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The Economic Impact of Science Parks and Innovation Policy: A Case Study of the High-Technology Industries in Taiwan

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The role of SPTs and AOIs in inter-regional cooperation

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The Economic Impact of Science Parks and Innovation Policy: A Case Study of the High-Technology Industries in Taiwan

Executive Summary

National policies for science parks and innovation have been identified as one of the major driving forces for high technology industries, especially for public funded science parks. By taking the globally recognized high technology industrial clusters and the case study of science parks in Taiwan, this paper evaluates the economic impact of science parks and innovation policy with a holistic viewpoint and nation-wide statistics. First, the economic added values, international trades, and employment in the benchmarked science parks are evaluated. Second, the concepts of academia-industry collaboration and policies to eco-innovation system are introduced, while the measures and performance of innovation and applied R&D in the science parks are addressed. Based on the research results, lessons learned and policy implications for science park developments and academia-industry cooperation innovations are discussed.

1. Introduction

The evident success of science park policy in promoting clusters of high-technology industries has motivated countries from around the world to apply it in an attempt to promote regional development. Many countries are continuously promoting science parks and high technology industries to drive economic growth, such as Silicon Valley in USA, Cambridge Science Park in the UK, Russia, Israel, India, Taiwan, and China. To the global trend of science park policy, the science parks such as Zhongguancun in Beijing, Daedeok Innopolis in Korea, and Hsinchu Science Park in Taiwan are characteristic benchmarks with a high linkage to public policy and governmental support. In addition, innovations and R&D have been identified as one of the critical driving factors for high-technology firms to compete and thrive under intensive global competitions. The influence of R&D for business has gained increasing interests in both academia and practice, especially for the high-tech industry.

Since the science park and innovation policy are getting acceptance by governmental agencies, a nation-wide macro viewpoint is needed for policy evaluations and high-technology industries should be considered as parts of the national/regional economies. This paper proposes a nation-wide economic impact analysis of science parks and innovation policy based on the real data from one of the globally recognized high-technology industrial clusters, the national science parks in Taiwan. By taking advantage of robust small and medium-sized enterprise networking, of high quality of human resources, of government support and government-industry-university-institute collaboration, the Taiwan science parks have become globally well-known examples of science parks set up for national prosperity. The policy of facilitating science parks and innovations have been making a tremendously contribution to the development of the high-technology industry clusters, the creation of innovation clusters, and the national economy in Taiwan. The promotion and development of high-technology industries by the Taiwanese government in the past two decades has been one of the most important factors that have helped Taiwan maintain an above-average rate of economic growth. Science parks in Taiwan have incubated six major industrial clusters, including integrated circuits (IC) industry, computer & peripherals industry, telecommunication industry, optoelectronics industry, precision machinery industry, and biotechnology industry. The science parks occupy merely 0.1% of Taiwan's total land area, but contribute around 16% to Taiwan's overall manufacturing revenue, 40% to domestic IT industry, 14% to foreign trade, and 15% to domestic invention patent output. As key high-technology industry actuators, science parks act as productivity sources in Taiwan and produce economic prosperity for Taiwan. Among the industrial clusters, several of Taiwan's IT products and related industry capacities rank in the leading positions worldwide.

By taking the case study of science parks in Taiwan, this paper systematically evaluates the economic impact of science parks and innovation policy with nation-wide statistics and holistic viewpoint. First, the economic added value and employment in the benchmarked science parks are reviewed. Second, the concepts of academia-industry collaboration and policies to eco-innovation system are introduced, while the measures and performance of innovation and applied R&D in the science parks are addressed. Based on the research results, lessons learned and policy implications for science park development and academia-industry cooperation innovations are discussed.

2. The Role of Government to Science Parks and Eco-Innovation System

One of the major driving forces for the success of science parks in Taiwan could be referred to the dedicated governmental organizations and responsibilities. As the government's dedicated scientific and technological development agency, the Ministry of Science and Technology (MOST) is charged with three main missions of promoting the nation's overall S&T development, supporting academic research, and developing the science parks. In addition, the National Applied Research Laboratories (NARLabs) supports MOST's promotion of national S&T development through its vision of "global excellence, local impact." In the area of S&T policy, NARLabs is responsible for the following developments:

1. Establishing mid-/long-term S&T trend monitoring and value-added intelligence analysis capabilities, performing S&T forecasting activities and planning and research on key issues, providing decision-makers with multifaceted analysis and intelligence on decision-making information.
2. Establishing capable patent consulting teams, and providing up-to-date specialized information.
3. Assisting and supervising the country's innovation system operating environment, providing performance assessment and recommendations for the country's major programs, and improving S&T policy governance and the competitiveness of domestic innovation.

With the supports of MOST and the Think Tank, NARLabs, policies for science park developments and innovation could be consistently promoted in Taiwan, including the development of science parks and the academia-industry links and innovation.

For more than three decades, the science parks have continually raised the bar for technological progress in Taiwan. By demonstrating successful production approaches and disseminating technology, the parks have not only improved the nation's industrial structure and economic prosperity, but also made a name for Taiwan's high-tech industries around the globe. Taiwan currently has three core science parks located in the northern, central, and southern areas. The Hsinchu Science Park (HSP) was established in 1979 as Taiwan's first science park, while the HSP is the best-developed science park and has the broadest range of industries. The Southern Taiwan Science Park (STSP) was founded in 1997, housing complete clusters of optoelectronic, semiconductor, biotechnology, and precision machinery companies. The park is also developing the green low-carbon energy and biotech medical device industries. Completed in 2003, the Central Taiwan Science Park (CTSP) is situated amid a major hub of the precision machinery industry.

In accordance with the government policy, the science parks offer dedicated spaces along with a wide range of professional advisory and resource referral services. In addition to legal, financial, and accounting advice, these also include product-to-application matching advice, marketing assistance, technical and equipment support, prototype development, and venture capital negotiation. The parks have also expanded their one-stop service functions to foster an environment conducive to innovation and entrepreneurialism.

3. The Economic Impact of Science Park Policy

In this section, the contributions of science parks to the national economic development and industrial chains were analyzed based on the statistics provided by Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Taiwan. The government policy has helped the focus of science park developments in the past decades. The three science parks have different but complementary industrial development focal points. They mainly promote the six industries of integrated circuits, computers and peripherals, telecommunications, optoelectronics, precision machinery, and biotechnology. Among the focused industries, integrated circuits and optoelectronics have become the largest core industries. In 2014, integrated circuits brought in the highest sales among all industries at the HSP, while optoelectronics and integrated circuits together contributed 93% and 95% to sales at the STSP and CTSP, respectively.

3.1 Economic Added Values and International Trades of Science Parks

In this section, the effect of the high-technology industries in the science parks on national economic development was evaluated by sales and international trades. In terms of the total sales of science parks from 2004 to 2015, it is observed about 170% growth in terms of operations scale in the three major science parks, while Hsinchu Science Park is the largest number in sales of this area over the other two. Given the fact that Hsinchu Science Park is the first science park initiated in Taiwan, which is recognized globally as one of the most intensive semiconductor areas, it has undergone a long history of development of science and technology and become the major spot for high technology industries in northern Taiwan. Based on its successful experience, both Southern Taiwan Science Park and Central Taiwan Science Park were then initiated consecutively as latecomers. At present, Hsinchu Science Park covers six locations—the Hsinchu, Zhunan, Tongluo, Longtan and Yilan parks as well as the Hsinchu Biomedical Science Park—that span a total area of nearly 1,400 hectares. All three science parks have their characteristics and strengths respectively; For instance, the sales of integrated circuits and biotechnology in Hsinchu Science Park are the highest among the three of 800,938 million NT dollars and 9,129 million NT dollars respectively, while sales of opto-electronics and precision machinery in Southern Taiwan Science Park are the highest among the three of 295,272 million NT dollars and 30,770 million NT dollars respectively.

To evaluate the relative position of Taiwanese science parks in the global market and international supply chains, sales in international trades and exports could be one of the performance indices. Global economy tips into recession in 2015, which leads to annual growth rates of total trades and export trades decline in Taiwan. However, the share of exports trades in total trades have gradually increased in recent years, it have accounted for 52.8% of total trades in 2013, 53.2% in 2014 and 54.6% in 2015. This fact indicates high competitiveness of Taiwan, saying that our industries are not only capable of satisfying domestic demand but also overseas high-end consumers; which shows an internationalized trend in our total trades as well. As to the average performance of Science Parks, the share of exports trades in total trades is higher than in entire Taiwan, which is 62.9% in 2013, 64.4% in 2014 and 65.5% in 2015. Exports trades in Science Parks have accounted for around 13.1%, 13.3%, and 15% exports trades in Taiwan in 2013, 2014 and 2015 consecutively. The statistical evidence shows positive effect of governmental policies in science parks' development, which boost high export performance in science parks annually.

Among the various exports trade items, the top three exports of Hsinchu Science Park were (1)wafers of other monolithic digital integrated circuits, (2)other hybrid integrated circuits, and (3)other monolithic digital integrated circuits; the top three exports of Central Taiwan Science Park were (1)thin film transistor liquid crystal display devices (TFT-LCD), (2)indicator panels incorporating thin film transistor liquid crystal display devices (TFT-LCD), and (3)chips of dynamic random access memory integrated circuits (DRAM); the top three exports of Southern Taiwan Science Park were (1)wafers of other monolithic digital integrated circuits, (2)parts of liquid crystal devices, and (3)other parts suitable for use solely or principally with the apparatus of headings nos. 85.25 to 85.28.

The results consistently suggest that the effects of high-technology industries in the science parks not only contribute significant economic values to Taiwan as a country but also promote industrial and technological upgrades to better fit in the global economic system.

Table 1. Sales of Science Parks by Statistics Area (Unit: a Hundred Million NT$)

Year / Area	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hsinchu Science Park	10859	9880	11214	11463	10079	8835	11869	10346	10588	11124	11633	11012
Central Taiwan Science Park	0.5	608	1785	2657	2861	2411	3625	2911	3233	4599	5220	4921
Southern Taiwan Science Park	2594	3527	4516	5588	5475	4610	6058	5794	6219	6151	6394	7151
Total	13454	14016	17515	19709	18416	15857	21553	19051	20041	21875	23248	23084

Table 2. Trades and Annual Growth Rates in Taiwan (Unit: Million US$)

Trades / Year	Total Trades	Annual Growth Rates of Total Trades (%)	Exports Trades	Annual Growth Rates of Exports Trades (%)
2002	250,890	6.2	135,744	7.2

2003	281,593	12.2	151,345	11.5
2004	355,197	26.1	183,643	21.3
2005	385,199	8.4	199,761	8.8
2006	432,346	12.2	225,904	13.1
2007	471.907	9.2	248,792	10.1
2008	502,518	6.5	258,051	3.7
2009	383,260	-23.7	205,663	-20.3
2010	534,282	39.4	278,008	35.2
2011	600,985	12.5	312,923	12.6
2012	583,733	-2.9	306,409	-2.1
2013	589,438	1.0	311,428	1.6
2014	601,942	2.1	320,092	2.8
2015	522,563	-13.2	285,344	-10.9

Data source: Ministry of Finance, R.O.C.

Table 3. Total Trades of Science Parks (Unit: a Hundred Million NT$)

Year / Area	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hsinchu Science Park	11,429	7,828	7,466	9,968	10,228	10,110	10,578	11,066	10,504
Central Taiwan Science Park	79	4,173	2,186	3,406	3,122	4,054	3,472	3,042	3,112
Southern Taiwan Science Park	4,182	5,060	3,720	6,473	5,790	5,584	7,245	7,111	7,359
Total	15,691	17,062	13,374	19,848	19,142	19,750	21,295	21,220	20,976

Data source: Ministry of Science and Technology

Table 4. Exports Trades of Science Parks (Unit: a Hundred Million NT$)

Year / Area	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hsinchu Science Park	7,124	5,331	4,801	6,398	6,160	6,554	7,143	7,380	6,774
Central Taiwan Science Park	0.23	1,607	1,558	2,444	1,891	2,079	2,094	2,318	2,268
Southern	2,827	3,381	2,504	3,429	3,414	3,845	4,160	4,151	4,697

Taiwan Science Park									
Total	9,952	10,321	8,864	12,272	11,467	12,480	13,398	13,671	13,740

Data source: Ministry of Science and Technology, R.O.C.

3.2 Number of Firms and Employment of Science Parks

Science parks could drive the economic development and social welfare by facilitating entrepreneurial firms and more job opportunities with employment. The total number of firms in the science parks have been steadily increased to 905, while IC firms, Optoelectronic firms, and Biotechnology firms are the major categories of enterprises. Accordingly, more job opportunities were opened and the total number of employment in the science parks are significantly increased.

In 2004-2013, employees of integrated circuits industry are around 45-50%; employees of computers & peripherals industry are around 5-6% among all the employees of Science Parks; employees of telecommunications industry are around 3-4%; employees of opto-electronics industry are around 35-38%; employees of precision machinery industry are around 4-5%; employees of biotechnology industry are around 2%. In 2013, researchers were around 11.3% of employees in Science Parks. Based on the statistic in 2013, the total number of employment in the science parks account for about 2.3% of the total number of employment in Taiwan. However, 2.3% labor force was able to deliver about 15% of GDP in Taiwan. The results significantly demonstrate the high value added and economic impact of high technology industries in the science parks in Taiwan. Higher level of income for the employees in the science parks is the subsequent benefit observed.

Table 5. Number of Firms Registered in Science Parks by Statistics Area
(Data collected before 2015/12) (Unit: Enterprise)

Industry / Area	IC	Opto-elec.	Computer & Peripherals	Telecom.	Precision Machinery	Biotech.	Others	Total
Hsinchu Science Park	192	94	56	45	42	83	9	521
Central Taiwan Science Park	7	40	14	1	67	37	14	180
Southern Taiwan Science Park	17	58	2	11	47	63	6	204
Total	216	192	72	57	156	183	29	905

Table 6. Number of Employees of Science Parks by Industry (Units: Persons)

Industry / Year	Total	IC	Opto-elec.	Computer & Peripherals	Telecom.	Precision Machinery	Biotech.
2004	146,613	74,136	14,109	6,239	47,833	2,638	1,658
2005	159,048	75,129	12,790	6,535	59,569	3,221	1,804
2006	176,669	81,996	12,981	7,198	67,742	4,843	1,909
2007	195,418	92,994	12,687	6,744	74,853	6,179	1,961
2008	197,023	100,687	13,349	7,661	65,617	7,511	2,198
2009	195,394	92,546	12,782	8,496	70,647	8,321	2,602
2010	213,665	103,041	12,971	8,536	76,181	9,743	3,193
2011	231,973	111,474	13,550	8,368	83,925	10,236	4,420
2012	238,930	111,811	12,518	8,729	89,292	11,462	5,118
2013	247,668	114,156	12,722	8,082	94,511	12,428	5,769

Note: The total numbers is based on the numbers of employees of major six industries clusters.
Data source: Ministry of Economic Affairs, R.O.C.

4. Innovation of High Technology Industries in the Science Parks

The innovation of high technology industries in Taiwan has been continuously facilitated by the government policy for strengthening academia-industry links and innovation. Industry-academia cooperative research matches the advanced and practical technologies and knowledge applications of universities with the needs of private-sector businesses. These projects develop the R&D capabilities of educational and research institutions while encouraging companies to participate in university-based applied research projects. To promote collaboration on highly innovative research projects, MOST defined the scope of research results and established optional models for technology transfer authorization, thus increasing the effectiveness of industry-academia cooperation. In 2014, a total of 813 such projects received government funding, 852 companies participated, NT$328 million was raised in corporate matching funds, and 2095 graduate students received training. To develop the R&D capacity and eco-innovation system of the high technology industries in Taiwan, more innovation policies were promoted as follows:

1. PIONEER Grants for AIC: MOST has been jointly funding the PIONEER Grants for Frontier Technologies Development by Academia-Industry Cooperation with the Ministry of Economic Affairs since 2013 to encourage internationally and regionally leading firms to form alliances and engage in cooperative research with universities.
2. Minor Alliance Projects: Academia-Industry Technological Alliance Projects make use of university researchers' technological capabilities and encourage professors to establish core technology laboratories as a bridge to industry users. Funded by MOST since 2013, these projects encourage academic organizations to build laboratories centered on their research as a new platform for industry-academia collaboration.
3. From IP to IPO: The purposes of this program are to encourage the establishment of startups

by young researchers, promote an innovative, entrepreneurial culture at universities and research organizations, and foster an environment for industrializing R&D results or innovations.

4. Germination Program: The program accelerates technological diffusion by helping scientific research organizations establish mechanisms for the promotion and use of R&D results.
5. Industrial Fundamental Technology Projects: The program brings together academic and industrial resources to reinforce the technical foundations of Taiwan's manufacturing industry.
6. Applied Research Incubation Projects: The program promotes a biotechnology integration and incubation mechanism to evaluate, construct, and connect R&D capabilities along Taiwan's biotech value chain.

4.1 The R&D Intensity for Innovation

Previous studies have proposed that R&D is a key factor for high-tech firms to compete and thrive under intensive global competition (Bharadwaj et al. 1999; Toivanen et al. 2002; Beneito 2006). Empirical studies on R&D intensive firms and high-tech industry clusters have proved higher production economics and added values (Yan and Chien 2013).

There has been a rising interest in the relationship between research and development (R&D) and firm performance for the high-tech industry. Owing to the intensive competition and rapid advances in innovations, high-tech firms have to invest on R&D to maintain or strengthen their market competitiveness. Previous studies (Griliches 1998; Hu 2001; Wang et al. 2013) have argued that R&D as a driving force for productivity, and the others have claimed that R&D efforts would help capture market share (Ettlie 1998; Bommer and Halajas 2000) and contribute to the profitability of firms (Cho and Pucik 2005; Prajogo 2006).

The R&D capacity and performance in Science Parks have played a leading role in Taiwan. Based on the research of "National Science and Technology survey" from 2009 to 2014, number of R&D personnel accounts for around 20% of number of employees of private sectors in Science Parks, and private R&D expenditure in Science Parks account for 40% of manufacturing industry's R&D expenditure in Taiwan. In addition, U.S. patents obtained by enterprises in Science Parks account for over 30 % of those obtained by Taiwanese enterprises; and among top ten Taiwanese enterprises who obtain U.S. patents, over 60% are enterprises in Science Parks.

Table 7. R&D Personnel and R&D expenditure of Science Parks

Year / Item	2009	2010	2011	2012	2013	2014
R&D Personnel of Science Parks (Units: Persons)	37,563 (19.14%)*a	42,214 (19.68%)	44,560 (19.13%)	45,457 (18.95%)	47,789 (18.51%)	50,773 (19.67%)

R&D Expenditure of Science Parks (Unit: a Hundred Million NT$)	932.56 (5.9%)*b (39.7%)*c	1,011.13 (4.7%) (39.3%)	1,081.20 (5.7%) (39.3%)	1,124.07 (5.6%) (38.6%)	1,243.97 (5.7%) (39.8%)	1,352.95 (5.8%) (40.0%)

*a: Percentage of R&D Personnel of Science Parks in total numbers of employees in Science Parks (scientific industries only) in the year.
*b: Percentage of R&D Expenditure of Science Parks in Sales of Science Parks in the year.
*c: Percentage of R&D Expenditure of Science Parks in R&D Expenditure of Taiwan Manufacturing Industry (private sectors) in the year.

Data source: Ministry of Science and Technology, R.O.C.

In 2013, R&D expenditure is around 5.7% of sales, and it can be more specifically separated into different industries: R&D expenditure of integrated circuits is around 7.2% of sales; R&D expenditure of computers & peripherals is around 8.9% of sales; R&D expenditure of telecommunications is around 15% of sales; R&D expenditure of opto-electronics is around 2.6% of sales; R&D expenditure of precision machinery is around 3.6% of sales; R&D expenditure of biotechnology is around 12.7% of sales. In summary, the total R&D expenditure in the science parks accounts for more than 48% of total R&D expenditure in the high technology industries in Taiwan. The significant results suggest that the importance of science park developments for the high technology industrial clusters in Taiwan.

Table 8. R&D Personnel of Science Parks by Industry, 2013 (Unit: Persons)

Occupation / Industry	Total	Researchers	Technicians	Supporting Staff	Number of Employees	Researchers as a Percentage of Employees
Total	47,789	28,096	16,595	3,098	247,668	11.3
Integrated Circuits	24,645	14,784	8,409	1,452	114,156	13.0
Computers & Peripherals	4,638	3,256	989	393	12,722	25.6
Telecommunications	3,507	1,794	1,427	286	8,082	22.2
Opto-electronics	11,600	6,284	4,544	772	94,511	6.6
Precision Machinery	2,016	1,059	863	94	12,428	8.5
Biotechnology	1,383	919	363	101	5,769	15.9

Notes:
1. Generally, firms reporting data of their branches, factories and headquarters with an integral whole instead of individual questionnaires. This table adopted their entire R&D personnel if their main R&D main department was located in these Parks.
2. Data of numbers of employees were from Hsinchu Science Park Bureau, Southern Taiwan Science Park Bureau and Central Taiwan Science Park Bureau websites; MOST, Taiwan.

Table 9. R&D Expenditure of Science Parks by Industry (Unit: a Hundred Million NT$)

Industry / Year	Total	IC	Computers & Peripherals	Telecom.	Optoelect.	Precision Machinery	Biotech.
2004	571	359	611	306	103	631	112
2005	710	461	721	318	127	805	988
2006	760	502	713	267	137	184	955
2007	836	565	682	320	143	174	105
2008	918	610	699	352	172	212	969
2009	933	610	703	394	183	204	966
2010	1,011	675	776	454	178	212	135
2011	1,081	729	655	464	204	225	146
2012	1,124	771	669	436	203	226	162
2013	1,244	886	723	453	195	247	204

Notes:

1. Data of sales were from Hsinchu Science Park Bureau, Southern Taiwan Science Park Bureau and Central Taiwan Science Park Bureau websites; MOST, Taiwan.
2. All definitions of R&D expenditure and R&D personnel applied in this survey follow OECD's, being distinct from those in financial statements.
3. Generally, firms reporting data of their branches, factories and headquarters with an integral whole instead of individual questionnaires. This table adopted their entire R&D personnel if their main R&D main department was located in these Parks.

4.2 The Patents Development with Innovation

Similar to R&D efforts, it has been argued by certain research (Cho & Pucik 2005), that patents act as an intermediate role that may protect innovations/creativities and R&D outcomes, and contribute to the profitability of firms.

Based on the statistical results, the number of patents granted by USPTO in science parks is steadily increased from 2011 to 2015. Furthermore, compared with all the numbers of patents granted by USPTO in Taiwan, the percentage of numbers of patents granted by USPTO in science parks accounts for more than 30% and the percentage is up to 38.5% in 2015. The results suggest the effectiveness of the eco-innovation system and the patents development in the science parks in Taiwan.

From the world-wide perspective, it is recognized that Taiwan has been ranked as Top 5 based on the number of patents granted by USPTO in 2015. The results suggest the relatively leading position of Taiwan for patents development with innovation. Furthermore, the Business Enterprise R&D Expenditure as a Percentage of Value Added in Industry in Taiwan is the lowest number among Top 5 countries. The results suggest the effectiveness of Taiwanese firms in the innovating processes instead of the total amount of patents.

Table 10. Patents Granted by USPTO in Science Parks

Item	2011	2012	2013	2014	2015
Number of patents granted by USPTO in Science Parks	2,327 (32.2%)*d	2,964 (35.1%)	3,023 (31.4%)	4,156 (36.7%)	4,630 (38.5%)

*d: Percentage of numbers of patents granted by USPTO in Science Parks in numbers of patents granted by USPTO in Taiwan.

Data source: Ministry of Science and Technology, R.O.C.

Table 11. Number of Patents Granted By USPTO in 2015

County	Number	Percent of Patents Granted as Distributed by Year of Patent Grant
U.S.	140,969	47.2
JAPAN	52,409	17.6
KOREA, SOUTH	17,924	6.0
GERMANY	16,549	5.5
TAIWAN	11,690	3.9
CHINA, PEOPLE'S REPUBLIC OF	8,116	2.7
CANADA	6,802	2.3
FRANCE	6,565	2.2
UNITED KINGDOM	6,417	2.2
ISRAEL	3,628	1.2
INDIA	3,355	1.1
RUSSIAN FEDERATION	440	0.1

Granted: 01/01/2015 - 12/31/2015

Data source：Patent Counts By Country, State, and Year - Utility Patents (December 2015)

http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

Calendar Year Patent Statistics (January 1 to December 31) General Patent Statistics Reports Available For Viewing

http://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports.htm

Patenting By The U.S. Government in 2015 http://www.uspto.gov/web/offices/ac/ido/oeip/taf/topo_15.htm#PartA1_1a

Table 12. Enterprise R&D Expenditure as a Percentage of Value Added in Industry (Unit:%)

Year / Country	2004	2005	2006	2007	2008	2009	2010	2011	2012
Finland	3.97	4.08	4.09	4.05	4.49	4.87	4.68	4.67	4.33
Korea, South	3.00	3.15	3.44	3.62	3.77	3.94	4.09	4.49	4.93
Japan	3.54	3.76	3.93	4.01	4.10	3.96	3.86	4.05	4.00
Sweden	4.30	4.24	4.49	4.06	4.47	4.30	3.81	3.82	3.78
Germany	2.74	2.73	2.78	2.78	2.94	3.12	3.03	3.15	3.26
United States	2.78	2.82	2.91	3.03	3.27	3.34	3.15	3.17	3.26

Taiwan	2.03	2.17	2.30	2.33	2.60	2.77	2.72	2.85	3.00
China	1.01	1.12	1.12	1.26	1.33	1.57	1.62	1.74	1.90
Russian Federation	1.07	1.00	0.99	0.99	0.92	1.11	0.96	0.94	0.94

Data sources: (1)Countries except Taiwan: Main Science and Technology Indicators, 2014/1, OECD. (2)Value added in Industry are calculated from National Accounts by DGBAS, and in accordance with the industrial scope of OECD definition.

5. Conclusions

To promote science and technology polices and high-technology industrial developments, public policy makers need to continuously evaluate the economic impacts and innovation indicators of science park development. Most importantly, policies for facilitating economic added values and innovations could be the critical driving force from the government side. In this paper, the concept of economic added values, international trades, employment, R&D intensity, patent development are applied to a case study of the economic impacts and innovations of science parks in Taiwan, which is an addition to the theoretical and practical contributions on the development of high-technology industries.

Especially for the governmental supported science parks, the proposed integrated analysis and performance evaluation provides a more comprehensive perspective in supporting the performance evaluation of industrial incubation policies. From a macro standpoint, the integrated economic perspective is worth to be incorporated into the list of those factors used for the construction of nation-wide policies on the industry choices, segmentations, and structural developments. Our research results suggest that the national science parks policy can facilitate successful development of high-technology industries, which bring about both significant economic benefits and R&D performance. While the operations of the science parks in Taiwan have long enjoyed governmental support, the proposed case study provides several policy implications. First, a nation-wide macro viewpoint is needed for the planning of high-technology industrial developments. Second, when high-technology industries are considered as one of the national/regional economies by governmental agencies, appropriate economy index can better represent the contributions of the high-technology industries. Third, a proper industrial clustering mechanism and eco-innovation system can further help high-technology industries to reach the status of an upgraded economy. The proposed policy implications should lead to improved future research for better developments of science parks and high-technology industries. Technically, for other future research, more innovative and practical indices that accommodate the integrated concept between the economic and innovations for specific industrial requirements could be continuously discovered and applied in the future.

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