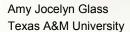
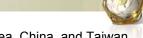
Imitation as a Stepping Stone to Innovation







- 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 θ 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.

$$a_M = V_M = \frac{\theta \pi_M}{\rho + I_N + I_S} + \frac{(1 - \theta)\pi_M}{\rho + I_N}$$

• θ = 0 is special case with no Southern innovation.

Northern Innovation Condition



- Following Northern innovation, let the fraction Θ 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.

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

 Special cases: θ = 1, Θ = 0 all Southern innovation awaits imitation; θ = Θ = 1 all Southern innovation immediate.

Labor Constraints



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

$$a_{M}\mu_{M}n_{S} + a_{S}I_{S}\left(\Theta n_{N} + \theta n_{M} + n_{S}\right) + E\left(\frac{n_{M}}{w} + \frac{n_{S}}{\lambda}\right) = L_{S}$$

- 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



	Northern innovation	Southern innovation	Imitation	Southern innovation /imitation	agg inn
L _N	+	_	+	-	+
Ls	0	+	+/0	+	+
σ_N	+	_	+	-	+/-
$\sigma_{\scriptscriptstyle S}$	0	+	-	+	+

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.