Economic Development through Knowledge Creation - The Case of Korea -

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Abstract

Knowledge is now recognized as the key to determining competitiveness in the 21st century, which emphasizes the role of information, technology and learning in economic performance. The objective of this paper is to identify the importance and characteristics of knowledge-based economy and identifies the current position of Korean economy in the process of transformation from a traditional resource-based economy to a new knowledge-based economy. Indicators of knowledge-based economy in terms of inputs and outputs are examined. It also examines policy alternatives for the successful transformation.

1. Introduction

Korean economy has achieved a remarkable economic growth during the last three decades. However, since 1977 Korea has been experiencing an economic crisis that continues to wreak havoc in Korea. As the means to overcome the crisis and to achieve the further economic growth, Korean government and companies tried to trace the origins of their weaknesses. Among many factors, the absence of core knowledge assets was regarded as one of the most important factor.

A key feature in the 21st century is that economic development rests upon knowledge and its useful application. Indeed, today's most technologically advanced countries are truly knowledge-based. By creating new knowledge and its commercialization, they create millions of knowledge-related jobs and thus generate new wealth from their innovations [1].

Korean economy is trying to move toward a knowledge-based economy from a traditional resource-based economy. Knowledge is now recognized as Korea's new driver of economic growth. Korean government is supporting potentially productive researches and many Korean firms have introduced knowledge management in their business process, including a heavy investment in R&D. They try to create new knowledge or technologies rather than acquiring or adapting knowledge already available in the advanced countries. However, we just move our first step toward that direction.

The objective of this paper is to identify the importance and characteristics of knowledge-based economy and examine the current position of Korean economy in the process of transformation to knowledge-based economy. Section 2 outlines a basic concept of knowledge-based economy, and section 3 examines why the transformation from a traditional resource-based economy to a new knowledge-based economy is important for nation's economic growth. Section 4 analyzes the current position of Korean economy by providing some indicators measuring knowledge inputs and outputs. Section 5 discusses government policies for narrowing knowledge gaps, which exist between developing countries and developed countries.

2. The Basic Concept of Knowledge-based Economy

Different writers can explain the knowledge-based economy in various ways according to their different points of view. In a narrow sense, for example, knowledge-based economy is sometimes referred to the information economy, in which the information technology (IT) plays a major role in determining nation's competitive advantages [2]. Or it is considered as one of the instruments with which it is possible to explain the "New Economy", in which there persists a high economic growth with a low level of price. There also exist many other similar concepts with knowledge-based economy, such as cyber economy and network economy.

However, knowledge is much broader concept than information. The term "knowledge-based economy" results from a fuller recognition of the role of knowledge and technology in economic growth. In general, OECD defines knowledge-based economy as the economy that is directly based on the production, distribution and use of knowledge and information. This means that Knowledge is regarded as the core factor of production leading

economies toward growth in high-technology investments, high-technology industries, more highly skilled labor and associated productivity gains, which allow producing high level of value-added [3].

In addition to giving the proper definition on the knowledge-based economy, OECD makes a clear distinction between different kinds of knowledge which are important in the knowledge-based economy: know-what, know-why, know-how and know-who.

- **Know-what** refers to knowledge about "facts". How many people live in New York? What are the ingredients in pancakes? And when was the battle of Waterloo? are examples of this kind of knowledge. Here, knowledge is close to what is normally called information – it can be broken down into bits. In some complex areas, experts must have a lot of this kind of knowledge in order to fulfil their jobs. Practitioners of law and medicine belong to this category.

- **Know-why** refers to scientific knowledge of the principles and laws of nature. This kind of knowledge underlies technological development and product and process advances in most industries. The production and reproduction of know-why is often organized in specialized organizations, such as research laboratories and universities. To get access to this kind of knowledge, firms have to interact with these organizations either through recruiting scientifically-trained labor of directly through contacts and joint activities.

- **Know-how** refers to skills or the capability to do something. Businessmen judging market prospects for a new product or a personnel manager selecting and training staff have to use their know-how. The same is true for the skilled worker operating complicated machine tools. Know-how is typically a kind of knowledge developed and kept within the border of an individual firm. One of the most important reasons for the formation of industrial networks is the need for firms to be able to share and combine elements of know-how.

- This is why **know-who** becomes increasingly important. Know-who involves information about who knows what and who knows how to do what. It involves the formation of special social relationships that make it possible to get access to experts and use their knowledge efficiently. It is significant in economies where skills are widely dispersed because of a highly developed division of labor among organizations and experts. For the modern manager and organization, is important to use this kind of knowledge in response to the acceleration in the rate of change. The know-who kind of knowledge is internal to the organization to a higher degree than any other kind of knowledge.

Among four different kinds of knowledge, the first two components of knowledge are called as codified knowledge because they can be easily transmitted with low costs by the codification of knowledge. On the other hand, the last two components of knowledge are classified as uncodified knowledge, which are slow and costly to transmit. Uncodified knowledge is sometimes called as tacit knowledge because it is difficult to measure and takes times to absorb [4]. However, Codified and uncodified knowledge are complements each of the other. Thus, we can expect the most of synergies when they are working together.

In general, "information" refers to codified knowledge. Thus, when the word "knowledge" is used with "information" it indicates the tacit knowledge. However, if the word "knowledge" is used isolated from "information" it refers to all four components of knowledge listed above [5].

3. Importance of Knowledge-based Economy

Traditional economic theories, especially concerning international trade almost neglect the differences in the level of knowledge (thus technology) among nations in their model, even though knowledge has long been an important factor in economic growth. By simply assuming that all countries have the same level of technology, they mainly focus on the primary factors of production, capital, labor and materials.

However, since production means the process of transformation of resources into commodities and resources are scarce, production must be done by using resources in ways that generate ever-higher returns to our efforts and investment. That takes knowledge [1]. Now analytical approaches are being developed so that knowledge can be included more directly in production functions. Investment in knowledge can increase the productive capacity of the other factors of production as well as transform them into new products and processes. Therefore, we can say that knowledge and technology are the key to modern economic growth [3].

Second feature of knowledge is that it leads to increasing return to scale possible in the production. Conventional production functions assume diminishing return to scale, where marginal costs increase. However, in the case of knowledge-intensive product, the fixed costs of production are large, but the variable costs of production are small. This cost structure allows industries enjoy substantial economies of scale. If the considering commodities are information oriented (information goods), such as CD encyclopedias, then they have an unusual cost

structure. For example, the additional cost of producing one more copy typically does not increase, even though great many copies are made [6]. In other words, multiple copies can be produced at roughly constant marginal costs. Therefore, the combination of constant or low marginal costs and economy of large-scale lead firms to make large profit margins.

However, as knowledge contain similar properties with public good, when created knowledge is open to public it is difficult for the creator of that knowledge to prevent others from using it. If they can use that knowledge without paying for it, this reduces the gains to innovators from creating knowledge. Then, innovators have no incentive to invest in the costly R&D to generate it in the first place [4]. Thus, it is necessary to protect their rights against theft under the Intellectual property laws of individual nation state.

So far, we have focused on the producer side. But, knowledge is also important in terms of social well- being and environment protection. Knowledge can be created and used with the objectives of curing life threatening diseases as cancer or reducing air pollution. However, in general, the social returns to a knowledge creation (to all those benefiting from it) far exceed the private returns (to just those investing in it). If this is the case, then investors are not willing to invest from a social perspective in knowledge creation. Because of the large gaps between private returns and social returns, many governments have assumed responsibility or provided financial incentives to the private sector for creating some types of knowledge. For example, with less than one-tenth the income per capita of the United States, Costa Rica boasts health indicators that compare favorably with those of many industrial countries [1].

Table 1. Gross enrollment rates in primary school in selected economies

Economy	1970	1980	1990
Hong Kong, China	117	107	102
Korea, Rep. of	103	110	105
Singapore	105	108	104
Ghana	64	79	77
India	73	83	97

Note: Data are total primary enrollments divided by the number of children of official primary school age in the population. Rates can exceed 100 percent when persons younger or older than the official age are enrolled.

Source: World Bank, 1998.

4. Korean Economy and Indicators for Knowledge-based Economy

Most economists agree that Korea's remarkable economic growth can be traced from the high saving rate which led to high rate of capital accumulation and high level of investment in education and training which led to high rates of increases in human capital. Well-educated and willing labor forces were the perfect complements to Korea's lack of natural resources. By 1970 Korea had achieved universal primary education (See Table 1). By 1995 the gross enrollment rate for secondary education was 90 percent, and that for tertiary education was 55 percent, which compares favorably with most OECD countries.

However, Korea's high rate of school enrollment does not mean that Korea has the same level of knowledge with the other economies of the Organization for Economic Co-operation and Development (OECD). It only indicates that Korea has a high potentiality for absorbing, acquiring and creating knowledge. Therefore, it is necessary to device proper economic indicator in order to measure the performance of the knowledge-based economy.

It is generally accepted that GNP is the best indicator for measuring nation's economic performances, even if it is criticized that GNP is not the good indictor for social well-being. According to the System of National Accounts, which are basically structured in the context of input-output model, the value of commodities (they may be either inputs for other commodities or final outputs) are measured by using their quantities and prices [7]. However, knowledge itself is particularly hard to quantify and has no price tag. Therefore, the problem of developing new indicators is itself an indication of the unique character of the knowledge-based economy. Were we faced with trivial modifications to the traditional accounting system, a few add-on measures might suffice. To fully understand the workings of the knowledge-based economy, new economic concepts and measures are required which track phenomena beyond conventional market transactions [8].

Since it is not our purpose to explain theoretically how to find the best economic indicators for measuring the performance of knowledge-based economy, simply by adding some modification to indicators used by OECD

this paper will examine two basic indicators. They are a) indicators measuring knowledge inputs, b) indicators measuring knowledge outputs.

4.1. Indicators measuring knowledge inputs

The principle knowledge inputs indicators, employed in this paper are: 1) expenditures on research and development (R&D), 2) number of official researchers per thousand labor force. Indicators of expenditures on R&D show direct efforts to enlarge the knowledge base and inputs into the search for knowledge, while the number of official researchers approximate the amount of problem to be solved in knowledge production.

Table 2 shows the indicators measuring knowledge inputs for some selected OECD countries. According to the table, we can see that gross domestic expenditures on R&D as a percentage of GDP in Korea is 2.79%, which is the second best next to Japan. When we compare Korea with other Asian competitors – Taiwan (China), Singapore, Hong Kong (China) – Korean figures are much more favorable. On the other hand, the number of official researchers per thousand labor force in Korea is 22.3, which is the lowest among OECD countries [9]. But the differences are not that significant compared with the United Kingdom (25.5) and France (25.8).

Table 2: Indicators measuring knowledge inputs

	Gross domestic expenditures on R&D as a percentage of GDP	Number of official researchers per thousand labor force
The United States	2.42	36.6
Japan	2.98	52.5
Germany	2.28	28.4
France	2.32	25.8
The United Kingdom	2.04	25.2
Korea, Rep. Of	2.79	22.3

Note: Data are for 1995.
Source: OECD, Human Capital Investment, 1998
Korea Department of Statistics, Korean Social Indicators, 1997.

4.2. Indicators measuring knowledge outputs

Knowledge outputs can be measured roughly by the number of patents issued and shares of gross value added produced by knowledge-based industries as a percentage of GDP. Patents, since they represent ideas themselves, are the closest to direct indictors of knowledge creation.

However, it should be noted that not all technical knowledge is patented and not all patents are equally significant. Patents also represent practical applications of specific ideas rather than more general concepts or advances in knowledge. Nevertheless, in general, the number of patents issued is regarded as the most direct indicators for measuring knowledge outputs.

Table 3 indicates that the number of patents issued per thousand labor force in Korea is 5.3, which is lower than other DECD countries except the United States. Figures on shares of gross value added produced by the knowledge-based industries are even more unfavorable for Korea. Only 8.2 percent of Korean GDP come out of the knowledge-based industries, while 15.8 percent of GDP is produced by the knowledge-based industries in the United States [10].

Combining results from table 2 and 3, it is obvious that Korean economy runs inefficiently in the process of knowledge formation and/or its commercialization. In other OECD countries knowledge-based industries play a key role in the long-run performance of countries by producing spill-over benefits, providing high-skill and high-wage employment and generating higher returns to capital and labor [11]. For example, OECD has classified manufacturing industry into three basic groups, high-technology, medium- technology and low-technology manufacturing sectors based on their relative R&D expenditures or R&D intensity (ratio of R&D expenditures to gross output). Computers, communications, semiconductors, pharmaceuticals and aerospace are among high-technology and high-growth OECD sectors and are estimated to account for about 20 percent of manufacturing production. However, less than 5 percent of manufacturing production comes out of high-technology sector in Korea.

Korea's low level of productivity in knowledge intensive industries mainly due to her weak science system, which takes on increased importance in a knowledge-based economy. According to OECD, a country's science system includes public research laboratories, institutions of higher education, government science ministers and research councils, certain enterprises and other private

bodies and supporting infrastructure. In Korea, for example, public expenditures on education is on the very low level, $370.00 per capita in 1995, while France is $1,594.10, which is more than four fold of Korea [12].

Table 3: Indicators measuring knowledge outputs

	Number of patents issued per thousand labor force	Share of gross value added produced by knowledge-based industries as a % of GDP
The United States	4.1	15.8
Japan	11.7	14.5
Germany	6.7	11.2
France	8.6	11.9
The United Kingdom	7.7	13.9
Korea, Rep. Of	5.3	8.2

Note: Data are for 1997.
Source: OECD, Main Science and Technology Indicators, 1999
WIPO, Industrial Statistics, 1999
Korea Department of Science and Technology.

Low professors / college student ratio and number of computers possessed by Korean population represent the current state of infrastructure for supporting knowledge-based economy (See table 4).

5. Government Roles and Policies

It is apparent that there exists knowledge gaps between Korea and other members of OECD. In order to narrow knowledge gaps, Korean government should play a crucial role. Currently, Korea has launched vast program for transformation from a traditional resource-based economy to a new knowledge based economy. The theoretical background of the government intervention for the successful transformation to knowledge-based economy can be traced from the neoclassical "market failure." According to the World Development Report by World Bank [1], it is explained by as follows:

(1) Because the market for knowledge often fails, there is a strong rationale for public action. The state is in a unique position to narrow knowledge gaps – for example, by adopting an open trade regime, supporting lifelong learning, or establishing a sound regulatory environment for a competitive telecommunications industry.

(2) Information is the lifeblood of markets, yet markets on their own do not always provide enough of it, because those who generate information cannot always appropriate the returns. Public actions are thus required to provide information to verify quality, monitor performance, and regulate transactions to provide the foundation for successful market-based development.

5.1. Policy Recommendation by World Bank

World Development Report by World Bank [1] explains three critical steps that developing countries can take to narrow knowledge gaps, which exist between developing countries and developed countries.

- **Policies for acquiring knowledge** - For developing countries, acquiring knowledge involves two complementary steps: obtaining knowledge by opening up to knowledge from abroad, and creating knowledge not readily available elsewhere. Three key means of facilitating the acquisition of knowledge from abroad are open trade regime, foreign investment, and technological licensing.

- **Policies for absorbing knowledge** - To narrow knowledge gaps, societies must ensure basic education for all and provide opportunities for people to continue to learn throughout their lives. Basic education is the foundation of a healthy, skilled, and agile labor force. Lifelong education beyond basics enables countries to continually assess, adapt, and apply new knowledge. In addition, Special emphasis must be on extending education to girls and other traditionally disadvantaged groups.

- **Policies for communicating knowledge** - Communicating knowledge involves taking advantage of new information and communications technology – through increased competition, private sector provision, and appropriate regulation – and ensuring that the poor have access.

5.2. Policy Recommendation by OECD

According to OECD [3], national strategies to narrow

knowledge gaps should be done in following ways:

- **Enhancing knowledge diffusion** – Support to innovation will need to be broadened from "mission-oriented" science and technology projects to "diffusion-oriented" programs. This includes providing the framework conditions for university-industry-government collaborations, promoting the diffusion of new technologies to a wide variety of sectors and firms, and facilitating the development of information infrastructures.

based economy. Knowledge is now recognized as the key to determining competitiveness in the 21st century, which emphasize the role of information, technology and learning in economic performance. After the economic crisis, Korea is moving toward that direction by reforming herself in various ways.

According the analyses done so far, all figures are favorable in terms of knowledge inputs, while they are unfavorable in terms of knowledge outputs. This low output/input ratio strongly suggests that Korea has a low level of productivity or efficiency in knowledge intensive industry. It is a disappointment since government and private sector put quite efforts in knowledge industry.

Table 4: Some indicators measuring knowledge infrastructure

	Gross domestic expenditures on education as a % of GDP (1996)	Gross domestic expenditures on public education per capita ($, 1995)	Number of professors per hundred college students (1996)	Number of computers possessed per thousand population (1997)
The United States	5.4	1,385.6	6.0	45.0
Japan	3.6	1,360.9	5.5	22.8
Germany	4.8	1,404.2	6.1	23.1
France	6.1	1,594.1	-	23.4
The United Kingdom	5.4	1,009.7	18.2	28.3
Korea, Rep. Of	3.7	370.8	3.1	12.4

Source: IMD, The World Competitive Yearbook, 1999
OECD, Human Capital Investment, 1998
Korea Department of Science and Technology

- **Upgrading human capital –** Policies will be needed to promote broad access to skills and competencies and especially the capacity to learn. This includes providing broad-based formal education, establishing incentives for firms and individuals to engage in continuous training and life long learning, and improving the matching of labor supply and demand in terms of skill requirements.

- **Promoting organizational change –** Translating technological change into productivity gains will necessitate a range of firm-level organizational changes to increase flexibility, particularly relating to work arrangements, networking, multi-skilling of the labor force and decentralization. Governments can provide the conditions and enabling infrastructures for these changes through appropriate financial, competition, information and other policies.

6. Conclusion

The world economy is being transformed from a traditional resource-based economy to a new knowledge-

It is true that there exist knowledge gaps between Korea and other OECD countries. However, successful strategy will close these gaps and allow Korea enter into a knowledge-based economy with competence and confidence. The suggested strategies are investing in the knowledge embodied in physical capital and investing in people and institutions to enhance the capability to create and use knowledge.

Finally, it should be noted that Korea's low level of productivity in knowledge intensive industries indicates that Korea is less efficient in commercialization of new knowledge than in creation of new knowledge itself. The creation of new knowledge is the domain of the individual, or of the research laboratory, or of autonomous business units. It need not require complex organization. However, the commercialization of new technology is increasingly the domain of complex organization. Therefore, new organizational forms and development and astute exercise of dynamic capabilities are required in order to increase productivity in Korea. It is also necessary to understand the nature of knowledge and competence as strategic assets [4].

References

[1] World Bank, *World Development Report 1989/1999: Knowledge for Development*, Oxford University Press, Washington, D.C. and Oxford, 1998.

[2] Arthur, W. B., "Increasing returns and New World of Business"*, Harvard Business Review*, 74(4), pp. 100-109.

[3] OECD (Organization for Economic Co-operation and Development), *The Knowledge-Based Economy*, OECD, Paris, 1996.

[4] Teece, D. J., "Capturing Value from Knowledge Assets: The New Economy, Markets for Know-how, and Intangible Assets", *California Management Review*, Vol. 40, N0. 3, 1998, pp. 55 – 79.

[5] Lee, S., S. I. Chang, H. S. Kim, K. H. Kwoun and J. K. Park, *The Theory of Knowledge-Based Economy*, Korea Institute for Industrial Economic & Trade (KIET), Seoul, 2000.

[6] Shapiro, C. and H. Varian, *Information Rule*s, Harvard Business School Press, Boston, MA., 1999.

[7] United Nations, *A System of National Accounts*, United nations, New York, 1993.

[8] Romer, P., "The Origin of Endogenous Growth", *Journal of Economic Perspectives*, Vol. 8, 1994.

[9] Hyundai Research Institute, "The Current Condition and Tasks on Knowledge-based Economy in Korea", *VIP Report*, Vol. 219, Hyundai Research Institute, Seoul, 1998.

[10] OECD, *The Knowledge-Based Economy: A Set of Facts and Figure*, OECD, Paris, 1999.

[11] Hyundai Research Institute, *Knowledge Economy Research Report*, Vol. 6, Hyundai Research Institute, Seoul, 2000.

[12] UNDP, *Human Development Report 1998*, Oxford University Press, New York and Oxford, 1998.