Imitation as a Stepping Stone to Innovation

Amy Jocelyn Glass
Texas A&M University
Shift from Imitation to Innovation

- Countries such as Korea, China, and Taiwan shifting from imitation to innovation.
- Product cycle literature examines effects of North-South trade on innovation.
- Existing work does not consider innovation in the South where only imitate.
- Goal to model both imitation and innovation in the developing South.
Southern High-tech Exports

• High-tech exports in 2007
  – Many countries have higher percentage of exports that are high-tech than US:
    • Philippines 53.6%, Malaysia 51.7%, Singapore 46.5%, Taiwan 44.7%, Korea 33.5%, China 29.7%, US 28.4% … Japan 19.8% (rank 17).
  – China’s high-tech exports larger than US or Japan’s (roughly equals those two combined)
    • China $337b, US $229b, Germany $156b, Japan $121b, Singapore $105.5b, Taiwan 94.0 billion.
  – *World Competitiveness Yearbook* (2009)
Southern R&D Increasing

• R&D expenditure growing
  – US $368.8b, Japan $148.4b, Germany $83.8b, France $53.9b, China $48.8b (up from $12.6 in 2001), UK $42.7b, Korea $28.6b (up from $12.5 in 2001), Canada $26.9b, … Taiwan $10.1 billion (rank 17) in 2007.
  – Israel 4.7% of GDP, Sweden 3.5%, Finland 3.6%, Japan 3.4%, Korea 3.0%, Switzerland 2.9%, US 2.7%, Taiwan 2.6% … Singapore 2.3% (rank 12) … China 1.5% (rank 23).
Southern R&D Yields Patents

• Average number of patents granted to residents per year 2005-2007:
  – Japan 127,644, US 81,329, Korea 78,122 (up from 34,052 over 1998-2000), Taiwan 36,772 (up from 20,094), China 25,909 (up from 3,742).
Questions About Southern Innovation

• Need a model in which Southern firms innovate (as well as imitate) to ask:
  • What determines how much innovation occurs in the South?
    – How can the South increase its innovation?
    – Can general Southern R&D subsidy promote innovation?
  • How do conditions affecting Southern R&D (such as resources and subsidies) influence how much innovation occurs in the North?
    – Does Southern innovation necessarily crowd out Northern innovation?
    – What happens to aggregate innovation?
    – How do results differ from case where no innovation in the South?
Quality Ladders Model

- Continuum of products.
- Consumers buy highest quality level of each, evenly spread spending across time & products.
- Southern firms imitate.
  - Northern firms do not imitate because they lack the production cost advantage that supports imitation by Southern firms.
- Northern firms innovate.
  - Initially no Southern innovation so like standard model.
Add Basic Southern Innovation

• As South develops, becomes able to innovate after imitation in some industries.
  – Imitation generates knowledge base that makes Southern innovation easier.
  – Fraction of industries where the South innovates after imitation increases with development.
Eventually South becomes able to innovate immediately after Northern innovation in some industries.

– Fraction of industries where South can innovate immediately also increases with development.
– When finally can innovate immediately in all industries, South is like the North.
Southern Innovation Condition

• Following imitation, let the fraction $\theta$ of industries have a low labor requirement in Southern innovation $a_S$ and the rest $A_S > a_S$.
  – Industries with the low requirement will try to innovate, while the rest will not.

• Southern innovation condition equates the cost of innovation to the expected reward in terms of profit stream in industries where Southern innovation.

\[
a_S = v_S = \frac{\pi_S}{\rho + I_N + I_S}
\]
Imitation Condition

- Southern imitation condition equates the cost of imitation to the expected reward.
- Reward is weighted average of reward when exposed to only Northern innovation and the reward when face both Northern and Southern innovation.

\[ a_M = v_M = \frac{\theta \pi_M}{\rho + I_N + I_S} + \frac{(1 - \theta) \pi_M}{\rho + I_N} \]

- \( \theta = 0 \) is special case with no Southern innovation.
Northern Innovation Condition

- Following Northern innovation, let the fraction $\Theta$ of industries have a low labor requirement in Southern innovation $a_S$ and the rest $A_S > a_S$.
- Northern innovation condition equates the cost of imitation to the expected reward, a weighted average of reward when exposed to only imitation & Northern innovation and the reward when also face Southern innovation.

$$w a_N = v_N = \frac{\Theta \pi_N}{\rho + \mu_M + I_N + I_S} + \frac{(1 - \Theta)\pi_N}{\rho + \mu_M + I_N}$$

- Special cases: $\theta = 1, \Theta = 0$ all Southern innovation awaits imitation; $\theta = \Theta = 1$ all Southern innovation immediate.
Labor Constraints

- Northern labor split between innovation & production.
- Southern labor split between imitation, innovation, and production.

\[ a_M \mu_M n_S + a_S I_S (\Theta n_N + \Theta n_M + n_S) + E \left( \frac{n_M}{W} + \frac{n_S}{\lambda} \right) = L_S \]

- Special case when no Southern innovation:

\[ a_M \mu_M n_S + E \left( \frac{n_M}{W} \right) = L_S \]
## Results With Southern Innovation

<table>
<thead>
<tr>
<th></th>
<th>Northern innovation</th>
<th>Southern innovation</th>
<th>Imitation</th>
<th>Southern innovation /imitation</th>
<th>agg inn</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_N$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
</tr>
<tr>
<td>$L_S$</td>
<td>$0$</td>
<td>$+$</td>
<td>$+/0$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>$\sigma_N$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+/-$</td>
</tr>
<tr>
<td>$\sigma_S$</td>
<td>$0$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
</tbody>
</table>
Notable Results and Contrast

• Rate of Northern innovation essentially *unaffected* by Southern labor or general Southern R&D subsidy but
  – *rises* when no Southern innovation

• Rate of imitation *falls* with general Southern R&D subsidy but
  – *rises* when no Southern innovation
Notable Results and Contrast

- Rate of imitation **rises** with more Southern labor when Southern innovation follows imitation (and when no Southern innovation) but
  - **unaffected** when Southern innovation unrestricted

- Aggregate rate of innovation (Northern plus Southern) **rises** with Northern R&D subsidy when Southern innovation follows imitation (and when no Southern innovation) but
  - **falls** when Southern innovation unrestricted
Answers

• Southern resources and R&D subsidies increase Southern innovation – in absolute terms and relative to imitation.
  – Both imitation* and Southern innovation increase with more Southern labor; Southern innovation increases and imitation decreases with a general Southern R&D subsidy (to both innovation and imitation).
  – *Whether innovation needs imitation as a stepping stone could matter for whether more Southern resources boost the rate of imitation.
  – Boost in Southern innovation has little impact on Northern innovation.

• Northern resources and R&D subsidies increase imitation and Northern innovation and decrease Southern innovation, with total innovation increased
  – Except that a Northern R&D subsidy can damage total innovation if all Southern innovation is unrestricted (all industries can innovate without needing imitation first).
Conclusion

• Novel product cycle model
• South innovates and imitates
• Industries heterogeneous: in some
  – can innovate in the South easily,
  – need imitation to make innovation easy enough,
  – or too hard to innovate even after imitation
• Fractions exogenous but likely increase as South develops so that eventually can innovate in all industries like the North.