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.

Then Advanced Southern Innovation

- 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.
  \[ w\Theta = v_N = \frac{\Theta \pi_N}{\rho + I_M + I_N + I_S} + \frac{(1-\Theta)\pi_N}{\rho + I_M + I_N} \]
- 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.

\[ a_M \mu_M n_S + a_M \left( \theta n_N + \theta n_M + n_L \right) + E \left( \frac{n_M}{w} + \frac{n_S}{\lambda} \right) = L_S \]

– 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

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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

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.