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# Evolution of a Technology Policy during Catch-Up: the Case of the Republic of Korea

Summary

The article provides a brief overview of the development and implementation of science and technology policy in the Republic of Korea, its current state, the strategic goals and objectives of science, technology and innovation policy in the near future and the tools to implement it.

In the Republic of Korea and in East Asia technological development has been rocketing in the past fifty years. Before World War II, Korea was among the poorest countries of the world, with backward technology and practially no industry or science. The war between North and South Korea, completely destroyed the economy. After World War II, the main directions of development have been studies in the field of defence, nuclear and space science and technology.[1]

*Research relevance.* An analysis of the characteristic features of public policy in innovative countries plays a significant role in determining the measures required to encourage innovation. Moreover, modern science and technology policy of Korea has always been aimed at national development and is currently focused on the wider requirements of social compliance. This is fundamentally different in comparison to the previous period, when the main objective was industrialization. In addition, increasingly integrated into the global community, Korea is ready to play an active role in the international efforts to improve living conditions with the help of science and technology. The Ministry of Science and Technology makes efforts at building an innovative system that promotes knowledge-sharing and a competitive triliateral balance between the industry, education and public research.[2]

*An analysis of the recent research and publications.* The effeciency of innovation policy and means of improvement have been examined by Humeniuk, M. Krupka, S. Onyshko, V. Alexandrov, L. Antonyuk, Y. Gaits and V. Soloviev.

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## Isolation of the unsolved aspects of the problem

The 1990s saw another milestone in the development of science and technology policy of Korea. The country's economy hallmarked by the "chaebol" is – in fact, a holding that combines a number of companies in various industries. The board of directors of a chaebol is usually selected on family grounds. The features of their compensation were established on the basis of a mechanism of unprofitable companies from the profits of other companies belonging to the chaebol. This arrangement increases the stability of the chaebol in general, allows investment in non-profit and long-term projects, but does not stimulate the profitability of teh individual companies.[3]

The novelty of the study is that a summary is given of the successful experience in the field of innovation policy and the various alternatives of implementation in international experience

## Presentation of the basic material

Korea is called an "Asian tiger" because of the incredible achievements of its economy, which is ranked 14th in the list of the world's best-performance countries in terms of gross domestic product and 10th by nominal GDP. The per capita gross national income has increased from USD 100 in 1963 to USD 20 000 in 2005. The growing popularity of the economic and technological benefits of Korea attract an increasing number of students to the country. HRD Korea – a professional organization that has a major role and a comprehensive responsibility develops and manages national human resources in collaboration with the business community in the areas of continuous development in competence, management skills, support for the employment of foreign workers, international cooperation, and the promotion of vocational and professional competition.[4]

Its objectives include:

1) Support of the establishment and management of the technical sciences;

2) Support of e-learning and specialised technical material as well as process development;

3) Evaluation of the resources for training and research in the field of vocational competence development;

4) Promotion of vocational competence development for employees;

5) Support for the establishment and management of schools for VET teachers and professionals HRD, labour education for social education and labour governance;

6) A national qualification system, and the registration of the examiners as well as qualified persons;

7) Technical assistance and materials for vocational training;

8) Professional encouragement;

9) Support to the employment of migrant workers;

10) International cooperation.

The early 1980's saw the third stage in the development and implementation of science policy. The aim was to correct the imbalances resulting from the preferential concentration of investment in selected strategic sectors in the liberalized finances, investment and customs regulations and the construction of new research facilities. In 1982, the first national programme of research and development was launched, which was not

purely economic nature. Public priorities shifted from the industry and applied research towards the fundamental domain. Research institutions were restructured in line with the new challenges.[5]

### The role of public research funding

The state-funded system of training was developed by highly qualified scientists and engineers with the help of prestigious foreign teachers and experts, and a system including extensive training and qualifications (primarily PhD) work abroad. A Science Park was created in order to provide a concentrated space for training and research institutions, both state-funded and private, high-tech and venture capital firms, and to promote collaboration in research. Another feature of this period was the significant contribution of domestic investment companies to research and development. The Korean government strongly supported development in the programme in order to raise the Korean industrial clusters to a globally competitive standard. The word 'cluster' originates from 'a cluster of grapes' and can also refer to any group or gathering of people or things.[6]

Conceptually, a cluster can be formed for various purposes from friendships through education and promoting business.

In our current societies, however, 'cluster' is used mainly as a synonym for 'industrial cluster'; as clusters typically form around enterprises and are aimed either at business or industry-related activities. Cluster policies should primarily be implemented in a comprehensive perspective. The OECD stresses that "cluster polices exist at the border of industrial policies, regional development policies and science & technology policies, and their ultimate goal is to strengthen industrial competitiveness through enhanced interconnection between the industry and the research sector".[7]

Cluster policies allow us to check and diagnose the interrelationships and bottlenecks, while keeping the entire picture in sight. First, individually implemented policies are generally less than optimal, and the optimum conditions can be achieved through policies generated within the cluster system. Secondly, cluster policies do not focus on the individual constituents but on the networks built of them. While it is important to support the individual members so that they can solve urgent problems and increase competitiveness, cluster policies place more emphasis on vitalizing interconnected networks created through the collaboration of large companies and SMEs. Thirdly, cluster policies encourage active participation by private sectors, as well as central and local governments in their planning and implementation. During the past 50 years of economic growth since the Korean War, the Korean government has implemented industrial location policies, which are similar to clusters. Industrial locations refer to geographical area where companies gather to conduct business activities. Some examples are the Transition of the Industrial Location.[8]

#### *Policy in Korea's steel industrial complex in Pohang, the machinery complex in Changwon, and the petrochemistry complex in Ulsan*

Industrial locations are sites reserved and developed for industrial activities. The Korean government initiated the poli-

cy of designating industrial location to heighten the land efficiency of the nation and secure some of the territory for production and other industrial activities.

During this period, the main concern of the Korean government was to find an effective way to provide the material groundwork for the nation's industrial growth. Accordingly, development policies focused on concentrating investment into certain locations and developing specific areas. For example, Seoul and Inchon, which have the agglomeration economies and infrastructure of large cities, and Ulsan which has a harbour and other conditions favourable for industrial activities were chosen as special areas for industrialization. Tieback and Youngman River regions were designated as special areas for encouraging efficient investment in resource development. Let us follow the list:

| **Period** | **the 1960s** | **the 1970s** | **the 1980s** | **since the 1990s** |
|---|---|---|---|---|
| Industrial Policy | Light industry | Heavy and chemical industries | Technology intensive industry | High tech IT industry |
| Core Businesses (Area) | Textile Sewing (Guro) | Steel(Pohang), Machinery (Changwon), Electronics (Gumi), Petrochemistry (Ulsan) | Parts and materials (Banwon·Sihwa, Namdong) | IT(Seoul Digital), Semiconductors (Suwon), Automobiles (Ulsan) |

Besides, in order to help the Korean economy jump to a higher level and join the rank of advanced economies, it was necessary to reverse the paradigm of the industrial and science & technology policies. In other words, a new policy paradigm was badly needed to link the two sectors geographically and functionally. The most effecicient way to achieve innovation-driven growth is the promotion of industrial cluster policies.[9]

As an example, we can take the transition to innovative economies in East Asia.

Innovation has become vital for the future economic performance of numerous Eastern Asian countries. In the current highly competitive, increasingly interdependent world, a necessary, although by no means sufficient, condition for rapid growth is the ability to harness technological knowledge creatively.' In this context, Baumol (2002, /133–34) observes, "Per capita GDP [gross domestic product] has in-creased almost nine-fold in the United States since 1870 nearly ninety percent of current U.S. GDP was contributed by innovation carried out since 1870. The total contribution o/innovation is certainly greater than that, since pre-1870 innovations such as the steam engine and the railroad add to today's GDP."

The Republic of Korea accepted a five-year plan for scientific and technological innovation between 1997–2002. The five-year plan was based on aspects such as:

– Public investment in research and development: increasing state investments in research and development, at least to the level of 5% of the total state

budget by the end of 2002 (in 2001, this figure was 4.4%),

– Government support for basic research: increasing investment in basic research to the level of 20% of national budget (in 2000, the figure was 16%),

– Development of human resources and their utilisation in scientific and technical sectors: increase in the number of qualified researchers to 192 thousand people (or up to 40 people per 10,000 citizens).[10]

Was a flexible system of human resources management, allowing reduction of the gap between supply and demand in this sector of the labour market, in which support to the local engineering colleges, schools and institutes focused on research training.

The five-year plan for scientific and technological innovation was adopted in December 1997. It was formulated in order to ensure raising national level of research to the standard of the Group of Seven (G-7). It was assumed that this wouldbe achieved by the beginning of 21st century through supporting innovation, strategic technologies and the development of scientific research. This is a national plan that combines the efforts of many ministries and organizations.[11]

Other Asian countries also set up various economy development strategies. Import substitution strategy prevailed in the industrial development of Malaysia between 1959–1968, within a relatively short period: domestic demand was the main factor in industrial growth only in this period, while in the immediately following one, between 1963–1968 the country already began splitting export industries. The reason for this was that the population was small and consequently, there was no large domestic market, so external relations had a traditionally significant role in the process of reproduction.

In the Philippines the import substitution policy was first introduced some time 1950–1968, and in Thailand between 1960–1972. Development of manufacturing industry of Indonesia began in the late 1960s and ended at the turn of the 1970–80s. Due to Singapore's historical development and geographical location (when it was a British colony, it specialized in processing, the re-supply and re-export of products from Southeast Asia to Europe and the re-export of processed products from industrial countries in Asia), and the limited domestic market, the country had targeted industrial development based on exports.[12]

Implementation of the policy of import substitution in Southeast Asia changed the sector structure of the economy. Light industry, including textile, footwear, food and tobacco manufacturing was highly accelerated. External factors increased greatly in the economic development of these countries. The saturation of the domestic consumer market with goods of local production was not accompanied by decrease, and growth in total imports increased share in goods. Consequently, demand for foreign exchange resources increased and could only be met by increasing the export of raw materials due to the limited growth capacity. In addition, dependence on the international division of labour was enhanced and did not require export diversification, as the discussed countries were forced to look for opportunities to move towards a policy of export-oriented manufacturing. Thus, shift to export orientation was associated

with the depletion of opportunities in the export-substitution strategy, growth and the improvement of the industrial potential of the countries concerned. However, one should not focus merely on the various aspects of domestic policy. The actual implementation of the export and industrial strategies was heavily influenced by external factors as it coincided with economy restructuring in the industrialized countries, and the changing role of developing countries in the international division of labour. In the 1970 the industrialized countries experienced a significant increase in wages and improvement in the social protection of workers, which resulted in the unprofitability of labour intensive production. To reduce production costs, Western European and American firms began to relocate enterprises in these sectors in developing countries. The export orientation strategy of industrial development NIK was supported by multinational corporations.

This strategy was implemented in the industrial development of Southeast Asia in the 1970–1980's: in Singapore – from the time of independence (1957) up to nearly the cyclical crisis of 1980–1982, in Malaysia and in the Philippines since around 1969, and in Thailand from 1973 to nearly the end of 1980's. The prerequisites for implementing the export orientation policy manufacturing industries in Indonesia developed considerably later. The general weakness of the industrial potential and quite roomy domestic market led to the dynamic development in industry, based on the strategy of import substitution up to nearly the 1980's. Growing demand for foreign exchange was satisfied by revenues from oil exports. Therefore, the first attempt at the transformation of the textile, woodworking, radio and electrical industries into export-oriented sectors was made before the 1980–1982 crisis, but it failed due to the overall deterioration in the global market.

This was the period in which the countries of Southeast Asia mainly established their industries that currently determine their respective specializations in the international division of labour. By the principle of "comparative advantage", the primary role was assigned to the development of light industries (textile, clothing, footwear manufacturing etc.). In addition, through the improvement of their service provision (the manufacture of synthetic fibres, basic chemistry etc.) they also started to gradually develop heavy industries (metallurgy, chemical industry and engineering). Therefore, in the global market they appeared as manufacturers and exporters of mass consumer products, mainly for the markets of industrialized countries. Although over time the complexity of products supplied to the foreign market increased (VCRs, CD players, computers, cars), they still remain mass consumer goods.[13]

However, NIK Southeast Asia did not demonstrate such a pure version of export-oriented manufacturing. This was due to the fact that they did not only develop import-substituting industries in consumer goods, and in the second half of the 1970's they started a transition to a higher level strategy.[14]

Trends in industrial development in NIK Asia, which became visible in the 1980's, indicate a new, third phase in their industrial development, as these countries started transition from the traditional capital- and labor-intensive industries to the development of knowledge-

based industries and creating their own research bases. Shift from the production of consumer goods (which remained the priority) to high-tech products and other components is gradual. Its main feature is increase in public and private R&D allocations to development. At the end of the 1980's, the share of R&D expenditure in GDP terms in the NIK countries was significantly lower than in the U.S. or Japan: in Singapore, it was equal to 1.2%, while in other countries of the Association it accounted for less than 1%.

It is known that for a long time, industrial development the NIK region of Southeast Asia was based on technologies coming from industrialized countries. And despite the fact that in recent years foreign companies, especially Japanese firms, began delivering not only a proven technology, but also the "know-how" to manufacture high-tech products such as semiconductors, optical fibres, compact discs etc. to the NIK countries, it is still difficult to expect them to build their own basic research on the requirements of modern scientific and technological revolution, that is, to develop their own research base in NIK Southeast Asia and compete with the US or Japanese multinationals in the global market, as they are unable to independently acquire high technology.[15]

To this end, these countries have started to organize so-called research parks – special zones where favourable conditions are created for foreign and local firms for the development and production of high-tech exports. The transition to high-tech manufacturing industry specialization at the turn of the 1970–1980's began in Singapore and the other NIK countries of Southeast Asia followed a decade later.[16]

Both were close to success. The main functions of the Ministry of Science and Technology of the Republic of Korea are:

– Development of a state-controlled science and technology policy and forecasting technology.

– Development of key, long-term and large-scale technology.

– The development and security of nuclear technology.

– Support for basic research and applied research carried out by research institutions, state-funded universities and private research institutions.

– The policy of funding research and development, human resource development, science and technology information and international scientific and technological cooperation.

– Promotion of science and technology.

Since 1998, when it was announced that the country needed to have a "small but efficient government", the position of the Ministry of Science and Technology in the Cabinet has significantly strengthened. It was responsible for the coordination of science and technology policy with other ministries, as well as checking their activities in compliance with the policy. The Ministry supports the operations of the State Council for Science and Technology, with competence to coordinate national research programmes and identify funding priorities.

*Legal basis of the scientific and technical activities*

The framework of scientific and technical activities is set out in the Constitution of the Republic of Korea (Chapter 127), and a number of special laws that have been adopted to this end, namely:

– Act on Supporting Technology (1972, № 2399) – which defines the financial and tax measures to support private companies in the field of technology;

– Act on the support of engineering services (1973, № 2472);

– Act on supporting basic scientific research (1989, № 4196);

– Act on Atomic Energy (1989 № 1959);

– Act on the program of dual-use (1998, № 5535);

– Adopted in January 2001, the Framework Act on Science and Technology repealed the Act and Supporting science and technology (1967), and the Special Law on Scientific and Technological Innovation (1997, № 5340).

*Research organizations of the Republic of Korea*

Research capacities of the Republic of Korea can be classified into several types of research organizations.

1. Public research laboratories and government agencies that conduct research and development as part of non-defence orientation, for example, the National Institutes of Health, and others.

2. Public research laboratories and government agencies that conduct research and development activities within the framework of state defence with special focus.

3. Research institutes are non-governmental, non-profit, private organizations, with funding dependent on the government. They are called GRI's (Government-supported Research Institutes).

4. Private research laboratories of industrial corporations, conducting research for profit.

5. Universities.

The development of government-funded research institutes started with the Korean Institute of Science and Technology (KIST), established in 1966 as a joint technical centre, which aims to meet the country's needs for technological development. Its status is determined as a private non-profit organization with a special status in a special statute. In the mid-1970's or early 1980's, group of specialized research institutes emerged from KIST. Each institution works in specific strategic areas: shipbuilding, earth sciences, electronics, telecommunications, engineering, chemistry, energy and others.

In the 1980's, the government reorganized the 16 institutions under the jurisdiction of different ministries, 9 large research organizations under the Ministry of Science and Technology, in order to consolidate research capacity and improve the efficiency of utilisation.

In 1996, the scheme was modified in research funding. A new funding system, called "Project-Based System" (PBS), replaced the previous cost-estimate scheme, and funds were allocated based on research contracts.

At present the institutions'task is to improve their efficiency. In January 1999, a new act regulating the creation, operation and development of the research institutions was passed by the government. This act allows institutions to work independently, manage themselves on their own, and have independent decision-making and organizational structures.

The new control mechanism consists of five research councils, which coordinate the activities of the institutions. These are:

– the Council for Scientific and Industrial Research (7 institutions);

– the Research Council for Social Technologies (8 institutions);

– the Council for Research in Fundamental Science (4 institutions);

– the Council for Economic and Social Research; and

– the Council for the Humanities and Social Studies.

The new system aims to increase the productivity of research, strengthen the ties between institutions, and provide for the transfer and commercialization of research results. Despite the existence of such a system, eight research institutes remain under the direct authority of the Ministry of Science and Technology, providing support or implementation of their special features. One of the leading Korean institutes of assessment and planning in the field of science and technology is KISTEP, which was established in February 1999.

The Institute is subsidized by the state for the following functions:

– The implementation of research and development, supporting the government in social policy: including healthcare and living standards, the environment, energy management and others fields.

– Functions assigned to them by the state: national security, the space programme, etc.

– Research in areas unattractive to investors in other sectors, or in areas where research capacity is insufficient.

In the field of applied research, an increasing role is played by industrial laboratory corporations. The number of such organizations multiplied from 1981 to 2000 (in 1981: 47 and 2000: 6789 organizations). If research staffs of more than five people are registered with a state laboratory, it is eligible for an appropriate support. By the mid-1990's the number of researchers grew to a level close to the most developed countries, such as France and the UK (29 researchers per 10 000 people).

## Main conclusions

A review of the development and implementation of science and technology policy in the Republic of Korea reveals the basic principles and mechanisms that have contributed to the rapid adoption and implementation of decisions. The most important factors include a uniform leadership and overall consistency, as the entire executive power operates in the same manner. All key decisions are made by the supreme authority and powers are delegated to mid-level management, while the hierarchy of administration functions smoothly. The second reason for success lies in careful planning: detailed studies and strict performance developed against plans, along with high performance discipline.

These management practices are definitely based on the pecurliarfeatures of the national culture and mentality, based on the principles of Confucianism, a conscientious attitude to work and respect for hierarchy.

*Prospects for the use of research results.* The development of innovation must become an integral part of reforming the economy, because insufficient attention to the development of scientific and technical advancement results in structural deformation in the economy and the predominance of low-tech industries, which are unfavourable for scientific advancement and cannot ensure the com-

petitiveness for the economy. Thus, there is a need for further detailed examination and analyses of the factors that affect the efficiency of innovative strategies into the Ukraine.

## Notes

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