t = \frac{(1 - 1/\lambda)L}{a_I} - \frac{\rho}{\lambda} \]

socially optimal research intensity

\[ t^* = \frac{L}{a_I} - \frac{\rho}{\log \lambda} \]

(Perhaps there are institutions that are more efficient than short-term monopoly)
Boldrin Levine Production Ladder

• consumption is produced both from labor and knowledge capital
• available knowledge capital of type \( j \) is \( k_j \)
• knowledge capital has three uses:
  
  produce consumption: one unit of knowledge capital and labor per unit of consumption

  generate more knowledge capital
    
    more of the same quality: at rate \( b > \rho \) (widening)
    
    higher quality (innovation): conversion rate \( a > \lambda \) (deepening)
Capital Dynamics

capital allocated to three uses: $k_j^w$, $k_j^d$, and $k_j^c$

resource constraint $k_{j,t} = k_{j,t}^w + k_{j,t}^d + k_{j,t}^c$

motion

$$\dot{k}_j = bk_j^w + \frac{k_{j-1}^d}{a} - k_j^d$$

also allow discrete of capital to the next run on the ladder

(i) $a > \lambda$ makes deepening costly

(ii) $b > \rho$ makes widening profitable

• ordinary diminishing return economy satisfying first and second welfare theorems
Steady State Cycle and Research Intensity

alternation between build-up and growth phases

build-up: consumption is constant, only one type of capital used to produce consumption

length \( \tau^b = (\log a - \log \lambda) / (b - \rho) \)

growth phase: consumption grows at constant rate \( b - \rho \), capital shifted from \( j \) to \( j + 1 \)

length \( \tau^g = \log \lambda / (b - \rho) \)

total length of cycle is \( \tau^* = \log a / (b - \rho) \)

research intensity

\[
\frac{1}{\tau^*} = j^* = \frac{b - \rho}{\log a}.
\]
Rationale

• capital prices determined by arbitrage (utility units)
capital gains equals growth rate of capital minus subjective interest rate
so prices must fall at rate $b - \rho$
and over $\tau^*$ must fall back to the level of the previous vintage, i.e. must fall by $1/a$

hence: $\tau^* = \log a/(b - \rho)$

• during growth phase consumption growth
standard investment model, grows at rate $b - \rho$
over $\tau^g$ must grow by $\lambda$

hence: $\tau^g = \log \lambda/(b - \rho)$
DRAM Output
Overview of Models

Grossman Helpman: \[ \nu = \frac{(1 - 1/\lambda) L}{a_I} - \frac{\rho}{\lambda}. \]

Grossman Helpman efficient: \[ \nu^* = \frac{L}{a_I} - \frac{\rho}{\log \lambda}. \]

Boldrin-Levine: \[ j^* = \frac{b - \rho}{\log a}. \]

multiply by \( \log \lambda \) to get growth rate of consumption
Common Features: Endogenous Growth

subjective interest rate $\rho$: more patience more innovation and growth

cost of innovation $a, a_I$: more costly less innovation and growth
Neutrality and Non-Neutrality

• in Grossman Helpman (either version) $L$ and $\lambda$ both increase innovation

$L$ (size of economy) bigger market, cost of innovation spread more widely

[not much evidence for this]

$\lambda$ bigger greater benefit of innovation

• in Boldrin Levine $L$ and $\lambda$ are neutral for innovation

[but could modify the model so that $\lambda$ depends on size of economy]
Playing Catch Up

easier to climb the ladder: smaller $a, a_I$

in Grossman Helpman no real limit to how fast you can climb

in Boldrin Levine as $a \to \lambda$ length of build-up goes to zero, but length of growth phase does not

research intensity approaches

$$j^* = \frac{b - \rho}{\log \lambda}.$$
**Static Misallocation**

not obvious how to model this in Grossman Helpman framework

in Boldrin Levine natural to interpret it as smaller value of \( b \)
cannot increase existing capital stock so quickly as so much of it tied up in inefficient operations
Growth of Consumption

\[ \frac{\log \lambda}{\log a} (b - \rho) \]

- catchup/research efficiency \( \log \lambda / \log a \)
- misallocation/education \( b \)
- patience/savings/demographics \( \rho \)
**Growth, Savings and Demographics**

<table>
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<th></th>
<th>Growth</th>
<th>Population</th>
<th>Net Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>6.9%</td>
<td>0.6%</td>
<td>24.8%</td>
</tr>
<tr>
<td>India</td>
<td>3.7%</td>
<td>1.1%</td>
<td>18.1%</td>
</tr>
<tr>
<td>Italy</td>
<td>1.5%</td>
<td>-0.1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>USA</td>
<td>2.3%</td>
<td>0.7%</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

Source: World Bank

Net Savings 2016; Growth and Population 2017