**Summary**

**Varieties of the National Innovation System (NIS)**

**and Readiness for the 4th Industrial Revolution:**

**South Korea compared with European Four Countries**

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Concept of the NIS (National Innovation systems)

This paper compares the national innovation systems (Nelson 1992, Lundvall 1992) of several countries, such as Korea, Italy, UK, France and Germany. Lundvall (1992) defines NIS as “elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge.” That is, NIS is a concept relating to the efficiency of the production, diffusion and use of knowledge. Scholars from the Schumpeterian school such as Lundvall and Nelson have advocated the NIS concept, arguing that differences in NIS among countries give birth to differences in innovation performance and thus countries’ economic performance.

Countries are compared in terms of the five indicators of the NIS proposed in Lee (2013).The first NIS variable is related to the source in the acquisition of knowledge and the degree of localization in the production of knowledge. That is, it regards how much knowledge being created relies on foreign or domestic knowledge bases. In other words, it measures how much knowledge is created domestically by citing the patents owned by inventors of the same nationality. It can be referred to as a measure of the localization of knowledge creation and is a proxy for how often the patent filed by a country cites other patents filed by its citizens. At firm level, it can be self-citation of patents belonging to a firm and is a variable that represents how independently firms produce knowledge. According to Lee (2013), Korea and Taiwan showed a low degree of localization in knowledge creation in the early 1980s, which was similar to that of other middle income countries but much lower than that of advanced countries. However, the degree increased rapidly after the mid-1980s and reached the average level of advanced countries by the late 1990s, indicating a significant catch-up in this regard.

The second NIS variable regards the concentration of actors or patent holders in knowledge creation. It regards whether the producers of knowledge are led by a few big businesses or evenly distributed among a variety of inventors. Clearly, this variable shows a quite even distribution of knowledge producers for advanced countries while knowledge creation is concentrated with a few inventors in the case of typical developing countries.

The third variable for NIS is originality. Existing literature describes it as how wide the range of the source of knowledge is when a patent cites preceding patents. That is, we say that knowledge has a high degree of originality if it relies on knowledge from a variety of fields. Similar to the concentration variable, advanced countries show a relatively higher degree of originality than developing countries. Interestingly, countries from Latin America show higher degrees of originality compared to South Korea and Taiwan (Lee 2013).

The fourth variable for NIS is related to whether or not countries specialize in sectors with fast obsolescence of knowledge or slow obsolescence of knowledge. This notion is expressed as the cycle time of technologies. It represents the length of the life expectancy of the particular knowledge being used. A short cycle time of technology means that the life span of the knowledge lasts only a few years and after that the usage declines dramatically as it soon becomes outdated or less used. Cycle time of technology is calculated by measuring average time lags between the application (grant) years of the citing and cited patents. That is, it means how much on average a patent relies on old technologies for invention of new knowledge. Lee (2013) shows that major advanced countries are specialized in sectors with relatively longer cycle times of technology, while South Korea and Taiwan have shown a tendency to focus on sectors with relatively shorter cycle times of technology since the mid-1980s, as their patents tend to cite other relatively recent patents.

The fifth variable for NIS is technological diversification. This regards whether countries or firms produce patents in a wide variety of fields or in a few limited areas. Lee (2013) shows that advanced countries have a higher degree of technological diversification than developing countries. In the case of South Korea and Taiwan, the degree of technological diversification has increased since the mid-1980s. Although it was still lower than that of German or Japan, the degree of technological diversification for South Korea and Taiwan has reached the average of high income countries.

Using the above five variables, one can describe and analyze the innovation system at the country level as well as at the firm level (Lee 2013, Chap. 5) by measuring proper variables at each level. In addition, this method can be applied to analyze the sectoral innovation system by measuring sector-level variables. For example, Park and Lee (2006) find that catching-up countries, such as South Korea and Taiwan, have registered many patents in sectors associated with short cycle times of technology, while advanced countries have registered patents in sectors with relatively longer cycle times of technology. Park and Lee (2006) argue that this difference in technological specialization has contributed to successful catching-up for South Korea and Taiwan

Evolution of the NIS in Korea

 While rapid economic catch-up in Korean can be better explained by its improved NIS (national innovation system) since the mid-1980s, now in the 21st century when some catch-up has been achieved, its growth momentum is slowing down. Lee (2013) shows that South Korea passed through the first technological turning point after the mid-80s by specializing in and entering sectors with short cycle times of technology. The country has thus been very successful in catching up to the income level of advanced countries. At the same time, South Korea also achieved a certain degree of localization in knowledge creation and technological diversification. Since the 2000s, the South Korean government has promoted industries such as biotechnology. As a result, South Korea was able to pass through the second technological turning point by entering sectors with longer cycle times of technology, but this is still an ongoing process. Although such industrial promotion policy succeeded in producing a certain number of patents (knowledge), it is generally agreed that those industries have not yet achieved commercial success.

Leaping into sectors with long cycle times of technology is not the only problem South Korea faces. As shown by the analysis in the preceding section on NIS, the country also needs to raise the degree of localization of knowledge creation and technological diversification, and lower the excessive degree of concentration. However, it will be very difficult to make this transition with the current NIS led by big businesses. Instead, the participation of various agents such as small and medium enterprises is required. Overall, this paper argues that South Korea needs to overcome three weaknesses in the current NIS (high degree of concentration, low degree of knowledge localization and narrow technological diversification) through three new combinations: a new combination of big and small firms, a new combination of labor and management, and a new combination of technologies.

Summary of NIS in European Countries.

First, the NIS of Italy can be characterized by the following elements: even distribution of innovation activities across inventors and higher specialization into longer cycle time-based technologies, but low degree of tech. diversification, lower degree of knowledge localization, and medium level of originality. This features seems to be consistent with SME oriented nature of Italian industry with strength in tacit knowledge oriented sectors. While this feature is something good, but these tend to indicate lower degree of readiness for the 4th Industrial revolution, as indicated by low originality and less diversification.

Second, the NIS of UK is characterized by higher originality and longer cycle technologies but less diversified and lowest intra-national diffusion (knowledge localization) which seems to reflect higher degree of internationalization of the UK NIS. Thus, UK may be advised to increase intra-national diffusion (which is lower than Korea), and a bit more of technological diversification.

Third, the NIS is Germany is characterized by: higher diversification and higher localization with relatively high originality and medium cycle time technologies.

More detailed analyses to be done.

Reference.

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Lundvall B (1992) National systems of innovation: toward a theory of innovation and interactive learning. Pinter Publishers, London