

Social Capital and National Innovation System

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Abstract

Research on national innovation system has increased noticeably in recent years. However, while some literature is available on technology management, little information is available on social capital. Similarly, the study on social capital has been mounting steadily, but little work is available on national innovation system. Thus, this work used the reports of World Bank and World Value Survey, applying the linear structural relation model to consider this relationship between the social capital and national innovation system. Overall, the results found that the innovation seem a collective achievement embedded with other social activities, and that the social capital like a catalyzer helps the collective innovation and economic productivity. Thus, this work suggests that every country should recognize that economy was closely embedded with social structure, and that should enrich the social capital to improve the performance of national innovation system and economic productivity.

Keywords: national innovation system, social capital

JEL Classification: E69, H89, O25, Z13

Introduction

Recently the issue of innovation has attracted a great deal of attentions worldwide. The innovation capability of knowledge and technology seems the key to the national economic development. However, the innovation process was affected by many complicated factors in the violent external competition. Thus, individual business already fails to initiate innovation alone, whereas should obtain and exchange different resources, information, and knowledge by external cooperation rather than internal resources. Put differently, the technology innovation significantly affected economic development, but the performance of

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innovation was inversely affected for lack of the social capital. Similarly, the issue on social capital has increased noticeably in recent years. Some works indicated that the social capital except technological competitiveness plays an important role in improving a sustainable political economic development. Moreover, the literature review of this work has found that the national innovation system was significantly embedded with the social capital. Put differently, the performance of national innovation system depends not only on the innovation of technology and knowledge, but also on the accumulation and application of social capital such as social cooperation, trust, and network.

In any case, most studies on the national innovation system are available on technology management, but little information is available on social capital. In contrast, most studies on social capital are available on organizational sociology, political sociology, and economic sociology, but little study is available on national innovation system. Moreover, while considering how the social capital affects the political and economic performances, some works nearly focus on the specific countries and regions (Putnam, 1993; La Porta et al., 1997; Zak and Knack, 1998; Crudeli, 2002) and use the qualitative analysis approach, whereas little works use the linear structural relation (LISREL) approach. Thus, this work used the reports of World Bank (WB) and World Value Survey (WVS) to consider the relationship and to construct a conceptual model between the social capital and national innovation system. Finally, this work tries to propose some tactical thinking and management implication and suggestions.

1. Theory and Hypotheses

1.1. Social Capital

Research on socioeconomic phenomenon by social capital has increased noticeably in recent years. In fact, the concept of social capital can be traced back to the eighteenth century; however, the content and context of the social capital in different fields often contrast with one another. First, Hanifan (1916) introduced the term “social capital” and implied that the concept contrary to economic capital should be recognized under maturity of capitalism development. Then, social capital has not attracted a great deal of attention over the past years. Until the late twentieth century, social capital became the contemporary focus again. For example, Granovetter (1973) proposed the concept of tie and then emphasized that various kinds of connection among individuals or organizations are available. As a result, the concept of social capital is increasingly embodied. Meanwhile, Granovetter proposed the term “weak ties” and then showed that the

difference between friends and acquaintances and how useful acquaintances can be for certain tasks like finding a job. The difference between a strong tie and weak tie can generally be revealed by time commitment underpinning the relationship. Strong ties are better for action, weak ties for new information.

Then, Bourdieu (1983) proposed the term *reproduction* and indicated that human society is a history of accumulation. Accumulation implying the conversion and transmission of capital plays an important role in social reproduction. Put differently, the reproduction involves both replication and reformation. In social capital, the accumulation and application of social capital facilitate to exchange and combine different resources by this reproduction process. These resources comprise economic, culture, and human capital. Further, Bourdieu (1983) noted that high status could use this reproduction process to maintain his or her own sustainable competitive advantage. In detail, social space is made of different champs, that is, the champs like the markets. People continuously compete against each other for obtaining the specific capital. In other words, the capital obtained previously usually affects the success or failure at the next competition. Thus, the potential of capital highlights the exchange capability over different resources (i.e., economic, social, and human capitals). People can maintain the sustainable competitive advantages in social games by the capital reproduction based on this exchange strategy.

Next, Coleman (1988, 1990) emphasized the social capital unlike traditional capital that depends on individuals or the tool of production inheres in social interrelation networks and implies the individual capital good. Coleman emphasized the term *trust* linking micro (i.e., individual) with macro (i.e., institution and norm). In micro level, the trust between individuals not only constructs the expectation and obligation within the mutual relations, but also facilitates the individual actor's convenience and solves problems through information network based on concrete social trust. In macro level, social capital can solve collective action predicament by external support and trust based on the legitimacy and proper norm and punishment.

Afterwards, Putnam's (1995) research on the United States of America and Italy defined the social capital as a characteristic of social organization, such as trust, norms, and network. Put differently, social efficiency can be improved by coordinating action among individuals and groups. In short, the concept of social capital comprises three parts: ethical obligation and norm, social value (i.e., trust), and social network (i.e., voluntary associations). Social capital embodied by the horizontal networks can improve the government's efficiency and economic development. In other words, a strong society implies a strong economy; a strong society implies a strong country. Thus, social capital may be over the physical and

human capital in improving national competitiveness. In addition, Peter Evans (1995) introduced the 'embedded autonomy' framework that plays an important role in the process of economic development in East Asia. He also found that the social capital can facilitate citizens' participation, trustworthiness, and social ties and networks. In practice, representing that accumulating social capital can enhance national competitiveness while the less developed countries lack the natural endowment.

More recently, Inglehart (1997) used social trust, association participation, and social cooperation concepts (Putnam, 1995) to investigate the relationship between social capital and economic development based on forty-three countries selected from WVS datasets. Likewise, Norris (2002) quoted the WVS materials to construct a measurement of social capital, as well as compared the differences across forty-seven countries. Further, Fukuyama (2000) noted that social capital (i.e., trust) significantly affects economic development (efficiency). Notably, in the post-industrialized era, the decreasing social capital owing to distrust atmosphere, high divorce rate, high crime rate, and authority collapse worldwide may yield the economic development instability

In addition, some countries and international institutions have paid more attentions to social capital research recently. For example, World Bank had devoted to improve the poverty question in the less developed countries by social capital research. Likewise, the Danish government subsidized the WB to launch the social capital initiative (SCI) that assessed the impact of social capital on the effectiveness of development projects. Meanwhile, some advanced countries and international institutes, such as OECD and the ONS on the UK had involved in measuring social capital to propose some available policy strategies. Overall, this trend represented that the social capital research have attracted extensive interests from many countries and government worldwide.

Overall, as this context of social capital has shown, the concept of social capital has been extensively offered by different fields for the past years. Thus, this work used the World Bank's operational definition of social capital, that is, the institutions, relationships, attitudes, and norms that can shape the quality and quantity of a society's social interactions and may contribute to economic and social development. Put differently, a country's social capital appears not only on structural social capital but also on cognitive social capital. The former refers to the relative objective and manifest social structure, such as network, association, rule, and institution. The latter refers to some subjective and abstract elements, such as trust, mutually beneficial attitude, and cognition among individuals. The structural social capital is external and can be observed and adjusted directly. In contrast, the cognition social capital is internal and only stays in ideology, but can be fostered and changed by the external actions.

1.2. National Innovation System

In the society of modern capitalism, although contributing to economic development by transforming knowledge into product, individual business has increasingly failed to initiate innovation alone, because such innovation, development, and proliferation of knowledge and technology was a collective achievement embedded with social and economic factors. For instance, the mass production of the United States automobile industry depends on a plentiful natural resource and a big domestic market. In contrast, the unique slim production in Japan was stemmed from a lack of natural endowment and land. Moreover, two famous global mobile phone brands Nokia and Ericsson were created by Finland and Sweden located at North Europe, because the geographical desert and cold weather cause the need of wireless communication. Similarly, the famous global anti-virus software PC-cillin results from a big market of anti-virus software because of the Taiwanese crazy plagiarism causing their PC to be attacked by the virus.

In fact, past research on the innovation and economic development emphasize the technology and knowledge rather than the social and culture factors. However, to date the focus of the national innovation system highlights not only the introduction, output, and proliferation of innovation in country, but also how the different innovation organizations evolve mutually and help national economic development. For example, Freeman (1988) firstly proposed the concept of national innovation system, emphasizing that a set of factors affect national innovation development, such factors as the relative economic institution and network structure. Put differently, these system factors help the innovation and proliferation of technology and knowledge by improving the efficiency of technology and the capability of brand-new production. Next, Lundvall (1992) thought that the national innovation system is made of the economic regime and structure. This system affects the speed and direction of the technology changes, implying the diffusion system of R&D and technology, as well as the attitude to the new technology.

In addition, Nelson (1993) highlighted the institutional concept of the national innovation system as follows: the interaction between production system and innovation process; the relationship between the individual business and institutional environment; the innovation capability of the national system based on different institutions. Furthermore, Patel and Pavitt (1994) thought that the national innovation system implying the institution, structure, and competitiveness that improve the speed and direction of learning of knowledge and technology. Similarly, Carlsson and Stankiewicz (1991) proposed the dynamic disperse concept of technology system, and emphasized that the network relationship and institution structure of application and proliferation of technology depends on

the dynamic evolution of time. Put differently, this technology system was not limited to the national territory, and implying both views of the localization and globalization of technology. However, either the national innovation system or the technology system emphasizes the dynamic interaction linkage within system. The intensively embedded structure will be affected as any individual organization change happens within system. Put differently, the evolution of the national innovation system was path dependent, that is, the innovation within system will cause the change of system structure. Moreover, because of the heterogeneity and asymmetry between different businesses, as well as the pluralism and complexity of globalization trend; the innovation system seems the cross-country discrimination and fails to completely copy, that is, many innovations only happen in some specific nations or regions.

In any case, research on the national innovation system has attracted a great deal of attentions worldwide in recent years. For example, Kumaresan and Miyazaki (1999), Dohse (2000), Liu and White (2001) addressed the influence relating the national innovation system to specific industry and economic development. Their finding suggested that the performance of national innovation system significantly affect the innovation proliferation of industry development and economic productivity of a country. Moreover, Dahlman (1994) proposed the approach how to measure the national innovation system and cross-country discrimination. In general, most findings indicated that constituting an excellent national innovation system or improving the performance of application and transmission of knowledge was the key to the innovation capability and economic competitiveness of a county. Overall, the focus of research on national innovation system either theory exploration or empirical analysis includes the following two dimensions: inputs and outputs.

In the inputs, the general analysis framework was not available to date, although Lundvall (1992) and Porter (1990) tried to construct a general analysis model. Similarly, Nelson (1993) thought that the ex-ante analysis framework fitting to overall national innovation environment was not available. In the outputs, some works have proposed some measured indicators for the performance of national innovation system, such as the granted patent application, published journal articles, and R&D expenditure (Grupp and Hariolf, 1994; Patel and Pavitt, 1994; Kumaresan and Miyazaki, 1999; Persson, 2000). In detail, in term of knowledge output, Pakes and Griliches (1984) proposed the following quantitative indicators: the technology input index such as the R&D expenditure and researcher; the technology output index such as the number of granted patent application and new product announcement. More recently, Soete and Wyatt (1983) proposed the revealed technological advantage (RTA) indicator applying

to either country or industry or business level. In any case, this measured innovation indicator that helps the comparison of relative advantage and weakness of innovation capability has been extensively used in recent years.

1.3. Social Capital and National Innovation System

The national innovation system consisting in individual business emphasizes the dynamic process of cross-organization interaction, that is, the social capital can embody and catalyze this interaction to improve the performance of national innovation system and economic productivity. According to the study of economic development and social capital in Atkinson et al. (1999), indicated that the innovation depending on the abundant social capital based on cooperation, learning, and network was the key to the national economic development. In addition, some works on the regional advantage highlighted that the unique social characteristic and global competitiveness of some regional industries, such as the financial industry in New York, the hi-tech industry in Silicon Valley, and the garments in Italian north region, can attract abundant talents of other relevant industries. Put differently, such the unique regional social characteristic like the resources embedded in social relationship network helps the learning and innovation of knowledge (Saxenian, 1991; Cohen and Fields, 1999).

In essence, the characteristic of influence relating the social capital to innovation activity was as follows: The interaction consists in the long-term relationship based on cooperation and trust. The formation involves the characteristic of formal and informal organizations. The former like the universities and research institutes helps knowledge proliferation, whereas the latter like interpersonal relationships network helps institutional learning. Although the social capital was embedded in the social relationship, the excessively close social relationships fail to absorb external information and to improve innovation learning more than an open system does (Adler and Kwon, 2002). Moreover, the social trust helps improve social cooperation except the density of the social network. In general, the social trust can be divided into interpersonal and professional trust. The former was inclined to be a close system, whereas the latter was inclined to be an open system that helps learning and innovation.

In detail, the intensive interaction and interpersonal trust may help the learning and innovation of knowledge, but the excessively close relationship inversely affects the innovation activities. For example, Granovetter (1985), Burt (1992), and Krackhardt (1992) noted that the strong tie with intensive relationship but lacking external connection seems a close system and fails to absorb external new knowledge outside. In contrast, the weak tie with loose relationship and abundant external connection seems an open system and helps the innovation

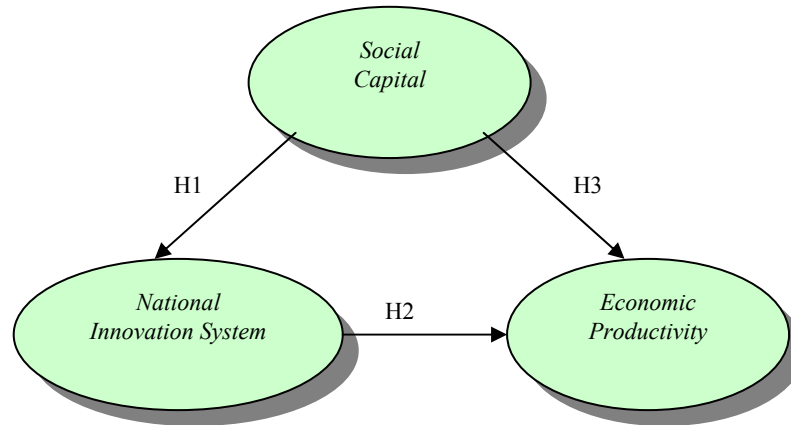
and proliferation of knowledge. Overall, a more open social capital based on the professional trust and weak tie relationship implied a higher economic productivity and national competitiveness. Moreover, the excessively mutual investments and close relationship between the financial banking system and the industries in Japan, as a result, the Japanese bank not only revealed the opaque financial report but also adopted the biased strategy saving crisis enterprises instead of pursuing bank's profit. In fact, this distorted strategy seems to contribute to the current unsolved financial crisis of Japan. In contrast, the Wall Street financial system that consists in accountant, lawyer, and invest company more than the interpersonal relationships emphasizes the professional evaluation and audit process. Thus, New York can still maintain the global financial innovation services leadership to date.

Overall, most scholars thought that the social capital affects the national innovation system by the following way: First, obtain the required resources of innovation. Technology innovation needs to combine different resources such as capital, talents, information, and knowledge. Thus, the society with abundant social capital helps construct a specific social network that helps absorb different resources and improve the performance of national innovation system (Kline and Rosenberg, 1986). Second, decrease the uncertainty of innovation. In general, the informal ties of social capital help share information and knowledge. Moreover, the knowledge of innovation can be divided into explicit and implicit knowledge. The transmission of implicit knowledge implied more face-to-face contact than that of explicit knowledge. Thus, the increasing informal ties of social capital help improve the implicit knowledge proliferation and decrease the uncertainty of innovation (Howells, 1995). Third, improve the capability of national innovation. Because the different risks in the technology innovation process are available from R&D inputs to product commercialization, and the innovation activity was like a collective achievement (Lundvall, 1988). Thus, individual business could hold the required resources and knowledge by innovation cooperation because of the limited capability of covering overall risks (Kline and Rosenberg, 1986). Overall, the social capital helps reduce the coordination cost and improve the possibility of innovation cooperation. Similarly, the relationship network of innovation system can be further improved by sharing cooperative profit.

1.4. Conceptual Model and Hypothesis Development

As noted above, research on the national innovation system has increased steadily in recent years; however most studies are available on technological management, little information is available on social capital.

Figure 1
Conceptual Model of Social Capital and National Innovation System



Similarly, most studies of social capital are available on organizational sociology, political sociology and economic sociology, but little information is available on the national innovation system. Thus, this work tried to integrate sociology, macroeconomics, and management theory into the conceptual model as shown in Figure 1, and then propose the following hypotheses:

H1: Social capital is positively related to national innovation system

H2: National innovation system is positively related to economic productivity

H3: Social capital is positively related to economic productivity

2. Methods

2.1. Materials

This work used the reports of WB and WVS that comprised the social and economic indicators from 1999 to 2005. However, these reports differed from each other on the sample countries and survey time. Thus, this work focused on seventy-one countries while considering the sample consistency and statistical requirement. Put differently, the sample size of this work was 213 that simultaneously used the cross-sectional and longitudinal data. As a result, the sample size met the LISREL requirement.

2.2. Measures

To test the proposed hypothesis, the LISREL model was used in this work. In general, the LISREL model comprises two submodels: the structural equation model and measurement model. The former specifies the causality between the

latent variables. The latter specifies how the observed variables depend on the latent variables. As this conceptual model has shown, the latent variables and observed variables in this work are as follows: ζ_1 is the social capital of latent independent variables; η_1 and η_2 are the national innovation system and economic productivity of latent dependent variable, respectively. The observed independent variables are as follows: X_1 is social network, X_2 is social cooperation, and X_3 is social trust. The observed dependent variables are as follows: Y_1 is R&D expenditure, Y_2 is journal articles, and Y_3 is granted patent application by USPTO, Y_4 is GDP growth, and Y_5 is overall productivity. The operationalizations of the proposed variables are the following:

Social Capital (ζ_1)

The proposed latent independent variable meant not only the relatively objective and apparent social structure (i.e., the social network, association, institution, and concrete cooperation relationship), but also the relatively subjective and abstract cognitive elements (i.e., the common values, shared vision, and collective trust). Thus, this work used the social network, social cooperation, and social trust to serve as this construct. The operationalizations of this variable are as follows: X_1 is the social network measured by the composite average indicators of fifteen kinds of association participation of the WVS report (e.g. social welfare, religious or church, labor union, and political parties or groups); X_2 is the social cooperation measured by the composite average indicators of two indicators of the IMD report (i.e., the company-university cooperation and inter-company cooperation); X_3 is the social trust measured by the average of the question of the WVS report: “*Generally speaking, would you say that most people can be trusted or that you can’t be too careful in dealing with people?*” (I.e., dichotomy scale: 1 = trustworthiness, 0 = carefulness.)

National Innovation System (η_1)

The proposed latent dependent variable meant the effective national innovation system that appears on the cooperative R&D expenditure, scientific and technical journal articles, and granted patent application. This system helps improve the productivity, innovation, and proliferation of knowledge by the interactions between public and private sectors. Thus, this work used the relative indicators of innovation of the WB report to serve as this construct. The operationalizations of this variable are as follows: Y_1 is the total expenditure for R&D as percent of GNP, Y_2 is the scientific and technical journal articles per million people, and Y_3 is the granted patent application by USPTO per million people.

Economic Productivity (η_2)

The proposed latent dependent variable meant that an effective national innovation system helps the innovation and proliferation of technology and knowledge. Put differently, a higher performance of the national innovation system implies a higher capability of economic productivity and development. Thus, this work used the relative indicators of national productivity of the WB report to serve as this construct. The operationalizations of this variable are as follows: Y_4 is the average annual GDP growth, and Y_5 is the overall productivity in purchasing power parity.

3. Data Analysis

As noted above, this work used the LISREL model and assumed that γ_{11} and γ_{21} are the regression parameters relating the social capital ζ_1 to the national innovation system η_1 and economic productivity η_2 , respectively. Then, β_{21} is the regression parameters relating the national innovation system η_1 to the economic productivity η_2 . Moreover, ζ are the residuals (errors in structural equation); the evaluation of all parameters is the significance of t -value at 0.05. In general, the goodness-of-fit of the LISREL model can be evaluated by external fit and internal fit. The former measures are as follows: The chi-square (χ^2) value should be insignificant; the goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and incremental fit index (IFI) should be greater than 0.9; the standardized root mean square residual (SRMR) should be lower than 0.008. In contrast, the latter measures are as follows: the square multiple correlations (SMC) of observed individual variables, that is, the R-square value of predicting observed variable by latent variables should be greater than 0.5; the composite reliability (CR) should be greater than 0.6; the average variance extracted (AVE) should be greater than 0.5.

4. Results

4.1. Goodness of Fit Test

The results of this work testing the proposed model by maximum likelihood indicated the convergent solution. In external fit measures, the chi-square value ($\chi^2 = 69.5$, $df = 17$) was not significant at 0.05, showing that the proposed model between the social capital, national innovation system, and economic productivity could be accepted. Moreover, other measures such as the GFI = 0.87 and AGFI = 0.62 were greater than 0.6; the IFI = 0.79 was close to 0.9; the SRMR = 0.0071 was lower than 0.08.

Table 1

Internal Fit for the Model of Social Capital and National Innovation System

Variables	SMC	CR	AVE
Social Capital (ζ_1)		0.69	0.71
Social network (X_1)	0.49		
Social cooperation (X_2)	0.75		
Social trust (X_3)	0.57		
National Innovation System (η_1)		0.75	0.77
R&D expenditure (Y_1)	0.77		
Journal articles (Y_2)	0.77		
Patent granted by USPTO (Y_3)	0.58		
Economic Productivity (η_2)		0.88	0.91
GDP growth (Y_4)	0.99		
Overall productivity (Y_5)	0.78		

Note: SMC – square multiple correlations; CR – composite reliability; AVE – average variance extracted.

In internal fit measure, the SMC values of $X_1 - Y_5$ except the social network X_1 were greater than 0.5. In detail, the social cooperation $X_2 = 0.75$ was over the social trust $X_3 = 0.57$ and social network $X_1 = 0.49$ for the social capital ζ_1 . Then, the R&D expenditure $Y_1 = 0.77$ and journal articles $Y_2 = 0.77$ were over the granted patent application $Y_3 = 0.58$ for the national innovation system ζ_2 . Next, the GDP growth $Y_4 = 0.99$ was over the overall productivity $Y_5 = 0.78$ for the economic productivity η_2 . Moreover, the CR and AVE values of the social capital, national innovation system, and economic productivity all met the required evaluation. To conclude, the results shown in Table 1 indicated that the overall goodness-of-fit of this model was satisfied.

4.2. Path Model Analysis

Moreover, Figure 2 shows that all observed variables $X_1 - Y_5$ positively related to specific latent variables themselves. In detail, the social cooperation $\lambda_{21}^x = 0.81$ was over the social trust $\lambda_{31}^x = 0.61$ and social network $\lambda_{11}^x = 0.49$ for representing the social capital. Then, the R&D expenditure $\lambda_{11}^y = 0.88$ and journal articles $\lambda_{21}^y = 0.88$ were over the granted patent application $\lambda_{31}^y = 0.76$ for the national innovation system. Next, the GDP growth $\lambda_{42}^y = 0.99$ was over the overall productivity $\lambda_{52}^y = 0.88$ for the economic productivity. Furthermore, all of the latent variables $\zeta_1 - \eta_2$ positively related to one another. The causalities between these latent variables were as follows:

Social Capital to National Innovation System (H1)

Firstly, the influence relating the social capital ζ_1 to the national innovation system η_1 , $\gamma_{11} = 0.99$ was positively significant, that is, the performance of national innovation system improves as the social capital increases. In detail, the

ranking order of these path coefficients to the national innovation system were the social cooperation X_2 , social trust X_3 , and social network X_1 .

The results agreed with some works' finding (Granovetter, 1985; Kline and Rosenberg, 1986; Howells, 1995; Atkinson, 1999; Cohen and Fields, 1999) that an open system of the social capital based on the long-term social cooperation, social network, and social trust helps construct an innovative learning environment by the following ways: absorb different resources by various social networks; decrease the innovation risk of individual business; reduce coordination cost and improve cooperation benefit; enhance the performance of national innovation system. Put differently, among three influences relating the social capital to the national innovation system, the social cooperation and social trust were important.

National Innovation System to Economic Productivity (H2)

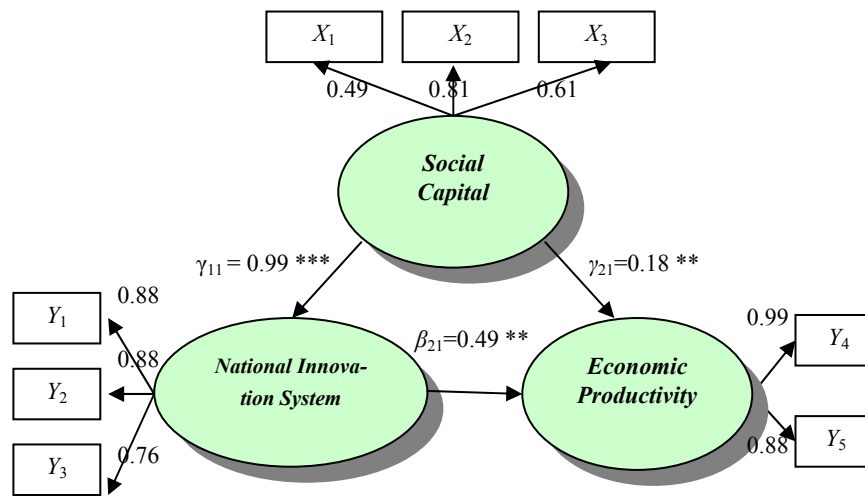
Then, the influence relating the national innovation system η_1 to the economic productivity η_2 , $\beta_{21} = 0.49$ was also positively significant, that is, the economic productivity improves as the performance of national innovation system increases. The results agreed with some works' finding (Dahlman, 1994; Kumaresan and Miyazaki, 1999; Dohse, 2000; Liu and White, 2001) that the innovation capability of knowledge and technology can explain the discrimination of cross-country economic performance. The national innovation system plays an important role in industry innovation development and national economic growth. Put differently, the innovation capability and economic competitiveness of a country depend on an excellent national innovation system that helps the productivity, proliferation, and application of knowledge. Overall, an effective national innovation system helps improve not only the innovation, accumulation, and proliferation of knowledge and technology, but also the overall economic performance.

Social Capital to Economic Productivity (H3)

Finally, the influence relating the social capital ζ_1 to the economic productivity η_2 , $\gamma_{21} = 0.18$ was positively significant, that is, not only the transactional cost decreases but also the overall economic productivity improves as the social capital increases. The results agreed with some works' finding (Bourdieu, 1983; Putnam, 1993, 1995; Evans, 1995; La Porta et al., 1997) that the accumulation and application of social capital help exchange and combine different resources and maintain the sustainable competitive advantages. Put differently, the level of social capital stock in a country helps reduce social transaction cost and improve overall economic productivity. Moreover, the influences relating the social capital ζ_1 and national innovation system η_1 to the economic productivity η_2 were positively

significant. The national innovation system $\beta_{21} = 0.49$ was over the social capital $\gamma_{21} = 0.18$ for the economic productivity. However, this finding indicated total effects (0.66) relating the social capital to the economic productivity, that is, the direct effect (0.18) of social capital itself and the indirect effect (0.48) of the national innovation system by improving the integration and proliferation of technology and knowledge.

Figure 2
Results of Path Coefficients Analysis



Note: *** $p < 0.01$; ** $p < 0.05$.

5. Discussion

The main purpose of this work was to consider the relationship between the social capital and the national innovation system. This work hypothesized that the social capital was positively related to the national innovation system and national competitiveness. To conclude, the results support these hypotheses and important conclusions are as follows:

5.1. Conclusions

Social Capital and National Innovation System: An open system of the social capital based on the long-term social cooperation, social network, and social trust helps construct an innovative learning environment by the following ways: absorb different resources by various social networks; decrease the innovation risk of individual business; reduce coordination cost and improve cooperation

benefit; enhance the performance of national innovation system. In the social network, the intensive cooperation helps the innovation and learning of knowledge, but the excessively close relationship may hurt the performance of innovation. Similarly, the strong tie with intensive relationship but lacking external connection, for example, seems a close system and fails to absorb the external new knowledge. In contrast, the weak tie with loose relationship and abundant external connection seems an open system and helps the innovation and proliferation of knowledge. In the social trust, the intensive interpersonal relationship helps improve the trust but incline to be a close system, and fails to improve innovation more than an open system based on the professional relationship does. Overall, the more an open social capital consisted in bridging and professional trust and weak tie, the more performance of national innovation increases.

National Innovation System and Economic Productivity: The innovation capability of knowledge and technology can explain the discrimination of cross-country economic performance, that is, the effectiveness of national innovation system improves as the proliferation performance of industry innovation increases. However, the innovation activity seems a collective achievement embedded with other organizations and social activities and seems not to be completed by single business. Moreover, because of the violent external competition, the innovation unit has shifted from individual business to the system and network of innovation. Put differently, individual business should hold the required knowledge and resources of innovation by external resources instead of internal resources. Thus, the following approaches should be considered: improve the linkage such as both in-business and inter-business resources; shift the focus of innovation from integration to system and network. Overall, the national innovation system was not only the participated public and private sectors such as the R&D institutes and universities, but also the relative economic structure, institutional environment, and various networks that affect the learning and innovation of knowledge in production, marketing, and finance process.

Social Capital and Economic Productivity: The conventional economy and the knowledge-based economy depend on different resource-driven bases. The former emphasizes the natural capital and physical capital such as the required facilities and infrastructure, whereas the latter highlights the knowledge capital and social capital such as excellent human capital and social cooperation and trust. Notably, recent research indicated that the innovation plays an important role in the economic development. Put differently, the physical capital and human capital significantly affect the technological innovation, but the performance of innovation will also inversely affected for lack of the social capital. Overall, in the uncertainty environment, not only the transaction cost decreases but also the economic performance improves as an open and abundant social

capital increases. Moreover, the innovation system at early stage emphasizes the formal network for transmitting explicit knowledge rather than the social network for transmitting implicit knowledge. Thus, for the improvement of the innovation performance and economic development, in addition to constructing the physical capital that helps the proliferation of explicit knowledge and information, every country should enrich the informal and social network that helps the innovation and proliferation of implicit knowledge and experiences.

5.2. Implications

Enrich the Intension of Social Capital: Face the external environment challenges, such as the violent global competitiveness, shortened product life cycle, speedy technology change, and the lack of natural resources. Either business or country should improve the ability of innovation to maintain sustainable competitive advantages. However, most countries focused on the technology development rather than the contribution of social capital for the national innovational system (**H1**) and economic performance (**H3**). In fact, recent research indicated that the innovation was the key to the economic development, notably innovation was greatly affected by the social capital rather than the scientific technology and physical capitals. Put differently, the performance of the national innovation system will inversely be affected for lack of the social capital. According to some successful development experiences, the social capital plays an important role in maximizing the capability of the national innovation system. Although lacking the natural resources, for example, Finland and Sweden constructed an excellent global competitiveness by the excellent human resources, prospective technology innovation, and abundant social capital. Similarly, the South Korean products with the progressive technology innovation have prevailed over the world in recent years, but the internal innovation networks based on intensive cooperation and social trust seem the key to this success. Thus, this work suggests that every country should recognize that economy was embedded with social structure, and effectively accumulate and use the social capital to improve the performance of national innovation system and economic productivity. In detail, either social network or social trust or social cooperation can transform and enrich the intension of social capital. Moreover, in the sustainable national development, the natural capital is like foundation, the physical capital is like hardware, the human capital is like software, and the social capital like an important lubricant helps integrate these different capitals. Thus, how to balance these different capitals was the key to the national competitiveness. Likewise, for the third world countries, the results show that enriching the social capital can overcome the lack of nature resources and improve the unfavorable national competitiveness.

Optimize the National Innovation System: Recently the innovation issue has attracted a great deal of attentions worldwide. The innovation capability of knowledge and technology can explain the discrimination of cross-country economic performances; as a result, innovation already becomes the key to the national economic development (**H2**). However, the innovation process was affected by a lot of complex factors in the violent external competition. Individual business already fails to initiate innovation alone, whereas should obtain and exchange different resources, information, and knowledge by external cooperation rather than internal resources, such external resources as suppliers, consumers, competitors, universities, research institutes, and public organizations. Put differently, the performance of what kind of the innovation cooperation with other organizations was always better than that of individual business themselves. Moreover, the business strategies were affected by various institutions and norms such as laws, culture, rules, and technology standards. Thus, the interactions between different organizations in different institution context help improve the national innovation system. In any case, the innovation unit has shifted from individual business to the system and network of national innovation, according to the evolution of innovation development. Moreover, the globalization trends and increasing foreign direct investment of multinational enterprises, but the importance of country seems not to be affected because of the cross-border characteristic of scientific technology development. In other words, constructing an effective national innovation system was more important than inputting a great deal of R&D budget. Put differently, the national innovation system helps introduce an effective national policy although this system was not without flaws. Overall, an excellent national innovation system depends on the knowledge accumulation and the organization-environment interactions. In detail, optimize the national innovations system not only focuses on the participated public and private sectors, but also expands to the relative economic structure, institutional environment, and various networks that affect the learning and innovation of knowledge in production, marketing, and finance process.

5.3. Recommendations

Increase the Sample Size: Because the adopted reports of WB and WVS differ from each other on the sample countries and survey time, this work selects seventy-one countries based on sample consistency and statistical requirement. However, for further addressing the relationship between the social capital and national innovation system, next study that replicating this model on a larger sample over countries worldwide should be developed.

Apply the Cross Group Analysis: This work addresses the relationship between the social capital and national innovation system. However, according to the evolution of social capital development, future study applying cross group analysis can be considered based on the different clusters, such as the economic development (e.g. the developed, developing, and third world countries) and the culture (e.g. the western culture and Confucian culture), thereby comparing with the results of this work.

Adopt the Longitudinal Analysis: This work is a cross sectional analysis that considers how the social capital affects the national innovation system. However, focusing on specific group by longitudinal analysis should be further considered, thereby comparing with the results of this work. Moreover, because of the sample size limitation that uses the LISREL model, the other statistical tools (e.g. PLS) fitting to calibrate the small sample problem should be applied.

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