Taiwan’s Industrial Policy since 1990

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I. Introduction

Taiwan, together with Korea, Singapore, Hong Kong were first recognized as newly industrializing countries (NICs) by Organization for Economic Development and Cooperation in 1979 (OECD 1979). More Asian countries were added to that list later on, including Malaysia, Thailand, and China. NICs distinguished themselves from the rest of developing countries by their fast pace of industrialization, which was believed to be driven by speedy capital formation (World Bank 1993). Some scholars (Rodrik 1995; Collins and Bosworth 1996) maintained that the ability of the government to accelerate capital formation beyond the normal pace dictated by the market forces explains the superior performance of NICs. For example, Rodrik (1995) argued that government interventions in Taiwan and Korea effectively removed coordination failures in the markets to enable rapid capital accumulation. However, judging from the historical data, speedy capital formation was not a consistent record throughout the history of Taiwan's economic development. For instance, between 1960 and 1970, when the export promotion policy was at its full swing, the average investment ratio (gross fixed capital formation divided by GDP) was only 18.0%. The investment ratio started to increase rapidly after 1973 when the economy entered the second stage of import substitution where heavy investments were made in the steel, petrochemical, and machinery industries. Between 1973 and 1982, when heavy industry dominated the investment scene, the average investment ratio was 27.7%. After that period of brisk investment, capital formation shifted to a low gear again. In 1984-1990, a period highlighted by trade liberalization and market opening, the average investment ratio went down to 20.0%. Whereas the investment sentiment had cooled, savings ratio remained high, resulting in ballooning excess savings. Entering

the 1990s, capital formation picked up the steam again. The investment ratio in 1991-2000 reached an average of 23.3%, higher than any other period in history except the “big-push” period of 1973-82. The investment ratio then sank again since 2001. The period of 1991-2000 can therefore be considered the second wave of “big push,” which was rarely researched and understood.

The study of this period will shed lights on how a NIC moved into a mature economy. After this “big push,” per-capita GNP of Taiwan rose from $8,982 in 1991 to $14,188 in 2000. It will be interesting to know how the effects of accelerated capital formation on economic growth in the medium-income stage differed from the same endeavor in the low-income stage. By comparing the experience in two episodes of “big push,” we may gain some insights about industrial upgrading at different stages of economic development. We conclude that the “big push” of the 1990s was essentially a push toward capital-intensive production, precipitated by massive foreign direct investment (FDI) since the mid-1980s. In other words, it was an FDI-driven capital formation. FDI created an opportunity for rapid capital accumulation at home, but there was little “upgrading” of the industry in terms of technology or value added. The main result of the big push was an increase in the scale of production, and concentration of the industrial structure. After this episode, diminishing returns set in and the Taiwan economy entered a decade of slow growth since 2000.

The government continued to push for capital intensive investments after 2000, targeting the industries characterized by large scale economies. Two industries stood out in this period: dynamic random access memory (DRAM) and liquid crystal display (LCD). The rise of these industries was closely related to the rise of China as the “world factory.” The government also designed policies to accommodate their huge capital needs. However, both industries encountered tremendous difficulties in establishing themselves in the world markets and one of them, DRAM, has collapsed

after the 2008 Financial Crisis.

II. The Big Push of the 1990s

Taiwan's manufacturing industry crossed a watershed in 1986 as the manufacturing share in GDP peaked at 37.5%, and that share was on the decline ever since. Beginning in 1986, Taiwan embarked on the course of foreign direct investment (FDI) which has not shown any sign of slow-down until today. However, beginning in 1991, the manufacturing industry entered a restructuring phase, characterized by rejuvenated capital formation at home. Overseas production staged by FDI precipitated and enabled the restructuring process back home. In essence, the labor intensive operations in the downstream industries were relocated overseas through FDI, and domestic investment was shifted to capital intensive upstream industries that linked to overseas production. For example, textile and apparel production was relocated overseas, creating a demand for textile fibers from Taiwan. Newly created overseas demand paved the foundation for investment on textile fiber production which is capital intensive, and is therefore consistent with the moving comparative advantage of the country.

Three industries dominated the scene of Taiwan's FDI since 1986, namely textiles, chemical products (including plastics), and electronics. All three were labor intensive industries which had constituted the mainstay of Taiwan's exports until then. They were forced to relocate overseas because of rising labor costs at home. Their upstream industries, namely chemical materials, electronics components and parts (particularly semiconductors), were the core of the domestic investment drive in the 1990s. It was essentially a backward integration process, just like what happened in the 1970s, except that integration occurred across borders this time.

Table 1 lists the changes of the stock of fixed capital in selected manufacturing

industries between 1991 and 2001, the years that industry census was conducted. It can be seen that the capital stock of the entire manufacturing sector increased 123.2% in the 10-year span. Out of all two-digit manufacturing industries, the electronic components industry recorded the highest growth rate in capital stock by 1009%, that is, an increase of roughly 10 times. In fact, the absolute amount of the capital stock in the electronic components industry also topped the manufacturing sector in 2001. This can be attributed to a few large semiconductor fabrication investments in this period. Along with the semiconductor industry, the electric & electronic industry and the ICT products industry also recorded rapid growth rates in the decade, at 392.6% and 187.0% respectively. Outside these three electronics-related industries, only chemical materials industry recorded an above-average growth rate in capital stock at 228.6%. The pace of capital accumulation in the rest of the manufacturing industry fell below par. For example, two stellar industries in the first big-push era, basic metals (mainly steel) and machinery industries saw their capital stock increased by merely 69.6% and 96.3% respectively in the decade, below the industry average of 123.2%. This suggests that the nature of the big push in 1991-2000 differed from that of the 1970s in terms of industry portfolio. This sets Taiwan apart from Korea in the post-NIC development. Both Taiwan and Korea pursued second stage import substitution in the 1970s with different degrees of success. Korea continued on the course of boosting the heavy industries and turned them into exports in the 1990s, a policy that Krugman (1984) termed “import substitution as export promotion.” Notable examples are steel, shipbuilding, and automobiles which have formed the cornerstones of Korea’s exports since the mid-1990s. In contrast, Taiwan stopped boosting the heavy industries in the early 1980s when the objective of import substitution was seen completed (Chen and Ku 1999). The fact that Korea stayed on the course of heavy industry drive while Taiwan disembarked explains why capital formation as a percentage of GDP remained

at a high level in Korea throughout the 1980s and stayed higher than that of Taiwan throughout the 1990s. Although Korean manufacturing firms also invested abroad since the mid-1980s, they did it to a much lesser extent when compared to their Taiwanese counterparts[1]. In short, while Taiwan's industrial development since 1990 was chartered by overseas production, Korea stayed on the course of export expansion by turning former import-substitution industries into export industries.

Taiwan's big push in the 1990s differed from the big push in the 1970s not only in terms of industry focus, but also in terms of sources of capital. In 1991-2000, private sector accounted for 63.3% of capital formation, while the public enterprises and government accounting for 13.3% and 23.4% respectively. In comparison, in 1973-82, the private sector only accounted for 52.6% of capital formation, while the public enterprises and government contributing 32.8% and 14.6% respectively. It is fair to say that the big push of the 1990s was driven by the private sector whereas the big push of the 1970s was driven by the public enterprises. It was also interesting to note that the role of public infrastructure investments by the government was actually more important in the 1990s than in the 1970s, contrary to the popular impression that the government was most active in infrastructure investment during the early rules of Chiang Ching-Kuo administration. In fact, government expenditures on public infrastructure were heightened in the 1990s, as a result of the aggressive "six-year national investment plan" launched in 1991.

The "six-year national investment plan," which was initiated in 1990, called for unprecedented massive government expenditures with a total budget of 8.2 trillion NT dollars over the 1991-1996 period, among which 3.1 trillion NT dollars were to be spent on infrastructure investments, 2.1 trillion NT dollars to be spent by public enterprises for capital expansion, and the rest went to social security programs and others. The plan was reminiscent of Chiang Ching-Kuo's famous "Ten Big Investment

Projects" in the 1970s, which set the stage for the first "big push." However, the "six-year national investment plan" did not fully materialize because of the fiscal constraints. Actual capital formation by the government in 1991-1996 totaled 2.5 trillion NT dollars, amounting to 81% of the initial plan; meanwhile actual investments by the public enterprises in the period totaled 1.4 trillion NT dollars, amounting to only 67% of the initial plan[2]. It indicated the weakening power of the state after democratization which began in the mid-1980s. In particular, the role of state-owned enterprises as a vehicle for capital formation had been severely hampered after democratization.

Therefore as far as the industrial policy is concerned, the episode of the 1990s can be seen as a market-led investment drive, at least close to be so, whereas the 1970s was typically a state-led investment drive (Wade 1990). The role of the state in the 1990s drive was limited to providing policy incentives with little discretion over the flow of investments. Two institutional developments underscored the changing role of the state from the 1970s to the 1990s: one is the maturity of market institutions, particularly those related to financial markets, the other is the receding role of the public enterprises. Two developments are inter-connected. Failures in financial institutions are often considered a justification for state interventions in early stage of economic development (Wood, Roberts and Wade 2003). As the financial institutions matured, the private sector could assume more investment risks which are intrinsic to capital intensive industries. Therefore capital intensive investments can be undertaken by private investors rather than public enterprises. Matured financial institutions also make it possible for the government to privatize the public enterprises.

III. Market institutions

Taiwan's financial markets were heavily regulated in the 1970s. The government

regulated the interest rates and owned most commercial banks. This allowed the government to direct the flow of funds. Private entry to the financial markets was allowed only in the areas of insurance, investment trusts and credit cooperatives, where limited licenses were granted to selected business groups. The government controlled the bank lending rates so as to make credit cheap, but less-privileged private enterprises often had to obtain funds from the informal financial markets at much higher interest rates (Shea and Yang 1990). Some scholars argued that the government should lower the official interest rates further so as to promote private investments (Wang 1973). However, the government decided to bypass private investors and relied on public enterprises as the policy vehicle to promote the second-stage import substitution. Indeed, given the high interest rates prevailing in the informal markets at the time, lowering official interest rates would probably only give the privileged borrowers more capital cost advantage without benefiting the disadvantaged borrowers. In other words, the main problem of the financial markets in the 1970s was the structure of the market, which was manifested by the inefficiency in the allocation of funds, rather than the level of interest rates. Imperfection of the financial market justified government interventions which were useful in encouraging savings and channeling financial resources into long-term investment (Stiglitz 1996).

Deregulation of the financial markets started to take place in the second half of the 1980s. The government first allowed commercial banks more flexibility in determining the interest rates, starting from the lending rates and then the deposit rates. By July 19, 1989 all interest rates were liberalized. At about the same time, 15 new licenses of private commercial banks were issued, and more licenses followed in later years. This broke the monopoly position of state-owned banks and ended the era of government-controlled credit allocation. Along with it, the interest subsidy

programs for export financing, which played an important role in Taiwan's SME-led export drive, were also terminated.

The major impact of the "big bang" financial liberalization in 1989 was the integration of the formal markets with the informal markets, or more precisely put, the penetration of formal financial institutions into the turf of informal markets (Wu and Hu 2000). The government relinquished its power to allocate credit, allowing the market forces to take the rein. The interest rates did fall after the financial deregulation, but only in nominal terms. Table 2 lists the interest rates prevailing in two periods of our interest, 1973-82 and 1991-2000. In the 1973-82 period, during which the policy of second-stage import substitution was implemented, the average bank lending rate for secured loans (loans that are secured by collaterals) was 13.15%. In 1991-2000, the average lending rate was 7.96%. However, inflation rates in the former period were much higher than the latter period. If measured by consumer price index, price increased by 181% in the former period and only 24.5% in the latter period, which can be translated into an annual inflation rate of 8.8% and 2.2% respectively. In other words, the real interest rate was only 4.35% on average in 1973-82, compared to 5.76% in 1991-2000. In other words, real interest rate actually increased after the financial market liberalization. This suggests that the government did not over-price the funds during the big push of the 1970s. In fact, it may have under-priced the funds, a typical phenomenon noted in the financial repression literature (McKinnon 1973; Shaw 1973). It also suggests that lower capital costs could not explain why a private-led investment boom was possible in the 1990s but impossible in the 1970s.

If credit did not become cheaper in the 1990s, then it must be the improved efficiency of credit allocation that enabled private enterprises to take charge in the big push of the 1990s. Without policy directives to credit allocation, which had prevailed

in the 1970s, banks were able to allocate funds in line with the market principles. However, despite the financial market liberalization, state banks remained the dominant source of funding after the entry of private banks, which were naturally more aggressive in seeking potential borrowers. The apparent beneficiary of heightened competition in the banking sector was small and medium sized enterprises which were previously discriminated in the formal loan markets (Shea 1983). State banks, however, continued to prefer large enterprises for lending. When policy loans and demand for funding from state-owned enterprises decreased over time as the role of state enterprises was confined and the privatization program ensued, state banks switched their love to large private enterprises. In the absence of policy loans, state-owned banks still took policy signals from the government as guidance for loan appropriation. Their favorites were large industry projects promoted or endorsed by the government. If these projects were to fail, the bank staff, who are public employees and liable to administrative penalty for misjudgment, could claim they followed the policy directions in aiding the industrial development of the country. Consortium loan became a popular format of lending where a number of state banks jointly finance a large project. Joint financing allowed the state banks to share the risks, and more importantly, allowed the bank staff to share the blame should the project fail. This explains why large investment projects in line with the policy directions enjoyed a preference in the liberalized bank loan market.[3]

Take the semiconductor industry as an example. Two pioneering semiconductor foundries in Taiwan, United Microelectronics and TSMC, were established and directly funded by the government in the 1980s, although both were organized as private enterprises and managed by professional managers. Since 1991, a series of new semiconductor foundries were established, including Macronix, Winbond, Powerchip, ProMos, and Nanya, none of which involved government funding. Large

private enterprises or venture capital provided initial funding to the companies, but all of them were heavily dependent on bank loans for working capital and subsequent expansions. The semiconductor industry was identified as one of the strategic industries under the Statue for Upgrading Industries which was promulgated in 1990. In 2002, it was officially targeted as one of the "Two Trillion" industries to be promoted.

In addition to bank lending, stock market also played an important role in the big push of the 1990s. After several decades of incubation, Taiwan's stock market eventually became a meaningful source of capital financing in Taiwan. Statistics collected by Taiwan's central bank show that in 1980, bank loans accounted for 74.5% of financing of business enterprises. In 1998, the share of loan financing had fallen to 51.6% whereas direct financing through stock and money markets increased to 48.4% (Yang 2001). Listing on the stock exchange became an effective means to raise funds, especially for expansionary investments. For industry in which replacement investment is critical to maintaining the competitive edge, equity financing is particularly attractive. Compared to the international benchmark, Taiwan's semiconductor industry was characterized by a higher ratio of capital investment and a lower ratio of R&D investment[4] (Ma and Lin 2005). The availability of low-cost capital from the stock market explains this characteristic. Low-cost capital allowed Taiwan's semiconductor foundries to continue to invest on new generations of equipment to stay on the frontier of fabrication technologies. Cost of capital was kept low by a promise of high growth potential. When investors were convinced by the prospect of rapid growth, they were happy to accept new shares as returns to their investment instead of cash dividends. This game continued until the prospect of high growth was no longer in sight. Therefore the newly emerged stock market was a natural ally of rapidly growing, quickly depreciating, and capital intensive industries

such as the semiconductor. As we will explain in the following section, this advantage was further reinforced by the tax incentives.

In spite of favorite conditions in the financial markets, state enterprises were inactive in making investments in the 1990s. The reason is political. As a result of democratization, it has become difficult for state owned enterprises to raise funds. Any capital expenditure plan of state owned enterprises had to clear the budget process of the parliament and it was considered a headache by government-appointed managers and the officials who oversee the enterprises. Unlike the private enterprises which engaged in new investments in order to exploit market opportunities, state owned enterprises pursued capital expenditure only out of absolute necessity as their role as a policy vehicle was relieved. Furthermore, a privatization program was implemented since the late 1980s, resulting in a declining number of state owned enterprises. By 2002, a total of 27 state owned enterprises had been privatized[5] (Wu, Sun, Hong and Lee 2003).

The case of state-owned China Steel illustrates the changing investment behavior of state owned enterprises. Established in 1971, China Steel undertook a series of capital expansion in the 1970s and 1980s to bring up its production capacity to 5.6 million tons by 1988. However, the final phase of expansion to bring the production capacity to 8 million tons of steel as originally designed was not implemented until five years later, 1993. The reason was that the executives of the company worried that the parliament might not like China Steel to grow too big so as to crowd out the private steel mills which were allowed to enter the market only after 1983. Instead of expanding the domestic capacity, the executives sought to invest abroad as a way of diversification but that budget was rejected in the parliament. In 1993, the executives finally presented an investment plan for domestic expansion and the parliament passed it with a substantial cut of the budget. In the meantime, privatization of the

company quietly began in 1989 through selling government-owned shares on the stock market. By 1995, China Steel was declared a private company as the government-held shares had been reduced to 30% of the total. Since then, China Steel entered a spate of capital expansions and diversifications at home, including the acquisition of one of its private competitors, Kwei-Yu Steel (later renamed Dragon Steel).

IV. Policy Environment

The big push of the 1990s was underscored by an industrial policy aimed at upgrading Taiwan's industry. Embedded in a new law conspicuously named "The Statue for Upgrading Industries," the policy focus was to upgrade the industry in terms of technology and value-added. In the initial version of "The Statue of Industry Upgrading," which was promulgated in 1990 and became effective in 1991, two types of incentives were provided: one is functional, the other is industry specific. Functional incentives covered R&D, personnel training, automation, environmental protection, and international branding. Investment in these categories was given a tax credit ranging from 5% to 20% of the related expenditure. The industry-specific incentives were awarded to "important" investment projects and "important" technology industries. A tax credit equal to 20% of the amount of capital expenditure was awarded to original investors against their business income tax or personal income tax. In a subsequent revision of the statute in 1995, these "important" investments were further provided with an option of five-year tax holiday for the forthcoming business ventures in lieu of tax credit for their original investors.

The introduction of functional incentives was a departure from the policy regime that underscored the big push of the 1970s (namely the "Statue for the Encouragement of Investment") where only industry specific incentives were provided. The idea was

to bar the government from picking the winners. The new law can therefore be considered a pro-market movement in terms of policy making. However, the law makers apparently did not fully trust the market as the industry-specific incentives were retained and later expanded. Industry specific incentives covered two types of "important" investments: "important" investment projects and "important" technology industries. The important investment projects were vaguely defined and were to be certified by Industry Development Bureau (IDB) on a case-by-case basis. The important technology industries were more transparent as they were clearly defined, specified in technical details, updated and published on a regular basis. For example, in 1991 immediately following the promulgation of the new law, IDB listed the following ten emerging industries as important technology industries: telecommunications, information, consumer electronics, semiconductor, precision machinery and automation industry, aerospace, advanced materials, specialty chemicals, medical and health, pollution abatement industry. Apparently these were strategic industries targeted by the techno-bureaucrats. It is noteworthy that none of the "heavy" industries promoted during the 1970s made the list. The list was updated over time, but most modifications occurred to technical details rather than the industry domains. For example, in 1998, two years before the law was to be over-hauled, nine of the ten strategic industries remained on the list, only the medical and health industry was replaced by "biotech" industry.

A common denominator for these two types of investment projects was capital intensiveness. According to the regulations issue by IDB, an "important investment project" had to satisfy the following conditions, among others, in order to obtain a certificate for tax incentives: (1) total capital investment exceeds 2 billion NT dollars, (2) the amount of investment in the project on machinery and equipment exceeds 1 billion NT dollars. A similar capital requirement applied to "important technology

industry," where the minimum capital expenditure is 200 million NT dollars and the minimum investment on machinery and equipment 100 million NT dollars. In other words, the project has to be big and entails a substantial amount of investment on machinery and equipment in order to qualify for tax incentives. In a nutshell, the policy incentive was aiming at promoting capital intensive investments.

In fact, IDB was given a policy agenda to promote large-scale investments since the promulgation of the law. In 1992, an investment promotion taskforce was organized within IDB with an objective to remove investment barriers to large-scale investments. Any investment project with capital expenditure exceeding 200 million NT might register with the task force, which would provide administrative assistance and track its progress until the project was implemented. The assistance included the provision of land, infrastructure (utilities, water, and roads), escorting through the environmental impact assessment procedures, importing foreign labor, etc. The official function of the taskforce was to remove "investment barriers." It seems that as a result of liberalization, the state could no longer dictate the resources allocation and had to set up a special taskforce in "assisting" the investors in overcoming the investment barriers, many of which erected by local governments or non-government organizations. Rodrik's (1995) theory of coordination failure continued to hold under democracy but it appears that the failure arose from the coordination between stakeholders who hold interests in the investment projects rather than from the coordination between market forces. In 1992-1998, a total of 1510 investment projects were tracked by the IDB taskforce with a total capital expenditure reaching 1.4 trillion NT (Liao 2007, pp.69-80). Unlike in the previous policy regime where IDB served as an incubator of new industries, under the new policy regime, IDB worked like a baby-sitter for large investment projects initiated by private investors. Private sector has become more assertive in the new policy regime, which carried a

strong bias toward large enterprises. This kind of bias did not exist under the previous policy regime of the Statute for the Encouragement of Investment where the major criteria to qualify for fiscal incentives of tax holiday or accelerated depreciation allowance were technological standards[6]. This explains why the post-1990 investment regime favored large investments.

As it turned out, most tax benefits conferred under the auspice of the Statute for Upgrading Industries went to reward capital expenditure rather than specific functions that were envisaged by the law as critical to industry upgrading, such as R&D, personnel training, and international branding. As previously mentioned, both investment credit and tax holiday facilities favored industries that required heavy start-up capital and frequent replacement investments. Theoretically if capital equipment fully depreciates in five years, a five-year tax holiday would make capital income completely tax free. In the semiconductor industry, for example, because of fast advancements in processing technologies, machinery and equipment used in wafer fabrication became obsolete in only a few years. The famous Moore's law asserts that the width of electric circuits embedded in a semiconductor chip is halved in every 18 months. It implies that in every 18 months, a new generation of technology will emerge, and along with it, a host of new equipment will be created. Frequent capital replacements reduced tax burdens through the benefits of tax holiday or investment credit. Because of tax benefits, Taiwan's semiconductor industry paid few or even negative taxes despite its high profitability[7] (Huang, Wang and Han 2004).

The reason that Taiwan's semiconductor industry was more willing to spend on capital investments than R&D investments can also be explained by the structure of tax incentives. Although the Statue for Upgrading Industries provided the same 20% tax credit to R&D and capital investments, capital investment was further given an

option of five-year tax holiday while R&D investment was not. The choice between tax credit and tax holiday was to be determined by investors before the investment project was implemented. Investors are more likely to choose the tax credit option when its current business was profitable but the new investment venture carried an uncertain prospect of returns. In contrast, a tax holiday option would be chosen if the new investment venture promised to yield a return higher than the current one. Therefore, a tax holiday favored the investment project with a prospect of improved performance on capital returns. If R&D and capital investments could improve the performance of the current business operation to the same degree, capital investment would be preferred because the option of tax holiday offered extra benefits.

The administration of tax incentives also mattered to the choice between R&D and capital investments. To qualify for industry specific incentives, the investors had to obtain a certificate of “important investment project” or “important technology industry” from IDB before the investment was implemented. In contrast, the application for R&D tax incentives was reviewed by the tax authority, Ministry of Finance, after the R&D expenditure had been incurred. The presumed R&D investment may not clear the bars set by the tax authority. The post-investment review process carried a risk which was absent in the case of pre-approved certificates.

Table 3 lists the actual tax benefits rendered under the Statue for Upgrading Industries in 1992-2002. The statute came into effect in 1991, and was applied to tax returns filed in 1992 for the first time. The statute expired in 2000, but was revised and extended for another 10 years until 2010. Tax holiday was not available until 1996, and was first applied to tax returns filed in 1997. Note that functional incentives for R&D, training, and branding were applicable to the current-year tax liabilities only whereas the tax credits given to “important investment projects” and “important technology industries” can be carried forward. This explains why tax holiday benefits

showed up only in later years.

It appears that tax credit given to investments on automation were most popular among different categories of incentives. Before 2000 when the law was revised, 15% tax credit was given to automation investment using machinery and equipment made domestically, 10% tax credit to those using imported machinery from foreign countries. There was no industry-specific restriction on the application of automation incentives. Therefore incentives on automation were essentially the incentives on capital expenditure for the industries that were not on the list of "strategic industries." Compared to the amount of tax credits given to investment on automation, tax credits given to R&D, training and branding were relatively small. In short, essentially all tax incentives came to reward capital expenditure.

Tax credit given to investors for investments on "important investment projects" and "important technology industries" were not especially large in early years but started to increase steadily in the second half of the 1990s. It is therefore fare to say that tax incentives under the auspice of the Statute for Upgrading Industries was not particularly distortive in terms of industry selection in the 1990s, although it generally favored capital-intensive industries. In other words, it carried a factor-intensity bias more than an industry bias.

However, a policy tool concurrent with the Statute for Upgrading Industries created a very strong industry bias in the 1990s, and even more so after year 2000. That was the science park facility. The first science park was established in Hsinchu in 1981, but it did not take off until the early 1990s (Chen 2008). Hsinchu Science Park went through three-phases of expansion in the 1990s. In 1997, the second science park was established in Tainan. According to the Statute for Science Park Administration, firms located in the science park automatically qualify for five-year tax holiday. In 1960-1990, tax holiday was also available to preferred industries under

the auspice of the Statute for Encouragement of Investment. As previously mentioned, tax holiday treatment was removed from the Statute for Upgrading Industries when the law was initially enacted in 1990, and was later restored by the legislators in 1995. In 1990-95, only enterprises located in the science parks enjoyed the tax holiday privilege. As the space of science parks was limited, entry to the parks was strictly controlled, and only "high-tech" companies were admitted. They became the exclusive beneficiaries of the tax holiday provision during this period. The Bureau of Science Park Administration, which controlled the business entry to the park, had a tendency to recruit investments in related industries so as to brew the cluster effects. Both Hsinchu and Tainan parks were overwhelmingly dominated by the semiconductor industry.

In the end, the policy environment in the 1990s was more conducive to capital expenditure than to industry upgrading. R&D investment did increase over time, but only at a very slow pace. R&D expenditure as a percentage of GDP increased slightly from 1.66% in 1990 to 2.05% in 2000. Business endeavor on personnel training and international branding was almost negligible. In other words, aside from automation, functional tax incentives did not produce significant effects. The failure of the Statute for Upgrading Industries to upgrade industries can be attributed to the following two reasons: (1) criteria of awarding tax benefits were often tied to capital expenditure, (2) the continuous existence of tax holiday outside the Statute in 1990-95 and the eventual restoration of tax holiday in the Statute after 1995 that overshadowed the functional tax incentives. Recognizing the failure of the Stature to promote R&D, tax credit given to R&D investments was increased in the revision of the Statute in 2000. Investment tax credit and tax holiday were retained after heated debates in the legislature. However, investment tax credit accrued to individual investors was to be reduced over time by 1% (beginning with 10%) every two years. The category of

"important" investments was removed from the law, the category of "important" technology industries was renamed "newly emerged important industries."

V. Market conditions

The big push in the 1970s was import substitution in nature. It was an attempt to replace upstream materials and capital equipment that were previously imported from advanced countries. The major policy tools to promote import substitution were import restrictions, particularly by means of import licensing and quota controls. Previous studies (e.g., Chen and Ku 1999) have shown that import substitution was more successful in the areas where Taiwan occupied a more significant share in the world's export market for the downstream products. It suggests that scale in the downstream industry and the associated buying power is a precondition for import substitution in the upstream industry. This is not surprising because the industries intended for import substitution, such as steel and petrochemical industries, require large fixed investments.

In contrast, the big push in the 1990s was intrinsically export expansion. However, there was a policy disjoint between import substitution and export expansion. The transformation from import substitution to export expansion was not made possible by industry upgrading, such as a collective increase in productivity of the upstream and downstream industries combined. Instead, it was FDI wave which began in the mid-1980s that paved the way for the export expansion. For example, textile fibers were exported to where Taiwanese firms established overseas production of apparels and fabrics. Plastic materials were exported to where plastic goods were made, and electronic components were exported to where computers were manufactured. Lower costs in overseas production enabled Taiwanese firms to capture a larger share of the world market, which in turn, provide a stimulus for the expansion

of upstream materials in Taiwan. In short, it was production relocation rather than productivity improvement that drove the export expansion. Although Taiwan's market shares in the related industries increased following FDI, it was achieved by cost reduction rather than productivity increase. It was the scale in the downstream industry that provided the impetus for investment expansion in the upstream industry. What happened to the upstream industries was also an increase in scale. There was little force to pull for industry upgrading. In other words, the big push of the 1990s was a scale-up process, which consumed more capital than labor at home, but scale-up may not result in competitiveness. More importantly, in the areas where scale-up do lead to better competitiveness, Taiwanese industries lost to Korea which had a competitive edge in scaling-up. We will discuss this issue in the later sections, with reference to the DRAM and LCD industries.

Unlike the big push in the 1970s, trade policy played virtually no role in the big push in the 1990s. In fact, this was the time when Taiwan was negotiating for the entry to WTO (formerly GATT) and had to lower tariffs and remove import restrictions in all commodity categories. The room for trade protections was totally eliminated. Fortunately, Taiwan's FDI had a tendency to locate in a host country which offers export incentives such as the rebate of customs duties on imported materials that are processed for exporting. This kind of policy arrangements allowed Taiwan's upstream industries to be freely connected with downstream operations in overseas locations. Consequently, an FDI-export nexus underscored the big push in the 1990s. This stood in sharp contrast with the Korean model where expansion in the upstream industries, such as steel, DRAM or LCD, was driven by the expansion of downstream exports from Korea in the form of automobiles, ships, cell phones and TV receivers.

This FDI-export nexus also implies that Taiwan's exports will only expand in

countries whose wage rates were lower than Taiwan's as FDI was concentrated in low-wage countries. This was exactly what happened since the mid-1980s. Low-wage countries such as China and those in Southeast Asia accounted for increasing shares of Taiwan's exports, whereas high-wage countries such as US and Europe saw their market shares declined[5]. In the export expansion period up until 1986 where advanced countries were the main destinations of Taiwan's exports, the export learning effects were evident (Chuang 1993). It was unlikely that exports to low-wage countries would have produced similar effects.

Theoretically, vertical integration can make production more efficient through interflow of knowledge or improved coordination in the production process. However, vertical integration was achieved through cross-border connections where both knowledge exchange and production coordination were impeded by distance. This was different from the episode of the second stage import substitution where newly established upstream industries were co-located with downstream operations at home. It was also different from the Korea experience in the 1990s where vertically related industries were co-located at home. For example, Korea's steel industry was co-located with the home-based automobile and ship-building industries; Korea's semiconductor industry was co-located with the consumer electronics industry. Automobiles, ship-building, and consumer electronics spear-headed Korea's export drive since the early 1990s. Co-location was conducive to knowledge spillovers (Audretsch and Feldman 1996). Compared to Korea, Taiwan's industrial structure was less vertically integrated and characterized by more diversified exports (Feenstra, Yang and Hamilton 1999). As a result of FDI, Taiwan's industry also became vertically integrated, only across borders, and consequently its export structure became more concentrated.

Whereas the vertical integration across borders failed to engender forces for

upgrading, the reallocation of industries to low-wage countries also failed to improve the overall productivity of the economy. Theoretically, when operations characterized by lower labor productivity are relocated to overseas, value added per worker increases automatically. This is supposedly what happened to FDI. However, the supposition is only true if resources left in low-productivity sectors can be fully transferred to high-productivity sectors. Unfortunately this was not the case. Labor discharged from the sectors that were relocated abroad was not fully absorbed by the expanded sectors at home. This can be seen from the following statistics. Taiwan's manufacturing employment reached a peak in 1987 with 2.82 million workers and was on a continuous decline until 1996 when it bottomed out at 2.42 million workers. Since then, manufacturing employment slightly rebounded and climbed back to 2.66 million in 2000. In other words, in 1987-1996, the heydays of FDI, at least 400,000 manufacturing jobs were displaced. This was in sharp contrast with the big push of the 1970s when investments in heavy industries created a large number of new jobs. Manufacturing employment rose from 1.42 million in 1973 to 2.17 million in 1982, an increase of 53%. In the 1970s, the upstream and downstream industries expanded simultaneously. In the 1990s, the upstream industries expanded while the downstream industries shrank.

It was obvious that newly emerged industries in the 1990s did not create enough jobs to absorb displaced workers, who had to seek employment in the service sector or stay unemployed. In fact, most displaced workers were reemployed in the service sector rather than unemployed. This can be judged by the evidence that unemployment rate did not significantly increase since FDI took off. Take 1986 as the bench mark when unemployment rate was 2.7%. Since then, unemployment rate never exceeded this level until it hit 2.9% in 1998, the year that the Asian Financial Crisis erupted.

Therefore it is the combination the following factors that explain the lack of productivity improvement after FDI ensued: (1) newly emerged capital intensive industries did not create enough jobs to replace jobs lost due to FDI, (2) labor productivity in the service sector was generally lower than the manufacturing sector and that gap was not closed over time. This suggests that factor substitution in the manufacturing sector whereby labor intensive industry was replaced by capital intensive industry was not sufficient to enable an overall industrial upgrading. Something needs to be done in the service sector, if "upgrading" is to succeed.

VI. The Post-2000 Era: Two Trillion Industries

In the 2000 amendment of Statute for Upgrading Industries, investment credit and tax holiday incentives were retained for the so-called "newly emerged important industries." Immediately following the amendment of the law, IDB published the list of newly emerged important industries. Eight industries made the list: 3C (semiconductor, computer, and communication products), precision electronics (including LCD), aerospace, biotech and special chemicals, green technology, advanced materials, and technological services. The list was not much different from the strategic industry list of the 1990s. Only green technology and technological services were new faces. The list was updated over time, but like in the previous decade, the industry domains were little changed. In 2006, the nano technology was added to list whereas the original eight industries remained intact.

In the decade following the amendment of the Statute, the semiconductor industry and LCD dominated the investment scene until the Statute was repealed in 2010. The ratio of gross capital formation to GDP in 2001-2010 was lower than that in the decade before, but these two industries stood out as the main attractions of domestic investments. In addition to FDI factor, the rise of China as the world factory

provided the momentum for investments in these two industries. Taiwanese personal computer industry began to invest in China in the mid-1990s. Taking advantage of cheap and massive labor in China, Taiwanese contract manufacturers had come to dominate the world production of PCs and the peripheral products by the early 2000s. This provided the business opportunity for all sorts of integrated circuits (ICs) and display devices.

As previously mentioned, Taiwan had developed a couple of semiconductor foundries by the mid-1990s. These foundries specialized in logic ICs, taking orders from a spectrum of fables IC design houses. The boom of the semiconductor industry in the 2000s was mainly driven by DRAM manufacturing, which also copies the foundry services model of logic ICs. The DRAM boom was fueled by ultra low interest rates which prevailed in the 2000s, coupled with tax incentives that encouraged capital expenditure. As shown in Table 2, the average interest rate in 2001-2010 was 3.79%. The average inflation rate, as measured by CPI, was 0.95% in the decade. This gave an average real interest rate of 2.84%, much lower than 5.76% in the 1990s. The boom was further accommodated by Japan's "lost decade" which prevented the Japanese DRAM producers from making new capacity investments in the generation of 12-inch wafer fabrication. Japanese producers were forced to outsource from Taiwanese foundries by licensing their technologies. With easy technologies and easy money, Taiwan's DRAM industry went through a spree of capital expenditure.

In 2002, the government declared DRAM and LCD as "Two Trillion" industries to be targeted for promotion. However, the main tax incentives were already slated in the Statute for Upgrading Industries. Following the declaration, IDB set up a "semiconductor office" to coordinate R&D, personnel training, and investments. Public finding was channeled into semiconductor research. A national R&D project,

named “Silicon Island” was launched in April 2002 to spearhead the research on system on chips (SOCs). More important, special funds were provided to major universities to expand the graduate programs related to the semiconductor technologies. As a result of DRAM boom, a shortage of engineers in the related fields was felt by the industry. The government also initiated a new human resources program whereby graduate students could opt to work in the semiconductor industry as a substitute for the mandatory military services. It indicates that the expansion of the semiconductor industry has exceeded the limit of the nation’s human resources pool. It was only natural that the DRAM manufacturers chose to license foreign technologies rather than conducting their own R&D.

The story of LCD was similar to DRAM but different in business models. The LCD was kicked off by licensing technologies from Japan in the late 1990s and boomed in the early 2000s. The industry was initially driven by the growth of flat-panel computer monitors, and later by notebook computers. Like the DRAM industry, rapid capacity expansion of the LCD industry in the 2000s was fueled low interest rates, favorable tax treatments, and the inability of their Japanese licensors to invest in new factories with ever-increasing panel sizes. Beginning in 2005 or so, the industry also benefited from increasing demand from China for large-size flat panels to be used in making TV receivers.

The LCD industry is a typical upstream industry of the PC and TV industries, just like what chemical fibers are to the textile industry. It had to conduct its own R&D, especially when their Japanese counterparts stop building the new generations of factories. The LCD industry gradually accumulates indigenous technologies. Nevertheless, like the DRAM industry, scale economies prevailed in the LCD industry and when the panel size increases, a larger capacity scale is needed to make efficient production. Before the Chinese LCD makers entered the industry in the late

2000s, Taiwan engaged Korea in a capacity race as the panel size increased from 32 inches to 57 inches. The fixed capital stock of Taiwan's photo-electronics industry (mainly LCD) increased from 264.0 billion NT in 2001 to 1,245.6 billion NT in 2006, an increase of 4.7 times in nominal terms. In the course of the competition, the number of firms decreased through merger and acquisition.

The 2008 financial crisis spelled an end to the ever-expanding DRAM and LCD industries. The developments following the financial crisis clearly indicated that Taiwan's DRAM industry was not competitive, although their manufacturing capacity might still be needed when the world demand exceeded the capacity of three surviving producers, namely Samsung, Micron, and Hynix. Meanwhile, the verdict on Taiwan's LCD industry was less clear. The fact that Taiwanese LCD makers performed relatively poorly compared to their Korean counterparts seemed to suggest that they had lost on the account of upstream and downstream linkage. This weakness might not be fatal, however. Taiwan's LCD industry still rivaled its Korean counterpart in connecting to the ICT industry, although it was apparently disadvantaged in the TV receiver industry. But even the latter was not insurmountable, as non-Korean TV makers might prefer to form strategic alliances with Taiwanese LCD producers if they could offer competitive products. More importantly, as a medium of image display, LCD may find other applications in the future. The fundamental question is whether it can offer innovative products so as to enable innovations of its downstream users.

VII. The Myth of Scale

The industrial development since 1990 achieved two things for Taiwan's industry: scale and vertical integration, which were uncharacteristic of Taiwan's industrial structure in the past. Taiwan's manufacturing industry has become more concentrated,

meaning that large firms accounted for a larger share of industrial output and exports. The traditional roles of SMEs have receded. Amsden and Chu (2003, pp. 7-10) argued that the advantage of scale is most prominent for a late-comer in the high-tech industries. As a later-comer, scale not only offers an advantage in the traditional sense of lowering unit cost of production, but also offers an advantage in information gathering, signaling, and transacting with first-moving firms in advanced countries. They called this advantage the “second mover” advantage. This term is coined to contrast with the “first mover” advantage of scale brought up by Schumpeter (1942). According to Schumpeter, scale creates advantages in three regards: production cost, innovation, and global production. We shall argue that, as a second mover, the advantage of scale is not clear in the areas of innovation and global production; it only serves the purpose of cost reduction. When cost is the only advantage of scale economies, this advantage is hard to sustain because the underlying operations do not generate enough profits to keep up with new investments needed to maintain the scale advantage.

Let us look at innovation first. Schumpeter suggests that scale advantage gives rise to a dominant market position, which in turn, provides economic rent to afford expensive R&D investment. R&D leads to innovations, which sustain the market position of the dominant firms. This reasoning does not apply to the second mover. Taiwanese firms gained scale economies and market position mainly in matured industries where production cost was the foundation of competition. They were more inclined to investing in automation equipment to reduce production costs than investing in innovations. At best, they invest in process innovations, the purpose of which was primarily for cost reduction rather than value enhancement.

Second, let us now look at globalization. When Schumpeter talked about the advantage of scale in global production, he referred to the advantage of managing a

network of global marketing and distribution operations. Indeed, scale is also important to the second movers who serve as global partners to “flagship” companies in the industry. As globalization proceeds, the ability to offer global services often becomes a precondition to participating in a global production network (Chen and Liu 2000). However, while scale allows firms from late-industrializing countries like Taiwan to assume more risks in global operations (which they called it global logistics), it does not enable them to access strategic assets in the host countries. As contract manufacturers, their FDI was essentially efficiency seeking and they mainly made use of non-strategic resources, such as labor, in the local economy. Without access to strategic resources, such as local knowledge base and marketing networks, FDI did not offer valuable resources to upgrade the capabilities of the parent companies. Globalization by Taiwanese subcontractors only secured their subcontracting positions in the global production networks instead of enabling them to upgrade themselves in the global production networks.

In short, although Taiwan’s industrial development since 1990 was characterized by up-scaling just like the advanced countries entering the matured stage of industrialization, up-scaling does not equal upgrading. Large firms in Schumpeter’s world are associated with some kind of intangible assets which yield economic rents. They command market power, which is conferred as a result of surviving the competition in a matured industry. Taiwan’s large firms hold little market power. They are no Dow and Du Pont in Chemicals, or GM and Toyota in automobiles. They are large because scale has become a precondition to market entry in their business domains. There is no economic rent to go with their big size. Neither is there an inclination to innovate to sustain their dominant market position. Therefore scale is a burden to Taiwanese firms rather than an advantage.

Take DRAM as an example, Taiwanese firms provide foundry services based on

their cost advantage. Their production scale is as large as the rest of the industry, but lack of innovations limits their profitability, which in turn, limits their R&D. Lack of R&D forecloses innovations. Taiwanese DRAM industry was therefore trapped in a vicious circle. When they ran out of funds to invest on new capacity, their role as a foundry service provider also finished. In contrast to the DRAM industry, TSMC was typical of the Shumpeterian dominant firms with scale economies.

The LCD industry was also characterized by ever-increasing scale economies. Its fate may be different because its business model is different from the DRAM industry. However, innovations are even more critical to the LCD industry as its value depends on whether it can enable downstream users to innovate. Without innovations in the downstream industry, cost competition prevails, and the LCD industry will enter the same destiny as DRAM. Innovation-enabling is the key mission of the upstream industry, and scale appears to be a precondition for fulfilling this mission. Compared to the DRAM industry, there are also more opportunities for product differentiation in LCD as new technologies and new applications continue to emerge.

So why were the policy makers so keen on promoting large-scale investments since 1990, given that SMEs had been the main vehicle for Taiwan's export drive up until the late 1980s? The policy makers seemed to have ignored the maturity of Taiwan's financial market and continued to believe that sharing the investment risks with private investors was a right thing to do. This belief was reinforced by the fact that state-owned enterprises could no longer serve as a policy vehicle for the formation of new business ventures as they did in the 1970s. The provision of investment credit to original investors of new ventures in the strategic industry, as instituted in the Statute for Upgrading Industries, was justified on the basis of risk sharing. The policy makers seemed to believe that private sector could bear the risk of small-scale investments, but not the large-scale ones. In the World Bank report on the

East Asian miracle, the inability of capital market to finance large-scale investments was considered a major justification of government interventions in East Asia (World Bank 1993, p.92). Limiting fiscal incentives to large-scale investments was also consistent with the concept of limiting government interventions in accordance with the market liberalization policy that had been adopted in the mid-1980s. Moreover, the policy makers were keen to encourage investment given that the fact that investment ratio (gross capital formation to GDP) had remained at low levels throughout the 1980s. The category of "important investments," which could be applied to "low-tech" industries, was specifically created for the purpose of accelerating capital formation. Policy makers were unaware of the fact that Taiwan's financial market was mature enough to shoulder the risk of large capital commitment by the 1990s. The real risk of the emerging industries was associated with the development and application of emerging technologies rather than capital investment. What needed were fiscal incentives that encourage risk taking in R&D and technology acquisition. Fiscal incentives designed to encourage investments with a scale bias led to overinvestment in large scale production using matured technologies.

The scale bias was further exacerbated by the advancement of globalization since 1990. Scale became a precondition for global production. Policy incentives, coupled with globalization, produced a new trend of industrial development which was unfamiliar to Taiwan. The pursuit of scale not only led to diminishing returns, loss of job opportunities, but also concentration of industrial activities in the ICT sector. The industrial development has gone beyond the limit of the nation's supply of engineers and therefore cannot be sustained.

VIII.Comparison with Korea

Korea went through a similar import substitution drive in the 1970s to develop

its heavy and chemical industries (HCIs), with similar policy tools such as tax incentives and import protection. This policy led to a serious balance of payments problem as resources were diverted from the traditional export industries to HCIs (Krueger 1990). The policy was reversed in the early 1980s. The scope of tax incentives was substantially cut back. Effective as of June 1982, the list of strategic industries eligible for tax preferences was reduced from 14 to six, namely naphtha cracking, steel, industrial machinery, electronics, shipbuilding, and aviation industry. Tax holiday was abolished; only accelerated depreciation allowance and investment credit were retained for the aforementioned strategic industries (Smith 2000, p.102). Later on, a series of tax reforms was made to replace the industry-specific tax incentives with functional incentives. First functional incentive was introduced near the end 1980s to encourage R&D. Three kinds of tax benefits were provided to R&D investments. The current R&D expenditure was eligible for a 10% tax credit; capital investment in R&D equipment was eligible for investment tax credit or accelerated depreciation allowance; finally, current corporate profits can be set aside as a reserve fund for future R&D expenditure (Smith 2000, p.102). Later on, a special tax incentive was offered to encourage the establishment of small and medium enterprises (SMEs), taking the form of tax holiday and an income tax credit for individual investors. More functional tax incentives were added to the tax law in the early 1990s: tax credits were provided to capital investment that enhances productivity, conserves energy, improves safety of workplaces, or protects environment. After the Asian Financial Crisis of 1997, a new tax incentive was introduced to encourage foreign investment. Today, the functional incentives for R&D, SMEs, preferred capital investments related to productivity, energy-saving, safety, and environmental protection, and foreign investment remain the core structures of Korea’s tax preferences for industrial development.

Compared to Taiwan, the Korea government appeared to be more committed to market-led industrial development since the 1980s. Tax incentives offered by the Korean government appeared to be neutral to industry selection. SMEs were promoted to dilute the market power of the chaebols. Concurrently, both tariffs and non-tariff trade barriers were lowered to encourage import competition. Financial market was liberalized and state-owned banks were privatized. Some argued that the Korean government liberalized the markets but failed to tame the chaebols who retained the power to monopolize the markets (Kim 2001).

Despite the dramatic policy changes, Korea stayed on the path of rapid capital formation after the government abandoned the HCI drive in the early 1980s. Fixed capital formation as a percentage of GDP averaged 28.44% during the HCI drive (1973-82); it increased to 30% in the period of 1983-90, and further increased to 34.17% in the 1991-2000 period despite the setbacks during the 1997-98 Crisis. Chaebols, who had preferred access to capital, were the main drivers of rapid capital formation. Unlike Taiwan where the industrial sector saw its share in the economy decreased drastically in the post-1986 period, Korea's industrial sector remained dominant. In 1986, manufacturing sector accounted for 28.3% of GDP, that share decreased slightly to 26.6% in 1990, but it recovered to 28.3.0% in 2000. Although Korean firms also invested abroad since 1986, the amount was relatively small and there was no apparent industrial "hollowing-out" phenomenon parallel to Taiwan.

Since 1990, Korea has outperformed Taiwan in terms of capital formation. In 1991-2000, the average fixed capital formation as a ratio of GDP was 34.17% for Korea, far ahead of Taiwan's 24%. The speed of capital formation in Korea kept accelerating since the 1970s, while that of Taiwan went down in the 1980s before it picked up again in the 1990s. The persistence of the pattern of rapid capital formation in Korea can be explained by the role of chaebols whose dominance was actually

enhanced when the government loosened its control of the market. Since the 1980s, the Korean authorities have attempted to restrict the policy favors to the chaebols and to demand greater specialization in chaboel's activities without success (Kim 1997, Lee 1997). However, financial market liberalization actually enhanced the ability of chaboels to obtain financial resources (Chen and Ku 2000). In addition to domestic financial resources, chaebols also obtained financial resources from international markets, with an implicit government guarantee. Although the Korean government successfully contained the run-away inflation in the 1980s, credit costs remained relatively low in Korea until the Asian Financial Crisis broke out in 1997. In 1987-96, the average lending rate in Koreas was 9.63%, while the average inflation rate was 6.03%. This gave a real interest rate of 3.6%, much lower than the level of Taiwan in the same period (See Table 4).

Korean chaebols served dual functions in the course of industrialization: they performed import substitution and export promotion at the same time. The Korean government offered import protection to these companies under the condition that they achieve a certain export performance target (Amsden 1989). By contrast, in Taiwan, import substitution and export promotion were performed by two distinctive groups of firms. In the 1990s, Korean chabols started exporting steel, automobiles, chemical materials which were previously protected under the HCI regime, whereas their Taiwanese counterparts remained largely domestic market oriented.

Chaebols also had a tendency to pursue vertical integration as they engage in large scale production and had easy access to capital. Vertical integration gave an advantage to the upstream industry when the downstream industry is volatile. For example, the Korean LCD industry benefits from vertical integration when the downstream users of TV makers are susceptible to business cycles. With vertical integration, the LCD industry enjoyed a stable income flow which allowed it to

maintain a steady stream of R&D expenditure.

Since 1990, technology has become the major barrier of entry to the high growth sectors for both Taiwan and Korea, therefore R&D pivotal in industrial competition. R&D expenditure is indeed characterized by scale economies, and therefore the R&D tax incentives naturally benefit large firms more than small firms. In 1990, Taiwan spent 1.67% of its GDP on R&D, almost the same level as Korea's 1.68%. In 2000, Taiwan's R&D ratio increased to 2.05% while Korea's ratio increased to 2.30% (See Table 5). With similar tax incentives offered, the Korean R&D incentive program appeared to be more effective than the Taiwanese one, probably because of the difference in business structure.

When globalization forced Taiwan to separate its downstream from the upstream industries, Korea was able to maintain both downstream and upstream industries at home. The presence of both upstream and downstream industries at home produced two benefits: First, there was a technological spillover from the upstream industry to the downstream industry, encouraging R&D investments in the upstream industry. Second, more employment is generated from each dollar of capital investment as the downstream industry is relatively more labor intensive. These explain why Korea's upstream industries were more active in R&D, and why Korean wage rates increased faster than Taiwan after 1990. Because both upstream and downstream industries were exporting, exports as a ratio of GDP increased rapidly in Korea since 1990. In 1990, Korea's export of goods and services was 29.1% of its GDP, that ratio increased to 44.8% in 2000, and further to 59.0% in 2010. In two decades, Korea's export ratio doubled. The value of its exports also rose from an amount close to that of Taiwan to twice of that.

IX. Conclusion

Rodrik (1995) argued that government interventions in Taiwan and Korea were justified because of coordination failures in the market, which in some occasions, was caused by the inability of the market to foster a large scale of production to meet the efficiency demand in the modern sector. Therefore the government intervened through credit allocation, credit subsidy, or establishment of public enterprises to guarantee an efficient scale of production in the modern sector. This argument, while valid for Taiwan of the 1960s and 1970s, was no longer valid in the 1990s. Financial institutions were mature and credits were no longer in short supply. In fact, domestic savings were in excess of domestic investments in most years that the surplus had to be absorbed by outward investments. The experience of Taiwan in the 1990s showed that matured private financial institutions had no trouble funding large scale production. In fact, they had an inherent bias toward funding large investment projects because large projects entail lower information costs. This bias was exacerbated by the policy incentives that favor large-scale capital expenditure. If the government of Taiwan had been right in correcting market failures in the 1960s and 1970s as Rodrik had suggested, it must have been wrong in the 1990s by doing the same thing.

Both the private sector and the government in Taiwan seemed to have been misled by an obsession over scale. The “big push” of the 1990s can be characterized as up-scaling without upgrading. The reason for Taiwan to fall into this trap was the permissive policy environment that lavishly reward scale expansions without due attentions paid to value enhancement. Both the financial sector and private investors welcomed the policy. By scaling-up, Taiwan secured its position in the global production chains. Large scale indeed improved efficiency of production, but it did not bring more innovations and better access to international strategic resources. It seems that scale does not confer an advantage to late comers in the industry. As a result, Taiwan was locked in a state of endless cost-competition by engaging in

ever-increasing amount of capital expansion. This took up a large share of Taiwan's resources, including capital and human resources, but failed to generate a higher value for the economy. We can simply say that Taiwan's industrial policy since 1990 has missed its goal of upgrading Taiwan's industry. It only resulted in an up-scaling of the industry.

Outside the large-scale industries, the policy makers did attempt to promote other types of industries, such as biotechnology and software (digital content) industries where scale economies are not evident. On the contrary, both industries require intensive R&D and innovations. Apparently, the tax incentives given to R&D investment within the purview of the Statute were not sufficient to incubate such innovative industries. To avoid repeating the failures of the last two decades, we have to figure out what is lacking in the industrial policy when innovation is to be promoted.

Table 1

Fixed Capital Stock in Selected Manufacturing Industries, 1991, 2001

Unit: billion NT dollars

Year/Industry	Total	Chemical materials	Chemical products	Basic metals	Machinery	Electric & electronic machinery	ICT products	Electronic components	Transport equipment
1991	3,375	227	99	306	187	461	169	142	191
2001	7,534	746	139	519	367	2,271	485	1,575	271
Growth (%)	123.2%	228.6%	40.4%	69.6%	96.3%	392.6%	187.0%	1009%	41.9%

Source: Report on Industry, Commerce, and Service Census 1991, 2001.

Note: Data are book value of fixed capital at yearend.

Table 2

Interest Rates 1973-82, 1991-2000, 2001-2010

Year	Interest rate (%)	Year	Interest rate (%)	Year	Interest rate (%)
1973	13.25	1991	8.62	2001	6.99
1974	14.75	1992	8.30	2002	5.53
1975	13.25	1993	8.00	2003	4.10
1976	12.00	1994	8.00	2004	3.47
1977	10.75	1995	7.80	2005	3.50
1978	10.75	1996	7.53	2006	3.47
1979	14.50	1997	7.65	2007	3.35
1980	16.20	1998	7.87	2008	3.46
1981	15.25	1999	7.84	2009	2.07
1982	10.75	2000	7.94	2010	1.97

Note: Interest rates before 2000 are lending rates on secured loans; interest rates since 2001 are average bank lending rates. Rates in 1973-82 are regulated; rates since 1991 are market determined.

Source: Taiwan Statistical Databook.

Table 3

Tax Benefits given under Statute for Upgrading Industries

Unit: million NT dollars

	Total Benefits	Automation	R&D	Training	Branding	Import Investment	Import Technology	Venture Capital	Tax Holiday
1992	2,581	969	1,519	70	22	0	0	1	0
1993	5,641	4,761	822	56	2	0	0	0	0
1994	7,376	5,654	1,193	148	16	240	125	0	0
1995	9,219	4,032	2,418	228	32	893	1,233	383	0
1996	7,026	4,476	1,632	163	19	430	294	12	0
1997	21,673	8,610	2,425	461	39	3,885	4,019	2,234	0
1998	29,941	22,534	4,142	181	33	830	1,791	430	0
1999	29,006	10,666	3,871	297	53	3,990	1,839	542	7,748
2000	75,948	23,240	7,853	540	165	32,343	6,636	1,199	3,972
2001	56,419	18,817	6,694	478	92	7,019	12,019	502	10,798
2002	82,578	40,645	27,264	1,198	106	4,466	6,523	1,091	1,285

Source: Yearbook of Tax Statistics, Republic of China.

Table 4

Korea Interest Rates and Inflation Rates, 1986-2000

Year	Interest rate (%)	Inflation rate (%)	Real interest rate (%)
1986	10.00	2.75	7.25
1987	10.00	3.05	6.95
1988	10.13	7.14	2.99
1989	11.25	5.70	5.55
1990	10.00	8.57	1.43
1991	10.00	9.33	0.67
1992	10.00	6.21	3.79
1993	8.58	4.80	3.78
1994	8.50	6.27	2.23
1995	9.00	4.48	4.52
1996	8.84	4.92	3.92
1997	11.88	4.44	7.44
1998	15.28	7.51	7.77
1999	9.40	0.81	8.59
2000	8.55	2.26	6.29

Note: Interest rate is the short- and medium-term bank lending rate; inflation rate is based on CPI. Real interest rate is the interest rate minus the inflation rate.

Source: Interest rates are taken from IMF International Financial Statistics; CPI data are from Bank of Korea.

Table 5

GDP Growth Rate, Investment and R&D Ratios of Taiwan and Korea

Unit: %

Year	GDP growth rate		Gross fixed capital formation* / GDP		R&D / GDP	
	Taiwan	Korea	Taiwan	Korea	Taiwan	Korea
1986	11.6	12.2	17.7	27.8	1.00	1.52
1990	5.4	9.0	21.9	36.2	1.67	1.68
1991	7.6	9.7	21.6	38.0	1.70	1.80
1992	7.5	5.8	23.6	36.0	1.78	1.89
1993	7.0	6.3	24.7	35.4	1.75	2.06
1994	7.1	8.8	24.2	35.5	1.77	2.26
1995	6.4	8.9	24.6	36.4	1.78	2.30
1996	6.1	7.2	22.2	36.6	1.80	2.36
1997	6.7	5.8	22.5	34.6	1.88	2.41
1998	4.6	-5.7	23.4	29.3	1.97	2.26
1999	5.4	10.7	22.7	28.6	2.05	2.17
2000	5.9	8.8	23.1	30.0	2.05	2.30

*: excluding inventory adjustment.

Source: GDP and investment data for Taiwan are taken from Taiwan Statistical Data Book, R&D data are taken from National Science and Technology Survey (National Science Council); GDP and investment data for Korea are taken from Statistical Korea, R&D data from National Science & Technology Service (Ministry of Science & Education).

Endnotes

1. According to the estimates by Hill and Jongwanich (2009), cumulative stock of Korea's outward FDI was 26.8% of its domestic fixed capital formation in 2000, compared to Taiwan's 66.7%. The respective ratios in 2007 were 66.2% for Korea and 158.4% for Taiwan. In other words, when normalized by domestic investment, Taiwan's outward FDI was three times of Korea's.
2. Many projects in the initial plan were revised or implemented with delay. For example, the high speed railway, which was initially designed to be a public project, was eventually invested by a private consortium in the form of "build owned and transfer" (BOT). The national health insurance program was not implemented until 1996.
3. When one of the largest semiconductor companies, ProMos, defaulted in June 2011, the press revealed its total bank debts to be 55 billion NT, mostly consortium loans. Five leading creditors were state-owned banks, which together accounted for 70% of the outstanding debts (2011/6/16 cnYES net).
4. Ma and Lin (2005) compared Taiwan's semiconductor manufacturing firms to those in US, Japan, Korea, Germany and France and found Taiwanese firms to be more aggressive in making capital investment but less so in R&D investment. Whereas the world's average of annual capital expenditure as a proportion of sales was about 25%, Taiwanese firms often spent more than 40% of sales on capital expenditure. In contrast, Taiwanese firms generally lag behind their counterparts in US, Germany, and France in R&D expenditure when measured in terms of a ratio of sales, although they spent more than their Japanese and Korean counterparts for the years studied (1998-2002). When measured in terms of the absolute amount of R&D expenditure, Taiwanese firms were the lowest in the

world.

5. 27 state owned enterprises that had been privatized included 13 financial-related companies (banks and insurance companies), eight manufacturing companies, three transportation companies (ship lines and bus), one construction company, one newspaper, and one printing company.
6. The Statute for the Encouragement of Investment requires the beneficiary of tax benefits to be share-holding companies on which corporate income tax is applied. This means unincorporated business entities are not eligible, a tradition followed by the Statute for Upgrading Industries. However, there is no restriction on the amount of capital expenditure. Instead the government set the technological level and the minimum production capacity as the criteria for an investment project to qualify for tax incentives. The capacity restrictions were made largely in line with the efficiency consideration from the technological point of view. For example, in the 1981 version of Statute, the criterion for an ethylene plant to qualify for tax incentives was an annual capacity of 200,000 tons or more, and that for a steel plant was an annual production capacity of one million tons or more. No monetary terms were applied to any industry category that was eligible for tax incentives.
7. Huang, Wang and Han (2004) reported that in fiscal year 2003, a total of 490,130 business enterprises were awarded some tax benefits, out of which 724 (0.2%) were in high-tech industries, including semiconductor, and 489,406 (99.8%) were in traditional industries. However, on average, each high-tech firm was given 214 million NT tax benefits, in comparison to 166,000 NT dollars only for each firm in the traditional industries.
8. For example, in 1986, US accounted for 47.7% of Taiwan’s exports; that share fell to only 23.5% in 2000.

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