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New Direction of Industrial Policy in Korea

Ji Hong Kim
KDI School of Public Policy and Management

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New Direction of Industrial Policy in Korea

Ji Hong Kim
Professor, KDI School

Abstracts

South Korea had achieved remarkable growth during the last decades, and is quoted as an example of successful industrial policy. This paper intends to review the history of industrial policy in Korean and issues on industrial targeting. Since Korean economy enters more mature stage, new paradigm of industrial policy is required to keep up with the changing environments. Particularly in 2000s, South Korean economy has transformed into knowledge economy and developed an innovation-intensive industrial structure. As a bench mark case, Israel case is presented. The knowledge revolution, together with increased globalization, presented significant opportunities for promoting economic and social development in Korea.

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I. Concept of Industrial Policy

There are several definitions for the concept of “Industrial Policy”. The World Bank defines it as “government policies directed at affecting the economic structure of the economy”[1]. UNCTAD defines industrial policy as a “concerted, focused, conscious effort on the part of government to encourage and promote a specific industry or sector with an array of policy tools,”[2] while OECD refers to “Industrial policies (that) are concerned with promoting industrial growth and efficiency."[3]

While the definitions differ slightly, usually representing the focus of the institution that is using them, there is a common and fundamental element to them: all definitions presume a declared intention to alter the structure of the economy, whether or not explicit sectorial targeting is involved. For the benefit of this paper, a commonly used and widely cited definition will be used by Pack and Saggi (2006), who define industrial policy as “any type of selective intervention or government policy that attempts to alter the structure of production toward sectors that are expected to offer better prospects for economic growth than would occur in the absence of such intervention.”[4]

The concept of industrial policy has been going out and back in favor over the course of the later part of 20th century, and as the World Bank also notes the past decade has seen renewed interest and broadest consensus in favor of it.[5] This literature review will chart

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[1] Stiglitz, Joseph E.; Yifu, Justin; Monga, Celestin. 2013. *The rejuvenation of industrial policy*. Policy Research working paper ; no. WPS 6628. Washington, DC: World Bank. Page 1.

[2] Warwick, K. (2013), “Beyond Industrial Policy: Emerging Issues and New Trends”, OECD Science, Technology and Industry Policy Papers, No. 2, OECD Publishing.

[3] OECD , Objectives and Instruments of Industrial Policy: A Comparative Study, Paris: OECD.1975.

[4] Pack, Howard, and Kamal Saggi. "Is there a case for industrial policy? A critical survey." *The World Bank Research Observer* 21, no. 2 (2006): 267-297.

[5] Stiglitz, Joseph E.; Yifu, Justin; Monga, Celestin. 2013. *The rejuvenation of industrial policy*. Policy Research working paper ; no. WPS

the evolution of the concept and theory, as-well as some the historic and economic forces that helped shaping it.

The 1960s and 1970s were marked by interventionist government policies to development in many of the developing countries. It was a result of a notion that the market economy had not brought development and further interference was needed.[6]

In the 1980s, the paradigm shifted towards free market, no doubt influenced by the international financial institutions reflecting the prevailing ideologies of the conservative Thatcher government in the UK and Reagan in USA. The pendulum shifted in the development policy literature and it became almost fashionable to dismiss any proactive attempt by the government to attribute economic success mostly to liberalization, privatization, and deregulation.[7]

The results of the interventionist policies in the 1960s and 1970s, and the deregulation in the 1980 were not immediately clear, and even when they were, the results of those policies were no equal everywhere. Asia, for example, saw rapid growth, challenging the liberalization policies prevailing in the west at the time, while the industrial policies in Sub-Saharan Africa saw not only per capita income decline, but a process of deindustrialization.[8]

This influenced some to seek redefinition of the concept of industrial policy, broadening it in order to encompass more factors that contributed to successes or failures. The conventional approach to industrial policy consisted of enumerating technological and

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6628. Washington, DC: World Bank. Page 1.

[6] Stiglitz, Joseph E.; Yifu, Justin; Monga, Celestin. 2013. *The rejuvenation of industrial policy*. Policy Research working paper ; no. WPS 6628. Washington, DC: World Bank. Page 5.

[7] Stiglitz, Joseph E.; Yifu, Justin; Monga, Celestin. 2013. *The rejuvenation of industrial policy*. Policy Research working paper ; no. WPS 6628. Washington, DC: World Bank. Page 6.

[8] Noman, A. and J. E. Stiglitz, 2012 "Introduction and Overview,", Good Growth and Governance for Africa: Rethinking Development Strategies, A. Noman, K. Botchwey, H. Stein, and J.E. Stiglitz, eds., Oxford University Press,

other externalities and then targeting policy interventions on these market failures.[9] Some studies had broadened the scope of the concept to include understanding of the process itself. Rodrik (2004) states - "the analysis of industrial policy needs to focus not on the policy outcomes—which are inherently unknowable ex ante—but on getting the policy process right."[10] His central argument is therefore that right way of thinking of industrial policy is as a discovery process—one where firms and the government learn about underlying costs and opportunities and engage in strategic coordination.

The theory and practice of industrial policy had evolved further in the 2000s. The 'how' rather than the 'why' of industrial policy became important and there is growing stress on the importance of flexibility in the practice of industrial policy.[11]

Pryce (2012) distinguishing three generations of industrial policy: a first generation in which government sought to pick winners through state aid (1960s-1970s), a second generation focused on privatization and financial deregulation (1980s-1990s), and a third generation of sector-specific intervention, "often motivated by the need to correct market failure or address obstacles to growth".[12] Pryce advocates a 'fourth generation' industrial policy "based on a holistic approach to policy and a new partnership between the private sector and the state".[13]

One of the main reasons the concept of industrial policy is now relevant more than ever is wide consensus it currently enjoys as a result of economic crisis of 2008. In USA,

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[9] Rodrik, Dani. "Industrial policy for the twenty-first century." (2004).page 2.

[10] Rodrik, Dani. "Industrial policy for the twenty-first century." (2004).page 3.

[11] Warwick, K. (2013), "Beyond Industrial Policy: Emerging Issues and New Trends", OECD Science, Technology and Industry Policy Papers, No. 2, OECD Publishing. page 18.

[12] Pryce, V. "Britain Needs a Fourth Generation Industrial Policy", Centre Forum, June 2012.

[13] Warwick, K. (2013), "Beyond Industrial Policy: Emerging Issues and New Trends", OECD Science, Technology and Industry Policy Papers, No. 2, OECD Publishing. page 19.

one of the main opponent of market intervention, the financial crisis "have tarnished the aura of infallibility around 'the self-regulating market'."[14] The government's response to the crisis was a program of targeted industry assistance, going against long-standing avowals that the government "does not and should not do such things".[15] As Wade (2012) notes, the small shift in USA, coupled with small increase in pressure from some middle-income countries for World Bank assistance in the development of particular industries, have led to a change in the World Bank policies.

We now witness the rise of a new, evolved concept of Industrial Policy. Defined as "new" or "systemic" industrial policy by academics and economic institutions, it calls for a policy which should be based on ***new technologies*** and supports society's long-term targets. The rationale goes beyond the traditional market failure arguments, such as monopolies, and is based on international externalities and coordination failures. The U.S. government, the European Commission, OECD, and as mentioned above – The World Bank, all advocate "reindustrialization and industry-oriented 'integrated' policies, since at least the recent financial crisis".[16]

Kuznetsov, for the World Bank (2011), sets the distinction between the old and the new industrial policy thusly: "In contrast to import substitution, the objective of open economy industrial policy is to increase economic openness by enhancing knowledge flows and fostering productive innovation and nontraditional exports. ***"Old" industrial policy focused on justification of specific set of priorities. In contrast, "new" industrial policy***

[14] Wade, Robert H. 2012. "Return of industrial policy?." *International Review Of Applied Economics* 26, no. 2: 224.

[15] Wade, Robert H. 2012. "Return of industrial policy?." *International Review Of Applied Economics* 26, no. 2: 224.

[16] Aiginger, Karl. "Industrial Policy for a sustainable growth path." WWWforEurope Policy Paper 13 (2014): page 2.

focuses on the governance of the priority-making process."[17]

The "traditional" industrial policy used tools such as tariff protection, tax rebates, R&D subsidies, directed credit, industrial zones, and so on. These instruments served sectors of the industry that were assigned as first priority. The priority sectors were those thought to have, certain promising developmental features and were either hindered by significant market failures or needed additional investment to facilitate their international competitiveness. In contrast, the "new" approach to industrial policy emphasizes strategic collaboration with the private sector to ensure interventions to work as expected. Recommendations are for the ***processes and procedures*** for selecting and correcting selections of both, rather than for specific policy instruments or sectors. One such procedure is diagnostic monitoring: systematic evaluation of a portfolio of projects or programs to detect and correct errors as each project evolves (including weeding out inefficient projects) in light of implementation experience and other new information.

Kuznetsov illustrates the benefit of this approach in the case of Chile. The staff members, hired on the basis of demonstrated technical knowledge and familiarity with the markets and business practices in a particular sector, apply for internal grants to develop a case for launching a new venture in some general area. The best of these preliminary plans can be used to apply for a second, longer term grant to develop a business plan for a new venture, typically in partnership with outsiders. This process continues until the proto-venture becomes a candidate for seed capital and enters the familiar sequence of VC financing. At every stage, projects are benchmarked against internal and external alternatives, and the start-ups that result are the institutionalized expression of the searches provoked by that

[17] Kuznetsov, Y. and C. Sabel (2011), "New Open Economy Industrial Policy: Making Choices without Picking Winners", World Bank PREMNotes, Economic Policy No. 161, September 2011.

benchmarking. The operation of the start-ups in turn relaxes constraints on the formation of the clusters whose growth propels the Chilean economy.[18]

"The Asian Miracle" and the challenge it provides to the main paradigm

The rapid growth of economies in East Asia has been challenging the main paradigm of the usually Western-dominated literature in the 80s and 90s. The World Bank's report on East Asia in 1993 proposed two models of East Asian Development. The first model, which was used in japan, South Korea and Taiwan forged industrial policy regimes with high levels of government intervention and protection. The other model, according to World Bank, in other "miracle economies" of Southeast Asia, pursued open-market and investment policies compatible with Anglo-American economic norms.[19]

The report, titled "The East Asian Miracle: Economic Growth and Public Policy" was controversial at the time. Political economists complained that it gave insufficient weight to the influence of the "developmental state" in East Asia, while Neoclassical economists claimed it gave too much credit to government intervention. According to Terry (1993), Japanese scholars disagreed with the study as-well, since they mostly viewed the success of other Eastern Asian countries as a result of conscious emulation of Japan and concentrated Japanese foreign direct investment, aid, and regional industrial strategy.[20]

The East Asian Miracle distinguishes several key government policy fundamentals to explain the respective countries' positive socio-economic performance. First, stable financial

[18] Kuznetsov, Y. and C. Sabel (2011), "New Open Economy Industrial Policy: Making Choices without Picking Winners", World Bank PREMNotes, Economic Policy No. 161, September 2011. Page 6.

[19] Terry, Edith. "An East Asian paradigm?." *Atlantic Economic Journal* 24, no. 3 (September 24, 1996): 183-198.

[20] Terry, Edith. "An East Asian paradigm?." *Atlantic Economic Journal* 24, no. 3 (September 24, 1996): 183-198.

systems were ensured as foundation for *high savings and investment rates*. The governments ensured *stable macroeconomics with low inflation rates and competitive exchange rates*. The universal access to primary and secondary education have led to accumulation of *human capital*. The investment in human capital, in turn, developed the domestic capacity to *absorb foreign technology*. And the governments employed *targeted interventions* to ensure a focus on desirable goals.[21]

The last two decades seen ever growing interest in the "Asian Miracle". One strand of literature argued that the Asian experiences were unique not transferable to other countries. Stiglitz (1996) saw a central theme in these Asian experiences: governments did not supplant markets but acted as catalysts and organisms that adapted to the particular functioning of markets. In turn, Rigg (2009) stressed the difficulties of breaking up 'the grand national and regional narratives into bite sized hot tips'.[22]

After the Asian crisis in 1997, some have called into question not only the applicability of the industrial policies as they were envisioned in East Asia, to other countries in the third world, but the objective success of the Asian Miracle in general.

The debate around the applicability of the South Asian model to other countries, is further complicated because the miracle economies of South Asia achieved the massive growth through different levels of government interventionism. Perkins (1994) suggested that there are actually three models of Asian development – Hong Kong and Singapore's free market model, Korea and Taiwan's Japanese model, and a third consisting of resource-rich

[21] Nyanjom, Othieno, and David Ong'olo. 2012. "Erratic Development in Kenya: Questions from the East Asian Miracle." *Development Policy Review* 30, no. Supplement 1: s73-s99.

[22] Rigg, Jonathan (2009) 'Grand Narrative or Modest Comparison? Reflecting on the "Lessons" of East Asian Development and Growth', Singapore Journal of Tropical Geography 30 (1): 29-34.

countries such as Indonesia, Malaysia and Thailand.[23] According to Leung (2007), Hong Kong has adopted a laissez faire policy, Singapore is distinguished by her heavy reliance on foreign direct investment (FDI) and Korea and Taiwan put their faith in the indigenous business conglomerates, and deliberately avoided courting the multinational corporations for FDI.[24]

The search for the perfect industrial policy model continues. It is of particular interest and urgency because some believe it could hold the solutions for the third world countries. Fontana and Srivastava has compared the industrial policies between the countries that experienced the "Asian Miracle" and India. While India had executed some of the similar policies, Fontana and Srivastava has concluded that the main difference was the investment in human capital, and since India lagged behind in human capital, it is the most influential factor in effectiveness of industrial policy.

Some studies shown attempts to apply the fundamental principles of industrial policy the way it was applied in East Asia. Nyaniom and Ong'lo (2012) showed such attempt in Kenya. Kenya implemented several of the fundamentals: it gradually transformed import substitution into an export-orientation strategy, established reasonable macroeconomic stability; and made large investments in human capital.[25] This policies hoever, did not yield positive growth, and in some areas even exuberated some challenges in Kenya, such as increasing socio-economic inequality.

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[23] Perkins, D. (1994) There are at least three models of East Asian development, World Development, 22, pp. 655–661.

[24] Hing-Man, Leung. "Two New Lessons from the Asian Miracles." Journal Of The Asia Pacific Economy 12, no. 1 (February 2007): 1-16.

[25] Nyanjom, Othieno, and David Ong'olo. 2012. "Erratic Development in Kenya: Questions from the East Asian Miracle." *Development Policy Review* 30, no. Supplement 1: 80.

II. History of Korean Technology and Industrial Policy

Background and Overall Assessment

Over the last 40 years, Korean economy has moved from resources-based development to innovation-based growth. The transformation of the Korean economy shows a gradual transition to a more sophisticated and advanced industrial structure. Korean economy faced with endless challenges but somehow properly responded and successfully adapted to them. For example, in the 1960s, Korea took advantage of expanded trade by following an outward-oriented development strategy. In the 1970s, however, the Korean economy experienced economic deterioration mainly due to excessive government intervention and the over-ambitious heavy and chemical industrialization drive. The 1980s have been a period of structural adjustment aimed at the promotion of continued economic growth with price stability. The 1990s are characterized as the period of liberalization of the economy, especially in the areas of financial reform and interest rate. The successful transformation has been possible through government's policy framework and industry's active engagement. Government set the development goals that clearly indicate where the country should move forward. The development goals and major policy directions have changed according to the development stages and changes in domestic and international economic conditions. In the course of economic development, S&T policy and its framework have evolved in response to the changes in the industrial structure.

In the late 1970s, heavy and chemical industries emerged, followed by semi-conductors and information technologies in the 1980s. Throughout this period, however, Korean firms continued to rely heavily on imports of key components and capital goods. This was in part a result of the focus of Korean firms on developing component assembling technologies that yielded quick investment returns. Korea achieved a globally competitive position in

processing technologies. But when it came to development technologies for core components and capital goods, Korea continued to depend heavily on technologies from the developed countries.

The problem of dependence on technologies from developed countries was exacerbated by the rapid advances of Chinese and the Southeast Asian economies. Thus, Korea faced the dilemma of lagging behind developed countries but at the same time being chased closely by emerging countries.

With new waves of technological advances continually sweeping across the globe, knowledge (information) is increasingly being developed, stored, and transferred in digital forms, and many advanced economies are making significant strides with the transition to a truly knowledge-based economy. Indeed, it is estimated that nearly half of the GDP of leading OECD countries is already produced by knowledge-based industries. For Korea, the challenge has been to catch up with advanced economies and positively accelerate the transition to a truly knowledge-based economy. In addition, Korean innovation policy has not been conducive to the creation of innovative start–ups, to technology transfer, or to building-up basic research capabilities, all of which are increasingly important as Korea moves toward knowledge frontiers.

This process required the transformation of techniques, organization, and composition of production in the direction of higher productivity. Major development strategies and policy goals are summarized in Table 1:

Table 1: Development Strategies and major policies of Korean Economy

	Development goals	Major policy directions	Macroeconomic policy framework	Human resource development	Science and technology
1960s	• Building production base for export-oriented industrializati on	• Expand export-oriented light industries •Mobilizing domestic and foreign capital	• Prepare legal and institutional bases to support industrialization	• Decreasing illiteracy • Establishing national infrastructure	• Scientific institution building: Legal & administrative framework
1970s	• Building self-reliant growth base	• Industrial targeting: Promoting HCI and upgrading industrial structure • Building social overhead capital	• Maximize growth: expanding policy loans •Government's intervention into the markets	• Vocational training • Improving teaching quality • Increasing engineering major college graduates	• Scientific infrastructure setting: Specialized S&T institutions, Daeduck Science Town
1980s	• Expand technology-intensive industries	• Industrial rationalization • Decreasing export subsidy and expanding import liberalization	•Stabilization • Enhancing private autonomy and competition	• Expanding higher education system • Developing semi-skilled HR	• R&D and private research center promotion • NRDP
1990s	• Promote high-technology innovation	• Supporting technology development • Building information infrastructure	• Liberalization • Reform and restructuring	• High skilled HR in strategic fields-IT, BT, etc. • Developing life-long learning system	• Leading role in strategic area: HAN
2000s	• Transition to knowledge-based economy	• Promoting venture business and SME	• Globalization • Balanced national development	• Increasing research productivity • Improving quality of university education • Regional development	• Building national and regional innovation systems

Source: Korea as the Knowledge Economy, WBI

The initiation of catch-up growth had recourse to new investments, and the successful maintenance of high savings propensity depends on the ability of a country to sustain high rates of return in investment. Export-oriented growth through international price-quality

competition is indeed conducive to achieving this objective, and Korea is an exemplary case for the role of export promotion in achieving industrialization in latecomers. According to Mr. Nam Duck-Woo, the following economic and non-economic factors contributed to the successful economic development. Economic factors: 1) outward-looking strategy, 2) good use of foreign resources, 3) favorable international environment, 4) education, 5) faith in free enterprise system, 6) activist role of government. Non-economic factors: 1) ethnic and cultural homogeneity and a strong Confucian tradition that places a high value on education, achievement, and loyalty to the nation. 2) security threat, 3) political leadership. (Nam, 1997)

World Bank also pointed the following features of Korea's economic development process; First, at the macroeconomic dimension, the high rates of investment and savings imply that Korea's economic transformation has been achieved by the massive capital investment. Korea's capital accumulation has been possible through increases in domestic savings, and the shortages in domestic savings in the earlier years had been appropriated through foreign capital inducement. Second, industrial and labor compositions have been changed in the direction of higher productivity, as the share of manufacturing has steadily increased. Trade structures has also fundamentally changed from a primary goods exporter to manufactured products including capital goods exports more than 40 % of total exports as of 2002. Third, the changes in the structures of industry, employment and trade have been preceded with great improvements in human resources and technology, two most important factors for sustaining economic growth that enables efficiency gains. Despite the debates on the nature of East Asian growth performances, it is apparent that Korea has poured tremendous efforts for upgrading her knowledge and human resource bases. Korea's industrialization process is not only the process of capital accumulation; but it is also the learning process, a key concept of the knowledge economy.

Science and Technology Policy in Korea

Korea has recognized the importance of developing indigenous capabilities in science and technology for successful industrialization, and therefore has made building such capabilities one of the key policies over the past four decades. Korean science & technology policies can be divided into three periods: (1) imitation, (2) transformation, (3) Innovation.

Table 2 Historical Perspectives: S&T Policy Measures to Build up Indigenous R&D

Imitation 1960s 1970s	◆ Foundation of KIST (1966), MoST (1967) ◆ The S&T promotion act (1967) ◆ Establishment of GRIs (1970s) in the areas of machinery, shipbuilding, chemicals, marine science, electronics ◆ Tax credit for R&D investment (1974) ◆ Development of human resources for R&D (KAIST)
Transformation 1980s	◆ National R&D program (NRDP, 1982) ◆ Establishment of Daedeok Science Town ◆ Promotion of private firms' research: financial and tax incentives to stimulate R&D investments (reduction of tax for technology-based start-ups (1982); tax credit for technology and manpower development expense)
Innovation 1990s	◆ Promotion of university-based research Science Research Center ◆ Five-year plan for innovation (1997) ◆ Establishment of the national Science and Technology Council (1999) ◆ S&T vision 2025 (1999) ◆ Promotion of university research :SRC,ERC,NRL, etc. ◆ HAN projects, Frontier R&D programs, etc. ◆ Establishment of inter-ministerial coordination body: NSTC
Innovation 2000s onwards	◆ First national Technology Roadmap (2001) ◆ E-government vision 2006 (2002) ◆ Broadband and IT Korea Vision (2007) ◆ New organization of MOST(2004)-Deputy prime minister, establishment of the office of the Ministry of Science, Technology and Innovation(OSTI) ◆ Innovation of overall coordination system: Ministerial office of S&T innovation in October 2004 ◆ Launch of the Ministry of Education, Science and Technology (MEST) (2008)

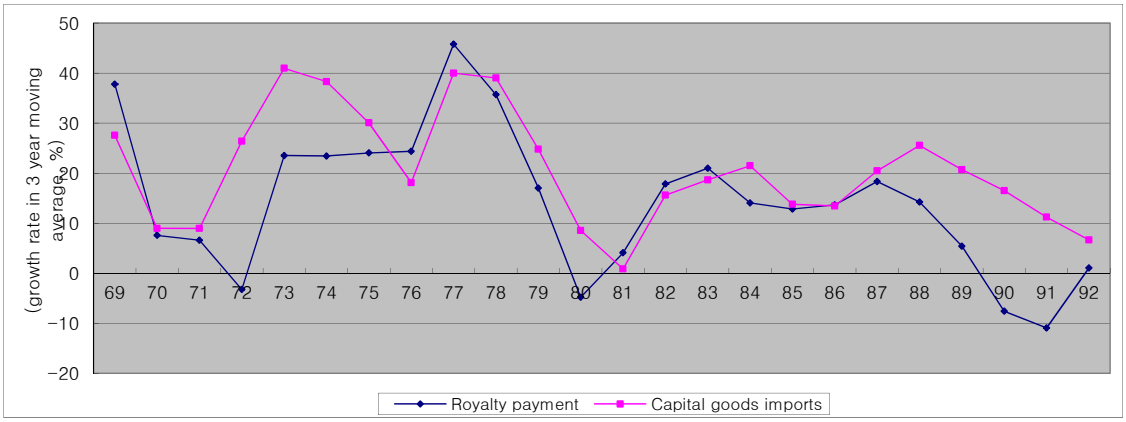
Source: Various publications of Korean government

(1). Catching-up period: Imitation

The technological base of Korean firms was well below that of the developed countries and thus showed a serious structural weakness for the economy. Since the First Five Year Economic Development Plan, science and technology areas got special attention. Creating institutional frameworks for mobilizing the resources towards targeted areas was among the primary tasks for the government, whereas the assimilation of technologies is among the main tasks of the industry. Industrialization is the result of both accumulation and assimilation through the concerted efforts from both the government and the industry.

When Korea launched its industrialization drive in the early 1960s, it had to rely on imported foreign technologies. By doing so, Korea pursued two key objectives: First was to promote the inward transfer of foreign technology, and second was to develop domestic absorptive capacity to digest, assimilate, and improve upon the transferred technologies and to adapt them to domestic production. The second objective required a relatively skilled labor force, which was abundant in Korea because of its aggressive educational policies such as compulsory education.

Figure 5. Royalty payment and capital goods imports



Source : National Statistical Office, Korea, 2009

Rapid increase in foreign capital inflow has contributed to economic growth by not only financing the expansion of production capacity, but also increasing productivity through the concomitant transfer of advanced technologies. As shown in the Figure 5, there is a close co-movement between capital goods imports and royalty payments for licensed foreign technologies. This implies that along with capital goods imports financed partly by the foreign capital, the industry has made great efforts to industrialize.

The technology assimilation strategy used various channels, such as original equipment manufacturing, foreign licensing-based production, reverse engineering of imported capital goods, and learning from the building of turnkey plants. These channels of informal technology assimilation enabled Korea to minimize its dependence on FDI, which had become more prominent since the 1997 financial crisis, and to maintain independence from multinational corporations. The strategy proved to be a success and Korean firms were able to assimilate technologies rapidly enough to undertake subsequent expansion and improvement with little assistance from foreign suppliers.

Table 3. Inflows of Foreign Capital (Unit: million current dollars)

	First Plan (1962-1966)	Second Plan (1967-171)	Third Plan (1972-1976)	Fourth Plan (1977-1980)
Loans	291	2,166	5,432	10,256
- Public	116	811	2,389	4,084
- Commercial	175	1,355	3,043	6,172
Direct Foreign Investment	17	96	557	425
Total	308	2,262	5,989	10,681

Note: Short-term capital and bank loans are excluded.

Source: Korean Government, The Fifth Five-year Economic and Social Development Plan, 1982,

In the early years of launching full-scale economic development plans, the Korean government recognized that science and technology would play important roles in the process. In the 1960s, two noteworthy institutions were established: KIST (1966) and MOST (1967). These two institutions, together with KAIS established in 1971, have exerted powerful influences over the S&T community in Korea.[26] Despite government's efforts for building S&T institutions in the 1960s and setting S&T infrastructures such as specialized government research institutes (GRIs) in addition to KIST in the 1970s, S&T policies played a limited role in those years.

(2). Building technological capabilities

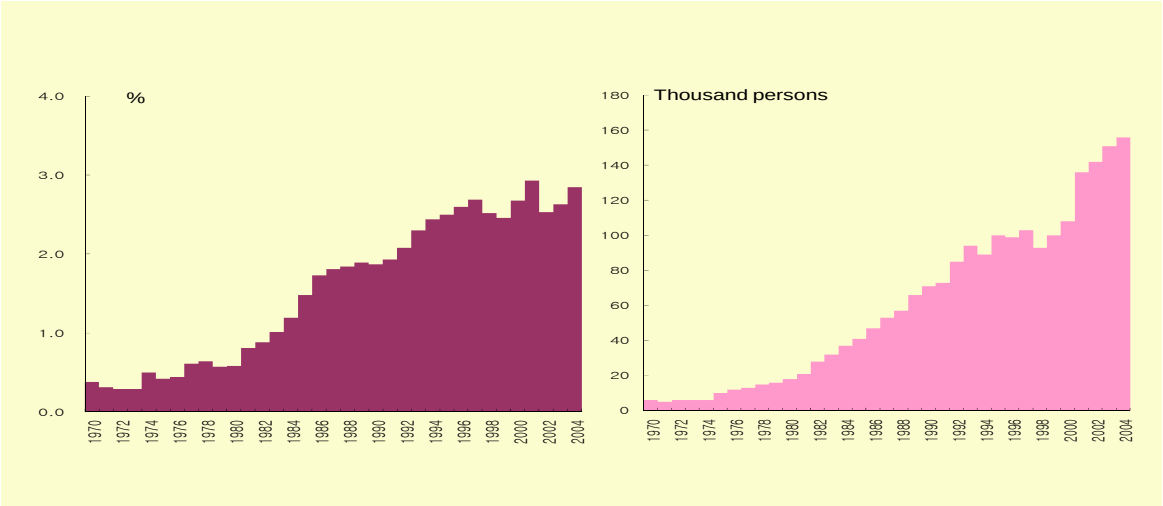
In accordance with the stages of economic development, the Korean government has successively reoriented the S&T policy. In the earlier years, more emphasis was put on building the infrastructure for technological development, whereas in later years the emphasis shifted towards more specific targeted technological development. Especially, changes in

[26] MOST has been the main designer of Korea's overall S&T policy; KIST has played the role of technological functionary in responding to industrial demands for rapid economic growth; and, KAIS (later KAIST) first implemented the concept of the research-oriented university into the Korean higher education system.

economic environments in the early 1980s induced Korea to embark on serious investments in indigenous R&D. On the one hand, Korean industrial development had reached the stage at which domestic industries found it more difficult to be competitive in the international market because they were reliant on imported technologies and employed domestic labor that was becoming more and more expensive. On the other hand, Korean industries had grown to become potential competitors in the international market, making foreign companies increasingly reluctant to transfer technologies to Korea; thus, it was inevitable that Korea would have to develop an indigenous base for research and innovation. Meeting the challenge required highly trained scientists and engineers as well as financial resources to support R&D activities.

According to Ministry of Science and Technology, Korea's gross expenditure on research and development (GERD) has tremendously grown both in the size and the intensity, especially in 1980s and 1990s: the percentage share of GERD increased from 0.25% in 1963 to 2.64% in 2003. The number of researchers has increased 100 times during four decades.

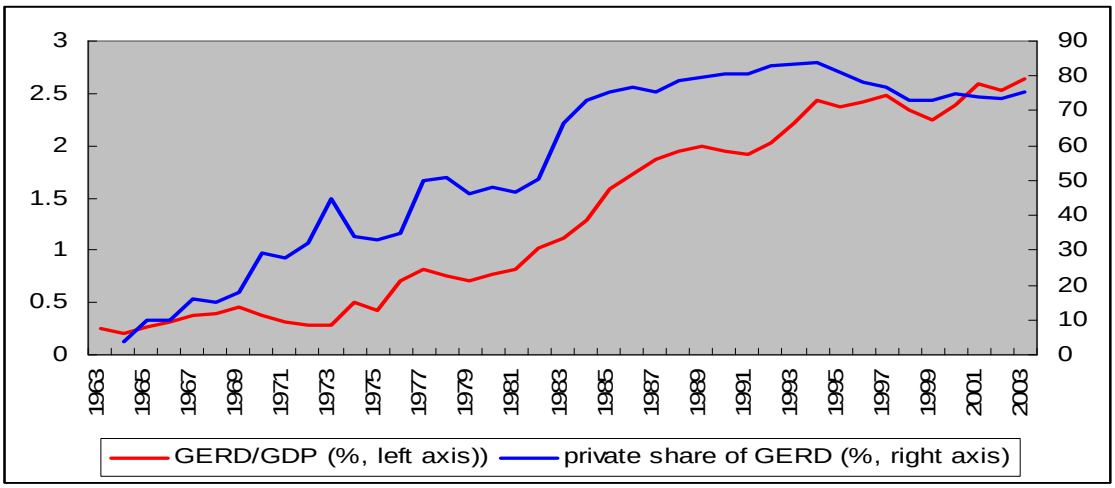
Figure 6: GERD=GDP ratios and R&D Personnel



Source: National Statistics Office, Korea 2009

The rapid increase in R&D has been possible through active expansion of private sector's investment. During the earlier years of industrialization, private sector's R&D spending was negligible; but as the rapid economic growth has called for commensurate investment in technology development, private enterprises have continuously increased R&D. Consequently, the funding sources have also greatly changed: government share of GERD has been continuously decreased, and in recent years, only one-fourth of GERD came from the government.

Figure 7: R&D trend, 1963-2003

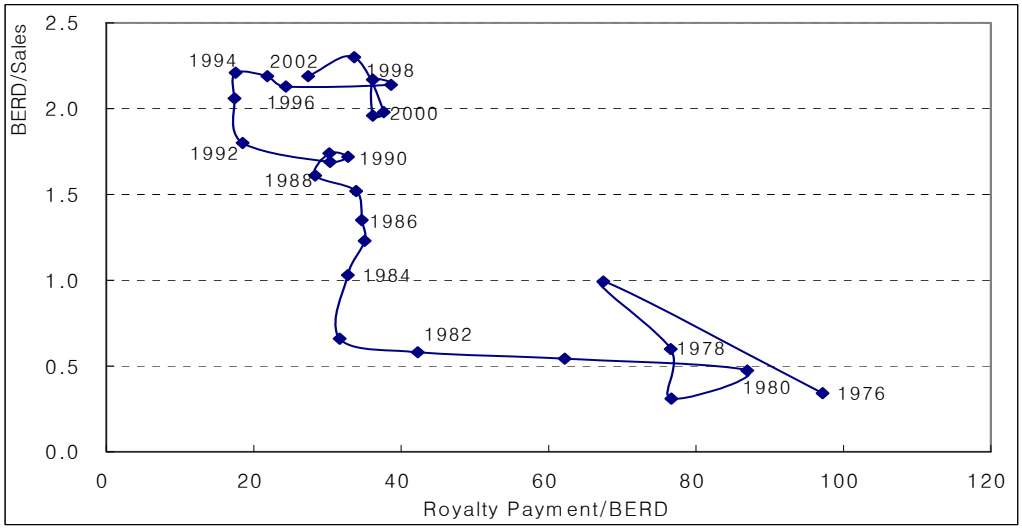


Source : Ministry of Science and Technology, Internal report

According to Woo's report, the process of technological capability building in Korea can be characterized as a dynamic process of the interplay between imported technologies and indigenous R&D efforts. Figure 8 plots the trend of the ratio of royalty payment over business R&D expenditures (BERD) on the horizontal axis and the trend of R&D intensity noted in terms of BERD over sales from 1976 to 2002. The ratio of royalty payment to BERD had substantially decreased until the early 1980s, which implies that the growth of BERD exceeded that of royalty payment. The R&D intensity, however, had not risen and remained at the level of 0.5%. There is a clear change in the trends since the early 1980s.

While the ratio of royalty payment to BERD had remained at the level of 30%, R&D intensity had started to increase.

Figure 8: Changing Relationship between Royalty Payment and R&D (1976-2002)

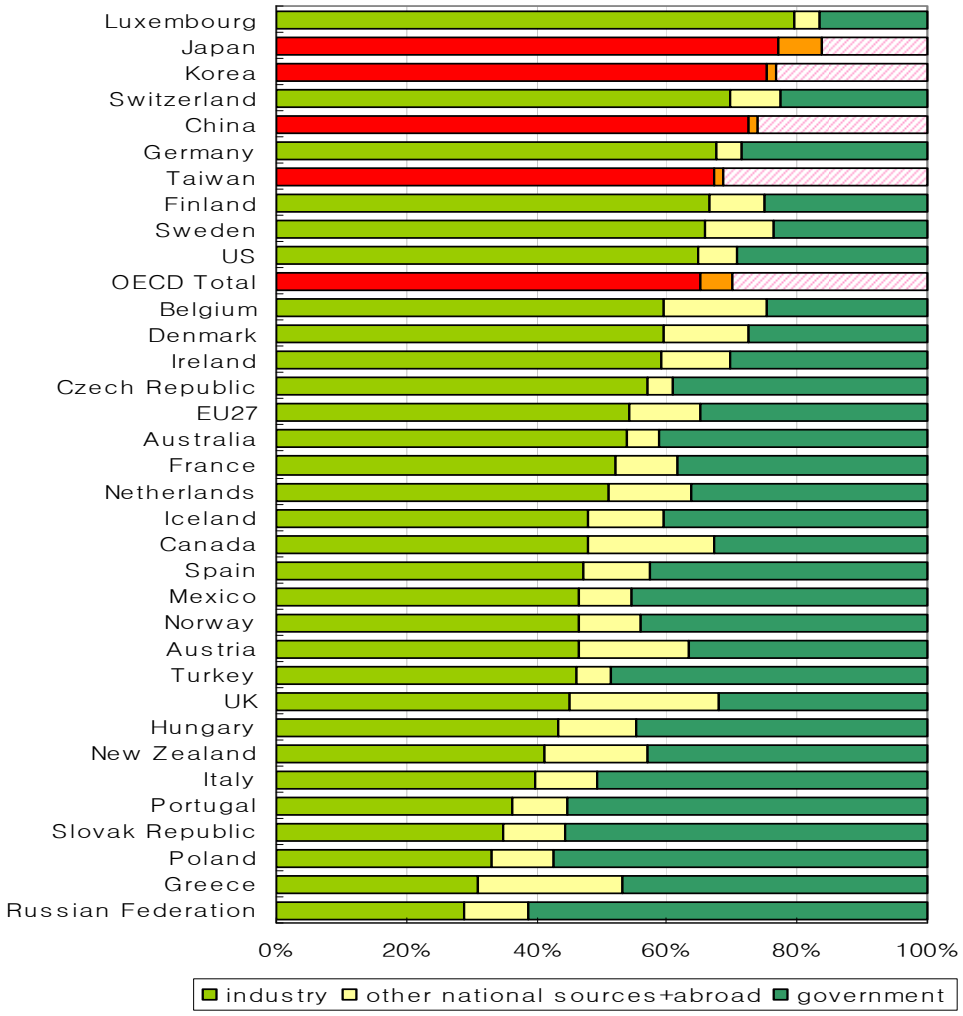


Source: Chun-Sik Woo

Within a very short period of time, Korea has accumulated great technology development capabilities; in particular, the private sector's willingness and ability to spend on R&D, and the presence of large number of relatively well-educated researchers. The ratio of patents to the private R&D increased in 2000s, and the share of private R&D in national total in Korea has surpassed the average of OECD. It has been found that the successful transition to the knowledge economy typically involves elements such as long-term investments in education, developing innovation capability, modernizing the information infrastructure, and having an economic environment that is conducive to innovation.

Figure 10: R&D expenditure by source of financing, 2006

As a percentage of the national total (business enterprises, government, other)



- OECD + China, Taiwan, Russian Federation, Brazil. India

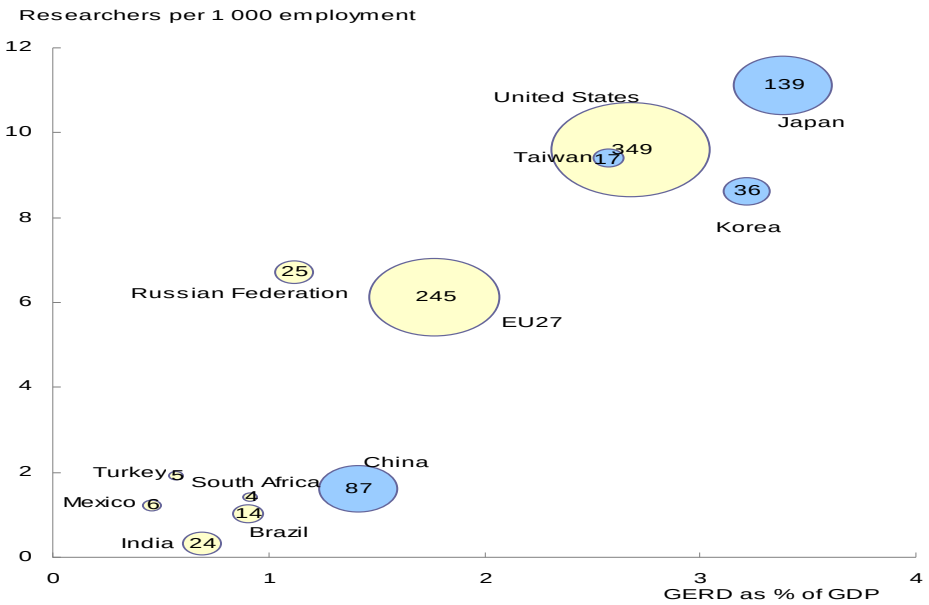
- Highlights: Korea, Japan, Taiwan, China, OECD average,

Source: OECD, STI, 2008(2)

(3). Building Knowledge Economy

After having fixed the monetary and foreign exchange turmoil and its underlying causes during 1997-1998 Asian crisis, Korea launched a major plan to make the country a full-fledged knowledge economy. This leads notably to major investments in Information and Communication Technology (ICT), making the country one of the most digitalized of the world, and in higher education, pushing enrolment rates at summits. This effort, coordinated at the highest level of the government, helped the country to recover quickly from the Asian crisis. In mid 2000s, Korea was again leading the world competition in terms of GERD as % of GDP as well as researchers per 1,000 employments.

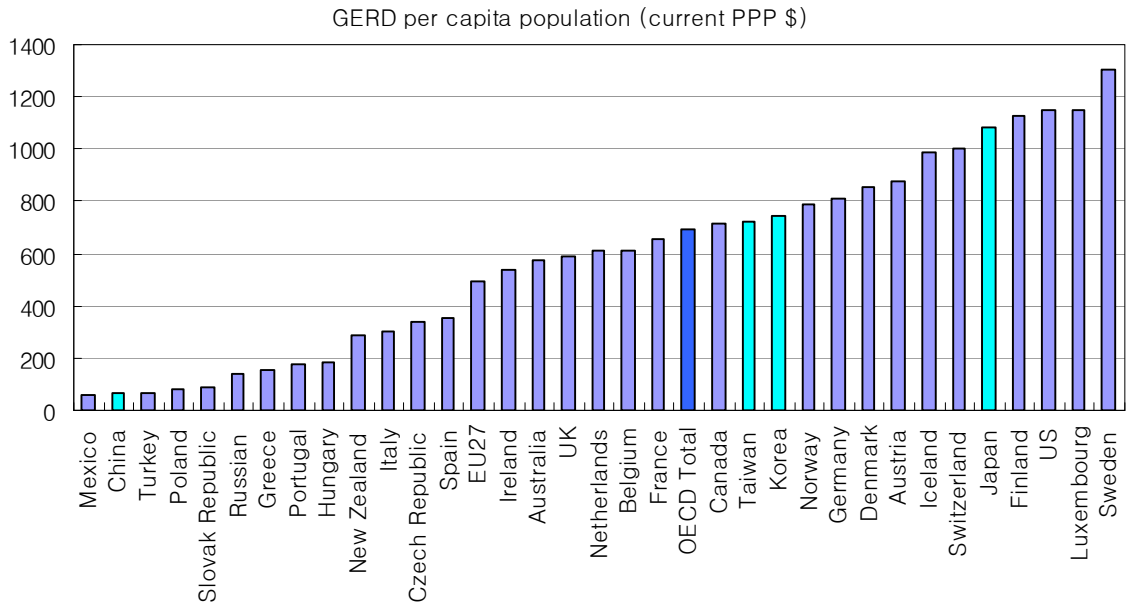
Figure 11.R&D Inputs: GERD as a percentage of GDP, in billions of current USD PPP, and researchers per 1,000 persons employed (2006)



Note: The size of the bubble and the number therein represents R&D expenditures in billions of USD in purchasing power parity.

Source: OECD, STI, 2008/2, Jean Eric Aubert

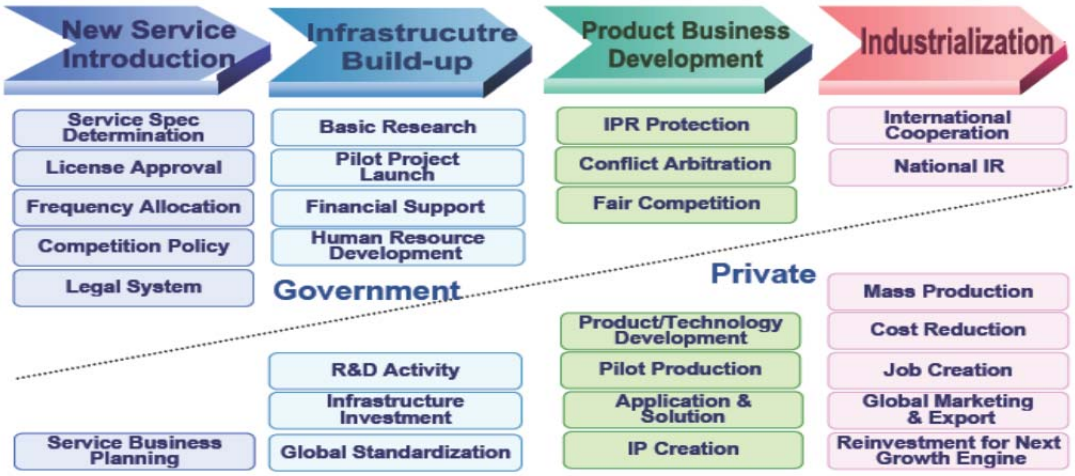
Figure 12. GERD per capita population (current PPP$)



Source: OECD, STI, Scorecard, 2008/2.

Korean government played the role of facilitator of R&D, early market development industry clusters, etc. The role of government is supplemented by the private industries in areas such as product development, application and solution development. The coordination of public and private sectors are illustrated as follows:

Figure 13.Roles of Government and Private in R&D



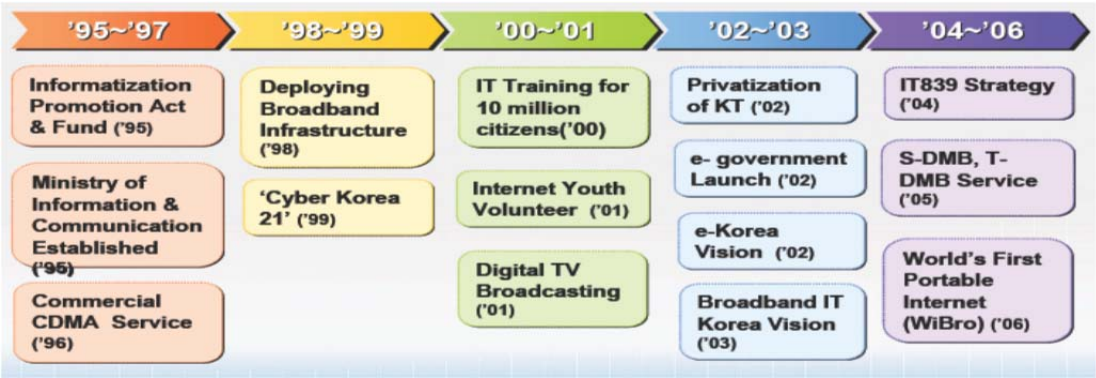
Source : DaeJe Jin

For example, the rapid development of the Korean information infrastructure hinged on key government organizations that were responsible for the informatization strategy. These organizations were restructured in the 1990s. They included the Informatization Promotion Committee, chaired by the prime minister; the Informatization Strategy Meeting, chaired by the president; and the Ministry of Information and Communication. Concurrently, the Korean government established three master plans for the development of the information society. In 1995, the Informatization Promotion Act was enacted, and the first master plan for promoting informatization was formulated a year later. In 1998 during the second master plan, Cyber Korea 21 was established to cope with the changing environment that resulted from the Asian financial crisis. And in 2002, when most of the policy goals set up by Cyber Korea 21 had been achieved ahead of the original schedule, the third blueprint, e- Korea Vision 2007, was laid out.

(4). Information Infrastructure:

In the early 1970s, Korean information infrastructure was inadequate and the provision of ICT services was too insufficient to meet the telecommunication demands associated with rapid economic growth. In 1975, only 3 percent of Koreans had a telephone. To improve efficiency in the provision of telecommunication services, the Korean government decided to rely on the invisible hands of the price mechanism and thus focused on introducing competition into the ICT infrastructure sector. A series of sequential but rapid policy measures were implemented for the deregulation and liberalization of the ICT services sector, along with privatizing the government-owned telecom operators.

Figure 14. Major government policies in ICT

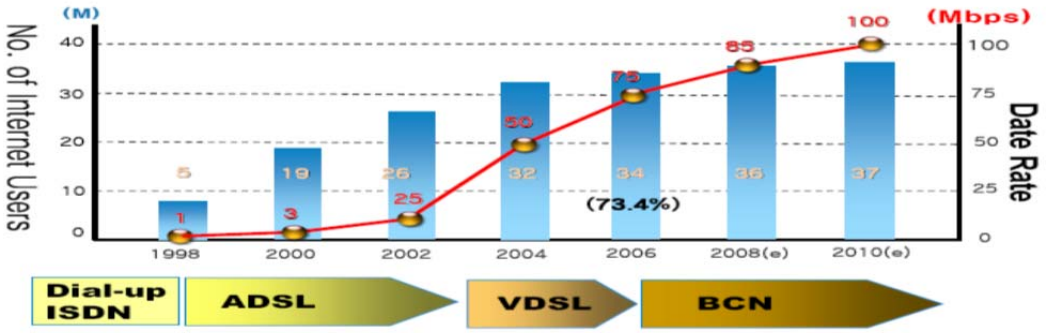


Source : various publications of Korean government

The reform of the ICT infrastructure sector resulted in tremendous improvements in terms of the ICT penetration rates. Most noteworthy are the recent penetration rates of cell phones and the internet. From 1995 to 2003, the proportion of Koreans with cell phones increased by nearly 20 times, to 70 percent, while the proportion of internet users increased by a whopping 75 times, to 60 percent. Similarly, Korea is currently among the leading countries in the world in terms of the proportion of broadband internet subscribers.

To build the infrastructure efficiently and economically, while actively responding to the technological development and changing demands, diverse implementation methods have been used. Networks in commercial and densely populated areas have been built with optical cables; networks that extend to subscriber premises have been built partly with optical cables and partly by digitizing and enhancing the speed of existing telephone lines or CATV networks or by building new wireless local loops.

Figure 15. Internet Penetration



Source: Korean government, Internal report

In order to finance the investment for the rapid deployment of Korea's information infrastructure, the Informatization Promotion Fund was established as a special vehicle to overcome short-term budgetary constraints. From 1993 to 2002, the fund reached a total of US$7.78 billion. About 40 percent of that was from government budgetary contributions, 46 percent came from private enterprises (of which licensing fees for new communication services composed major portions), and the remaining 14 percent came from miscellaneous profits and interests. Korea has constructed ICT networks connecting all areas of the country, and ICTs are used extensively in numerous economic and social activities. The number of individuals using ICT-related services is also constantly rising: the number of subscribers to internet banking services reached 22.58 million as of March 2005, and e-commerce has rapidly increased from 50 billion won in 1998 to 314 billion won in 2004, which is equivalent to 40% of GDP.

Led by an e-government initiative, the public sector is also extensively using ICTs. The entire process of managing government documents (i.e. production, distribution, transfer and retention) will be digitized. Since 2003, central and local government organizations have adopted standardized e-Document systems and have begun to distribute documents

electronically.[27] The number of organizations to be using the systems is due to expand to include the private sector in 2007, along with security improvements leading to the establishment of an e-document tracking system. The process of archive management (collection, retention, and destruction) has been digitized and standardized.

[27] In 2004, about 97 percent of documents were dealt with through the e-approval system in the government agencies, compared with only 21 percent in 1998.

III. Industrial Policy in Other Countries – Israel

Background and Motivation of Creative Economy

On the surface of it, Israel has taken radically different path than Korea in its industrial policy. However, the countries have some characteristics in common which makes their paths interesting and beneficial to examine. Israel has no natural resources of its own. Like Korea, it was established in 1948 after devastating war, deep national trauma and a tumulus colonial past in the previous year. And like Korea, Israel continues to live in somewhat uncertain geopolitical situation, which forces it to divert much of its GDP to military and national defense.

Israel strategy has been focused on creating knowledge economy, investing in diverse portfolio of future technology. Israel been active in all fields of future technology from stem research to internet security, but by far most successful field is ICT (information and communications technology, a major part of hi-tech industry).

The government policies were vital in creating the knowledge economy. All science and technology policies and budgets are managed exclusively through OCS – Office of Chief Scientist, under the ministry of Economy.

Established in the early 70s, the OCS's objective was defined as "maximization of industrial R&D without targeting any specific sectors or technologies." [28] This conceptualization led the OCS to embark on a long series of horizontal technology policies

[28] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

(HTPs), a novel policy idea at the time. The first program, which continues to this day, provides conditionally repayable loans covering part of the cost for any approved industrial R&D project originating from the private industry that is aimed at developing a new exportable product. The loan is payable only if the R&D project ends with a profitable product. These royalties have assumed an increasing percentage of the OCS's annual operating budget, reaching 20% during the 2000s.[29]

In the 1980, Israel went through hyperinflationary crisis. The hyperinflation of 109,187% between 1978 and 1986 decimated the traditional industry. A new R&D law in 1984 stipulated that the OCS would have an "unconstrained" annual budget for its main R&D fund, so all approved projects suggested by private industry to develop high-technology products would be supported.[30] Many of these new projects proved to be successful in international markets, as evidenced by the rising amount recouped by the OCS as payment for successful projects: from a mere $8 million in 1988 to $139 million in 1999. These payments were immediately injected into the industry, continuing this growth cycle until the mid-1990s.[31]

In 1989 the Soviet Union started to break apart, and Russian Jews who had been previously unable to emigrate, started moving to Israel in large numbers. This wave was perceived to bring the best and the brightest technologically educated workforce from the Soviet Union and, together with the thousands of engineers who were made redundant by the defense industry, raised the question of how to tap this body of knowledge. Although this

[29] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

[30] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

[31] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

convergence was a historical accident, the OCS's two decades of patiently developing and introducing policies using an HTP framework established an alternative model that shaped Israel's Science and technology policies.[32]

> In 1991, the Technological Incubators Program commenced operation. It was presented as a solution to two problems, equipping first-time technological entrepreneurs with management skills and assisting technologically skilled Russian immigrants in integrating into a capitalist society. It established a network of technological incubators managed by local public – private joint ventures across Israel.[33] The Inbal Program was the first attempt at implementing a targeted ITP directed to the VC industry. Its central idea was to stimulate *publicly traded* VC funds by guaranteeing the Downside of their investments. The mechanism used was a Government Insurance Company ("Inbal") that guaranteed VC funds traded in the Israeli stock market to up to 70% of initial capital assets. The program imposed certain restrictions on the investments of the VC companies covered by the program ('Inbal Funds'). Four 'Inbal' funds were established. They and the Inbal program as a whole were not a great success. Inbal funds valuations in the stock market were low, similar to Holding Companies' valuations; and the funds encountered bureaucratic problems. More significant was the fact that the program didn't attract any 'adding value' agents or capabilities. Moreover, the funds did not succeed financially and did not raised additional capital. Eventually all four 'Inbal' funds quit the program.

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[32] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

[33] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

The second initiative of OCS started operations in 1992 and kick-started the Israeli VC industry. This time, the OCS decided that the necessary skills and knowledge did not exist in Israel and that, to succeed, the VC industry needed strong networks with foreign financial markets rather than the Tel Aviv Stock exchange. Accordingly, Yozma was created as a government VC fund of $100 million that had two functions. The first was to invest $8 million in 10 private venture funds, which would be 40% or less of the total capital— the rest was provided by other private limited partners. To get this financing, the funds' managers had to secure investment and partnership from at least one local and one established foreign financial institution.[34]

The design of Yozma was the outcome of a long and intensive preparation involving first, search for the possible causes of the increasingly perceived weak economic impact of companies having received R&D subsidies from the OCS; and second attempts at finding a solution to the problem. At some point the search process included visits of OCS officers to Silicon Valley, interviews with U.S. entrepreneurs, venture capitalists, investment banks, and Small Business Administration officers; etc.

The above comparison further emphasizes the distinctive and original characteristics of INBAL and Yozma's design:

[34] Breznitz, Dan, and Darius Ornston. "The Revolutionary Power of Peripheral Agencies Explaining Radical Policy Innovation in Finland and Israel."*Comparative Political Studies* (2013)

Figure 16: Design aspects of YOZMA & INBAL Program

YOZMA	INBAL
Promoted by the OCS & mostly structured as Fund of Funds with a Single Objective of creating a VC industry	Promoted by the Treasury & structured as a Government owned Insurance company. Dual objective: Promoting the local Stock Exchange; & creating a VC pool.
Limited partnership form of VC-the ideal form of organization according to US experience and to Agency Theory	Publicly traded form of VC; no value added; hard to leverage current success to fundraising, low incentives for managers, and bureaucracy.
Leveraged Incentives to the Upside. Attracting professional VC teams.	Downside guarantees, which favor entry of non-professional VC firms
No Government intervention in the day by day operation of Yozma Funds	Government frequently intervened and imposed bureaucratic requirements on VCs supported
Limited period of government incentives; and clear and easy way out of the program.	Unlimited period of government incentives and complex way out of the program.
VC abilities were one important criterion for selection of 'Yozma Funds'. There was flexibility in the choice of the funds. Personal recommendation of the OCS was important	Administrative & financial criteria figured prominently in selection of Inbal VCs (there being no assurance of existence of specific VC abilities). No OCS recommendation required
Limited number of Yozma funds-created an incentive to join fast. This in turn contributed to creation of critical mass in two-three years.	No explicit limit (neither time nor money) to the number of funds that could enjoy the INBAL benefit.
The program was designed and implemented by the OCS who was skilled in promoting high tech industries. It was a consensual outcome of an interactive policy process, which included the Treasury, the private sector and foreign investors.	The program was designed and implemented by the Treasury who had no specific hi tech knowledge & who emphasized financial rather than 'real' aspects. Presumed limited interaction with relevant stakeholders; and a more limited consensus among all interested parties.
Strong incentive to collective learning, to VC cooperation, and to 'learning from others' (through requirement of having a reputable foreign financial institution)	No incentive to collective learning, to learning from others or to VC cooperation (legal limitations to cooperation).

Source: Gil Avnimelech, “From Direct Support of Business Sector R&D/Innovation to Targeting Venture Capital

Mechanisms of Coordination

The guiding principle of all activities of OCS is ***“risk sharing”.*** This principle is particularly evident in Incubator program: in the first two years, most of the risk is taken by the government. An incubator licensee can invest only 15% of the approved budget of a new

project and receives up to 50% of the shares.[35] This encourages the active participation of the private sector.

There are currently 24 incubators in Israel funded by the OCS, with 22 of the incubators in the field of technology, 1 is a technology based industrial incubator and 1 is a designated biotech incubator. The incubators are spread all across Israel including 8 that are located in peripheral areas. There are approximately 180 companies in various stages of R&D that operate in the incubators at any given time. All incubator programs are run as grants that are repayable to the OCS on successful completion of the project.[36]

The primary goal of the incubator program is to transform innovative technological ideas in their early, high-risk stages into viable startup companies capable of raising money and operating on their own. Secondary goals of the program are as follows: 1. Promote R&D activity in peripheral and minority areas. 2. Create investment opportunities to the private sector, including venture capitalists. 3. Transfer technologies from research institutes to the industry. 4. Create an entrepreneurship culture in Israel.[37]

The incubators support the formation of startup companies in order to lead them toward Round A investments. For a period of two to three years, the program provides companies whose projects were approved by the Incubators Committee with full financial support (~USD $500,000 – USD $750,000, of which 85 percent is granted by the government and 15 percent is invested by the incubator for technological incubators and USD $2,025,000, of which 85 percent is granted by the government and 15 percent is invested by the incubator), to be repaid to the government only upon generation of sales, in the form of 3% of the

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[35] Chief Scientis Office, *Incubators*, Accessed July 7, 2015.***http://www.incubators.org.il/article.aspx?id=1703***

[36] Chief Scientis Office, *Incubators*, Accessed July 7, 2015. ***http://www.incubators.org.il/article.aspx?id=1703***

[37] Chief Scientis Office, *Incubators*, Accessed July 7, 2015.***http://www.incubators.org.il/article.aspx?id=1703***

revenues annually.[38] In addition, projects in peripheral incubators are entitled for an extra budget of $ US 125,000, in order to diffuse the development to all geographical areas in Israel.

Since 1991 and to the end of 2012, the government initiated over 1,700 companies with a total cumulative government investment of over 650 Million Dollars. Over 1,500 companies had matured and left the incubators. Of these graduates, 60% have successfully attracted private investments. By the end of 2012, ~40% of the incubators graduates are still up and running. The total cumulative private investment in graduated incubator companies reached over 3.5 Billion Dollars. ***This means that on every Dollar the government invested in an incubator company, the company raised an additional 5 – 6 Dollars from the private sector.***

Change of trends in Policy

The OECD classifies Israel's science and technology policy as "bottom-up approach". [39]. The R&D in Israel has been a national priority from the mid-80s, but while the ***importance*** of investment in science and technology remains to be national priority, the implementation is done through policies that target ***specific areas***.

In early stages of knowledge economy industrial policy in Israel, the policies targeted mainly the spheres of activity that were lagging behind, for example – the venture capital

[38] Chief Scientis Office, *Incubators*, Accessed July 7, 2015.***http://www.incubators.org.il/article.aspx?id=1703***

[39] : *http://libproxy.kdischool.ac.kr/b0d1677/_Lib_Proxy_Url/www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en*

industry that needed to be jump started in Israel. In the recent years, Israeli government mostly doesn't invest in venture capital business, as it is very successful on its own, and focuses on international cooperation and coordination as well as pre-seed companies (helping them to mature enough to get funding elsewhere).

The "Yozma" program that jump started the FDI in Israel, no longer operates, due to its overwhelming success. Some principles of it still exist in other OCS programs, mostly those which target international cooperation. Nowadays, OCS mainly operates in 4 revenues that need its attention the most: "**pre-seed and seed programs"**, "**Incubators programs"**, "**Pre-Competitive and Long-Term R&D Programs", "International programs"** and the **"National R&D Fund".**

"**Pre-seed and seed programs"** support the wide range of activities required of entrepreneurs who are taking their *first steps* towards developing a new technological initiative before industrial production becomes feasible.

The **"Incubators"** Encourage technological innovation by creating a system that will provide entrepreneurs with a comfortable and convenient incubator in which they can conduct the research, development and organization that is necessary for *transforming a technology-based idea into a commercial product.*

"**Pre-Competitive and Long-Term R&D Programs"** Support generic R&D that is still *far from practical implementation* in the market and *forming bonds between the academia and the industry* that will ultimately produce products based on advanced knowledge and technology. **"National R&D Fund Programs"** –help *budding and mature companies* develop processes of converting theoretic knowledge into a *functional product*. And the "**International programs"** help Israeli companies form strategic links with

companies abroad in order to develop their competitive capabilities and their ability to penetrate international markets.

In other words, the OCS targets all fields of the industry, in all stages of development, from theoretical research in academia, to mature companies, but is focused on the investment to the fields that will have trouble finding investment elsewhere. ***The Government sees its main task as to bridge the gap between academia and private sector.*** The VC initiatives in the 90s were so successful, the OCS mainly invests only so the companies could survive long enough, to attract other investors, and educates the inventors how to attract that investment, or, on the other hand, targets theoretical research that is unlikely to attract private sector investment. Israeli start-ups are so highly valued world-wide, they bring steady foreign investment in on their own with OCS mainly facilitating maturing of the companies.

If the incubator programs illustrate best the principle of risk sharing, the "pre-competitive and long term R&D programs illustrate well the role Israeli government plays in bridging the gap between the academia and private sector, as-well as growing attention to specification that is the trend in the last decade or so. The pre-competitive programs (which exist under the name "Magnet programs" under the OCS) target niche research that is in need for development. At the time of composition of this research, Magnet had several specific programs: for example, "NOFAR" provides support and funding in the field of biotechnology, nanotechnology and development of medical equipment. "MEIMAD" supports R&D technologies that can have both military and civilian use (media streaming, for example, encoding, cyber security, etc). "TSATAM" gives grants for research in Biomedical engineering, biotech, human genome etc. those fields are selected because the research in them is long-term, and while it provides long term benefit for the science field on the whole, the rsearch is far from practical implementation and therefore is not likely to attract

investment from private sector. Likewise, “KAMIN” grants are given to researches in universities to encourage production of functional research in the future (mid process grant) “MAGNETON” – grants for technology transfer between academia and commercial companies. So, Magneton targets scientific research after the phase in which “KAMIN” assists.

International Cooperation

The international cooperation and coordination is another field that seen change of focus of Israeli government. While previous policies included international cooperation mostly in funding, the bulk of OCS activity nowadays is focused on expanding the Israel’s cooperation in development internationally. All International collaboration in research in Israeli economy is coordinated through the executive agency of the (OCS). It provides large variety of different grants as well as works as sort of matchmaking service between Israeli and Foreign companies through their database.

The Government of Israel has entered into more than 40 Bi-National Industrial R&D Support Agreements all over the world and participates actively in 5 multi-lateral European programs. The bilateral programs support commercially focused R&D projects between Israeli companies and the European companies in all fields of technology. It is open to all industrial/commercial companies performing R&D, from start-ups to multi-nationals. Academic and research institutions, hospitals, and other non-profit entities may participate as sub-contractors. The participating entities are required to demonstrate that there are strong scientific, technological and commercial synergies between them, and that the collaboration will be fruitful for both of the respective nations' economies, as-well as both of the companies.

Grants to the partner companies are given up to 50% of the approved R&D project expenses plus regional incentives. Whether the grant is "conditional", i.e. that it must be repaid if the project results in actual commercial sales, is determined in accordance to the regulations of each country. As for Israeli companies, royalty payments of 3% - 5% of sales are required. Neither equity in the companies, nor intellectual property rights, are taken by the governments in return for the grants.[40]

Israel also participates in multiple multilateral international projects. The main ones is EUREKA and EUROSTARS. EURREKA was founded in order to challenge the increasing migration of R&D and industrial innovation to Asian and North-American countries. EUREKA promotes international, market-oriented research and innovation through the support they offer to small and medium-sized enterprises, large industry, universities and research institutes. EUROSTARS is another European funding and support programme specifically dedicated to research-performing SMEs. It includes 20 plus European countries + European Union, Israel and Korea. Eurostars is backed by 861 million euro of national funds from its countries and is further supported by the EU, with 287 million, making a total of 1.14 billion euro in funding.

You can see the recent trends of targeting niche in R&D also in international cooperation. Those policies are specific to the needs of the government on one hand, but still general enough to not limit the companies that can use those grants. One of those programs provides ***Support for Product Adaptation in Latin America, China, and India***. In recognizing the increasing importance of the emerging markets of China, India and Latin America, the Israeli government and the Office of the Chief Scientist office have taken significant steps in recent years to promote cooperation with and penetration into these

[40] http://www.iserd.org.il/?CategoryID=388&ArticleID=484

leading target markets. One of the primary barriers for advancing cooperation with China, India and Latin America, was found to be the fact that many Israeli companies develop and design their products primarily for western markets. Since the needs and requirements in these target countries do not necessarily match those of the western market, often times further development, research or trials are required in order to adapt and customize such products to the markets of China, India and Latin America.[41]

Another program that targets a specific need of the Israeli 2government is ***the Global Enterprise Collaboration Program***. It encourages the creation of MNC-Startup partnerships in Israel[42].

Israel has a reason to want to attract new multinational companies. The cooperation between local firms and multinationals has been extremely beneficial so far. The multinational companies in Israel have a mixed strategy within the eco-system: they seek out and purchase the start-ups with the technology solutions that they need, preferring absorbing whole companies if needed, rather than developing the new technology in-house. But the multinational also actively engage with the eco-system, developing it and the human capital further, as well as with each other. For example, Intel Israel is one of the most important subsidiaries of Intel. The Sandy Bridge chip developed by Intel Israel accounts for 40% of Global Intel Corporation's notebook processors revenue.[43] It absorbed the local firms speaciliazing in different technology it deemed necessary to it expansion - Neocleus, experts in PC virtualization, Telmap, an Israeli-based navigation software company and Idesia, specialists in computer security. On the other hand, Intel also participated in 64 as a passive

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41 http://www.matimop.org.il/product_adaptation.html#sthash.f4ooJh3H.dpuf

42 http://www.matimop.org.il/mnc.html#sthash.XXnewqQ3.dpuf

43 "Multinationals - Intel." Invest in Israel (Israeli Ministry of Economy). June 8, 2012. Accessed May 22, 2015. http://www.investinisrael.gov.il/NR/exeres/CEB4D0F6-1AC0-455A-9875-42D5D1A56548.htm

investor just reaping the benefits if the company been successful, and absorbing the loss if it was not.

Miscrosoft Israel has followed a similar strategy within the Israeli Eco-system. Relying on local talent it developed several technologies vital to its global activities – Microsoft gateway VPN technology; Microsoft Security Essentials anti-virus suite, the recommendation system for Xbox systems and others. Microsoft also absorbed companies with narrow specialization such as Peach's "enhanced TV services for digital television", Gteko, a provider of automated technical support for personal computers, Secured Dimensions, with its technology for the protection of applications and others.[44] Miscrosoft further engaged with the innovation system by establishing a Microsoft accelerator, which provided start-up companies regardless of their future profitability, legal aid, free office space, coaching, and mentorship from specialists in the technology, finance, investors and CEO of other start-ups. Microsoft takes no equity stake in local start-ups, nor it provides funding, focusing instead in improving communication between Microsoft and start-ups and between start-ups themselves.

Results

A recent research by the Hebrew University of Jerusalem, found that every 1m shekels lent by the government, generated further R&D of two to three times the amount of the grant given.[45] The significance of hi-tech industries' growth may be illustrated by their having accounted for only 37% of the industrial product in 1965, a rate that grew to 58% in

[44] "Multinationals - Microsoft." Invest in Israel (Israeli Ministry of Economy). June 8, 2012. Accessed May 22, 2015. http://www.investinisrael.gov.il/NR/exeres/CEB4D0F6-1AC0-455A-9875-42D5D1A56548.htm

[45] http://www.ft.com/cms/s/0/babcfd3e-98b0-11e3-a32f-00144feab7de.html#axzz3hu3vdTUb

1985 and around 70% in 2006.[46] In 2009, only the product of ICT contributed 17.3% of the business sector GDP, and its exports were close to $16 billion.

Overall, Israeli exports $ 63.21 billion (2014) and imports $69.73 billion (2014).[47] It imports mostly consumer goods and raw materials, and exports mostly high technology equipment, telecommunication equipment, military equipment and pharmaceuticals.[48] Hi-tech exports quadrupled from $3 billion in 1991 to $12.3 billion in 2000 and to $29 billion in 2006 (plus another $5.9 billion of hi-tech services exported). Almost 80% of hi-tech products are exported, while the more traditional, low-tech firms export only close to 40% of their product.[49]

The main driving force of the economy are small, high-tech enterprises – Start-ups, and the interactions between start-ups and multinational conglomerates present in Israel, wither through joint ventures or acquisitions. As far as independent start-ups go, Israel boasts the highest density of start-ups in the world. There are a total of 3,850 start-ups, one for every 1,844 Israelis. More Israeli companies are listed on the NASDAQ exchange than all the companies from the entire European continent.[50][51] The number of Israeli companies traded on the largest stock exchange in the world, New York Stock Exchange, ranks third, behind only the United States and China.[52]

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[46] "Sectors of the Israeli Economy." Israel Ministry of Foreign Affairs. Accessed May 23, 2015. http://www.mfa.gov.il/mfa/aboutisrael/economy/pages/economy-%20sectors%20of%20the%20economy.aspx

[47] "Israel: Trade Statistics." GlobalEDGE, Michigan State University. Accessed May 23, 2015. http://globaledge.msu.edu/countries/israel/tradestats.

[48] Israel Fact Book." Central Intelligence Agency. May 18, 2015. Accessed May 22, 2015. https://www.cia.gov/library/publications/the-world-factbook/geos/is.html.

[49] "Sectors of the Israeli Economy." Israel Ministry of Foreign Affairs. Accessed May 23, 2015. http://www.mfa.gov.il/mfa/aboutisrael/economy/pages/economy-%20sectors%20of%20the%20economy.aspx

[50] Dan Senor and Saul Singer, *Start-Up Nation: the Story of Israel's Economic Miracle*, International Edition ed. (New York: Twelve, 2009), 13.

[51] "Companies in Israel." NASDAQ. Accessed May 22, 2015. http://www.nasdaq.com/screening/companies-by-region.aspx?region=Middle+East&country=Israel&page=2

[52] David Ogul, "Israel: A Perfect Example," *San Diego Jewish Journal*, December 2012 (accessed April 18, 2014), http://sdjewishjournal.com/site/4570/israel-a-perfect-example/

Foreign direct investment (FDI) in Israel reached $4.4 billion in 2009. By 2011, it had reached a high of $10.8 billion, while in 2013, total foreign investment totaled $11.8 billion. As of 2010, Israel led the world in venture capital invested per capita. Israel attracted $170 per person compared to $75 in the USA.[53]

2013 was a record-breaking year in terms of the amount of capital raised in the hi-tech industry, with a 662 Israeli high-tech companies receiving $2.3 billion investment, a 13-year high. Foreign investors in Israeli high-tech account for a vast majority – 76% -- of capital investment in Israeli companies.[54] The majority of investments over 2013 – two-thirds – was follow-up investment, with first-time investments constituting only one-third of the total. [55]So far in 2015, 166 Israeli startup companies raised $994 million from venture capital firms in the first quarter of 2015.[56]

Israel has about 70 active venture capital funds, of which 14 international VCs with Israeli offices, and additional 220 international funds which actively invest in Israel. Foreign investment is also leading in the volume of investment: Israeli venture capital firms invested only $180 million in local startups and high-tech companies, or 18% of all investments, in the first quarter this year.

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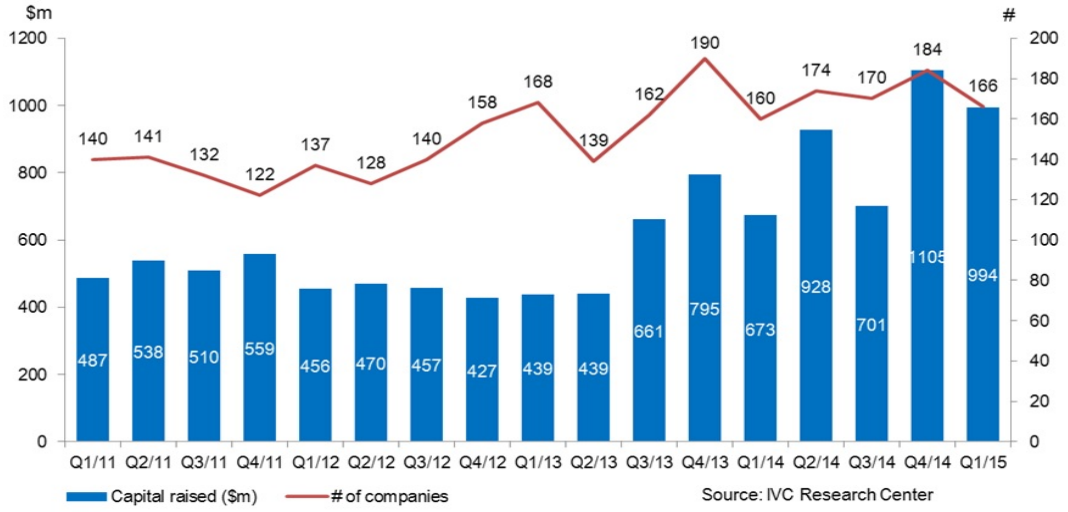
[53] Israel ministry of Economy (investment) http://www.investinisrael.gov.il/NR/exeres/AEB3AC3A-76B3-42DC-9899-71A7CD84A6AC.htm

[54] "IVC Survey." IVC-Online: Israeli High-Tech and Venture Capital Database. Accessed May 22, 2015. http://www.ivc-online.com/.

[55] Israel ministry of Economy (investment) http://www.investinisrael.gov.il/NR/exeres/AEB3AC3A-76B3-42DC-9899-71A7CD84A6AC.htm

[56] "Israeli Startups Raise Impressive $994 Million In First Quarter Of 2015." NoCamels Israeli Innovation News. April 28, 2015. Accessed May 22, 2015. http://nocamels.com/2015/04/israeli-startups-raised-billion-q1/.

Chart 1: Israeli High-Tech Capital Raising ($m)



The high value of the technology coming from the smaller start-ups brought many high-tech multinationals to establish subsidiaries in Israel. Those companies both establish their own research centers, factories and so on, but also actively compete with each other on purchasing successful start-ups – in many cases it's easier for a multinational company to purchase a better innovation than developing it in-house. See for example a record breaking purchase of Waze by Google for $996 million, to replace it's failing google maps. The multinationals also actively engage and develop the local innovation system by investing in start-up (versus purchasing as above) and in establishing their own incubators and development programs. Some of most prominent multinationals are Microsoft, Intel, IBM, Motorola, GE, Siemens, HP, SAP and Sisco. Intel in particular provided the largest-ever foreign investment in Israeli tech, with Intel injecting nearly $6 billion into upgrading its Kiryat Gat chip plant in 2014 and promising to spend up to $550 million in the Israeli economy in the next five years.

IV. Future of Industrial Policy

Back and Motivation of Creative Economy

Strong development in ICT and electronics sectors has made Korea one of the fastest-growing OECD economies over the past decade. It weathered the global crisis better than most OECD and non-OECD economies, and was the world's most R&D-intensive country, with GERD at 4.36% of GDP in 2012.

However, according to OECD and The World Bank, Korea faces some challenges in the field: slowing growth, rising inequality and unemployment, a rapidly ageing society, and emerging environmental problems.[57]

High technology exports were 27% of the total exports in 2013, down from 29% in 2010. 19% of the total volume of goods exported is ICT, down from 21.4% in 2010.[58] For comparison sake, Israel ICT service is 62.5% of the total services exported in 2013, and 11.8% of ICT goods. Israel's economy is much smaller – USD 290 billion of gross domestic product, vs USD 1.3 trillion of Korea's, on almost exact relative R&D expenditure to Korea – 4.4% of GDP in 2014, Israel seems to out-perform in most areas of R&D and it benefits to the economy, on a smaller investment.

In recent years Korea become increasingly aware of the need to restructure its economy to follow more diverse, innovation and creativity-driven path. Korea been using some of the policies that were implemented in Israel previously. It should be noted that Korea

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[57] OECD (2014), OECD Science, Technology and Industry Outlook 2014, OECD Publishing. http://dx.doi.org/10.1787/sti_outlook-2014-en

[58] "Science and Tecnology Indicators." World Bank. Accessed July 23, 2015. http://data.worldbank.org/indicator/TX.VAL.ICTG.ZS.UN/countries.

is not new to “knowledge economy” which it implemented successfully in the past several decades. The new government under the leadership of president Park Geun-hye has refocused its goals to “creative economy”, one which will move from technological catch up and into developing entirely new technologies and fields Korea will be able to dominate from the start.

Mechanisms of Government Coordination

Under the new government, a ministerial overhaul and major changes in STI policy co-ordination arrangements were carried out in 2013. The Ministry of Science, ICT and Future Planning (MSIP) was established to support the implementation of the Creative Economy initiative and the Ministry of Trade, Industry and Energy (MOTIE) groups its trade functions with the R&D, industry and energy policy portfolio. In addition, a new National S&T Council under the Prime Minister’s Office is the highest decision-making body on cross-agency STI policy issues.

Previously, Public research was mainly conducted in the PRIs, which have strong links with industry. One of strategies that Korea adopted aims to establish a new eco-system for co-operation among PRIs, universities and industry to promote greater use of public R&D results for industrial and social purposes. It includes a “One-Stop Assistance Centre” to help SMEs access the facilities and expertise of PRIs.[59]

The MSIP also has programs to support exchanges of professors and students between universities and PRIs, and plans to establish 18 new joint industry-university-PRI R&D centers by 2017. In addition, the 3rd S&T Basic Plan encourages greater shared use of

[59] OECD (2014), OECD Science, Technology and Industry Outlook 2014, OECD Publishing. http://dx.doi.org/10.1787/sti_outlook-2014-en

S&T infrastructure to broaden access to S&T knowledge and information. PRIs are required to devote 15% of their total budget to support SMEs by 2017 (compared to 7% in 2012) and 3% to transfer technology to SMEs and support human resources (compared to 1.76% in 2012).[60]

The Seoul Metropolitan Area was previously the focus of much S&T and innovation activity, and this has led to unbalanced regional growth. The government has therefore created special R&D districts, such as Daedeuk, Gwangju, Daegu and Busan, each with its own technological orientation, to promote regional industrial bases and local job creation. The Venture Investment Fund for special R&D districts was initiated in 2012 with USD 148 million (KRW 125 billion) to strengthen regional private investment.

Besides balancing the regional growth, the role of the free economic zines is to attract FDI. For example, Busan-Jinhae Free Economic Zone (hereinafter BJFEZ), located at Busan and Changwon (Jinhae), was designated by the Korean Government in 2003 to provide the best business as well as residential environment in order to attract leading multinational companies. BJFEZ has attracted 104 cases, totaling approximately USD 1,676 million. Along with Doodong Area and Jisa Area, including 2 Foreign Investment Zones (Jisa and Mieum), the regions serve as a home to core R&D centers as well as high-tech industries for shipbuilding parts & materials, auto-parts and mechatronics industries. Ungdong Area mainly targets tourism, leisure and logistics. Myeong-ji Area is referred to as so-called "international business city".[61]

The Second Parts & Material-Exclusive Foreign Investment Zone within BJFEZ, Mieum Foreign Investment Zone in Busan, and Nammoon Foreign Investment Zone in

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[60] OECD (2014), OECD Science, Technology and Industry Outlook 2014, OECD Publishing. http://dx.doi.org/10.1787/sti_outlook-2014-en

[61] "Investment Guide, Spring 2015." European Chamber of Commerce Korea. http://ecck.eu/nhc/bbs/board.php?bo_table=sub06_01_02&wr_id=5

Jinhae were all designated to provide various incentives to foreign-invested high-tech companies. Within Mieum Foreign Investment Zone, there are several foreign invested companies, such as German Bosch Rexroth and Wilo Pump, Swedish Hoganas, Austrian Geislinger, while Danish Sondex and Japanese Tsubaki are located in Nammon.[62]

BJFEZA is also trying its best to provide optimal residential environment for foreigners, especially in Ungdong and Myengji areas. Friedrich-Alexander-Universitat Erlangen-Nurnberg, a German University, has established its Branch Campus of Graduate school and R&D center for chemical and bio engineering within the BJFEZ region. Moreover, BJFEZA signed an MoU with British Brighton College, which led to establishment of western branch office of Busan District Court at Myeongji District. In Ungdong Area, Changwon International Foreign School has been scheduled to open in 2017. In addition, BJFEZ is also focusing on attracting new IT industries. For example, LG CNS DATA CENTER is already on operation, while other foreign IT related companies are under negotiation now.[63]

Korea has invested heavily in higher education and ranks third in the world in terms of the share of GDP spent on higher education. However, the Korean education system has mixed results. For example, OECD notes that with a large share of tertiary-qualified adults, adults' technical problem-solving ability is just average, and while 15-year olds perform well in science, the rate of doctorates in science and engineering is modest. There are also growing concerns within the Korean scholars about the fact that Korean education system does not encourage creativity. Rigid government control over the education system included the

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62 "Investment Guide, Spring 2015." European Chamber of Commerce Korea. http://ecck.eu/nhc/bbs/board.php?bo_table=sub06_01_02&wr_id=5

63 "Investment Guide, Spring 2015." European Chamber of Commerce Korea. http://ecck.eu/nhc/bbs/board.php?bo_table=sub06_01_02&wr_id=5

curriculum, examination system, tuition fees, number of students, and so forth for both public and private schools. The result of these top-down education policies has been the loss of autonomy and lack of accountability by individual institutions. As a result, strategic partnerships and connections, along with the institutional and organizational structures that govern such partnerships, among knowledge producing institutions such as corporations, universities, and research institutions are weak.

Such systemic weakness is also found in the international exchange of people and knowledge, such as the debilitated establishment of foreign universities and research institutions in Korea and inadequate participation in joint international research projects. In addition, the brain drain from Korea has accelerated with the increased international competition for highly skilled workers.

Universities have focused on the traditional mission of training scholars and the leaders of society. They have remained passive in the practical application of knowledge and failed to respond effectively to job market realities. The universities have not succeeded in specializing in a manner that reflects the uniqueness of local industry and culture—consequently, their role as a center for creating and disseminating knowledge in the local community has remained weak. Therefore, the training of high-quality human resources and the acquisition of advanced technology have relied on such alternative means as overseas education.[64]

The MSIP has developed a Comprehensive Plan for the Scientifically Gifted and Talented (2013-17) to identify pupils with high potential and nurture them to be more creative.

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[64] Kim, Anna, and Byung-Shik Rhee. "Meeting Skill and Human Resource Requirements." In *Korea As a Knowledge Economy : Evolutionary Process and Lessons Learned*. Washington, DC: World Bank, 2007.page 124

The Five-Year Plan for University Start-ups (2013-17) aims to improve entrepreneurship education in secondary schools and universities. Korea's demographic pattern indicates that the student population will decline from 2018. The National Scholarship programme, the Income Contingent Loan for low-income students, with a zero interest rate, and the 3rd Women S&E Promotion Basic Plan (2014-18) all aim to increase participation in higher education. The MSIP, along with other ministries, is implementing various initiatives to attract young scientists and engineers to SMEs, e.g. by establishing a one-stop information network for job markets and encouraging pre-employment of students.

International Cooperation

Despite the high R&D expenditure and increasingly favorable conditions, Korea has attracted relatively low levels of FDI. According to UNCTAD, Korea received USD 9,899 million, which makes 2.4% of gross fixed capital formation; Israel's has received USD 6,432 million, which is 11.4% of gross fixed capital formation.[65]

According to OECD, levels of international co-authorship and co-patenting in Korea are well below the OECD median. A traditionally strong focus on applied research and technological development performed largely in PRIs partly explain low levels of international co-authorship.

The low level of patent applications with foreign co-inventors is also partly due to Korea's conglomerate industrial structure, which tends to retain technology development

[65] "World Investment Report 2015 - Reforming International Investment Governance." Unctad.org. June 25, 2015. Accessed August 4, 2015. http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1245.

within the group. In the past, there have been occasional instances of cross-border co-operation but no comprehensive strategy for international STI co-operation.

The MSIP has therefore developed a Comprehensive Plan for STI Global Co-operation, which includes the formation of a global network of overseas STI outposts, expansion of S&T official development assistance (ODA), reinforcement of science diplomacy, promotion of international joint R&D, and sharing of large R&D facilities. The MSIP is also implementing measures to encourage international mobility of highly skilled labor.

According to 2013 study, Korea is one of the countries that lead in the ease of acquiring skilled labor. The parameters such as time it gets to receive work permits, tracks for citizenship, spousal work permits were assessed positively.[66] The Korean government also provides foreign investors with a variety of benefits in relation to their arrival, departure, and stay. There are immigration checkpoints dedicated exclusively to processing foreign investors, and permanent residency is granted if certain conditions are met. Also, the Investment Consulting Centre at KOTRA provides a one-stop service for foreign investors ranging from investment consulting to resolution of grievances during his/her stay in Korea..[67]

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[66] De Smet, Dieter. 2013. Employing Skilled Expatriates : Benchmarking Skilled Immigration Regimes across Economies. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/16905

[67] "Investment Guide, Spring 2015." European Chamber of Commerce Korea. http://ecck.eu/nhc/bbs/board.php?bo_table=sub06_01_02&wr_id=5

V. Conclusion

South Korea had achieved remarkable growth during the last decades, and is quoted as an example of successful industrial policy. This paper intends to review the history of industrial policy in Korean and issues on industrial targeting. Since Korean economy enters more mature stage, new paradigm of industrial policy is required to keep up with the changing environments. Particularly in 2000s, South Korean economy has transformed into knowledge economy and developed an innovation-intensive industrial structure.

As a bench mark case, Israel case is presented. Israel strategy has been focused on creating knowledge economy, investing in diverse portfolio of future technology. Israel been active in all fields of future technology from stem research to internet security, but by far most successful field is ICT (information and communications technology, a major part of hi-tech industry).

The government policies were vital in creating the knowledge economy. All science and technology policies and budgets are managed exclusively through OCS – Office of Chief Scientist, under the ministry of Economy. Two government sponsored VC programs (INBAL and Yozma) are compared and the differing mechanism is discussed.

The knowledge revolution, together with increased globalization, presented significant opportunities for promoting economic and social development in Korea.

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From Startup Nation To Scale-Up Nation, Israel Reached New Heights In 2014 http://nocamels.com/2014/12/israel-tech-startup-nation-2014/

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