The Relationship between Technology Industrial Cluster and Innovation in Taiwan

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Abstract

Many economic activities, especially research and development, still rely on face-to-face communication and the geographical linkages among industries are beneficial to technology sharing and in decreasing unnecessary expenditures. It is observable that the salient role of research and development in today's knowledge economy heavily relies on geographical linkages, the localization of learning networks, and face-to-face communication. Hence, these predicaments make the clustering of high-tech industries plausible and are in fact popularly practiced all over the world. Specifically, this research discusses the effects of the clustering in the technology industry and its innovative variants in Taiwan. It is hypothesized that variants in Taiwan's technology industry and innovation are interfacing with each other instead of working independently. The relationship between the clustering of Taiwan's technology industry and innovation is investigated through 3SLS. The results show that clustering of the technology industry and innovative production are positively correlated. That is to say, clustering of the technology industry is beneficial to the industry itself and moreover is also beneficial to the development of innovative practices in the industry. As a result, clustering in Taiwan’s technology industry is observably speeding up.

Keywords: Technology industry, industrial cluster, innovation, face-to-face communication

1. Introduction

Innovation fuels economic growth. The definitions researches use in understanding innovation often vary simply because the scholars’ academic and research background and purpose for undertaking research work likewise varies. Nevertheless, in generalizing the views of most of the scholars, we find that innovation is a kind of learning process and its consequent result. In such a process, new knowledge is generated through interactive learning among the various creative mechanisms. Also, through the interactions, knowledge in the originally different fields might lead to the development of new learning interactive processes and its resulting new applications (Gregersen and Johnson, 1996).

The distribution of innovative activities in terms of geographical space is not even. This is being experienced by the Silicon Valley, Route 128, Research Triangle Park, and Hsinchu Science-based Park. In the era of globalization and the knowledge-based economy, although barriers such as distance and social differences have been much reduced, localization remains an important factor unaffected by the lowering of transportation and communication cost. Many economic activities, particularly in the field of research and development, nonetheless demand face-to-face communication. Being situated near one another helps facilitate effective

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technology exchange and in lowering trade costs. Therefore, having clustering economics remains the norm.

Although developments in communication and transportation technology have reduced the time and space needed for interaction and considerably these technologies have decreased the obstacles that hinder social and economic activities between the participating regions, the space though does not reveal non-differentiation as expected with the reduction of transportation and communication costs. As the knowledge-based economy greatly depends on its innovative nature and because of the characteristics of localized networks and the need for face-to-face interaction, the clustering of technology industries is on the rise all around the world (Audretsch and Feldman, 1996; Feldman and Florida, 1994; Saxenian, 1994).

In recent years, industry planners have attempted to follow the rapid growth model of the technology development parks such as the Silicon Valley in the U.S. and Hsinchu Science-based Park in Taiwan. Through the establishment of science parks, it has become an investment for newly founded industries and it similarly has pushed for advocating cooperative education among universities and the technology industry circle. Industry planners duplicated the successful model of these two parks to trigger more energy into other thriving industries. However, there is a dearth on theories and models that further supports and demonstrates the potential for such a boom and the possible niche that can be further explored as a result of the technology clustering.

The clustering of industries and regional innovation projects are some of the primary methods used by the Taiwanese government to boost industry development. Through job creation, incentive for migration and increased consumption, the local economy has been vitalized. Therefore, empirical researches on the consequences of these developments are beneficial to industry development and economic growth.

This research aims to discuss the effect of innovative environmental facilities on other high tech sectors within the same region in order to examine whether innovative facilities could directly influence the innovative production of the said region. Technological innovation was chosen as the subject of research for the purpose of effectiveness in recognition and quantification. This research defines innovation in terms of technology and product. Yet there are different standards to measure the degree of improvement in the product.

The characteristics of the local environment determine the conditions of new technology and innovation. Industrial clusters are not existing parts of the region, but the products. Regional characteristics are created by universities, research and educational institutions, and selecting the region to settle in is not an option for the industry sector, but is determined by regional characteristics. This is also one of the focuses of this study.

Porter (1998) defines industrial clusters as “geographic concentrations of competing, complementary, or interdependent firms”. Businesses situated in an industrially clustered region are also more competitive than others. Innovation is an important factor crucial to the establishment of industrial clusters as determined by many scholars who have looked into the reasons behind clustering. Researches indicate that innovation is the key factor to increased productivity, and is the result of the interaction among the industry, business, community, and consumers. Producers and consumers act as the medium through which innovation spreads, and a clustered environment helps boost this process. How government initiatives focus on industry innovation and its diffusion to enhance industrial clusters are central to the future development and management of the said industries. As such, this research intends to construct and examine the impact on the model of technology industrial clusters and the effectiveness of the innovative environment model, and analyzes the correlation between technology industrial clusters and innovation using 3SLS (three-stage least squares method).
In order to look for related discussions which properly explain the hypotheses of this research, we reviewed and analyzed related theories with regard to the influences of local and regional environmental factors on regional technical innovation to probe into the correlation among the spatial factors of technical innovation as the base of the hypotheses of the research.

The structure of this article is as follows. First, we review the literature focusing on technology industrial cluster theory and regional innovative environment facility theory. Next, there is an empirical analysis to test our models. Findings of this study and the managerial implications are then discussed. In the final section, we point out the limitations and suggest future research opportunities.

2. Review of Related Literature

As has been already pointed out in the introduction, the spatial distribution of industrial activities and innovation activities might be interrelated. Studies examining the spatial distribution of innovation activities are rare and have a different focus (Feldman and Florida, 1994; Audretsch and Feldman, 1996; Paci and Usai, 2000).

More recently a growing interest in regional innovation systems has emerged (Acs, 2000; Doloreux, 2002). Whilst not denying that national (as well as international), technological and sectoral factors are essential, it is argued convincingly that the regional dimension is of key importance. Several reasons are supporting this view: First, regions differ with respect to their industrial specialisation pattern and their innovation performance (Breschi, 2000; Paci and Usai, 2000). Second, it was shown that knowledge spillovers, which play a key role in the innovation process, are often spatially bounded (Anselin et al., 2000; Audretsch and Feldman, 1996; Bottazzi and Peri, 2003). Third, the ongoing importance of tacit knowledge for successful innovation has to be mentioned (Gertler, 2003). It is now well understood that its exchange requires intensive personal contacts of trust based character which are facilitated by geographical proximity (Morgan, 2004). Concerning innovative activities, Feldman and Florida (1994) analysed the geographic distribution of product innovations. Paci and Usai (2000), instead use patents as proxies for innovative activities, but apply a similar calculation method as Feldman and Florida (1994).

As to the reasons why the technology industrial cluster phenomenon occurs, Krugman (1995) notes that this largely due to the external economy which mainly originated from the accumulation of master labour, effective investment of non-trade middle product and technical spillover.

More recently attention has shifted to innovative regions and milieux (Camagni, 1991), high-tech areas (Keeble and Wilkinson, 1999), clusters of knowledge based industries (Cooke, 2002) and knowledge spillovers (Audretsch and Feldman, 1996; Bottazzi and Peri, 2003). These studies concentrate on the analysis of well performing regions, dealing with the questions of why such industries concentrate in particular locations, which kinds of linkages and networks exist, and to which extent knowledge spillovers can be observed.

Previous studies mainly focused on the influence of knowledge spillover generated from the facilities or systems in different regions on the innovation of different industries (particularly the technology industry) which emphasized that the new product innovation could really result in profits instead of placing even more importance on the application of the said innovation to the business industry. Besides, research data and quantifiable measurements in research studies on industry developments or the economic geography have defined innovation as the by-product of technical innovation (Feldman and Audretsch, 1999; Audretsch and Feldman, 1996; Henderson et al., 1995; Feldman and Florida, 1994; Glaeser et al., 1992; Jaffe et al., 1993). In the study of Wu J.-H. and Chen H.-S. (2001), they found out
that industries in Taiwan’s Science Parks based their latest development on the research result of local universities and institutions.

Jaffe (1989) treated individual states in the U.S. as spatial units and number of new products as innovation proxy variable and targeted on the influences of technical facilities on innovation. In addition, the number of patent was also the proxy variable of innovation. The said research result suggested that university and industry R&D revealed significant influence on high-tech industries such as medical technology, electronics, optical and nuclear technique industries. Feldman and Florida (1994) treated the number of American new products as the innovation proxy variable and found that when 4 technical facilities (related factor clustering in metropolis area, university R&D, industry R&D and producers’ service industry) clustered more in the metropolis area, the innovative capacity would be stronger. The study of Anselin et al. (2000) found that when treating the states as a unit, university R&D revealed significant influence on technology industry innovation; when regarding metropolis area as the unit, university R&D had different influences on the innovation of internal and external technology industries of metropolis area.

This would imply that if industrial activities are geographically concentrated, innovation activities should also be geographically concentrated. Besides industrial activities, other economic and social factors might also play a role for the occurrence of innovations. If these factors are unequally distributed in space, innovation can be expected to be similarly unequally distributed. The literature provides evidence for the fact that the innovation activity in a region depends, besides the R&D employment in the respective industries, on university R&D(Feldman and Florida, 1994), science institutions(Blind and Grupp, 1999), business service firms (Feldman and Florida, 1994), various kinds of human capital, and cooperation and networks(Pittaway et al., 2003). The distribution of innovations in space might affect the distribution of these factors such as the accumulation of human capital as well as the cooperation, network or industrial activities (Faggian et al., 2006). The study of technical facilities asserts that innovation is dependent on the information and knowledge drawn by local technical facilities. It focuses on how these local hardware and facilities could induce innovation and the effect on these facilities and industries when clustered.

3. Technology industrial clusters and innovation - The model and the variables

This study has so far discussed factors influential to technology industrial clusters and regional innovations. This section first defines the technology industry, and examines what affects the technology industrial clusters and the facilities that induce innovation. The Metrics Model and its important variables will be explained.

3.1 Defining the technology industry

An objective definition of the technology industry in Taiwan has yet to be identified. In most cases, a common consensus is formed through discussion conferences. Principal industries are selected and various favourable measures are provided to support the development of the industries. In 1991, a six year Project on National Construction was proposed with the identification of ten new industries at that time which were deemed necessary for the development of Taiwan. These industries are information, communication, semiconductor, precision machine, automation, pollution prevention, medical care, specific chemical and pharmacy, aerospace, consumer electronics, and the high-class material industry. Overall goals were established and individual industries were made to develop strategic targets for growth. Top ten new industries became the focus of the industry policies of the government. In 1995, the Executive Yuan advocated the “critical promotion of high-tech and high additional value industry development”. Top ten new industries became outshined in
Taiwan’s high-tech industry. The range of key industry observations selected by the government has been relatively consistent for over twenty years. Electronics, machinery, communication, material and medicine have all been instrumental to national development.

This study uses the classification defined in the 2001 Industry, Commerce and Service Census by the Directorate-General of Budget, Accounting and Statistics, Executive Yuan. Thirty-nine industries were chosen which includes the semi-conductor industry.

3.2 Technology Industrial clusters model and its variables.

As discussed, elements affecting technology industrial clusters include human resource, technology infrastructure, knowledge source, and investment (Porter, 1990). In addition, the SANDG grouping analysis suggests that LQ, associate industries, and regional economic wellbeing are also among the factors that influence technology industrial clusters. This research thus bases the regression model on the following seven variables. The model is as follows:

\[
(LQ)_{it} = \alpha_0 + \alpha_1(PAT)_{it} + \alpha_2(RD)_{it} + \alpha_3(BANK)_{it} + \alpha_4(TEA)_{it} + \alpha_5(REL)_{it} + \alpha_6(AVSA)_{it} + e_i
\] (1)

where

- \(LQ_{it}\): Regional quotient of technology industry during time interval \(t\) in year \(i\).
- \(PAT_{it}\): Number of patents approved in the technology industry during time interval \(t\) in year \(i\).
- \(RD_{it}\): Number of R&D institutions established during time interval \(t\) in year \(i\).
- \(BANK_{it}\): Output of banking industry during time interval \(t\) in year \(i\).
- \(TEA_{it}\): Number of teachers employed by technical colleges during time interval \(t\) in year \(i\).
- \(REL_{it}\): Number of technology-related factories during time interval \(t\) in year \(i\).
- \(AVSA_{it}\): Comparison of average employee salary in the technology industry and others during time interval \(t\) in year \(i\).

3.3 The Innovation Model and its Variables.

As reflected in the studies on innovative environment and facilities and analysis through model building, this section explores how these factors facilitate innovations. This model has been adopted in reference to the works of Feldman and Florida (1994) and Audretsch and Feldman (1996).

The regression model is as follows:

\[
(PAT)_{it} = \beta_0 + \beta_1(LQ)_{it} + \beta_2(RD)_{it} + \beta_3(REL)_{it} + \beta_4(TEA)_{it} + \beta_5(KIBS)_{it} + e_i
\] (2)

where

- \(PAT_{it}\): Number of patents approved in the technology industry during time interval \(t\) in year \(i\).
- \(LQ_{it}\): Regional quotient of technology industry during time interval \(t\) in year \(i\).
- \(RD_{it}\): Number of technology R & D institutions during time interval \(t\) in year \(i\).
- \(REL_{it}\): Number of factories in the technology industry during time interval \(t\) in year \(i\).
- \(TEA_{it}\): Number of teachers employed by technical colleges during time interval \(t\) in year \(i\).
- \(KIBS_{it}\): Number of concentrated knowledge-based industries and service providers during time interval \(t\) in year \(i\).

Descriptions of the reasons, functions, and data processing of the variables in the above formula are presented as follows:
A. Location Quotient of the Technology Industry (LQ)

LQ is the criterion to judge whether certain industries are considered basic local industries, as defined upon the concept of export. The study used LQ as the technology industrial cluster index. When LQ is greater than 1, the industry considered a local basic, as it meets local demands of export. When the LQ is higher, it is considered critical for local economic growth; contrarily, when the LQ is less than 1, the industry is not considered a local basic, as import is required for local demand. The formula is shown, as below:

\[
LQ = \left( \frac{E_{ij}}{\sum_{i} E_{ij}} \right) / \left( \frac{E_{i.}}{E_{..}} \right)
\]

- \(E_{ij}\): Number of employees for j industry in i region.
- \(\sum_{i} E_{ij}\): Number of employees of all industries in i region.
- \(E_{i.}\): Number of employees of j industry in all regions.
- \(E_{..}\): Number of employees of all industries in all regions.

B. Number of Patents in the Regional Technology Industry (PAT)

Upon the view of the innovation system, whenever there are more innovation opportunities and nodes in an industrial cluster, knowledge or trading flow are more frequent and there are more innovation opportunities. This research identified the number of patents registered in the patent database of the Intellectual Property Office of the Ministry of Economic Affairs as an index for innovation. The topic of this study is the innovation output of overall regional space, and thus, the study focuses on the evaluation of regional innovation capacity. Unfortunately, the statistical data of “joint-applied patents” is difficult to collect.

C. Number of Regional R&D Institutions (RD)

Reference source: The technology R&D institutions defined by the National Science Council of the Executive Yuan, including universities and colleges, research institutions of public and private departments, display institutions and innovation incubation centres. The data can be found on the National Science Council website. The technology R&D institutions defined by the National Science Council of the Executive Yuan, including universities and colleges, research institutions of public and private departments, display institutions and innovation incubation centres. However, some units collect no data on R&D expenditures, or consider them as confidential, such is a limitation of this study.

D. Amount of Output Value of Regional Financial Institutions (BANK)

The key success factor of Silicon Valley is the development of local risk investment; the capacity of companies in developing new technologies in the region depends on successful risk investment, which creates a new financial environment (Saxenian, 1994). In recent years, with growing technology industry, venture firms in Taiwan are founded one after another, and funds are accumulated continuously. However, most of these companies are located in Taipei. There may be errors when calculating the number of venture fund firms, or funds as proxy variables of regional fund resources.

E. Number of Full-time Teachers in Technology Departments in Universities and Colleges in Different Regions (TEA)

Knowledge talents are the principal assets of high-tech firms. The industries which are more knowledge-intensive are in greater need of professionals and high-quality talents. This research treated the number of full-time teachers in colleges respectively as a spatial unit and as the proxy variable for regional high-quality human resource. With regard to human resources, this study takes full-time technological teachers over colleges of the region as its proxy variables. Unfortunately, the data shows only the number of teachers in certain time interval of certain regions, instead of the overall flow, which is a limitation of data acquisition.
F. Number of Related Factories (REL)

New products and manufacturing rely on close interactions with innovations of research institutions, and are affected by the networking density of the related industries. Noticeably, product users (downstream products) play as significant a role as the suppliers (upstream products) in the process of innovation. Thus, in the innovation processes of technical products, knowledge is created, applied, and significantly absorbed by suppliers and demanders. It demonstrates that both upstream and downstream companies of the industry are critical in the process of innovation.

The present research looked into the “industry correlation table of forty-five departments in Taiwan, R.O.C.” which was edited by the Directorate-General of Budget, Accounting and Statistics of the Executive Yuan in 1999 as a primary reference material. The industries with technology industry involvement factor and correlation factor over 0.03 are considered as related industries. The researcher compared it with the industrial and business survey of 1981 to 2001 and calculated the number of related factors in each spatial unit.

G. Ratio of Average Salary in Regional Technology Industry and all Industries (AVSA)

SANDG analyzed the last factor influencing Industrial Cluster: The ratio between average employee salary of a specific industry in the region and that of all industries in the same region. Whenever the ratio was more than 1, it meant that the economic importance of the industry in the region was significant which also demonstrated the economic prosperity factor showing the influence of the industry on the economy of the region through scalable employee salaries. The higher the ratio is, the higher the industrial cluster level. Therefore, the ratio is deemed as a factor which influences technology Industrial Cluster which was subjected to empirical analysis in this research.

H. Number of Service Industries of Knowledge Intensive Industries (KIBS)

Muller and Zenker (2001) indicated a trend of knowledge economy. In recent years, Knowledge Intensive Business Services (KIBS) has experienced significant growth. KIBS refer to the industries that provide consulting services for companies that result in significant additions of smart value for the companies. It is an important and competitive advantage for companies in this knowledge economy system. By providing smart value services, KIBS transfers different kinds of specific knowledge to general industrial knowledge. In the interaction with the clients, KIBS learns, creates, and accumulates experiences and knowledge. With regard to overall industrial development, KIBS facilitates the diffusion of industrial knowledge and accelerates the innovation capacities of industries, thus, playing an important role in regional innovation systems.

The database covers information regarding transportation, communication service, finance and insurance, research development, professional science and technology service, investment, consulting, legal services, and accounting.

4. Results, Analysis and Discussion

The neighborhood effect of factors on regional innovation and knowledge spillover is not limited to the space. Thus, since the related factories, production service industries, research institutions, or innovation centers in the spatial unit all contribute to the innovation of the technology industry, and will effect the towns. This study does not treat towns as spatial units; instead, larger counties and cities are defined as a unit. In addition, the quantitative data of this study is based on that of the Directorate General of Budget, Accounting and Statistics, Executive Yuan. However, the unit is the administration district. The literature mentioned in
this study, such as Romer (1986); Glaeser, et al.(1992); Henderson, et al. (1995), also treat the administration district as the unit of analysis. In fact, it is the limitation of this study.

This study is based on twenty-two cities and counties in Taiwan, with statistics from five annual reports during the period of 1981 to 2001, and 108 samples. (Note: The cities of Hsin-chu and Chia-Yi were under the jurisdiction of Hsin-chu and Chia-Yi county, respectively, in 1981.) This research hypothesizes and intends to demonstrate that technology industrial clusters and innovation are not independent from each other, but are inter-dependent and consequential. A simultaneous formula is devised to analyze this relationship.

However, in using a simultaneous equation model, the endogenous variable in an equation would have feedback in the variable of another equation. For example, in this research, the characteristic might appear between technology industrial cluster and the regional innovation output variable. This situation might lead to the predicament in which an error term and endogenous variable are perceived to be connected. Thus, the two endogenous variables are simultaneously explanatory variables of other equations. The residual items are relational to the exogenous variables, leading to biased errors and inconsistencies in the estimated parameters of OLS. Hence, in this study, 3SLS is used to estimate parameter values of the regression variables. 3SLS applies a generalized least square estimation in equations, each of which is first estimated by 2SLS. In the first stage of the estimation process, a simplified form of the model system is estimated. The fitness values of endogenous variables are used to calculate the 2SLS parameter values of all the equations, after which the residual value of each equation can be used to estimate the variance and covariance of the transversal equation. Then, in the final stage of the estimating process, the generalized least square parameter estimated values can be obtained. In comparison with the 2SLS method, 3SLS can obtain efficient parameter estimated values, as it takes the relevance of transversal equation into consideration.

4.1 Technology industrial clusters regression model

In table, Adj-R2 = 0.414 represents the technology industrial clusters regression model based on twenty-two city/counties, five annual reports spanning from 1981 to 2001, and one hundred and eight observations. Technology industry produces a high volume of patents, demonstrating positive influence on industrial clusters, which supports the research hypothesis.

With respect to the number of R&D institutions, this research combines colleges, universities, R&D institutions, and educational organizations to represent the regional technology institutions and facilities. The regression model indicates a positive outcome, which also confirms the hypothesis of this research in regards to how technology institutions contribute to industrial clusters. In the area of investment, a similar result reveals that investment flow greatly affects industrial clusters. Human resource, on the other hand, did not yield expected results using the entire post-college population within the region as a research subject as this population was not well categorized. Therefore, the teachers employed by the colleges became the variable instead. Yet again, negative results were yielded. Teachers probably represent only a portion of the significant population of the highly-trained personnel.

If we can calculate the number of R&D personnel in the research institutions of each region and in the various technology firms, it is more feasible to draw together more convincing results. This research attempted to investigate financial data about R&D personnel. However, since the number was enormous and firms are unlikely to provide reliable information due to business confidentiality, we suggest that future studies can be done which attempts to acquire data about high-quality human resources in the technology industrial cluster in the region which might increase the explanatory power of the regression model.
Finally, with regard to the economic prosperity factor, SANDG treated the average ratio of number of employees of a technology industry and all industries in the region as a proxy variable. When the ratio was more than 1, it meant that the technology industry was considerably important to the economy of the region. When the ratio was high, the technology industry revealed higher clustering level in this region. Through the empirical analysis, we found that although the variable did not reach a significant level, it showed a positive correlation instead. In other words, the economic prosperity factor in the region had positive influence on the clustering of technology firms.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>OLS</th>
<th>3SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LQ</td>
<td>PAT</td>
</tr>
<tr>
<td>C</td>
<td>0.338726 (0.0408)</td>
<td>-316.6355* (0.0153)</td>
</tr>
<tr>
<td>PAT</td>
<td>0.000124* (0.049)</td>
<td>0.000251*** (0.000)</td>
</tr>
<tr>
<td>LQ</td>
<td>424.9123** (0.0096)</td>
<td>775.9898*** (0.000)</td>
</tr>
<tr>
<td>BANK</td>
<td>3.74-9E (0.4178)</td>
<td>3.05E-09 (0.4804)</td>
</tr>
<tr>
<td>RD</td>
<td>0.011022*** (0.0002)</td>
<td>10.95979* (0.0343)</td>
</tr>
<tr>
<td>REL</td>
<td>6.43E-06* (0.0413)</td>
<td>0.017923*** (0.0004)</td>
</tr>
<tr>
<td>AVSA</td>
<td>0.131984 (0.3592)</td>
<td>0.012580 (0.3183)</td>
</tr>
<tr>
<td>TEA</td>
<td>-5.79-E05 (0.1221)</td>
<td>-0.119473 (0.1243)</td>
</tr>
<tr>
<td>KIBS</td>
<td>0.024983 (0.0729)</td>
<td>0.022233 (0.0897)</td>
</tr>
<tr>
<td>Adj R2</td>
<td>0.414</td>
<td>0.473</td>
</tr>
</tbody>
</table>

Note: * p < 0.05, ** p < 0.01, *** p < 0.001

4.2 Regression model for how an innovative environment affects innovation

The technology industrial clusters index (LQ) shows a positive relation with its variables, which means that the more the industry is clustered, the more that innovations are made possible. The number of research institutions also reveals similar relations with the industry. More so, the number of factories within the region also shows the same direct proportional relationship. All of these results confirm the hypothesis earlier presented in this research. In reference to Florida (1995), it has been observed that the density of cluster concentration in a networked industry boosted innovativeness. This research uses the industry association chart to reflect the association of upper and lower related industries, re-affirming the positive impact of clusters on innovation.

As far as human resources are concerned, this research treated the number of full-time teachers in technology departments in the sampled colleges in the region as the proxy variable. After the model test, a negative correlation was observed between the human resource index and output of regional innovation. However, it did not reach significant level. As mentioned above, if we can add R&D personnel of industry firms and public and private research institutions, the explanatory power of the model might be stronger.
In terms of the variable of the number of knowledge-based service providers, a positive relation is shown with the number of patents approved, though this finding is not of high significance. Nevertheless, the development of local concentrated knowledge-based service providers should be positive to the overall development of the technology industry and its R&D capability.

5. Conclusion

Industrial clustering effects and the construction of a regional innovation atmosphere are major measures of government to facilitate economic development. They are critical for enhancing the growth of the region and increasing the national quality of life standards. The improvement of local industrial development is a major drive of local economic growth, through increasing the number of jobs, introduction of a workforce, and increasing consumption. According to the empirical data of Taiwan, this study shows that there is significant and positive correlation between industrial technology clusters and innovation outputs. The profit of a clustering economy results in industrial technology clusters, which enhance industrial innovations and industrial clusters.

This research proves that such factors as the number of patents approved, number of R&D institutions, investment resources, location quotient, number of related corporations, and the overall regional economic well-being are variables that all contribute to the positive growth of technology industrial clusters. This research also found the direct proportional relationship between technology industrial clusters and the output of regional innovation, meaning the more clustered the industry, the more innovations are made possible. The number of research institutions, as well as enterprises, factories and related businesses also demonstrates a similar positive relation with the industry. Overall, this research confirms that technology industrial clusters and innovations are significantly correlated.

The knowledge intensive service industry is positive with respect to the innovation effect of the technology industry in Taiwan. The development of the local service provider industry should have a positive influence on the R&D capacities of technology firms. Any time that an industry experiences organizational structure adjustment, the development of the technology industry can combine with the knowledge intensive service industry and change the idea of absolute location separation of both industrial and business lands in the past so that there can be a proper spatial nearness between the two which can contribute to the realization of the technology firms’ R&D and innovation function.

It is suggested that with regard to the development of human resources, since education and human resources markets involve significant externality, government should plan proper directions for human resource development, which meet the demands of the knowledge economy era. In addition, with regard to innovation systems, it is very important for government to support scientific research, as it significantly enhances knowledge creation and accumulation through human activities. The government should function particularly as a bridge between scientific research and industrial development.

In a knowledge-based economy, industrial innovation is the primary external reason behind industrial clusters, and is also why many scholars urge clustering in the technology industry. Findings in this research confirm that innovations are often the result of the interaction among the industrial clusters or its co-related partners. The diffusion of innovations, which takes place in the same medium, solidifies the result and effect of the innovations. Where industrial clusters exactly are, heightened economic activities likewise takes place. Given the fact that knowledge sharing and information exchange also happens here, industry innovation and diffusion are undoubtedly an inherent economic advantage of a clustered economy, and an important feature of high-technology industries.
With regard to developments of industrial location theories, spatial development patterns and location factors of technology; indicating that the traditional location theory emphasizes on materials, markets, and transportation costs. Rather, it is replaced by technique-oriented research and development, research institutions, universities, technical workforces, etc. This study validates the importance of the above resources on industrial technology clusters. It is suggested that the government can involve technology industries in regional development through critical technology resource activities, incentives of industrial development, and other location factors, integrated with the original industrial development of the region, which would further upgrade traditional industries and facilitate economic development. Industrial technology clusters created in R&D intensive locations reveal special efficiency on spatial intensity, which would improve industrial quality and enhance competitiveness through technical diffusion.

In addition, uncertainty is involved in R&D of innovations in technology industries. In order to reduce the risks and increase development functions, high-level R&D environments are keys to the development of industrial technology. This study also finds the importance of a complete basic environment with facilities aimed at technical innovations for technology companies. Thus, it is suggested that industrial technology cluster development can combine regional R&D resources to create high-quality space that facilitates industrial innovation. The introduction and cultivation of technological companies will be the keys that enhance regional economic development.

References