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The philosophical views of national innovation system: The LED industry in Taiwan

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ABSTRACT

Prior research on the national innovation system mostly emphasizes technological diffusion and industrial performance. The discipline of the national innovation system leads to extensive discussions of technological policy, strategic alliances, technological transfers, joint ventures, mergers and acquisitions, and even talent acquirements. However, little research has examined why and how the philosophical views of actors in a national innovation system (e.g. egoism, utilitarianism, and altruism) affect the industrial performance. This study draws on a qualitative, theory-building case study to examine the transforming LED industry in Taiwan and to renew and extend existing research on the national innovation system.

1. Introduction

The national innovation system has been viewed an effective tool to understand the competitive advantage of a country (Samara, Georgiadis, & Bakouros, 2012). A national innovation system (NIS) focuses on a dynamic process involving multiple actors, e.g., academia, research institutes, government, and industry, to establish a value creating system collectively (Carlsson, Jacobsson, Holmen, & Rickne, 2002). Indeed, most research focusing on NIS tends to spotlight the bright side of various visible collaborative patterns, such as knowledge transfer, strategic alliances, and technological collaboration and diffusion that bestow the actors with mutual benefits. In general, the spotlight effect embodies actors' utilitarianism, which triggers them to secure the greatest common benefits for the most actors.

On the other hand, the spotlight effect also leads to overlooking the egoistic motivations embedded in utilitarianism, which could potentially impede long-term industrial development. With the present paper, we seek to reveal the puzzles of utilitarianism-based and egoism-based national innovation systems and propose a perfect altruism-based NIS, according to the case of the LED industry in Taiwan.

The industry, which emerged in Taiwan in the 1970s, has a complete industrial value chain, including epitaxy manufacture upstream, chip production midstream, and packaging and testing downstream. Today, the industry has the largest output quantity of LEDs and plays a key role in the LED global market arena. However, the output value of Taiwan's LED industry was transcended by Korea in 2011, pushing its ranking from second to third. The potential destroying force, however—egoistic motivation and action—is silently eroding the LED industry in Taiwan. Indeed, we are urged to understand and answer: why and how does Taiwan's LED industry suffer from the crisis of growth?

We extend the research on NIS to put forward a perspective on NIS of philosophical thinking that highlights the difference of egoism-based, utilitarianism-based, and altruism-based motivations for industrial development. To advance this perspective, we pose two important research questions to guide our empirical analysis of building altruism-based NIS: (1) How do the actors' motivations influence their actions to produce different results of NIS? (2) Why do the actors need to downplay or even abandon the motivations of egoism and utilitarianism and move forwards to an ideal NIS, the altruism-based NIS? To answer the first question, we focus on three philosophical views (i.e., egoism, utilitarianism, and altruism), engaging the analysis of NIS. Drawing on this analysis, we explore the second question with a detailed case study of the LED industry in Taiwan to demonstrate an eternal advantage of altruism in the NIS.

Based on an in-depth qualitative study, we conclude that egoism, utilitarianism, and altruism trigger three types of action

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circles in the NIS, including a sightless self-centered circle, a temporary interaction circle, and a permanent reciprocation circle. Underlying these circles, an industry would be in an unformed NIS, a virtual NIS, and a solid NIS, respectively. Consequently, this study shifts the research stream of NIS from the analysis of physical collaborative patterns to psychological philosophical motivation, which positively extends and enriches the literature of NIS.

2. Theoretical background

National innovation systems (NIS) play an important role in the economic development of a country (Bartels, Voss, Lederer, & Bachtrog, 2012). Metcalfe (1997, p. 289) defined a national innovation system (NIS) as the "set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process." In a national innovation system, the public and private sectors form an interactive institutional network to initiate, import, modify, and diffuse new technologies (Freeman, 1987). Pavit and Patel (1999: 94) also proposed that the NIS significantly influences innovative activities of companies.

The Organization for Economic Co-operation (OECD, 2002) further addressed that the performance of a national innovation system depends on the intensity and effectiveness of the interactions between the main actors to generate and diffuse knowledge. However, although performance of a national innovation system could be measured by intensity and effectiveness of interactions, the real and crucial factor, the original motivation of actors to form a robust NIS, is still ignored. This study thus maintained that motivation of actors should be considered in analyzing the NIS.

In the present study, we consider that most interactive conditions in a NIS follow both philosophies of utilitarianism for common benefits (Bentham, 1776) and egoism for self-interest (Smith, 1776). According to Bentham's view, the philosophy of utilitarianism took for its "fundamental axiom, it is the greatest happiness of the greatest number that is the measure of right and wrong." Bentham adopted the concept of "usefulness" to explain the principle of utility. The more useful the product is to us, the more value we are willing to pay or exchange for the product. His principle of utility regards "good" as that which produces the greatest amount of pleasure and the minimum amount of pain. Likewise, he regards "evil" as that which produces the most pain without pleasure.

Underlying the philosophy of utilitarianism, actors in a NIS are likely to adopt actions that pursue their greatest amount of pleasure but are equally as likely to sacrifice or ignore others' benefits. In other words, although the actors would like to gain cooperative opportunities from their partnership, their egotistical motivation may silently erode the foundation of the partnership.

In contrast, Smith (1776) argued that people intrinsically have the motivations of self-interest. Thus, people work naturally toward maximizing their self-interests, butchers, brewers and bakers can be financially rewarded by selling products people want to buy. Smith further pointed out, "It is not from the benevolence of the butcher, the brewer, or the baker, that we can expect our dinner, but from their regard to their own interest." In short, Smith (1776) emphasized that the egoism embedded in individual's mind plays an important role in creating wealth.

According to the arguments of Smith (1776), individuals act based on egoism that could increase mutual benefits. However, as far as the NIS is concerned, the egoistic actors in NIS would lose long-term mutual benefits when they focused on short-term survival and advantages, as the case of the LED industry in Taiwan. In other words, NIS should stress on creating an interactive innovation platform for evolving innovation contribution of actors over time.

On the other hand, according to Olson's (1965) arguments, when individuals in any group has interests in common, they will produce collective action. However, no matter what size of group, collective action is difficult to achieve even when they have interests in common. The main reason is that they have incentives to "free ride" on the efforts of others. Further, Olson indicated that even though the utilitarian-based individuals seek to form interests in common, their egoism-based motivations would be likely to break the collaborative relationship.

The two ends of the utilitarianism spectrum are egoism and altruism (Philips & Philips, 2011). Egoism motivates behavior for the purpose of self-enhancement or self-enrichment, while altruism enables behavior with self-initiation and is undertaken without expectation of external reward (Bierhoff, 1987). Mueller (1986) further indicated two natures of human – a selfish nature and a cooperative-altruistic nature. Hu and Liu (2003) considered that when a person has an interest to benefit another person, not all the reasons are altruistic. This is because the person might be motivated by a desire to earn friendship, social acclaim, or other objectives relevant to self-concern, reciprocity, and direct benefits. Hu and Liu (2003) thus classified altruism into three types of reciprocal altruism – for reciprocity, calculating altruism for direct benefits, and pure altruism without earning rewards.

In this paper, we regard calculating altruism for direct benefits as egoism embedded in utilitarianism because behind a seemingly cooperative status for common interests is the self-concern motivation. Reciprocal altruism and pure altruism are different levels of altruism in terms of motivation purity. In this present research, we found that the actors in the NIS usually have three types of motivation – earning their own interests in the NIS (egoism), seeking common interests (utilitarianism), or devoting themselves to the NIS (altruism). We, therefore, maintain that actors' motivation with egoism, utilitarianism, or altruism influencing their innovation actions should be considered and examined in the context of a NIS.

3. Method

This is a qualitative case study that explains the development of Taiwan's LED industry based on philosophical thinking. This study draws on two main sources of data: primary data (interviews) and secondary data (archives). Primary data were collected through focused interviews (Merton & Kendall, 1946) during 50 one- or two-hour sessions from 2009 to 2013. The interviewees include 23 CEOs, general managers, department managers, and engineers in listed companies or small-to medium-sized enterprises; eight researchers in public and private research institutes; four public officers in government departments; and 13 professors in academia. The collected materials and transcribed interview materials were examined iteratively (Miles & Huberman, 1994). We also attended three industrial conferences to gain related information and data about LED industrial development.

Secondary data consists of four types of sources. First, we examined internal and external business documents. Internal sources comprised press releases, company websites, and internal presentations. External sources included business and management periodicals, trade magazines, and public company records. Second, we looked at governmental magazines, publicity materials, press releases, and the official websites of Taiwan's government. Third, academic websites were consulted regarding LED research outcomes in public and private universities. Fourth and finally, we examined online or written periodicals and publications from public and private research institutes. The data were triangulated among the sources, and the variety of informants enhanced the study's construct validity (Eisenhardt, 1989; Patton, 1987). We stopped collecting data when we reached a level of saturation

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(Glaser & Strauss, 1967).

For data analysis, the present study adopted the iterative (Eisenhardt, 1989) and narrative (Pentland, 1999) processes of switching among data collection, data analysis, literature review, and theory building to construct a graphically theoretical framework. First, we chronicled the key events that occurred in the LED industry. Second, we exposed the notion that a negative force of industrial development—egoism—exists in industry, government, academia, and research institutes. Third, we analyzed why and how the events were formed according to the interactions of innovative actors to present an interactive picture of egoism, utilitarianism, or altruism. Finally, we developed a theoretical framework featuring a three-level national innovation system. The explanation-building process enhances the internal validity of this study (Yin, 1994).

4. Case analysis

Our analysis explores the resonance between the views and experiences of actors in the NIS on the ground in the Taiwanese LED industry, the abstraction characteristics of the philosophical perspectives, and the conceptual and practical work involved in NIS building. We present our analysis of NIS building based on different philosophical views in this section to illustrate the issues and to develop a conceptual model of the three-level philosophical perspectives of NIS as shown in Fig. 1.

5. Egoism-based NIS

Egoism is an important critical factor that negatively impacts the NIS of the LED industry in Taiwan. In other words, the actors are usually able to concentrate on their own needs; however, the lack of altruism in the NIS could lead to the collapse of the NIS. For the egoism that existed in the LED firms, a general manager of a LED epitaxy manufacturing company presented,

> *Most Taiwanese firms are mainly small-medium enterprises. The first priority for them is survival. However, they are lack of foresight to have a long-term strategic plan. They all expanded their production capacities when the market was blooming. The expanding production capacities caused a large surplus of capacities next year which leaded to a falling price of products. This is a distinguishing industrial feature in Taiwan. In other words, these companies always solely consider themselves (i.e. LED firms) and lack of effective cooperation mechanism for survival.*

Likewise, a professor of an electro-optical engineering department at a national university in Taiwan added,

> *When I was a manager worked for a LED company ten years ago, the LED technological level in Taiwan was ahead of Korea. However, nowadays, we lag Korea. The reasons were ascribed to partly from the insufficient devotion of our government and partly from the*

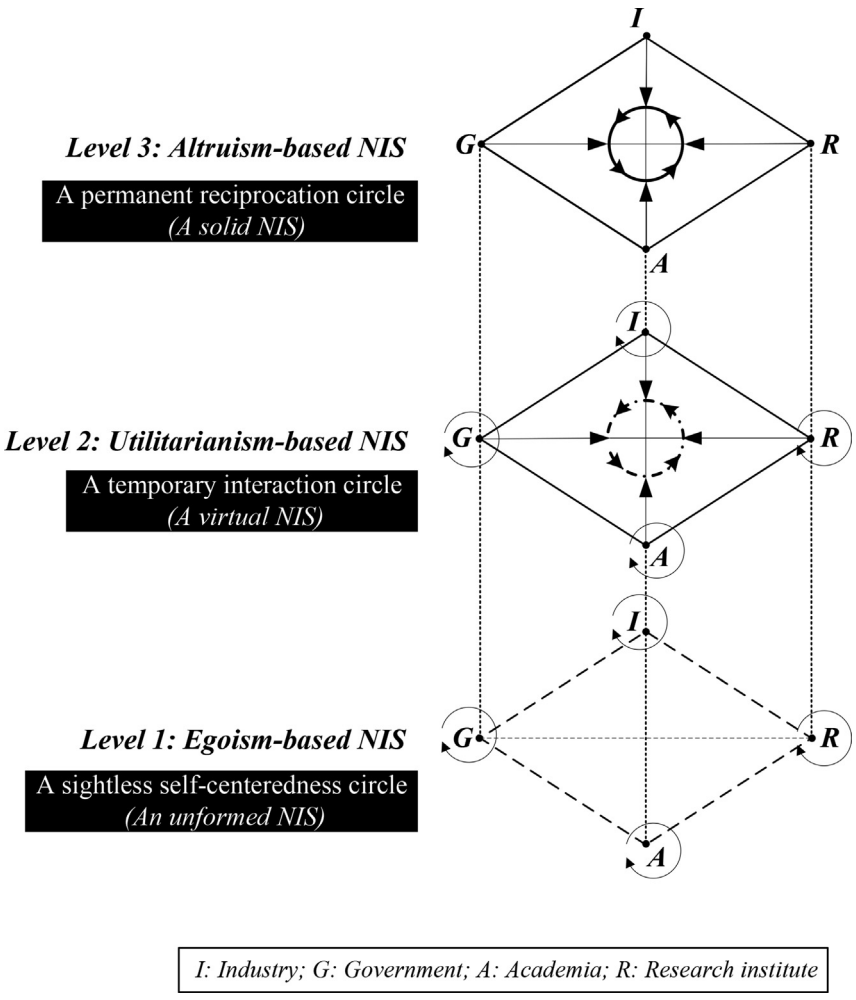

Fig. 1. The NIS with three-level philosophical perspectives.

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shortsighted R&D strategies of the firms. Specifically, most of the firms were heavily focused on the rate of return on investment rather than engaging on the fundamental research continuously. Many firms did not have confidence that their firms can live long so they solely centered on the present benefits.

In addition to cooperation, a merger involving some potential firms could be a possible and competitive strategy to reinforce the NIS. However, as a financial and accounting manager in a LED packaging company addressed, the egoism phenomena still exists in possible merger activities.

There are too many LED packaging firms in Taiwan. I think some potential firms should be merged with some big companies in order to reach the effect of economy of scale. However, no matter Chinese people in Taiwan or the China are more egocentric or have strong self-consciousness so they would not be likely to sacrifice their interests through merger for the purpose of growth. Especially, many LED packaging firms in Taiwan are family businesses. These entrepreneurs often designate their next generation as successors so they would not be willing to make their family properties shift to other companies.

In addition to egoism in the LED industry, egoism also existed in the government. An assistant manager of a leading LED epitaxy manufacturing firm in Taiwan presented,

I still think our government values the LED industry. However, strictly speaking, our government did not take concrete and effective actions. This is because our government always cares about a conflict of interests among all possible interests groups. Therefore, we do not have sufficient compensation from the government like Korea and China.

A general manager of a LED lighting product company also pointed out,

Frankly speaking, the LED industry established a solid technological foundation which was originated or shifted from the technological talents of the successful semiconductor industry in Taiwan. In contrast, our government provided little compensation or support for LED firms. In general, the firms in the LED industry were struggling for survival in the past. We don't have considerable government supports like Korea and Japan.

In other words, these egoistic firms all expected but were disappointed by the financial support from our government. In contrast, although the above firms would like to earn more compensation from our government, some firms hold an opposite view. For instance, a general manager of a small-medium LED epitaxy manufacturing company said,

I don't think our government needs to do something in the LED industry. This is because we believe the government is likely to support the large firms which will reinforce the competitive advantage of the large firms but weaken the other firms' competitive advantage. It is unreasonable. In contrast, even our government compensates all firms in the LED industry; it means the government does nothing for us. Therefore, I think our government is not necessary to do something for us.

According to the above comment, we find that the general manager did not advocate the government's compensation policy because this company was a small-medium enterprise and he worried the compensation would drift to its rival ad hoc – the large companies. Strictly speaking, the opposite viewpoint was still out of egoism. In contrast to a large LED company, a different view was presented. As a general manager of a leading LED epitaxy manufacturing firm in Taiwan pointed out,

Our government always considered that it cannot displease some people and cannot also irritate the other people. Our government maintains that it must treat all firms or industries fair. However, I think this is not a policy and even no decision at all. On the other hand, taking an example of developing fundamental research for upgrade industry, I think our government has to decide who should take the responsibility to do this. Is ITRI, academia, or firms? Once the decision has been made, the government should shift resources the chosen organizational unit.

In short, the government in a way was afraid that if it offered compensation to certain industries or companies, it may lead to social grievances influencing its next presidential election outcome. Apparently, the consideration of the government also can be out of egoism.

Equally, the egoism phenomenon still showed in academia, which influences the outcome of industry-academia cooperation. As a professor of an electro-optical engineering department at a national university in Taiwan indicated,

There are some LED research centers funded by our government that were built in some leading universities in Taiwan. However, they all focused on the short-term research because the academic professors in these centers would be more willing to publish their research in the international journals based on the resource of these centers and thereby upgraded their academic reputations.

In sum, due to the motivation of egoism, all actors always centered on their interests and would not devote themselves to the NIS. We call the egoism-based NIS an unformed NIS and all actors live in their own sightless, self-centered circles.

6. Utilitarianism-based NIS

Many firms were striving for survival through cooperation in the NIS out of utilitarianism. Underlying the motivation of utilitarianism, the actors in the NIS would pay much more attention to their individual interests than common interests when they engaged in cooperative activities. As a general manager in a LED lighting product company pointed out,

I used to promote the LED industrial alliance for technological integration or collaboration in 2008. Indeed, many alliances were blooming since 2009. However, we found there was a serious problem that the technological alliance is an illusion although these firms apparently seemed to be partners. In fact, they were secretly absorbing their partners' technologies for their own new product developments. They would not share their best technologies with their partners.

Utilitarianism could also cause the partners in a cooperative relationship to distrust each other. For example, even ITRI has had a cooperative relationship with businesses for a long time; some businesses still doubt ITRI's motivation involving egoism. As a financial and accounting manager in a LED packaging company pointed out,

We consider the research institute as ITRI often prefers to build the R&D relationships with the big LED companies like Epistar or

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Everlight because the research institute needs to produce prompt and effective R&D outcomes based on the abundant R&D resources of these big companies. In contrast to these big companies, we are relatively to be a small scale so we do not have many opportunities to form R&D relationships with the research institute as ITRI like Epistar or Everlight. In other words, the research institute as ITRI would screen out the unqualified companies, especially, who don't have the R&D capabilities.

Furthermore, egoism embedded in utilitarianism equally disables a multilateral technological cooperative relationship in the NIS. A general manager of a LED epitaxy manufacturing company presented,

Take an example of IP bank, IP bank is dominated by the government to build an industrial alliance forming an industrial competitive barrier to compete other international firms. However, it could be violate many international trade agreements. I consider this is populism and this mechanism will definitely fail because the participants in the IP bank alliance are all concerned their own interests rather than common benefits. If A company was accused, B would not be likely to support A because B consider this is a great opportunity to beat its rival, A. In other words, IP bank alliance conjoins many competitive firms for cooperation but they all based on their own interests. Although we participate in this alliance to stay in a protective umbrella of our government, we are not looking forward to its success.

The above comment shows the partners joined the IP alliance in case they were excluded from getting possible benefits from the government. Therefore, the egoism embedded in utilitarianism is actually behind their seeming cooperative integration, which has negatively influenced the NIS. Similarly, egoism embedded in utilitarianism also disables the bilateral cooperative relationship. A professor at a national university in Taiwan indicated,

For the industry-academia cooperation, they commonly applied projects from the government. The cooperative model is the famous professors with the high academia reputation being able to easily secure the most funds (usually more than 80%) from our government through the elaborated composition of projects. The firms just needed to put up the rest. However, due to the pressure of research publication in a short time for professors, the outcomes were usually short-term, applied orientation rather than long-term, fundamental orientation. Therefore, the cooperative model could not be really helpful for industrial technological ground.

Likewise, a general manager of a LED epitaxy manufacturing company added,

For the cooperation between academia and industry, they often apply R&D projects from the government together. However, I don't think it will produce an effective outcome and I don't expect it will develop the leading edge technologies. This is because they often centered on or disputed interests allocation including compensation from the government and IP ownership developed in the common R&D project.

The motivation of egoism embedded in utilitarianism further influences the cooperative willingness for firms. As a financial and accounting manager in a LED packaging company indicated,

Because our business focuses on LED package, I don't think the industry-academia cooperation is very important to us unless academia can provide added value to our company. Therefore, the purpose of our company is to advance performance based on our present business model rather than to arrange any possible cooperation with academia.

Besides, considering the LED industrial alliance, an assistant manager of a leading LED epitaxy manufacturing firm in Taiwan presented,

Our company is open-minded and willing to form an integrated alliance. Honestly, our CEO said he would like to devote himself to the LED industrial alliance. However, we found that the owners of some companies were concerning their own interests so the alliance could not be formed even the alliance was beneficial to their shareholders and employees.

Indeed, it seemingly has a cooperative mechanism among the actors in the NIS. However, due to the motivation of utilitarianism with egoism, the NIS would not produce really efficient and effective innovation results. We call the utilitarianism-based NIS a virtual NIS. That is, all actors enter in the temporary interaction circles and put their own interests above common benefits.

7. Altruism-based NIS

The motivation of altruism can effectively facilitate trust and a cooperative relationship and in turn generate reciprocal results without any self-interest consideration. For example, the ITRI simply possessed a motivation of altruism to coordinate business interactions and upgrade industries in their early stage (i.e., the stage sponsored by the government), which is an important social responsibility. A general manager of a LED epitaxy manufacturing company presented,

Indeed, ITRI takes a social responsibility in a way as an industrial facilitator to upgrade industry in Taiwan. As a technological pioneer, it is really helpful to the emerging industries including biotech, battery, electric vehicle and the early LED industries.

A sectional chief of electro-optical components and system applications at the ITRI also recalled,

The mission of ITRI was to continuously bring contribution for society. In the beginning of Taiwan' LED industry, ITRI transferred its outcomes of technologies development into industry, while almost all LED firms were still focused on price competition. To upgrade the LED industrial technological capability rather than price competition, ITRI established some committees such as Opto Semiconductor Industrial Technology Development Advisory Committee in 1986. ITRI played the role of a mediator in the facilitation of this committee. This unofficial organization was in charge of the coordination of supply and procurement of LED products among firms. This committee, which is responsible for coordination among firms, provides international information on LED product prices for Taiwan's LED firms to avoid a dramatic price competition among these firms, thereby helping the industry establish, test, and validate LED standards. Through the mechanism of the committee, the LED firms were able to form a united force to propose industrial suggestion to our government. In other words, ITRI played a neutral role among the government and LED firms but involved no interests. Besides, most LED firms would like to apply industrial projects funded by the government through ITRI, because ITRI usually helped policy formulation of our government and thereby has the ability to bridge the government and firms.

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Besides, the ITRI also helped with interaction and negotiation between Taiwanese LED firms and international LED firms. An assistant manager of a LED lighting luminaire company added,

There is a Japanese company once would like to set up a production line in Taiwan. However, this company found the patents used in its production have been registered by our company. Therefore, ITRI mediated the matter of technological authorization between our company and the Japanese company. Finally, we authorized technological patents to and secured license fee from this company.

According to the above descriptions, the early ITRI won trust from firms underlying its disinterested devotion for industry development. The ITRI also gained altruistic benefits from firms. As an assistant manager of a leading LED epitaxy manufacturing firm in Taiwan presented,

For the relationship between our company and ITRI, because our president used to work for ITRI and encouraged to start a new LED company by ITRI, we always keep a good collaborative relationship with ITRI. In the start-up stage of ITRI, this institute was sponsored by our government. However, when ITRI transformed its identity into a juridical person, it must seek to earn half preliminary expenditure by itself. Therefore, our company bought some crucial IPs such as ITO and AC LED even they were expensive.

A general manager of a leading LED epitaxy manufacturing firm in Taiwan added,

Actually, ITRI is the first inventor of ITO in the world. However, although ITRI would like to sell this IP to LED firms, none of firm bought it in 1996. Therefore, the technological inventor of ITO in ITRI was assigned to start a new venture based on this IP for production. Relying on this special factor, we sustained a good, long-term R&D collaborative relationship between ITRI and our company.

The comments indicate altruistic collaboration between this leading company and the ITRI. On one hand, the ITRI developed the crucial IPs used to upgrade the industrial technological abilities. On the other hand, the leading company also helped the ITRI earn more financial capital to continuously engage in R&D development and to survive. However, although the early ITRI had altruistic motivation and actions, the egoism embedded in utilitarianism happened in the present stage, which eroded its mission of social responsibility. A professor at a national university in Taiwan indicated,

ITRI could gain all financial support from our government in the past, so it could concentrate on research and development of industrial technology. Nowadays ITRI has no choice but to win the half funds from the cooperative firms so that they can get the rest half funds from our government. The compensation institution caused ITRI can not engage in the long-term, fundamental research likes before and formed a weird cooperative mechanism that has mutual interests involved.

In addition to the altruistic case of the early ITRI, the essential altruistic motivation is to consider partners' interests in advance and then to activate a reciprocal cooperative model. An assistant manager of a leading LED epitaxy manufacturing firm in Taiwan presented,

We (an upstream company) don't want to make our customers feel that we are competing with them so we didn't enter the market of the LED downstream industry. However, we still want to expand our market. Therefore, we united our downstream customers to jointly cooperate with our end users, i.e. some famous luminaire companies. In this case, we provide a total solution for our end users, which is not only from our technological capability but from the technological collaboration between our downstream customers and our company. Underlying the model, we can deliver the exclusive customized technologies or products for our end users.

In brief, due to altruistic motivation, all actors are willing to devote themselves to the NIS and downplay their own interests. We call the altruism-based NIS a solid NIS and all actors can enjoy the benefits from the permanent reciprocation circles.

8. Discussion and conclusion

Although the LED industry in Taiwan has seen significant performance over the past three decades, the potential and crucial problem of the national innovation system is eroding industrial development. We found that the real problem results from the ego of the actors. Specifically, the government cautiously lays particular stress (e.g., financial support) on specific industries for fear of giving voters a bad impression of government-industry collusion. The research institute, like the Industrial Technology Research Institute (ITRI), currently tends to implement the short-term and attainable projects, which ensures that it can favorably complete projects and sustain constant incomes. In academia, most scholars would rather do research with minor and incremental contributions instead of breakthrough and disruptive ones for their promising research publication. While firms face severe competition from international leading companies, a variety of domestic industrial alliances cannot lead to symbiotic cooperation because most firms deem their benefits override their partners'. Given that, this study presents a framework that explains a more effective mechanism for the national innovation system based on a mechanism of altruism.

This paper centers on the three philosophical views of egoism, utilitarianism, and altruism in a NIS context. Our analysis of the NIS context of the LED industry in Taiwan allowed us to develop a grounded theory of the puzzles of the spotlight effect on national innovation systems built on a rich empirical case in which philosophical thinking is being undertaken as a tool for industrial development. We now elaborate on how our findings contribute to and extend existing NIS accounts of industrial formulation and change.

According to the analysis of the NIS of the LED industry in Taiwan, we propose the present paper's theoretical contributions as follows. First, this study posits that not only interactive patterns but motivation should be considered in analyzing the NIS. The change of the NIS is influenced by the actors' motivations and the following actions. Indeed, prior research mostly focused on what interactive pattern brought the most competitive advantage and how to use the interactive pattern to secure the most resources in a NIS. However, the motivation of actors in a NIS should be the most important driver, which triggers the model of interaction and determines the quality of interaction. Especially, when the interactive environment is full of uncertainties and complexity, the focus of the NIS should shift to emphasize the purity of motivation in terms of goodness.

Second, we address there are three types of motivations that exist in the NIS – egoism, utilitarianism, and altruism – that trigger three action circles: a sightless, self-centered circle, a temporary interaction circle, and a permanent reciprocation circle, respectively. The sightless, self-centered circle means that the actors selfishly focus on individual growth by taking advantage of others'

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resources. The temporary interaction circle represents actors that enter a temporary cooperation circle of the NIS for common benefits with egoism-embedded utilitarian motivation, whereas the permanent reciprocation circle signifies that actors devote themselves to partnerships through fulfilling their own innovation duty and naturally form a permanent reciprocal circle of the NIS.

Finally, we propose that the NIS be ranked by three levels, including an unformed NIS, a virtual NIS, and a solid NIS. Each level is shaped by the motivations and actions stemming from egoism, utilitarianism, and altruism. The egoism-based and utilitarianism-based motivations induce an imperfect NIS and altruism-based motivation forms an ideal NIS. More importantly, the crucial source of competitive advantage of the NIS is from altruism-based motivation. Underlying the altruism-based NIS, actors are willing to share and collaborate without expectation of rewards. Their common goal is to effectively activate the NIS. Then the fruitful outcome of the NIS will naturally present a reward to them. However, the key point is that the reward is not calculated by them in advance.

Indeed, the government demonstrated economic performance through supporting long-term industrial development will be recognized by people. The research institute will be acknowledged by industries because it developed and transferred fundamental and effective industrial research outcomes. In academia, scholars can produce breakthrough and disruptive contributions for their promising research publication. The symbiotic industrial firms can thus create win-win and outstanding competitive advantage in an international arena.

Considering practical implications for government, business, academia, and research institutes, we address, firstly, that government must engage in altruistic thinking to build a national innovation institution that offers effective interactions for actors and abandon prior considerations for gaining votes. Second, businesses need to downplay ego-centric thinking patterns and to put more emphases on the whole competitive advantage of NIS such as the integrated innovation development or industrial standard formation rather than solely on their short-term individual interests. That is, firms can form a symbiotic cooperative relationship through a variety of domestic industrial alliances. By doing so, although firm still have their egoistic strategies, the whole innovation outcome of NIS will be still promising. Firm can thereby be benefited from the NIS's innovative contributions. Third, academia should embrace the spirit of dedication to the long-term, as well as basic, research and cultivating talent for the foundation of industrial innovation rather than simply focusing on short-term and application-oriented research for prompt academia publication. Finally, research institutes need to continuously develop and transfer disruptive innovation technologies to upgrade industries rather than simply raising more funds from short-term projects with businesses.

On the other hand, the limitation of this study are the characteristics of qualitative methodology that impacted or influenced the interpretation of the findings from the research. They are the constraints on individual subjective views and generalizability. However, acknowledgement of the qualitative study's limitations also provides us with an opportunity to critically demonstrate the real problem of this NIS through the analysis of a variety of interviews. Furthermore, the key objective of the qualitative research process is not only discovering new philosophical knowledge of NIS but also confronting underground and invisible phenomena. In sum, the philosophical views of actors in NIS become more focused because of this qualitative study.

Consequently, this study offers the important theoretical and practice contributions that reframes and renews the conventional NIS by adding the philosophies of egoism, utilitarianism, and altruism to present a three-level NIS and develop a novel, contextualized understanding of the philosophical NIS.

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