

Technological Change in East Asia

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Outline

- ▶ An overview of technological change in East Asia
- ▶ Knowledge diffusion in East Asia and beyond
- ▶ China's patent explosion

R&D expenditure in East Asia

	R&D/GDP (%)	
	1995	2002-05
Japan	2.98	3.19
Korea	2.68	2.99
Taiwan	1.81	2.45
Singapore	1.10	2.36
Hong Kong	0.30	0.74
<i>China coast</i>	0.93	1.59
All China	0.60	1.34
Malaysia	0.20	0.63
Thailand	0.10	0.25
Phillipines	0.70	0.30
Indonesia	0.10	0.50
India	0.50	0.61
OECD average	2.07	2.25

Source: Hu and Jefferson (2007)

East Asia's USPTO patent grants

	Number of Patents		Patents per 100000 People		
	1990-04	2000-04	1990-04	2000-04	Change
Hong Kong	184	616	3.15	9.32	11.4
Korea	633	4,009	1.44	8.67	19.7
Singapore	36	382	1.09	9.87	24.6
Taiwan	1,307	6,593	6.3	30.17	17
Indonesia	6	15	0	0.01	8.8
Malaysia	13	64	0.07	0.28	15.3
Philippines	6	18	0.01	0.02	10.4
Thailand	6	43	0.01	0.07	20.9
China	48	368	0	0.03	22.9
Latin America (11)	173	368	0.04	0.08	6.3
Emerging Europe (9)	205	348	0.07	0.12	5.6
Developed (21)	104,170	168,017	12.88	19.58	4.3
Japan	22,647	35,687	18.23	28.54	4.6
USA	59,024	97,104	23	33.56	3.9

Source: Brahmabhatt and Hu (2007)

Technology Achievement Index: UNDP (2001)

1. Technology Creation Index

- ▶ Patents granted by USPTO / million people, avg 2001-05
- ▶ Royalty and license fees receipts (US\$/pop.), 2004

2. Diffusion of Recent Innovations Index

- ▶ Internet users per 1000 People, 2004
- ▶ High-tech exports as % of manufacturing exports, 2004

3. Diffusion of Old Innovations Index

- ▶ Total telephones per 1,000 people, 2004
- ▶ Electricity consumption (kWh per capita), 2004

4. Human Skills Index

- ▶ Researchers in R&D / million people, 2004
- ▶ Adult literacy rate (% age 15 and above), 2004

Technology Achievement Index and its components

Rank	Technology achievement index		Component indices Technology creation index	
	1	Japan	0.888	Japan
2	Taiwan	0.815	Taiwan	0.553
3	Singapore	0.743	Singapore	0.382
4	Korea	0.701	Korea	0.302
5	Hong Kong	0.598	Hong Kong	0.285
6	<i>China coast</i>	0.385	Malaysia	0.012
7	Malaysia	0.339	Indonesia	0.004
8	Thailand	0.303	Thailand	0.002
9	All China	0.292	<i>China coast</i>	0.002
10	Phillipines	0.238	All China	0.001
11	Indonesia	0.175	Phillipines	0.001
12	India	0.002	India	0.000

Source: Hu and Jefferson (2007)

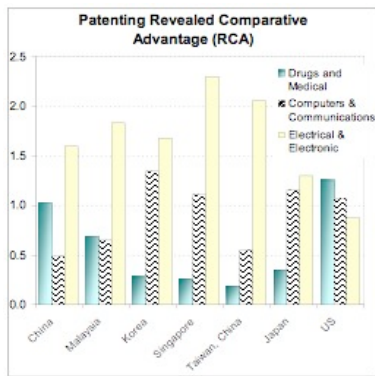
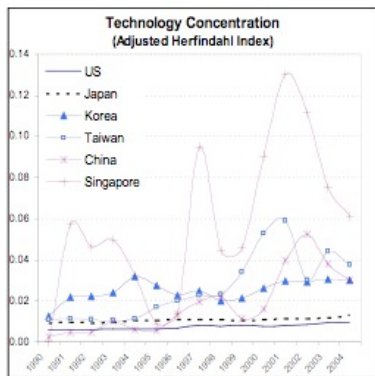
Technology Achievement Index and its components (continued)

		Component indices			
Diffusion of recent innovations index		Diffusion of old innovations index		Human skills index	
Taiwan	0.905	Taiwan	0.987	Japan	1.000
Korea	0.865	Singapore	0.916	Singapore	0.876
Singapore	0.797	Japan	0.887	Taiwan	0.817
Hong Kong	0.734	Korea	0.864	Korea	0.773
Japan	0.690	Hong Kong	0.811	Hong Kong	0.561
<i>China coast</i>	0.494	<i>China coast</i>	0.534	<i>China coast</i>	0.508
Malaysia	0.438	Malaysia	0.525	All China	0.446
Thailand	0.393	Thailand	.389	Thailand	0.428
All China	0.358	All China	0.361	Phillipines	0.405
Phillipines	0.263	Phillipines	0.283	Indonesia	0.392
Indonesia	0.174	Indonesia	0.130	Malaysia	0.379
India	0.000	India	0.000	India	0.007

Asian Technology Ladder

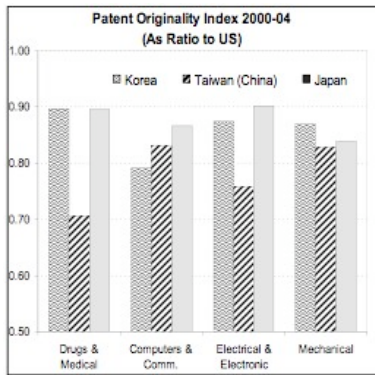
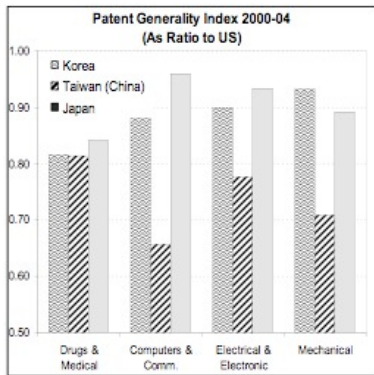
- ▶ Technology growth poles: Northeast Asian economies of Japan, Taiwan, Korea and to some extent, Singapore
- ▶ Followers: Southeast Asian five, interior China, India
- ▶ China's coast is moving ahead of Malaysia and Thailand

What Does East Asia Patent?



Source: Brahmahtt and Hu (2007)

How good are East Asian patents?

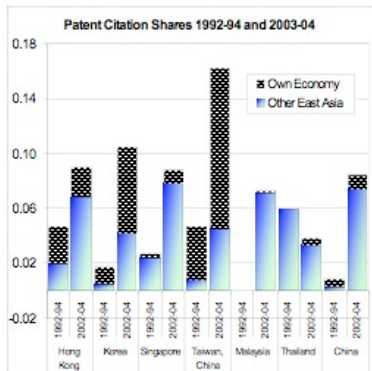
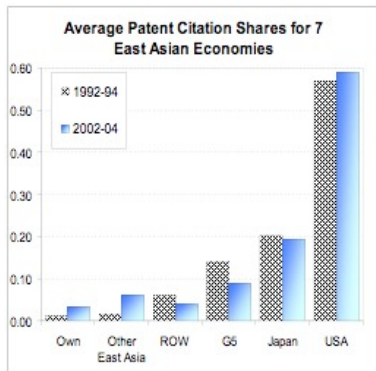


Source: Brahmahtt and Hu (2007)

Patent citations as a measure of technological innovation

- ▶ Citations delimit property rights of a patent
- ▶ Noisy measure of knowledge flow
 - ▶ Patent examiners may insert citations
 - ▶ Only citations to U.S.P.T.O. patents
 - ▶ excluding journal publications and other patent office patents
- ▶ Correlation between patent citations and knowledge flow
 - ▶ Trajtenberg(1990) and Jaffe et al (2000)

East Asia's sources of knowledge



Source: Brahmahtt and Hu (2007)

Citation Frequencies: Country-Pair Fixed Effects

<i>Citing Economies</i>	<i>Cited economies</i>			
	USA	Japan	Korea	Taiwan (China)
USA	1.00	0.57	0.38	0.29
Japan	0.46	0.80	0.44	0.23
Korea	0.46	0.70	1.16	0.69
Taiwan (China)	0.26	0.25	0.71	0.83
China	0.36	0.31	0.44	0.41
Hong Kong	0.45	0.41	0.42	0.40
Malaysia	0.44	0.32	0.53	0.57
Singapore	0.95	0.60	0.93	1.63
Thailand	0.66	0.33	0.27	0.10

Source: Brahmhatt and Hu (2007)

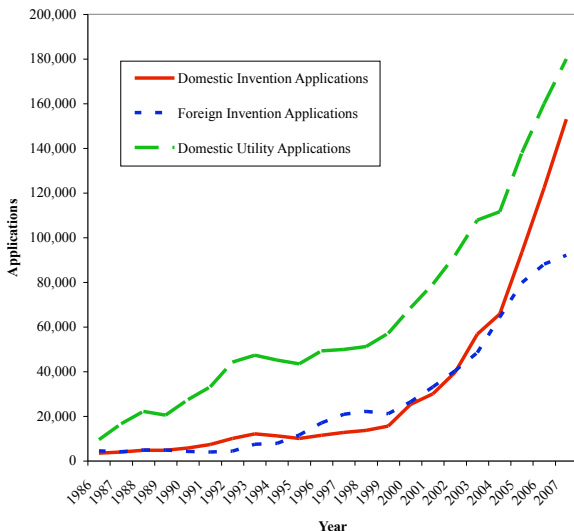
Knowledge diffusion in East Asia: summary

- ▶ USA and Japan remain the major sources of knowledge diffusion to East Asian economies
- ▶ Increasing regionalization of knowledge diffusion: Korea and Taiwan as sources of knowledge diffusion
- ▶ Patterns allude to roles of foreign direct investment, international trade and migration of talents

Multinational corporations, affiliate R&D and knowledge diffusion: case of Singapore (Hu, 2004)

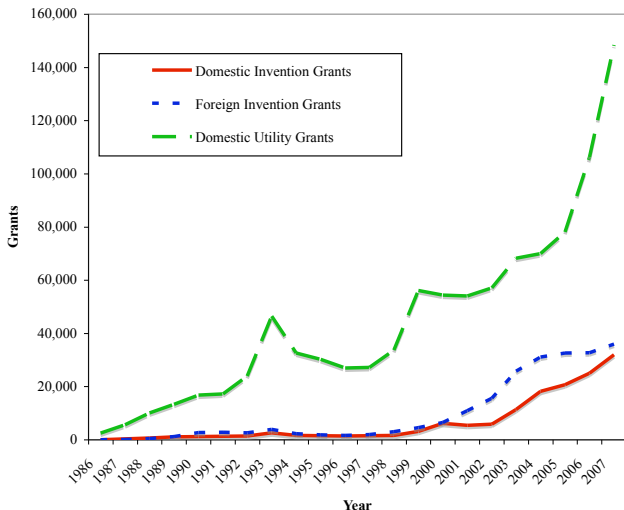
- ▶ Large presence of multinational corporations (MNCs): over 80% of manufacturing sales
- ▶ R&D performed by MNCs: 60% of corporate R&D
- ▶ Does MNC R&D facilitate knowledge diffusion to local, indigenous companies?
 - ▶ USPTO patents and patent citations data
 - ▶ Local Singapore inventors cite patents of MNCs with subsidiaries in Singapore disproportionately more
 - ▶ The likelihood of citing these MNCs' patents increases with their R&D in Singapore.

China's patent explosion: patent applications



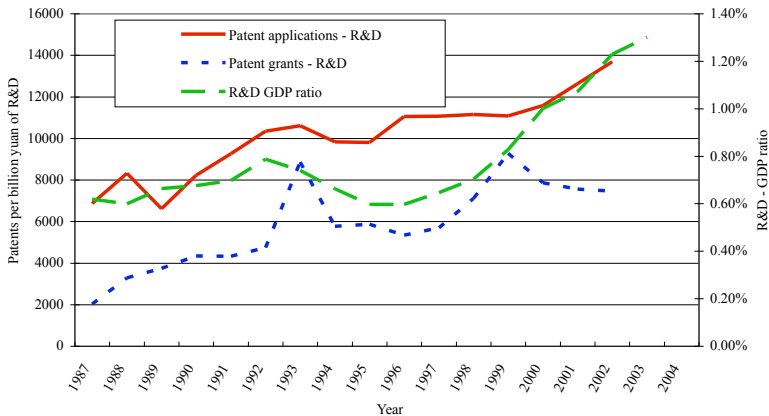
Source: China's State Intellectual Property Rights Office

China's patent explosion: patent grants



Source: China's State Intellectual Property Rights Office

R&D Intensification and Patents-R&D Ratios



Source: Hu and Jefferson (2008)

What Accounts for China's Patent Explosion?

- ▶ Propensity to patent vs. productivity of R&D
- ▶ Hu and Jefferson (2008)
 - ▶ Estimate a patents production function using firm-level data
 - ▶ Low patents - R&D elasticity: 0.07–0.3 vs. OECD: 0.61–0.99
 - ▶ The patents-R&D link much weaker in foreign invested firms
 - ▶ However, industry FDI explains the patent explosion as much as R&D does.
 - ▶ Large differences in propensity to patent across ownership groups
 - ▶ Significantly higher propensity to patent after 2000: China's patent reform and WTO entry

What Accounts for China's Foreign Patent Explosion?

- ▶ Why do foreign inventors seek out Chinese patents?
- ▶ Hu (2007)
 - ▶ Chinese patent office patent data and bilateral trade data matched at the three-digit ISIC level
 - ▶ Significant, positive effect of competition between foreign companies in the Chinese market on their Chinese patent applications
 - ▶ Foreign patenting also correlated with domestic Chinese invention patents but not with utility model patents

Concluding Remarks

- ▶ Rapid but uneven technological change in East Asia
- ▶ Significant role of technology diffusion in the process
- ▶ Increasing incidence of knowledge diffusion within East Asia
- ▶ FDI and trade have been agents of technology diffusion.
- ▶ Patents and patent citations data provide a unique window to look into this process.
- ▶ Our understanding is still coarse and incomplete; much remains to be done.

References

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