APDSI 2000 Full Paper (July, 2000)

"Mad" Technology: International Technological Regimes and National Innovation Systems in Japan, Korea, and Taiwan

Ingyu Oh[1], Hun-Joon Park[2], Sunghoon Park[3]

[1] University of Waikato, Faculty of Arts and Social Sciences (ingyu@waikato.ac.nz)
[2] Yonsei University, Department of Business Administration (hjpark@yonsei.ac.kr)
[3] Yonsei University, Department of Business Administration (gohoon77@yahoo.com)

Abstract

This paper delivers two theoretical questions about the overall national innovation system (NIS) in three different countries, Japan, Korea, and Taiwan. They are: (1) what distinguishes the three countries in terms of their NIS and their outcomes; and (2) what courses of action are these countries taking to ameliorate past problems and to meet the challenge of the new international technological regimes (NITR)? To answer these questions we introduce a new term, "mad technology." This is to capture the dynamics of the newly rising NITR that is more or less based on the revolutionary ascendance of internet-based free flowing international diffusion of new technologies. We posit that the three countries had different NISs before the Asian financial crisis, although similarities were also very great. We advance the thesis that particular state-business relations in a given domestic and international environment lead to different NIS outcomes. In Japan the NIS was designed to replace and catch up to the Western level of technological influence on postwar industries. In South Korea the NIS was to invite and learn large scale Japanese (mostly) and American (sometimes) technological transfers. In Taiwan the NIS was to produce high-tech parts for large Japanese companies that would transfer only necessary technologies for the OEM purposes.

These NIS differences tend to wane as the three economies have navigated through the hefty waters of the financial crisis. The NIS in each country is noticeably becoming more privatized and flexible than the pre-crisis period. We argue that this assimilation is due to the free flowing technologies readily available in the international markets, either real or virtual. Commercial technologies are no longer subject to national territories, tariffs, or international piracy. Mad technology has now the same value as the free flowing foreign currencies that also travel all over the world. Mad technology, like mad money, is openly traded in the technology exchanges (TE) of many countries, not to mention its diffusion throughout the virtual space. Mad technology augurs significant shifts in the NIS of these three countries, notably a move from manufacturing-based NISs with a high level of protection, imitation, and stability to venture-based NISs with a high level of flexibility, risk taking, and technological innovation.

1. Introduction

Investment in new technologies involves a decisional dilemma. Your firm's new technology is easily copied by your competitor, which did not invest in the innovation effort. But if neither you nor your competitor invests in new technologies, your country will lose competitive advantage (Elster, 1983). Public investment in new technology development is not a perfect solution to this dilemma, either. Your government's investment in new technology, too, can be an easy target for piracy by your competitor country that puts no effort into investment projects. Although the cost of public research and development (R&D) can be subsidized, the waste is eventually borne by consumers. Neither the market nor the state perfectly solves this dilemma surrounding new technology development.

Similar decisional dilemmas existed in the investment of national income in international currencies under the Bretton Wood system. A firm's purchase of U.S. dollars had lower interest yields than that of investment in the stock market, because the dollar did not fluctuate. However, if firms did not purchase the dollar, no international trade was possible. A state's dollar reserve was thus necessary, because firms then only have to buy the dollar to pay foreign bills. The continual loss of this national reserve of dollars again had to be compensated for by taxpayers (Cohen, 1998).

The picture widely changes at the disappearance of such restrictions. If no country can issue forged dollar notes, and the dollars fluctuate according to demand and supply, private firms will vigorously participate in the international transaction of the dollar. Not only dollars but other international currencies as well that have any market value (Cohen, 1998; Strange, 1997, 1998). In a similar vein, if no firm can copy internationally patented technological knowledge and the price of such intellectual commodity fluctuates according to demand and supply, private investment in R&D has a strong profit potential.

In this paper, we want to document the above changes, by addressing two questions. First, what distinguishes the national innovation system (NIS) in Japan, South Korea, and Taiwan before the birth of the new international technological regime (NITR)? Second, what is being changed in the NIS of these three countries at the emergence of the NITR? We have completed fieldwork in all three countries and collected data pertaining to our questions. Our analysis in this paper yields a tentative thesis that the above three countries had different NISs, which are now rapidly becoming similar to each other, because of the rise of the NITR. The responses to the NITR include a characteristic similar to gambling where national and private R&D investment mandates decision-makers to monitor carefully the international technology markets and to invest at the right time for overnight profits. As R&D investment is becoming more privatized and flexible, long term plans for innovating existing technologies are rapidly replaced by short-term plans for immediate economic gain. The structure of this paper is to discuss some germane concepts, e.g., NIS, NITR, "mad" technology, and to analyze the change in a firm's technological investment.

2. National Innovation System in the Mature Industries

The established definition of the NIS is that of Lundvall's (1992) that a country's NIS is structurally determined by the country's economic, political, educational, and social factors. Nelson and Rosenberg (1993) defended the importance of the NIS by arguing that it is a germane source of national economic power and an index of future economic development.

To take this structural notion of the NIS seriously is to produce a state-centered approach to the problem of the NIS (Kam, 1995; Kim L.S., 1993, 1997; Soh, 1997). That is, the role the state plays in economic development must dilute the decisional problems surrounding new technology investment and concentrate national resources in conducing splendid R&D outcomes to overcome private losses suffered from by individual tax payers. In fact, Japan, South Korea, and Taiwan are model cases of establishing the state-led NIS, downplaying the importance of private sector R&D that necessarily suffers from deadweight losses (i.e., investment shirking). This, however, does not mean that all these countries have the first rate NISs that are more or less on an equal footing with the U.S. and European NISs. Although South Korea and Taiwan have tried very hard to catch up to the Western and Japanese level of technological know-how, Korean and Taiwanese technological advancement clearly demonstrates the weakness of the state-centered model of their NISs. The current financial crisis in Japan also reveals its own weakness, notably in the areas of corporate governance, productivity, and financial and service sector technologies (Makino, 1998).

In this sense, we can discern that the NIS can be compared and contrasted to highlight reasons for success and/or failure of each NIS in the mature industries (i.e., controlling on the variable of industrialization). Other things being equal, the success of state-centered NIS depends on three pillars—government policies, infrastructures, and private innovation systems. In our cases of Japan, South Korea, and Taiwan, Japan has played a pivotal role in guiding and consulting Korea and Taiwan in their NIS formation, given the obvious technological gap between these three countries (Cumings, 1984; Koo, 1993; Lie, 1998). The purpose of comparison here is not to affirm the fact that the three factors of governmental policies, infrastructures, and private innovation systems were more efficient in Japan than in Taiwan or Korea. Instead, we use these three factors to demonstrate that the NIS was very different in these three countries, despite Japan's role model status and their cultural similarities.

2.1 Governmental Policies

The role the government plays in the shaping of the NIS differs from country to country, noticeably depending on how state decision-makers perceive their governmental ideologies (or goals) and strategies of attaining those goals (Lundvall, 1992;

Nelson and Rosenberg, 1993). In all three countries, the state took an active and central role in shaping their NISs, although their perception of the ideologies (ends) and means differed greatly. Here, the central role assumed by the state was not due to an absence of private initiation but because the state actively promoted private resources and a commitment to the NIS. In this sense, the state-business network in all three countries was very closely and densely interwoven. Nevertheless, a significant difference is in the amount of private commitment to R&D, as Taiwan's private R&D expenditure has been enormously less than that of either Japan or Korea (Chang, 1999). Other differences are also remarkable, for instance, in the areas of targeting sectors and the distribution of public funds to private R&D. This was, we argue, due to government policies. How then are governmental policies shaped, especially in the cases of Japan, Taiwan, and South Korea?

The most critical factor of governmental policy making in the development of the NIS is the pattern of state-business relations itself. Suppose that NIS development had a decisional dilemma before the commercialization of knowledge. Under this particular situation of the prisoner's dilemma, neither arm's length nor public intervention could solve the problem, as each government in these three countries faced the problem of establishing trust between public resources (e.g., money and new knowledge) and private utilization of such resources. Trust between public resources and private utilization would, in theory, discourage private defection from the NIS commitment and maximize efficiency, once fully established. An ideal example is the relationship between public scholarship money to a student and his or her utilization of the money. Trust has been achieved between the public resource and the end user of the resource if the student worked hard and passed all required exams. Three patterns emerged in these three countries, as ways of inducing trust, namely, private trust of private R&D (Japan), public trust of private R&D (Korea), and public trust of public R&D (Taiwan).

To make a complex and long story short, state-business relations in Japan occurred in the physical space that many call the *keiretsu*. The keiretsu, a loose yet dense network of businesses, was possible because members of each keiretsu voluntarily organized their group interests under the roof of state protection (Oh, 1999). State protection was more or less providing shelters (*yamagoya*) in times of economic downturn or weeding out unnecessary duplication (*mugi fumi*) in times of upturn (Tsuru, 1993: 97-98). Nothing more than that. The rest was up to the keiretsu itself. As long as these private firms in a keiretsu didn't fight each other for the sake of self-interest, the state didn't have to intervene in their day-to-day decision-making (i.e., private trust). In this sense, both sheltering and weeding were to control unnecessary inter-keiretsu competition or distrust. Tax breaks for private R&D efforts (the Japanese government had provided roughly 20% tax breaks for each dollar spent by private firms in R&D until the recent reform) were thus minimal compared to the total amount of private investment in new technology development (MITI, 1999). The system of the keiretsu, a private protection of private interests, sufficiently encourages private investment. The government made sure that duplication didn't occur in a wild cat fashion, and the keiretsu main banks provided the bulk of R&D investment, roughly twice the amount of cash based assets—i.e., private trust of private R&D (Ishizawa-Grbic, 2000; Tsuru, 1993). Of course, elite scientists from elite universities also preferred keiretsu firms for their lifetime employment, but this occurred in other countries, too.

The picture in South Korea was 180 degrees different. Private protection of private interests had never existed, as firms of all kinds sought state protection. State protection here went beyond sheltering and weeding out—it called for targeting and favoritism (Kim E.M., 1997; Lie, 1998; Oh, 1999). This was because the demand for state protection exceeded that of the supply of private protection of private interests. Not a single pair of firms trusted each other to form an alliance or consortium in a Japanese fashion. The state had no choice but to use its sword to chop out firms that were not favored either by political leaders' personal preferences or by macro economic priorities. Those selected and protected by the state formed conglomerates of their own, which we often refer to as the *chaebol* (i.e., public trust of private interests). The chaebol was a system of extreme inter-chaebol competition to maintain public trust. Such competition necessitated innovation through overspending in R&D and facilities investment, as long as the state would underwrite such extravagance (Kim L. S., 1997; Oh, 1999). Facilities investment was particularly important for the chaebol because it could quickly upgrade the chaebol's technological capacity through transfer of technologies from overseas sources, especially from Japan and the U.S. Firms' R&D efforts thus were more or less learning and refining the transferred technologies, as the transfers were frequent and fast (Hong, 1993, 1994; Lee, K.U., 1994; Soh, 1997). Nevertheless, the state had to subsidize and underwrite the chaebol R&D and facilities investment, because of its strong alliance with the "chosen" chaebols (i.e., public trust of private R&D). Over the decades, the state provided on average more than twice the total cash based assets for a single chaebol (Koo and Kim, 1992; Wade, 1990).

In Taiwan we see neither of the above two patterns of state-business relations. Small family firm networks we call *guanxi quieh* in fact tried to distance themselves from state funding, or vice versa (Cheng, 1986; Fields, 1995). Family financial resources thus played a pivotal role in the formation of these family firms in Taiwan. It was the distrust between the state (mainlanders) and these family firms (Taiwanese) that averted any close cooperation between the two that was the norm in Japan and South Korea (Fields, 1995; Cheng, 1993; Cheng and Haggard, 1987). The necessity of developing the Taiwanese economy in the face of the Chinese threat called for some sort of macro economic policies directed toward these Taiwanese owned firms. However, until the ascendance of Taiwanese politicians in the nationalist KMT, the state had focused on spending megatons of dollars in building public corporations which were owned and controlled by the mainlanders—i.e., public trust of public interests (Cheng, 1993). The government gradually began providing finance to guanxi quieh, but most importantly, it started selling technologies to these firms. This was novel to the family firms, which initially sought technological transfers from Japanese firms that either directly invested in Taiwan or established joint ventures with the family firms (Chang, 1999). Transfer of public R&D amid the absence of private R&D (i.e., public trust of public R&D) allowed some Taiwanese firms to develop high tech industries, a goal once thought beyond the limits of small family firms. The growth of the memory chip and computer parts industries is a case in point. The rapid growth of high tech industries, however, was still contingent upon state guidance and direction, as the state didn't encouraged private R&D spending.

Government R&D policies grow out of the interaction between state and business actors. Trust between them was a key factor in shaping the NIS in each country. The Japanese NIS policy proved very effective in developing value-added technologies that could exceed the level their American or Western competitors could achieve. The South Korean NIS policy proved very effective in concentrating the resources in the hands of big players in the market and developing its technological level very fast, covering a multiplicity of industrial sectors. The Taiwanese NIS policy proved successful in concentrating R&D resources in the hands of the state officials and encouraging competition among family firms in their bid to gain access to either foreign direct investment or state-developed technologies. However, there is more to it.

2.2 NIS Infrastructures

R&D infrastructures are important boosters for a policy success. Infrastructures boost the supply of material and human capital for R&D institutions and the utilization of new findings by end users (Carlson, 1997; Nishiguchi, 1994; North, 1990). The role the state plays in this area is to provide tangible social institutions to the R&D participants to reduce the barriers to R&D participation. Examples are the deliveries of a high quality educational system, quality financial services for R&D investment, intellectual property rights protection for innovators, and quality and a balanced supply of manpower to needed industries. We argue that state policies surrounding the NIS question affect how infrastructures are organized in our sample countries.

Japanese NIS policies guarantees the private protection of private interests. For this to happen, monetary resources must be in the hands of the keiretsu main banks, which in fact is the case. As we pointed out earlier, these banks have underwritten the bulk of R&D expenditures. This also means that the flow of monetary resources within each keiretsu was much smoother and flexible than interkeiretsu loaning (Mukai, 1997; Suzuki, 1993; Tsuru, 1992). Evidence is the traditional, albeit outdated now, practice of overborrowing and low interest rates, which did not exceed 6% (although real borrowing interest rates remained around 10%). Low interest rates are still the norm in Japan, which distinguishes itself from both South Korea and Taiwan. The Japanese financial infrastructure for R&D efforts thus couldn't have been better until the end of the Heisei boom. Domestic intellectual property rights protection was relatively reliable in Japan, not because of its institutional commitment to protection but because of the trust-based state intervention in the area (Itami, et al., 1998). Foreign patent applications were seemingly outside of this trust network, raising vociferous complaints from American corporations, as it sometimes took more than twelve years to get American applications approved (Johnson, 1995). But many Japanese critics themselves execrate their educational system as inept and are opting for more group uniformity than individual creativity (Beauchamp, 1989; Ishida, 1993; Makino, 1998). The system of selection and advancement in the Japanese schools often favored candidates from those families that demonstrate commitment to the system and punished those that deviate from normal family values. This group conforming elitism led to an unequal distribution of qualified employees to different layers of industries. That is, major keiretsu firms received the bulk of top-level university graduates, while medium and small firms struggled to employ graduates from top-notch universities. The only compensation medium and small firms had was the employment of retired bureaucrats seeking through the system of *amakudari* (Calder, 1989). Private protection of private R&D secured an easy flow of money between keiretsu member firms. It also easily attracted a steady flow of elite university graduates into the keiretsu member firms. Intellectual property protection prolonged the incubation period for many new foreign inventions, so that keiretsu member firms could devise their own ways of responding to such invasions of foreign knowledge.

The public protection of private interests in South Korea requires the placement of monetary resources in the hands of state bureaucrats. Monetary resources didn't just move from one recipient to another as freely as it was in the case of Japan. This augurs a very static and bureaucratic nature of the banking sector in South Korea with an apparent weakness of being susceptible to state influences in the matter of loan decisions (Cole and Park, 1984; Kang et al., 1991; Krugman, 1999; Oh, 1999; Paik, 1994). In other words, chaebol owners often found it necessary to talk to important state decision-makers before they talk to bank officials when seeking large loans. Those who lacked such networking and influence within the government couldn't participate in R&D efforts. The scarcity of monetary resources also forced the chaebol innovators to take high interest rates (along with overborrowing, the real interest rates were more than 21%) and private loans from the curb market (interest rates were between 30-40%) (Kim E.M., 1997). The state did on one occasion nullify curb market loans after a series of outcries for help from the chaebol. But the fundamental problems of banking sector corruption remained a time bomb, even after the partial privatization of both urban and regional banks in the 1980s. Both domestic and international intellectual property rights protection had never been satisfactorily institutionalized. Outright copying and piracy often raised serious disputes in the area of international trade (Han, 1994; Kwon and Song, 1998). A chaebol's new invention was another's target of illegal copying, unless the state intervened on behalf of the inventor chaebol. Nonetheless, chaebols spent large sums of money in R&D or technology transfers all at the behest of the state. The South Korean educational system resembled that of the Japanese, but differed most visibly in the area of educating the top-notch elite. Secondary schools didn't have selective entrance exams, which obviously lowered the standard of education and later affected the quality of university education. South Korean elite thus had to seek advanced degrees from the U.S. and other countries. The retention and utilization of the best brains were more or less deadlocked, as U.S. educated Ph.D.s found employment there. Even when some of them returned from the U.S., they mostly remained on university campuses, not seeking positions in the chaebol or the government (Kim, S.R., 1998; Lee, K.U. 1996; Soh, 1997; Sung, 1994). Domestic university graduates on the other hand couldn't function in the global corporate world without a long period of training. Top-notch university graduates, that is, those who couldn't go to the U.S. for advanced degrees, rushed to the government for employment. The rest of the elite university graduates (i.e., those without the opportunity of overseas study or government employment) worked for the chaebol firms. Just like Japan, where elite graduates were recruited by the government and keiretsu firms, the South Korean medium and small firms had to rely on mediocre college graduates. The public trust of private R&D resulted in an inferior structure of innovation to that of Japan, because of the lack of R&D infrastructure development.

The public trust of public R&D requires the government to control both financial and technological resources of the country. The KMT nationalist government on the island of Taiwan maintained a firm grip on its banking system (Lin, 1991). Most urban and regional banks remained in public hands until recent privatization (Cheng, 1993). Unlike in South Korea, however, these banks did not invest heavily in private firms, auguring low loan default rates and/or high BIS rates. Private firms instead borrowed money from family members and relatives, naturally putting a low ceiling on the size of those corporations (Chang, 1999). The government's utilization of its public R&D facilities boosted innovation within public corporations (top one-hundred guanxiqiye account for only 34% of total GNP, compared to 90% in South Korea). Some private firms bought innovation generated by the government. But they often signed OEM contracts with Japanese corporations for technology transfers, done mostly in the form of foreign direct investment. Contrary to the nationalistic standpoint of the KMT, the Taiwanese flow of monetary and R&D resources thus came from Japan (Aberbach et al., 1994; Chiang and Mason, 1988; Chou and Shy, 1991; Chu, 1994). Intellectual property protection was nil in Taiwan. Public R&D and its breakthroughs, if there were any, were just for large public corporations. For most private firms they were out of touch. This began changing only when Taiwan joined the PC revolution, as some family firms (e.g., Acer, UMC, Macronix) produced computer parts either through their own technological know-how developed in the U.S. or through alliances with government labs. The birth and later development of memory chip industries also benefited from this alliance between private firms and government labs, transforming the structure of public trust of public R&D to "private trust of public R&D." Private trust of public R&D is most visible in the areas of memory chips and flat panel industries (ITRI, 1998; MOEA, 1999). There was obviously no sense of international property rights protection in Taiwan. Almost everything was copied, except those that were transferred from Japan. The Taiwanese education system suffered from severe brain drain mostly to the U.S. Top-notch university graduates went to the U.S. for higher degrees, and even when they returned they remained on college campuses. Mostly family members and mediocre college graduates did family business, while the government and public corporations recruited the good crop of the education system. The public R&D infrastructure turned out to be more developed in Taiwan than in South Korea. However, its apparent weakness is not being able to develop cutting edge technologies for high tech industries. The smallness of private industries curtailed the potential for developing a wide range of new technologies that require large production facilities.

Although different NIS policies engendered different patterns of industrial success in Japan, South Korea, and Taiwan, disparity in the infrastructure development between the three countries caused various problems in their technological development. Japan's weakness is most obvious in the imbalance of the technological levels of keiretsu and non-keiretsu firms. Educational insufficiency is also notable due to the lack of motivation for creativity. Nonetheless, its NIS proved far more efficient and productive than its South Korean and Taiwanese counterparts. South Korea suffered the most in the area of monetary resources. High levels of corporate debt from the public funds required quick commercialization of existing technologies, discouraging long term technological development. Educational system failed to produce creativity-oriented high quality university graduates. Also, the lack of intellectual property system discouraged innovation, especially between medium and small firms. The technological imbalance between chaebol and non-chaebol firms is more serious here than in Japan. Taiwan's problem derives from no public commitment to private innovative efforts. The education system also discouraged innovation among family firms, the majority of the Taiwanese corporate sector. Easy piracy of foreign knowledge and cheap technological transfers did not motivate innovation, either.

2.3 Private Innovation System

The NIS causes the outcome of private innovation system (PIS). If the market is perfect, then the development of PIS, as we explained above, is always problematic because of the prisoner's dilemma. The main purpose of the NIS is to encourage PIS, despite the apparent loss individual firms have to bear. To do this the NIS has to fight free riding and sometimes whimsical purchase of foreign patents and licenses. On top of that, the NIS must guarantee a quick spread of new inventions among domestic producers and suppliers. This is an oxymoron, because how do you fight free riding, simultaneously spreading new technology in a short period of time? Each country in our sample had various results in fighting free riding (i.e., encouraging R&D investment) and in knowledge dissemination (i.e., encouraging innovative supply networks).

The Japanese PIS had an advantage in controlling R&D monetary resources, as well as retaining a steady inflow of talent in the R&D sector. The NIS also discouraged foreign licensing and patenting, all in order to encourage PIS. In this sense, free riding was minimized, especially when the firms set a goal of competing with American and European firms through price and technology advantages (Itami et al., 1998; Kakurai, 1998; Makino, 1998). This means that by the ideological commitment itself, the keiretsu firms shied away from buying licenses or patents from foreign PISs. The pool of keiretsu R&D money went directly into central keiretsu labs or individual members' R&D institutes. Both types of labs recorded enormous success. The innovation record of SONY, Matsushita, Hitachi, Toyota, Honda, and others was but a few examples of a long list. The flow of R&D monetary stocks into these R&D centers assumed trust and commitment from members by reciprocal stock holding and contracting (Ishizawa-Grbic, 2000; Oh, 1999; Okumura, 1991; Watanabe, 1992). The role the main banks played in this network was thus pivotal, as they held the bulk of such monetary stocks. Free riding disappeared substantially, even between keiretsus, because main banks were willing to provide monetary stocks to R&D efforts, not to the purchases of or imitation of others' technologies. After all, keiretsu's survival, and thus the main banks' survival, depended on the conquest of American and European markets, not those of domestic or developing economies. This required a long-term commitment to both fundamental and commercial technologies, simultaneously fueled by heated competition between keiretsus. The keiretsu was a good organizational arrangement for the dissemination of new technological inventions. The top down flow from either central labs or member firm labs to medium and small firm suppliers was much smoother than was the case in the U.S. or Germany. For instance, Toyota's "just in time" system was but one of many such innovations in the producer-supplier network in Japan (Nishiguchi, 1987, 1991, 1994). However, the PIS did not have any vision whatsoever in innovating the financial sector itself, the holder of R&D money stocks. It was not necessary, as long as the state safely countered international efforts at opening up the Japanese financial sector and keiretsu firms kept their original loyalty to their main banks. After all, the state controlled low interest rates easily barred any international banks from entering the Japanese market, until the 1980s interest rate liberalization—thus, no incentives for innovation (Ishizawa-Grbic, 2000; Saito, 1998; Suzuki, 1993). In a similar vein, the distribution keiretsu also elided the importance of innovation in wholesale and retail distribution. Consumers' input in the system was none in terms of pricing, and retailers' kindness (as in the expression of "consumers are the king") silenced whatever consumer complaints there existed. In this sense, American buyers' slogan of "find the cheapest price or perish" didn't attract the Japanese distributors (Tajima, 1994; Makino, 1998; Tanaka, 1998). Japanese retailers only had to import or imitate American inventions (e.g., Sears Department Stores, supermarket chains, Seven Eleven, McDonald's restaurants, QVC channels, etc.), unless they wanted a massive invasion of American retail outlet chains. Even the speed of distribution innovation was slow at best, because of the tenacity of the existing retail keiretsus. The Japanese PIS more or less succeeded in establishing one of the best R&D organizations in the world for the manufacturing sector. Its apparent weakness was not realizing the importance of innovation in the financial and distribution sectors.

The South Korean PIS could only organize itself at the behest of the state, since the R&D monetary stocks had never been in the hands of the chaebol (except in the 1950s). In this sense, sector targeting was common (Ernst, 1997, 1998; Hong, 1994; Kim, L. S. 1997). The state's money created conflicts of interests so severe at times that the state forcefully closed some firms in the same targeted sector. Those not favored by the state naturally perished from the markets (Oh, 1999). Targeting the sectors, however, did not mean it encouraged R&D for the selected industries. Rather, the state actively promoted technology transfers first from the Korean Japanese industrialists, who agreed to build new factories in their motherland (Lie, 1998). The first wave of technology transfer was thus free (i.e., no licensing payments or OEM profit sharing with multinational firms). Additional transfers, however, required state approval, because they were not free. Yet, targeting created more conflicts of interests. It was always cheaper for firms in the targeted industry to import technologies either from Japan or the U.S. then developing their own. The state had double standards—it promoted PIS by giving monetary stocks for R&D, but it also allowed the purchase of foreign technologies. This is why the logic of product cycle theory applies to the Korean case, just like the clockwork itself. We frankly don't know how much R&D investment was in fact used for technology development or for technology imports. Nevertheless, once a new technological know-how was either developed or purchased, it was protected by the system of targeting. Ideological commitment by the state and the chaebol, indeed, was not to the takeover of Japan or the West. It was only recently that Samsung, Hyundai, and LG could surpass some of the Japanese technological R&D capacity in the areas of memory chips and digital electronics (Lim, 1998). Instead, ideological commitments were to the takeover of the emerging markets, mostly in Asia, Middle East, Central/South America, and Eastern Europe. Targeting by definition entails protection and oligopoly. Electronics, automobile, and heavy and chemical industries had fewer than four giants in each sector (Lee, K. O., 1977). In the case of semiconductor and memory chips, Samsung, alone, account for more than half of total exports. Despite this, competition was obviously stiff in each sector, especially among the big four. It, thus, coaxed high levels of private R&D efforts, all funded by state banks, although more money was spent in purchasing new technologies than developing a new one. Chaebols distributed technological development to their subsidiaries and suppliers that were also owned by the chaebol. Distributional efficiency within the chaebol thus was similar to the Japanese level. However, the lack of talents in the lab, either private or public, or the flexibility of monetary allocation to long term and short-term projects killed most of the innovative minds. Mediocre minds dominated the industry with mediocre levels of R&D infrastructure. A steady inflow of talents in the public or private R&D centers had never existed until the growth of the top five chaebols into global firms. On top of that, chaebols did not disseminate new knowledge to small and medium firms, unlike the Japanese keiretsu. Financial and distributional sectors had worse innovation records than Japan, as Korean banks and distribution networks of both wholesale and retail only tried to imitate what was successful in Japan. The result of the Korean PIS was concentration of R&D resources in the top five chaebols and their subsidiaries with low level of knowledge distribution.

The Taiwanese PIS had never passed the 'taking off stage' even in the early 1980s. This was again due to its NIS policy—i.e., public trust of public R&D, and later, private trust of public R&D. Nonetheless, product cycle theory also worked in this country *qua* supplier of Japanese OEM products, including bikes, tennis rackets, sporting and leisure equipment, finished computers or parts, electronic goods, and semiconductors. In addition to Japanese-related technological transfers, innovation came also from the West Coast of the U.S., where Chinese Americans actively participated in the Silicon Valley venture firms. The breeding ground for the Taiwanese PIS was thus similar to that of Korea—i.e., foreign inputs. But the lack of monetary support from the government for the PIS forced them to commit themselves to small scale technological R&D, usually found in individualized garage shops with equipment supplied from family firms and their financial service centers. Although backward in their organizational scale (i.e., no economies of scale), they excelled in developing know-how for small firms connected to each other through family ties. What family shop clock engineers were to the Swiss clock industry was what these Taiwanese garage shop engineers were to the guanxi quieh. But the lack of traditional PIS based on craftsmanship, as was the case in Switzerland, prevented the family firms from producing top quality products. It in turn made firms easier to disseminate new invention through imitation and outright copying. Accumulation of capital and innovation made some of these guanxi quieh as big as some mid ranking Korean chaebols (e.g., Taiwan plastics, Shin Kong, etc.). Their large-scale R&D supplies came mostly from the government labs, a nexus we discussed above. Targeting and favoritism also existed because of this bilateral relationship. Conflicts of interests ensued, but PIS did not blossom in a similar scale to that of the Korean chaebol. Who can purchase the government developed technology still remains murky, although both the recipient and provider of such technology claim equality and justice (MOEA, 1999). Because of targeting for large scale R&D, the flexibility of guanxi quieh disappeared. Complaints from the large family firms became more vociferous as public R&D could not attract Taiwanese brains from the U.S. (ITRI, 1999; MOEA, 1999). Competition with the Korean providers of semiconductors and flat panels, both of which were targeted by the Taiwanese government, required something very different from the family business organization. The smallness of population and land and individual financial austerity led to high levels of saving and income equality. The banking sector did not suffer from any major loan fiasco, but its service did not excel that of Japan or Korea. Overall, however, the Taiwanese PIS remains the least developed among the three, despite its strength in small firm networks.

3. Mad Technology

Different layouts of the NIS in these three countries were the cause of the development of R&D infrastructure and the PIS, not vice versa. This point needs attention from researchers when they intend to compare these countries with the Western NISs, where infrastructure and PIS often play important roles in shaping the NIS. Having said this, it is not always the NIS that causes the differences of the NIS outcomes in these three countries. There are other factors, such as external influences, most visibly from the U.S. or Europe. The emergence of what we call, "mad technology," is one of the external agents that seem to change all the NISs in Japan, South Korea, and Taiwan.

Mad technology is a technological revolution that is occurring on a global scale ever since the invention of digital information system. This is what Bell (1960) called the revolution of information society as postindustrial society. However, the intensity of the information revolution is such that no one had actually predicted what has happened in this world in terms of globalization and technological, thus, industrial, reorganization. Susan Strange (1997, 1998) has already analyzed this "great" transformation of the late 20th century capitalism and penetratingly dubbed it as either "mad money" or "casino capitalism." We concur totally that the industrial reorganization that is occurring now on a global scale is not a mere replica of the 18th century industrial revolution, but its scale is more worldwide and its intensity is more tenacious and penetrates into every corner of the world. We also agree with Cohen (1998) that the 19th century regime of the national monetary state is no longer a valid labeling for the changing nature of the international currency exchange and international financial exchange.

Following the lines of argument developed by the above authors, we devise a new concept, "mad technology," referring to a state of technological chaos in R&D development, distribution of new innovation, and the commercialization of technological exchanges of all kinds. In other words, like casino capitalism and mad money, technology itself is defying the boundaries of the nation-state and the nationalist regime of the NIS. In other words, mad technology poses a threatening question to the national regime of the NIS, is the NIS really necessary now, given the magnitude of the development and encroachment of the mad technology regime?

The rise of mad technology requires a new international technology regime (NITR). The birth of WTO and the Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) ignited debates on their impacts on the developing economies (see *inter alia*, Gadbaw and Richards, 1988; Sell, 1998; Sherwood, 1990). Most importantly, however, these global institutions created a new global trade regime and the NITR. Whether NITR is detrimental to the emerging and developing markets is no longer our concern, as long as corporations welcome it. In our sample of Japan, South Korea, and Taiwan, we could affirm that both governments and corporations welcomed it. In the case of the survival of Hangul and Computer, a South Korean software company that miraculously escaped bankruptcy or a merger with Microsoft, scholars attributed it to the TRIPS and the government's crack down on software piracy (Kwon and Song, 1998). What is important about the NITR is that it allowed mad technology to surface in the global trade network.

Mad technology has the following characteristics when it comes to its relations with the global economy. That is, first, it does not claim the ownership of new technological invention in terms of nationality, as was the case in the past. For example, when the Japanese first invented transistor radios, that technology belonged to the Japanese national regime, the NIS. But these days, a Toyota car with all those newly invented electronic gismos and digital technologies cannot claim its nationality, because its parts come from several different nations. Nowadays, technological innovation only occurs on the pedestal of the amalgamation of inventions that had been accrued and disseminated by other nations. The creation of business to consumer (B2C) or business to business (B2B) networks that fueled and fanned the growth of the NASDAQ and other similar alternative stock markets in East Asia was possible due to these non-nationalistic Internet software technologies. The downloading of software, either for free or fees, defies national boundaries and national tax or tariff regimes. The breeding ground of mad technology is not the protected national R&D market, but the free flowing nature of the international technological exchange that occurs either online or offline.

Second, mad technology does not claim protection under the NIS as much as it used to, because its commercial values come only from sharing it with others or selling it in the global market. For instance, an invention of heat or laser guided missile trajectory systems does require protection by the NIS so that its know-how must not be spread to unwanted users. Under the old NIS regime, countries, especially those in stiff global competition, actively set up bulwarks against foreign imitation or piracy of their new technologies, not to lose the competitive edge. But the Internet based information technology requires no such nationalist protection. Shareware software provides more people with more diverse ways of communicating with more people in the world (e.g., Internet Explorer, Netscape, Hot Mail, Yahoo, etc.). These technologies did not come by for free, yet, their commercial value is only created when more and more people use it for free, so that their inventors can sell their web sites to other business runners (e.g., domain or web site purchases). Free dissemination of Internet software and/or technologies certainly allow more people to participate in the Internet market, which by definition boosts up the values of the Internet market itself. Piracy of shareware thus is meaningless, and even the piracy of non-shareware has lost much of its commercial value because, as in Bill Gate's (1999) own words, producers can always upgrade their products, making inferior or old versions obsolete in a short period of time. Use of free or pirated ware basically makes more people addicted to the software, so much so that it eventually forces them to buy the license under the TRIPS (e.g., MS Windows and MS Office). Microsoft's strategy is to load their software to any PC that installs its disk operating system (i.e., MS Windows), making piracy meaningless.

Third, mad technology defies the level of infrastructure investment in each country, because it can be disseminated to almost everywhere in the world, as long as there is a server, satellite hookups, and the phone line. Under the old NIS regime, it was clear that certain NIS policies caused the intended outcomes of the NIS infrastructure and the development of the IPS in Japan, South Korea, and Taiwan. Here, the level of the infrastructure development, especially, the availability of monetary stocks, was very important. However, the mad technology defies all that as it can be spread into poor countries without mature monetary or infrastructure bases. Anyone who has access to the Internet and credit cards can participate in software, thus knowledge property, transactions. This means that individual net users can be not only users but also learners of new technologies, they themselves eventually becoming disseminators of these new technological breakthroughs. The emergence of India and Ireland as forerunners of the Internet industries is a case in point. Examples are not just these two countries. Many underdeveloped countries and even least developed countries, like Vietnam, runs internet servers and networks, not that these countries had enough technological know-how or infrastructural bases, but that they could have easy access to internet technologies that foreign firms provided for relatively cheap prices. This point has never been dealt with properly by the scholars on the NIS. In the past, the state could target particular sectors and push selected elite students to learn new technologies (e.g., atomic bomb development, atomic energy development, etc.), even making poor countries members of the "formal" or "informal" nuclear club. Mad technology does not necessitate state intervention. Individual net users can easily turn into learners and creators of new technological know-how, creating their own networks of net users. We do not underscore the governments' efforts at supporting these online industries in India and Ireland, but the level of such support is minimal compared to the development of nuclear bombs.

Fourth, mad technology destroys the conventional network of industrial and technological hierarchies among companies. This does not mean that offline technologies are no longer effective in shaping and maintaining interfirm networks. What we emphasize here is that new online technologies, an exemplar of mad technology, intend to replace old interfirm networks with new online-based networks. The inauguration of business to business networks augurs the upshot of closely webbed business communities with free exchange of information and frequent participation in partners' decisions, especially in the matter of supply and procurement (e.g., B2B Just-In-Time Systems). Big buyers thus demand medium and small suppliers to comply with the system and software requirement of this new online technology, and if they cannot comply, then new supplier-finisher networks emerge. Global B2B networks that are being crafted by major market players thus require a new understanding of its purpose. The bottom line is that these are not to replace old networking technology with a new one, but to overhaul the traditional networks. The new players with new technologies will replace the old ones the big buyers want to ditch. That is, networking itself becomes a new market of mad technology.

Finally, mad technology encourages the development and spread of the so-called "casino capitalism." This concept is germane to the explanation of the changing financial systems in each developed country, threatening the tenacious resistance from the old financial establishments. Globalized stock portfolios and international currency trading were attributed to the birth of mad money and casino capitalism. Bankers are no longer conservative calculators of interests and investment options. They are now chain smoking casino game players sitting in front of computer monitors that are connected to internet servers (Strange, 1997, 1998). Their game partners are from all over the world, and they play 24 hours a day. Mad technology certainly boosts, if not causes, casino capitalism. Investment decisions in new R&D projects or internet-based ventures are no longer subject to the prisoner's dilemma game. Venture capital firms and individual "angel" investors now only calculate the timing of pulling their money out from the share markets, not calculating whether they should put their money in to begin with. The whole series of investing and divesting works like a casino game. It occurs in a short period of time, as if a successful R&D were not investors' immediate priority. Added to this madness of R&D investment is the growing phenomenon of individual day traders, popping up everywhere in local Internet cafes or their own office cells. Banning the use of the Internet for the purpose of stock trading in office spaces engendered employers' new demand for the invention of Internet supervising devices, so that they can monitor their office employees.

4. The Changing NIS in the Age of Mad Technology

Mad technology is a bottom up revolution that challenges the NIS in each country. Its momentum came from the Internet community that has been growing from the West Coast in America and challenging the existing NISs not only in East Asia but in the rest of the world as well. We discuss changes in the NIS, focusing on the NIS infrastructure and the PIS in Japan, South Korea, and Taiwan.

4.1 Mad NIS Infrastructure

Among the three countries, the South Korean government responded to mad technology with massive assistance in the venture sector, a market that never took off properly, compared to the Japanese small and medium firm networks or the Taiwanese family firm networks. In 1999 the total number of venture firms in Korea jumped to 4,256 from 2,042 in 1998, a 108.4% increase. In the same year, the total venture investment increased to over $400 million, an 84.5% jump from the previous year (National Statistics Office, 2000). This kind of overnight growth of one sector was rarely heard of in the previous periods, when investment and technology transfers took a long trajectory of time, energy, and planning. However, this change in South Korea augurs a new development in this region—all three countries are becoming similar in their NISs, especially, their infrastructures.

Indeed, the South Korean example only completes the already emerging image of East Asia as a breeding house of mad technologies. Japan's NIS infrastructure measured by investment in mad technology is only second to the U.S. (Kumon Shumpei, 1996). As we mentioned earlier, Taiwanese high tech firms are now demanding the government to keep away from their R&D investment decisions. The total number of the Taiwanese venture firms is only second to South Korea in the East Asian region. What is becoming similar in three countries' NIS infrastructures, if not NIS policies? First and foremost, all three countries seem now busy adopting a new NIS philosophy of "private trust of private R&D," a prototype Japanese system of innovation. But it is not a mere imitation of the Japanese NIS and its infrastructure, since the new private trust of private R&D is not for big companies, but for small, innovating, and internet-based private venture firms. It is a mixture of Taiwanese corporate size and Japanese corporate mind/brain with Korean style corporate muscles.

Second, the movement of monetary stocks in the face of the advancement of mad technology and mad NIS infrastructure is from the private hands to the private innovators. This again is different from the Japanese NIS infrastructure, in that the private hands are no longer banks and the private innovators are no longer big corporations. The network of private R&D investment includes innovators themselves, some angel investors, ventures firms in California or Kyoto, venture capital firms from all over the world, and individual stock holders who trade their stocks in the local internet cafe or on their own company PCs. These R&D investments are thus shaky and unstable with no long-term institutional or public-based commitment. Nonetheless, it creates enormous monetary value, unimagined in the past. The state can intervene in this new market, helping stabilize and institutionalize the financial basis of mad technology. The establishment of the mad technology industries expands the role of mad tech companies from mere software developers to investors themselves (e.g., Microsoft, Cisco, Softbank). Stock IPO is a catchword of these firms, again, a novelty in the industry. Unlike traditional R&D investment, the worries of piracy or other forms of free riding, as was discussed above, do not restrict mad technology investments. This is because the gambling characteristics of the mad technology investment, a point we discussed in the above. This will remain a strong advantage of mad technology in soliciting investors.

Third, people in the mad technology industry come from all over the world, another point that distinguishes it from traditional R&D firms, where nationality was very important. Internet networking, for instance, allows different groups of people to work together (e.g., 24 hour gambling or chatting) from different regions. The immediate supply of innovators comes from overqualified corporate workers who got sacked due to restructuring or downsizing, a Schumpeterian lesson most big corporations put into action in the 1980s in the U.S. and in the 1990s in East Asia. These people often have ties with U.S. educated scientists or have educational background in the U.S. themselves. The reliance on the national education system thus became meaningless in building the NIS infrastructure. The three countries thus have more technological reciprocity in their venture R&D development than before, when technological hierarchy in the form of product cycle clearly existed. The link between Yahoo.com, Japan Yahoo, Korea Yahoo, and Taiwan Yahoo is not purely based on a technological hierarchy. Their relationship is more or less an expansion of a computer network through more or less equal partners. They seem to share similar educational, ethnic, and cultural background (but not nationality). The emergence of Indian software and hardware technicians in the U.S. is another case in point. In this new industry, the traditional ceilings imposed on racial and ethnic differences seem not as important as it used to be.

4.2 Mad PIS

It is the mad PIS that will eventually destroy the sluggishness of the existing NIS. If any individual can generate information through accessing the Internet, the mobility and flexibility of such information will be great. In this sense, the mad PIS has an enormous space in which it can maneuver itself to generate highly mobile and flexible sets of information available for anybody who connects to the servers. This space is called the cyber space. This cyber space is the factory and the market of the mad PIS. The mad PIS provides an unlimited space for anyone who is interested in visiting and leaving ideas for innovation. A typical example is an interactive communication via web posting between web masters and web customers. In this newly emerging PIS, the distinct line between customers and innovators become thin. That is the number one similarity of the new PIS in Japan, South Korea, and Taiwan.

There are other similarities that are becoming more visible. First, all three countries enjoy high levels of interactive communications between innovators and end users. The individual motivation in participating in such communication is very strong, which can be gleaned from the popularity of all kinds of portal sites that popped up almost everywhere during the last five years in each country of our sample. Second, there is equally visible motivation among people to participate in the innovative activities, as gleaned from the number of between-job people who want to join venture firms or who stay online for a number of hours per day. Third, the rate of patenting and stock disclosure in these countries is almost as high as that of the Silicon Valley. Finally, protection of new knowledge and commercialization of new knowledge has never been more successful during the venture revolution in 1998-1999 than in any other periods of industrialization. Cyber space is protected by various security means, but most importantly, as we discussed above, it gains its commercial value only on free or semi-free transfers of new knowledge to any end user. Free riding creates commercial value, a business principle that could never have been understood in the previous years (the only exception was free airtime on TV or radio). It's like having passengers ride your bus for free to create more commercial value of your tourist bus. Based on this new principle, the cyber space in each country was flooded with the so-called Nintendo kids, all eager to exchange information for free. The engine of this type of private innovation comes from incorporating more investors and advertising agencies. Whether mad technology will institutionalize its financial basis is yet to be seen. We notice various kinds of information that seem to affirm that it will happen, although individual venture investors have many qualms in throwing in their money in the market, especially after the fall of Microsoft and other IT stocks in the NASDAQ. Nevertheless, mad PIS in Japan, South Korea, and Taiwan all espouse to be individualistic, small, and rich in ideas and investor networks.

Conclusion

This paper tried to put a finger on the relationship between the NIS and mad technology. The NIS itself did not provide the momentum for the development of mad technology. It came from abroad, as restrictions on R&D investment gradually disappeared due to casino capitalism and mad money. The NITR emerged about the same time when casino capitalism and mad money were seeking new investment markets, and investment in new technologies had all the characteristics of gambling due to their enormous risks. This, however, does not mean that mad technology is standing on a sandy pedestal. It has a strong technological know-how and innovative minds. Its vantage point is increased reciprocity through networking and the mobility and flexibility of its invention.

Japan, South Korea, and Taiwan had different NIS structures, deciphered from their NIS policies, infrastructures, and private innovation system, the PIS. Notably, Japan excelled Korea and Taiwan in all aspects, although its NIS outcomes had hidden problems in the areas of education, recruitment, and financial sectors. We called the Japanese NIS, a private trust of private R&D. South Korea overrode the prisoner's dilemma surrounding new R&D decisions through a system we called, a public trust of private R&D. Here, the potential of rapid growth and innovation was also possible, although the country suffered from a lack of creative minds, poor education, and a wobbly financial sector. Taiwan has never ruled out the prisoner's dilemma, as its system, which we called a public trust of public R&D, did not trust private R&D efforts. Nonetheless, the country demonstrated its ability in cultivating small firm networks to tap into the flexible consumer goods markets.

Changes from the global market, especially, the rise of casino capitalism, mad money, and mad technology, placed the NIS in these countries under siege. The state-led initiation of the NIS building in the past is now being gradually replaced by the PIS that is individually motivated, organized, and coordinated. The role the private monetary stocks play here is unwittingly grandiose, resembling the gambling establishments in Las Vegas, Monaco, or Macau. The future is yet to be written about mad technology and its hosting venture firms. But we can safely ascertain that the present predicament of the NIS in Japan, South Korea, and Taiwan needs to be resolved through incorporating the rise of these mad venture firms into their conservative, yet innovative, system—the NIS. Otherwise, these venture firms would seek their own ways of survival, of which it must include alliances between multinational venture firms with no national boundaries or identities. They are nationless, borderless, and identityless cyber space occupiers who only communicate with each other through domain names and aliases. It is time now we seriously considered the real potential of both online and offline development and transactions of mad technology with institutional emphases on the regulation of such ventures.

Acknowledgements: This research was supported in part by Royal Society of New Zealand (00-BRAP-26-OHI), the University of Waikato, and Yonsei University. We thank Fukagawa Yukiko, Douglas Ishizawa-Grbic, Eonoh Lee, Changsoo Kim, and Youngtae Kim.

References

Aberbach, J., D. Dollar, and K. Sokoloff (eds). 1994. *The Role of the State in Taiwan's Development*. New York: M. E. Sharpe.

Beauchamp, E. 1989. "Education." In T. Ishida and E. Krauss (eds), *Democracy in Japan*. Pittsburgh: Pittsburgh University Press.

Bell, D. 1960. *The End of Ideology: Under Exhaustion of Political Ideas in the Fifties*. New York: The Free Press.

Calder, K. 1989. "Elites in an Equalizing Role: Ex-bureaucrats as Coordinators and Intermediaries in the Japanese Government-Business Relationship." *Comparative Politics* 21.

Carlson, B. (ed.) 1997. *Technological Systems and Economic Performance: The Case of Factory Automation*. Boston: Kluwer Academic.

Chang, S. C. 1999. *National Innovation Systems and Development: Models and Policy Strategies*. Taipei: National Science Council.

Cheng, T. J. 1986. "Sequencing and Implementing Development Strategies: Korea and Taiwan." Paper delivered at the Conference on "Developmental Strategies in Latin American and East Asia." La Jolla, CA: Center for U.S.-Mexican Studies.

Cheng, T. J. 1993. "The State as Banker in Taiwan." In S. Haggard, C. H. Lee, and S. Maxfield (eds.), *The Politics of Finance in Developing Countries*. Ithaca: Cornell University Press.

Cheng, T. J. and S. Haggard. 1987. "Newly Industrializing Asia in Transition: Policy Reform and American Response." *Policy Papers in International Affairs* 31, Berkeley: Institute of International Studies, University of California.

Chiang, S. C. and R. Mason. 1988. "Domestic Industrial Structure and Export Quality." *International Economic Review* 29.

Chou C. F. and O. Shy. 1991. "A Model of Technological Gap, Product Cycle, and the Process of Catching up Between the North and the South." *Economic Record*, September.

Chu, Y. H. 1994. "The State and the Development of the Automobile Industry in South Korea and Taiwan." In J. Aberbach, D. Dollar, and K. Sokoloff (eds), *The Role of the State in Taiwan's Development*. New York: M. E. Sharpe.

Cohen, B. 1998. *The Geography of Money*. Ithaca: Cornell University Press.

Cole D. and Y. C. Park. 1984. *Hanguk ui Kumyung Balijon: 1945-1980.* Seoul: Korea Development Institute.

Cumings, B. 1984 "The Origins and Development of the Northeast Asian Political Economy: Industrial Sectors, Product Cycles, and Political Consequences." *International Organization* 38.

Elster, J. 1983. *Explaining Technical Change: A Case Study in the Philosophy of Science*. New York: Cambridge University.

Ernst, D. 1997. Technology Management in the Korean Electronics Industry: What Factors Explain the Dynamics of Change? Prepared for the conference on "Business Systems in the South," Copenhagen Business School, January 22-24.

Ernst, D. 1998. "Catching-up, Crisis, and Industrial Upgrading: Evolutionary Aspects of Technology Management in the Koreas Electronics Industry." *Asia Pacific Journal of Management*, 15 (2).

Fields, K. 1995. *Enterprise and the State in Korea and Taiwan*. Ithaca: Cornell University Press.

Gadbaw, R. and T. Richards. 1988. *Intellectual Property Rights: Global Consensus, Global Conflict?* Boulder: Westview Press.

Han, C. S. 1994. *Sobis Sanop Gaebang gwa WTO*. Seoul: Dasan.

Hong, Y. S. 1993. "The Japan's Strategy for Technology Transfer to Asia and Korea's Response." *KEIP Working Paper* 23, November. Seoul: Korea Institute for International Economic Policy.

Hong, Y. S. 1994. "Technology Transfer: The Korean Experience." *KIEP Working Paper* 3, November. Seoul: Korea Institute for International Economic Policy.

Ishida, H. 1993. *Social Mobility in Contemporary Japan*. Stanford: Stanford University Press.

Ishizawa-Grbic, D. 2000. *Network of Distrust: Explaining the Japanese Financial Crisis*. Unpublished Master's Thesis, Hamilton: University of Waikato.

Itami, H., T. Kagono, M. Miyamoto, and S. Yonekura (eds). 1998. Inobe-shon to Kijutsu Chikuseki. Tokyo: Yûhikaku.
ITRI, 1998. *Annual Brochure*. Taipei: ITRI.
Johnson, C. 1995. *Japan: Who Governs?* New York: Norton.
Kakurai, Y. (ed.). 1998. *Daikeisô Jidai to Kiseiganka*. Tokyo: Shinnippon Shuppansha.
Kam, W. P. 1995. *National Innovation System: The Case of Singapore.* Singapore: Science and Technology Institute.
Kang, C. K., J. Choi, and C. Chang. 1991. *Chaebol: Songchang ui Juyok inka Tamyok ui Hwasin inka?* Seoul: Bipong.
Kim, E. M. 1997. *Big Business, Strong State: Collusion and Conflict in South Korean Development, 1960-1990.* Albany: State University of New York Press.
Kim, L. S. 1993. "National System of Industry: Dynamics of Capability Building in Korea." In R. Nelson (ed.), *National Innovation System: A Comparative Analysis.* Oxford: Oxford University Press.
Kim, L. S. 1997. *Imitation to Innovation: The Dynamics of Korea's Technological Learning.* Boston: Harvard Business School Press.
Kim, S. R. 1998. "The Korean System of Innovation in the Semiconductor Industry: A Governance Perspective." *Industrial and Corporation Change* 7 (2).
Koo, H. 1993. *State and Society in Contemporary Korea*. Ithaca: Cornell University Press.
Koo, H. and E. M. Kim. 1992. "The Developmental State and Capital Accumulation in South Korea." In R. Appelbaum and J. Henderson, *State and Development in the Asia Pacific Rim*. Newbury Park: Sage.
Krugman, P. 1999. *The Return of Depression Economics*. New York: Norton
Kumon Shumpei. 1996. *Netizun no Jidai*. Tokyo: NTT.
Kwon, Y. and W. Song, 1998. "Chichok Chaesankwon Bohocheido." *STEPI Yonkyu Ch'oso, 98-1.*
Lee, K. O. 1977. *Shichang Kucho wa Dokgwachom Kyuchei*. Seoul: KDI.
Lee, K. U. 1994. "Ownership – Management Relations in Korean Businesses." In L. J. Cho and Y. H. Kim (eds.), *Korea's Political Economy: An Institutional Perspective*. Boulder: Westview Press.
Lee, K. U. 1996. *The Theory and Policy of the SMEs*. Seoul: Jishik Saneopsa.
Lie, J. 1998. *Han Unbound: The Political Economy of South Korea*. Stanford: Stanford University Press.
Lim, H. 1998. Korea's Growth and Industrial Transformation. London: Macmillan Press.
Lin, P. A. 1991. "The Social Sources of Capital Investment in Taiwan's Industrialization." In G. Hamilton (ed.), *Business Networks and Economic Development in East and Southeast Asia*. Hong Kong: University of Hong Kong.
Lundvall, B. 1992. *National Systems of Innovation: Toward a Theory of Innovation and Interactive*. London: Pinter Publication.
Makino, N. 1998. *Nihon no Kijutsu wa Madamada Tsuyoi*. Tokyo: PHP Kenkyûsho.
MITI, 1999. *Shiken Kenkyû Zeisei no Bappon Kaikaku ni Tsuite*. Tokyo: MITI.
MOEA, 1999. *1999 Development of Industries in Taiwan, ROC*. Taipei: MOEA.
Mukai, J. 1997. *Kinyû Bigguban*. Tokyo: Kôdansha.
National Statistics Office. 2000. *Gyongche Ilchi*. Seoul: National Statistics Office.
Nelson, R. and N. Rosenberg. 1993. "Technical Innovation and National Systems." In R. Nelson (ed.), *National Innovation System: A Comparative Analysis*. Oxford: Oxford University Press.
Nishiguchi, T. 1987. "Competing Systems of Automotive Components Supply: An Examination of the Japanese 'Clustered Control' Model and the 'Alps' Structure." Policy Forum Paper, International Motor Vehicle Program, MIT.
Nishiguchi, T. 1991. "Beyond the Honeymoon Effect." *INSEAD Information*, Summer.
Nishiguchi, T. 1994. *Strategic Industrial Sourcing: The Japanese Advantage*. Oxford: Oxford University Press.
North, D. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.
Oh, I. 1999. *Mafioso, Big Business and the Financial Crisis: The State-Business Relations in South Korea and Japan*. Aldershot: Ashgate.
Okumura, H. 1991. *Hoojin Shinhonshugi: Kaishahoni no Taikei.* Tokyo: Asahibunko.
Paik, I. 1994. *Hankuk Chaebol Kucho Kyocheian Yonku*. Seoul: Paiksan Sodang.
Saito, T. 1998. "Nihonpan Kinyû Bigguban to Kokumin Seikatsu." In Y. Kakurai (ed.), *Daikeisô Jidai to Kiseiganka*. Tokyo: Shinnippon Shuppansha.
Sell, S. 1998. *Power and Ideas: North-South Politics of Intellectual Property and Anti-Trust*. Albany: State University of New York Press.
Sherwood, R. 1990. *Intellectual Property and Economic Development*. Boulder: Westview Press.
Soh, C. R. 1997. *From Investment to Innovation: The Korean Political Economy and Changes in Industrial Competitiveness*. Seoul: Global Research Institute, Korean University.
Strange, S. 1997. *Casino Capitalism.* Manchester: Manchester University Press.
Strange, S. 1998. *Mad Money: When Markets Outgrow Governments.* Ann Arbor: University of Michigan Press.

Sung, S. 1994. *Kishul Hyokshin ui Kyung Bunsok*. Seoul: KDI.
Suzuki, Y. 1993. *Nihon no Kinyû Seisaku*. Tokyo: Iwanami Shinsho.
Tajima, Y. (ed.). 1994. *Kiseiganka: Ryûtsu no Kaikaku Bwijon*. Tokyo: NHK Books.
Tanaka, T. 1998. "Ryûtsu no Kiseiganka to Chûshôgyôsha, Jiyokushakai." In Y. Kakurai (ed.), *Daikeisô Jidai to Kiseiganka*. Tokyo: Shinnippon Shuppansha.
Tsuru, S. 1993. *Japan's Capitalism*. Cambridge: Cambridge University Press.
Wade, R. 1990. *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization.* Princeton: Princeton University Press.
Watanabe, O. 1992. *Kigyôshihai to Kokka*. Tokyo: Aokishoten.