East and Southeast Asian countries experience with Patenting and technology development in the Integrated Circuits Industry

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1. Introduction

- Comparing technology policies of different countries is never easy.
- The economic importance of patenting is a function of industry type, the level of development and trade structure of the firm.
- Although the evidence is not as convincing as in pharmaceuticals, patent filing in the integrated circuit (IC) has been strong.
- The need for patenting increases as firms move closer to the technology frontier. National firms
- China's multi-path approach differs significantly from policies of smaller East and Southeast Asian economies
- Some countries have explicit technology policy with strong government support – e.g. Singapore and Malaysia.
- Some countries have ad hoc technology-related policy instruments – e.g. Thailand, Indonesia, Philippines and Viet Nam.
- Some countries have no clear policy blueprint on technology promotion – e.g. Brunei, Cambodia, Laos and Myanmar.
- Japan, Korea and Taiwan province of China have enjoyed most pronounced development of patenting in the US in ICs among the East and Southeast Asian national firms. Given its earlier development, this presentation excludes Japan.

2. Policy Types

- Sectoral technology promotion policies – on the basis of existing endowments or based on strategic policy decisions drove technological catch up in ICs in Korea and Taiwan province of China. Both economies have enjoyed strong patent take up in the US.
- China has a multi-path approach that varies from national funding of technology ventures (especially in high tech clusters) to county and province driven initiatives (e.g. button cluster in Qiaotou) or the EPZ framework of Shenzen.
- Singapore has matured from EPZ framework to leveraging framework to drive technological upgrading to level 4 activities. Foreign MNCs enjoy grants for upgrading.
- Malaysia has both the EPZ framework and efforts to finance technological upgrading.
- General guidelines for technology promotion without any strategic emphasis (Indonesia, Thailand, Philippines and Viet Nam). EPZ framework.
- No serious emphasis (Brunei, Cambodia, Laos and Myanmar).

3. Typology of Technological Capabilities by Level of Development

- General classification of systemic development of technological capabilities (see Table 1). Government policy in the successful countries such as Japan, Korea and Taiwan Province of China changed as firms moved from level 1 to level 5 activities.
- Incentives are strong drivers of catch up from level 1 to 2 and level 3. Grants are the major driver of a shift to levels 4 and 5. Direct government support critical in formative years in IC development.
- Technology transfer agreements, and strong vetting, monitoring and appraisal ex post critical to prevent dissipation of rents.
- Singaporean strategy – successful in coordinating smoothly quick changes to macro-institutions to support upgrading – essential to support continuous expansion in value added.
- Government policy has driven many industries to frontier phase in Singapore (level of designing and adaptive R&D).
- Some industries in China have attained level 4 sophistication (e.g. buttons, clothing).
- No industry have moved significantly to level 4 activities that involves strong participation in R&D in the second-tier NIEs of Southeast Asia. Singapore shows strong involvement in level 4 activities, while Korea and Taiwan Province of China have reached level 5 activities. Figure 5 shows the importance of levels 4 and 5 activities with a focus on R&D as the highest stage of public goods.
- Only Korean and Taiwan province of China firms in the group have strong IC patent take up in the US (see Figure 3).
- Singapore (e.g. Avago), China (e.g. Hong Hua) and Malaysia (e.g. Silterra) have significantly fewer patent take up in the US.

Table 1: Policy Focus on Driving Systemic Pillars

	Basic Infrastructure	High Tech Institutions	Network Cohesion	Integration in Regional and Global Markets
Initial Conditions (1). Myanmar	Political stability and efficient basic infrastructure	Critical mass of economic agents	Social bonds driven by the spirit to compete and achieve	Integrated in global economy
Learning Phase (2). Cambodia and Laos	Strengthening of basic infrastructure with better customs and bureaucratic coordination	Import, learning by doing and duplicative imitation. Human capital development	Expansion of tacitly occurring social institutions to formal intermediary organizations to stimulate connections and coordination between economic agents	Access to foreign knowledge through machinery and equipment import and FDI Integration in global value chains
Catch Up Phase (3). China, Malaysia, Philippines, Thailand, Viet Nam	Smooth integration with all institutions in 4 pillars	Import, creative duplication and innovation. Developmental research. Creative destruction is a major source of technological catch up (Schumpeterian Mark I). IPR regulation becomes strong from this phase.	Participation of intermediary and government organizations in coordinating technology inflows, initiation of commercially viable R&D	Access to foreign knowledge through licensing, acquisition of foreign companies and imitation. Access to imports and exports. Upgrading in global value chains starts here.
Advanced Phase (4). Singapore	Advanced basic infrastructure instruments to support short lead times	Developmental research to support accelerate creative destruction (schumpeterian Mark 1). Strong filing of patents in the US starts here.	Strong participation of intermediary and government organizations in coordinating technology inflows, initiation of commercially viable R&D	Access to R&D human capital and collaboration with R&D institutions, high tech resources and markets abroad.
Frontier Phase(5) Korea and Taiwan Province of China	Novel basic infrastructure support instruments to support short lead times	Basic research. Creative accumulation (Schumpeterian Mark II system). Generating knowledge new to the universe. Technology shapers generate invention and design patents extensively here	Participation of intermediary organizations in two-way flow of knowledge between producers and users	Connecting to frontier nodes of knowledge, and exports of new products.

Figure 1: Knowledge Synergies Associated with Research

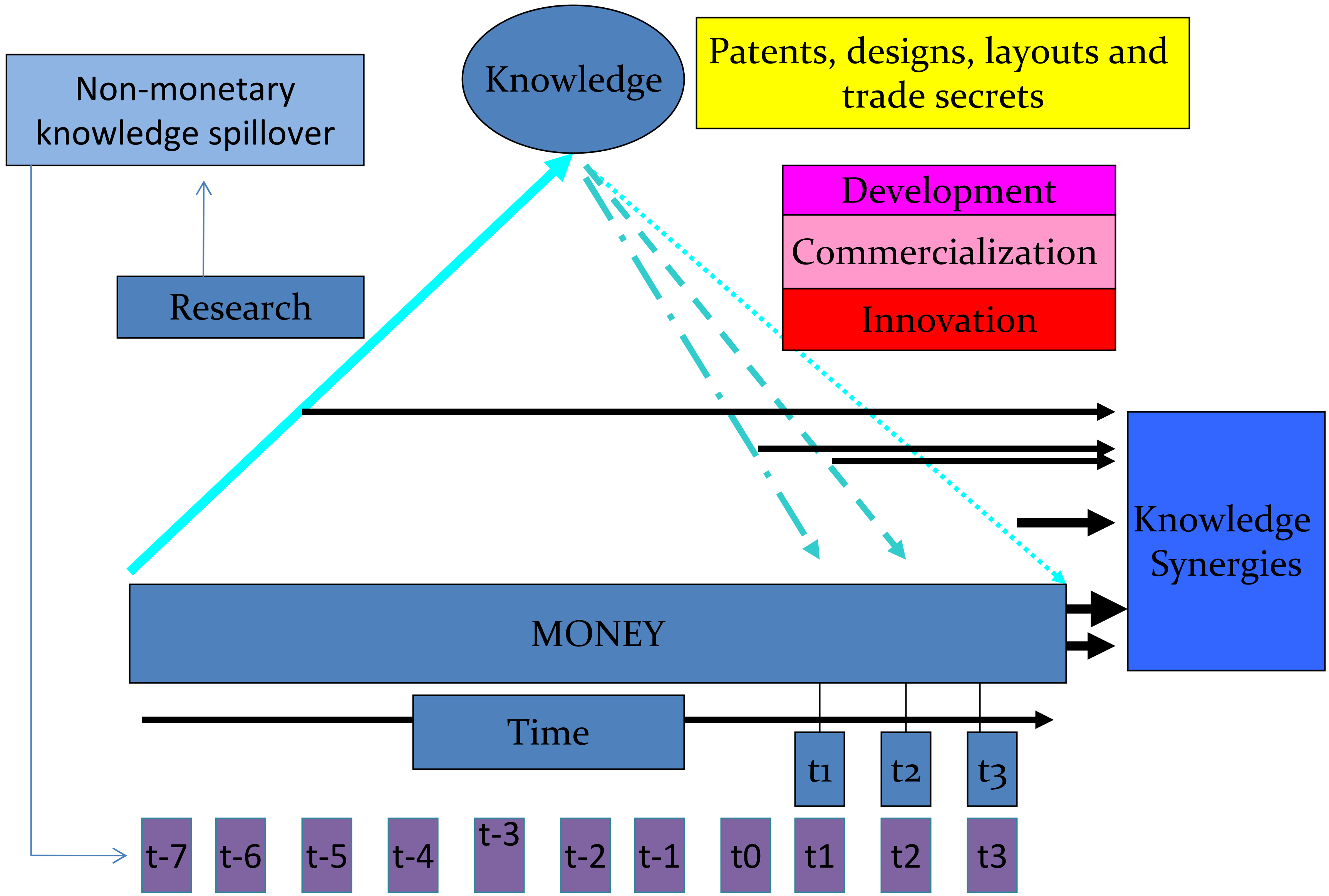
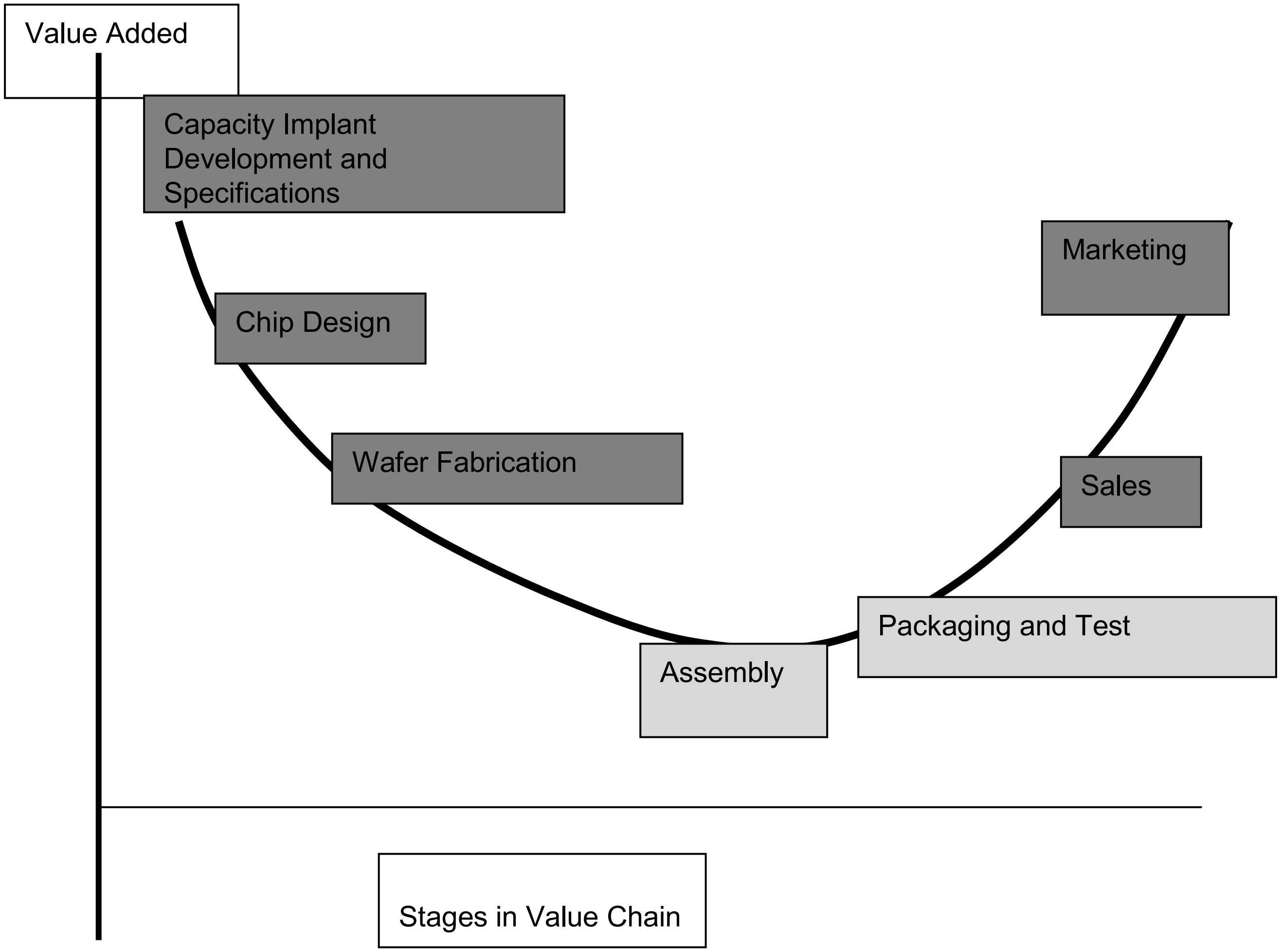
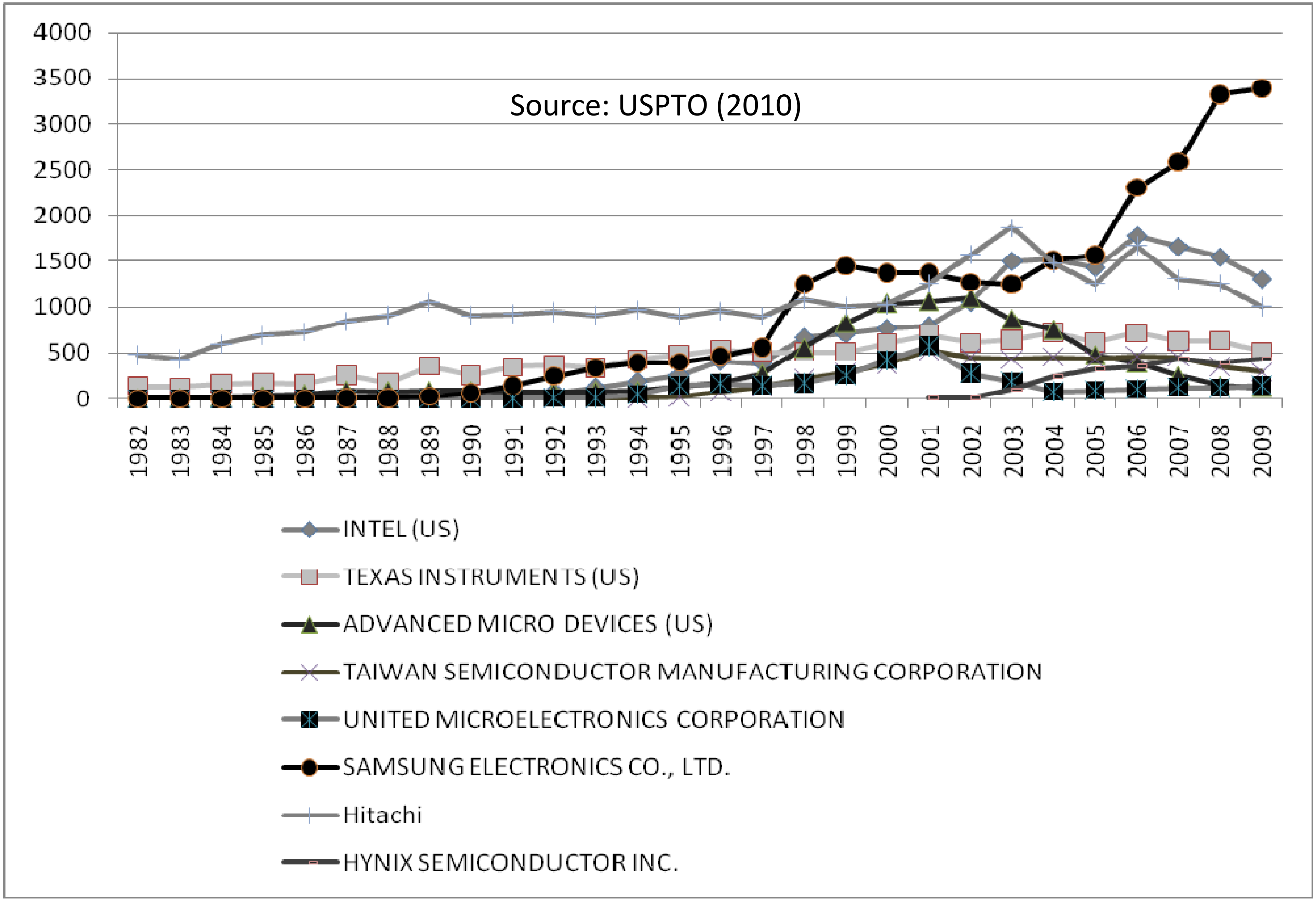


Figure 2: Value Chain of ICs, 2010



Source: Adapted from Marsh (1981)

Figure 3: Patents Granted in the United States, Top IC Firms, 1982-2009 (Numbers)



4. Industry Specific Example of Leveraging on MNCs

- Leveraging strategies of governments depend on the level of economic development of host-sites.
- The level of technological infrastructure and policies is reflected in the IC trade balance, specialization in IC stages and patent take up shown in Figures 3-4, and revenue performance of national firms shown in Tables 2-3. Malaysia in 1990 and Philippines positive balances distorted by tax holidays enjoyed by MNCs.
- Korea has enjoyed positive trade balance in 1990-2008.
- LDCs of Cambodia, Laos and Myanmar do not have any IC firm with critical size. They could appropriate IC synergies by attracting application specific circuit assemblies to drive automation of processing and assembly industries.
- Taiwan Province of China's and Singapore's trade balance improved dramatically to become strongest in 2008.
- China's trade balance seriously negative.
- In such a high technology industry the shift from knowledge adaptation activity to R&D is important for China to reverse its current trade imbalance in the industry.
- MNCs with foreign names dominate IC manufacturing in Singapore whereas national firms dominate in Korea and Taiwan Province of China.
- National-owned Hua Wei (telecommunications) and Lenovo (computers) dominate in China.
- No National or foreign firm dominate in Malaysia, though, Intel, Motorola, Alterra and Agilent have designing activities in Penang, and Silterra, Infineon, Osram and 1st Silicon undertake wafer fabrication activities.

4. Performance of IC Trade

- The level of technological infrastructure and policies is reflected in the IC trade balance shown in Figure 2. Malaysia in 1990 and Philippines positive balances distorted by tax holidays enjoyed by MNCs.
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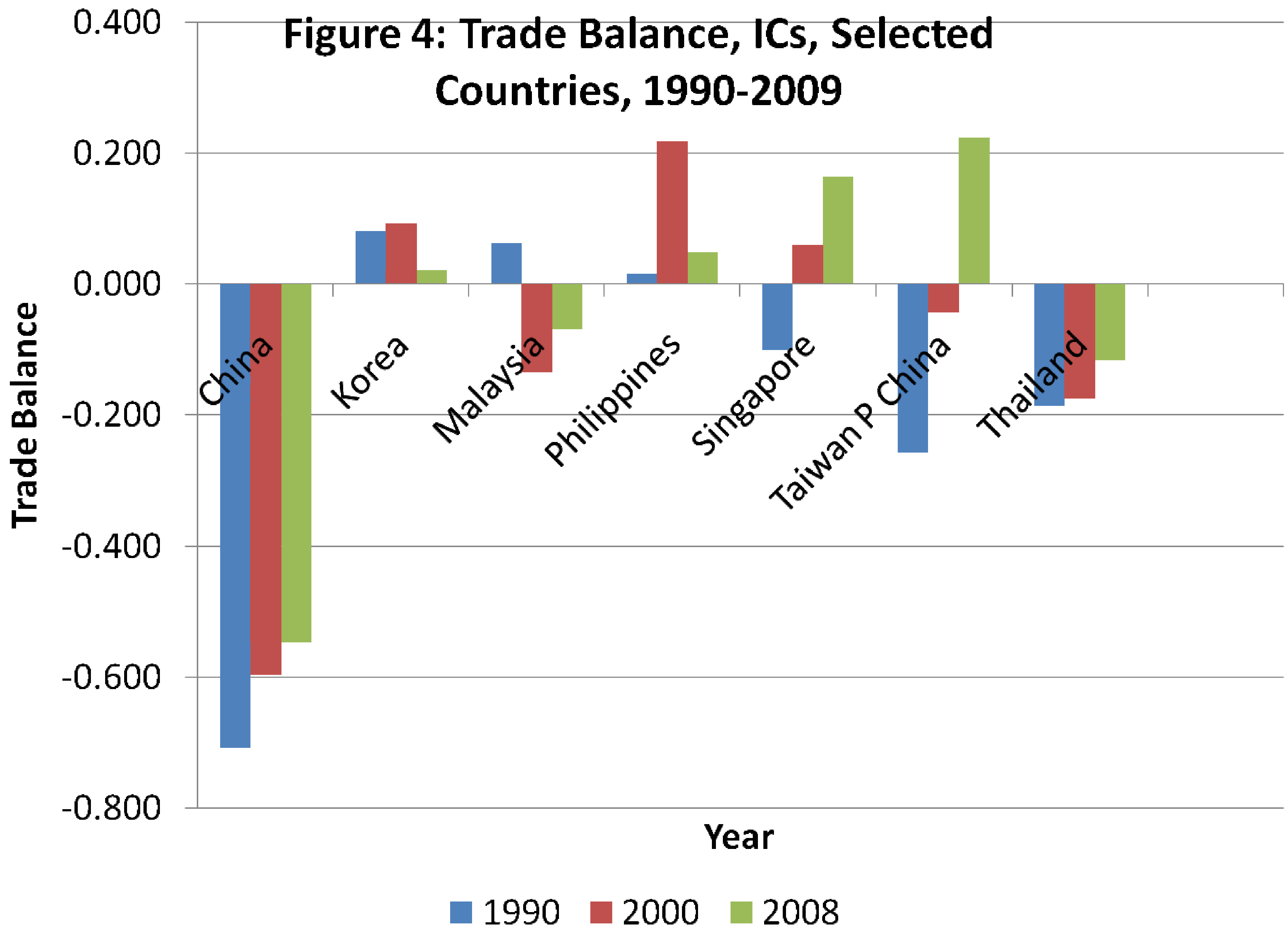
Figure 4: Trade Balance, ICs, Selected Countries, 1990-2009
Trade Balance
0.400
0.200
0.000
-0.200
-0.400
-0.600
-0.800
China
Korea
Malaysia
Philippines
Singapore
Taiwan P China
Thailand
Year
1990
2000
2008

Table 2: World's Top Integrated Circuits Firms by Revenue, 2005 and 2008 (US$ Millions)

	Nation	2005		2008	
		Revenue	Rank	Revenue	Rank
Intel	United States	35395	1	34490	1
Samsung Electronics	Korea	17838	2	20272	2
Texas Instruments	United States	11300	3	11618	3
TSMC*	Taiwan P. China	8217	8	10556	4
Toshiba	Japan	9045	4	10422	5
STMicroelectronics	Italy	8870	5	10325	6
Renesas Technology	Japan	8266	7	7017	7
Qualcomm	United States	3457	18	6477	8
Sony	Japan			6420	9
Hynix Semiconductor	Korea	5599	10	6182	10
Infineon Technologies	Germany	8297	6	5903	11
AMD	United States	3936	16	5808	12

Table 3: Market Share of World's Top DRAM manufacturers by Revenue, 1st half of 2009

Rank	Company	Home Country	Sales (US$ Millions)	Market share (%)
1	Samsung	Korea	4,924	33.3
2	Hynix	Korea	3,189	21.6
3	Elpida	Japan	2,705	18.3
4	Micron	United States	1,762	11.9
5	Nanya	Taiwan P. China	830	5.6
6	Powerchip	Taiwan P. China	601	4.1
7	Winbond	Taiwan P. China	312	2.1
8	ProMos	Taiwan P. China	153	1.0
9	Etron	Taiwan P. China	136	0.9
	Others		183	1.2

5. Conclusions

- IC firms in East and Southeast Asia are in different levels of technology development.
- In a high tech industry such as ICs China has not evolved to the frontier level 5 activities of Korea and Taiwan Province of China. Singapore is still very much at the level 4 stage.
- The assembly and Test activities of China is similar to that of Malaysia, Philippines and Thailand (Viet Nam is emerging now in this area).
- For China, Malaysia, Philippines, Thailand and Viet Nam to reach levels 4 and 5 technological capability activity and enjoy positive trade balance they must support R&D activities and strengthen the high tech infrastructure.
- Incentives and grants are critical in stimulating progression of firms from level 1 to level 5 activities with the former important in levels 2 and 3, while the latter in levels 4 and 5.
- Licensing, acquisition and government-subsidized or funded start ups were the entry routes of successful IC firms (patent take up in the US) in East and Southeast Asia.
- To prevent dissipation of rents, technology transfer agreements, and vetting, monitoring and appraisal critical to ensure movement of firms enjoying incentives and grants to reach level 5 activities.