University-Industry Cooperation in Taiwan Technological and Vocational Education Across Academic Discipline

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***Abstract*--University-industry cooperation is not only a promotion of research but also an economic activity. It is essential for the purpose of science development and technology innovation. Vocational education plays an important role in product development and technology research in Taiwan. This study surveyed the performance of university-industry cooperation on productivity of patent, paper and resources of funding across eight academic disciplines in Taiwan technological and vocational institutions by providing an overview of research productivities and funding resources. The results reveal that college of agriculture, college of engineering and college of design perform quite well in university-industry cooperation with better mean of patent, paper and funding.**

I. INTRODUCTION

Since the advent of the Bayh-Dole Act in 1980, university-industry cooperation has become closely related for the purpose of science development and technology innovation. It moves research output from universities into industry. Bloedon and Stokes [1] defined university-industry linkage the cooperated research activities and programs between higher educational institutes and industries. Bleiklie, et al. [2] indicated a mutual beneficial pathway by commercializing research output into industry products. Severson [3] pointed out the importance of university-industry partnership as "an impressive list of innovative products and has led to the belief that basic research at universities supports the development of innovative products that can help maintain competitiveness."

Inspired by the worldwide booming promotion of university-industry partnership, Taiwan government implemented the Fundamental Science and Technology Act in 1999, in which autonomy of research outputs that sponsored by government funding is granted to research universities and institutions. Regulations with respect to patent have legislated to stimulate the research and practice collaboration.

Vocational education plays an important role in product development and technology research in Taiwan. It is considered as a hotbed for industrial technology research and technician cultivation. There were 78 vocational colleges in 1984. To enhance and develop education quality and productivity, Taiwan government applied series policies to develop its vocational education. Since 1990s vocational colleges of technology started to transform into science and technology universities, and by then, has played a profound function in Taiwan higher education. Up to 2011, there were 93 vocational and technology institutions in which there were 690 thousands students, taking up 3/5 of the total university students in Taiwan higher education.

University-industry cooperation is not only a promotion of research but also an economic activity. Previous studies has explored measurements of cooperation efficiency refer to the input/output ratio which applied in economic researches. Niosi [4] illustrated the measurement of efficiency of university-industry cooperation as knowledge input, output and their proliferation. Hameri [5] pointed out that new technical products and services, patents, scientific books and academic papers etc. are core for university-industry partnership.

University research fund resources are mainly from those science and technological projects which assigned by government, industries or other organizations. Acs, et al. [6] considered university-industry cooperation inputs as project funds, amount of full-time faculties, and outputs as patent and paper amount. Johnes and Johnes [7] found research efficiency in major universities increased by investing of R&D funding, indicating an essential effect of R&D funding on research output. Since then studies such as Pakes and Griliches [8], Kumar and Siddharthan [9] and Basant and Fikkert [10] applied R&D funds as a measurement for research input. Adams and Griliches [11] found a positive relationship between research funds and count of published papers.

Patent is applied as the measurement of research performance, development and business value [12, 13]. Siegel, et al. [14]indicated patent can be considered as protection of innovative research and promotion of commercialization. Surveyed by Ernst [15], Carlsson and Fridh [13], Reitzig [16] and Grupp and Mogee [17], patent count is critical in measuring the output of innovative research application and performance of research institutions. Tussen, et al. [18] discovered a significant relationship between patent count and technology innovation. Cohen [19] illustrated the economic value of patent contributed by research of universities.

The main objective of this study is to survey the performance of university-industry cooperation on certain core categories across academic disciplines in Taiwan technological and vocational institutions. According to those literature reviews provided above, this study investigates paper count, patent count and funding amount to examine university-industry cooperation level across 8 major

academic disciplines in Taiwan higher education. Academic discipline is one of the most important variables influencing the academic activity and research productivity [20]. Becher and Trowler [21] and Biglan [22] claimed that academic disciplines exist differences in theory and methods of research. Kyvik [23] indicated that publication patterns are different between liberal art and science & engineering, as joint authorship in research is more common in the latter discipline. These provide evidences for this study of academic disciplines categories.

II. METHODOLOGY AND MEASUREMENT

A. Data

The data used in this study is from the vocational education database built by Taiwan government project named "Basic database of higher technological and vocational education". This database was first built in 2001 and solely sponsored by Taiwan government. It has considered as a high accuracy database with specific column definition and clear filling instruction. We then adjusted extreme values by dropping imperfect information. Finally, we obtained a sample set that included 71 institutions and 11,713 observations.

B. Measurement

- *The 8 academic discipline categories:* college of humanities, college of engineering, college of tourism and recreation, college of business, college of design, college of agriculture, college of languages, college of medicine.
- *Patent count*: The number of patent and new breed issued by faculties or in the name of university.
- *Paper count (I)*: The number of papers published on SCI, SSCI, AHCI, TSSCI, EI index.
- *Paper count (non-I):* The number of papers published on other professional or academic journals.
- *University-industry-government cooperation fund categories:*
- *Industry funds*: The total amount of income of the projects and the training programs undertaken by university assigned by businesses.
- *Government funds*: The total amount of income of the projects and the training programs undertaken by university assigned by government.
- *Other organization funds*: The total amount of income of the projects and the training programs undertaken by university assigned by other organizations.

III. FINDINGS AND DISCUSSION

Table 1 shows the overall statistic description. Of the 8 academic disciplines of technological and vocational universities in Taiwan, college of engineering has the most faculties of 4631, followed by business with 3058 faculties and medicine with 1494 faculties. College of agriculture owns the least amount with only 61 faculties.

Top three colleges in patent rank are college of engineering, design and agriculture with the mean of 1.67, 0.96 and 0.66 respectively. College of language and humanities stay the lowest with mean of only 0.1 and 0.08. This can be partly due to the subject nature as science and engineering subjects have far more spaces for patent application and technology development.

Top three colleges of paper publication are college of agriculture, engineering and medicine with the mean of 4.84, 3.48 and 3.02 papers per faculty respectively. This rank stays almost the same in rank of paper publication on SCI, SSCI, AHCI, and TSSCI, EI index, as shown in table 2, with college of engineering 2.68, agriculture 1.67 and medicine 1.65. However, paper publication rank (non-I) has sharp changes while college of agriculture 3.16, tourism & recreation 1.79 and humanities 1.79 papers. Only college of agriculture stays in both paper publication ranks, indicating its great publication advantages in both qualities and quantities. College of engineering and medicine thus present their high quality of paper. Although college of tourism & recreation and humanities maintain good quantities of publication, there are weaknesses in publishing on high level journals.

TABLE 1 STATISTIC DESCRIPTION WITH ALL VARIABLES

		Patents		Papers		Total funds	
Discipline	N	Mean	S. D.	Mean	S. D.	Mean	S. D.
Humanities	277	0.08	0.69	2.51	4.50	445241.29	4876099.94
Engineering	4613	1.67	5.83	3.48	5.49	2825617.49	8826329.60
Tour&rec	851	0.22	1.37	2.46	4.11	1195777.45	4589028.87
Business	3058	0.41	4.62	2.26	4.14	1094753.64	4272756.89
Design	670	0.96	5.18	1.21	2.64	1650014.17	4129083.94
Agriculture	61	0.66	1.63	4.84	4.69	8134189.26	18247610.68
Languages	689	0.10	0.83	1.13	1.98	390935.82	996273.57
Medicine	1494	0.37	1.86	3.02	4.71	1674017.91	5220201.05

TABLE 2 PAPER PUBLICATION CATEGORIES ACROSS DISCIPLINE

		Papers(non-I)		Papers(I)	
Discipline	N	Mean	S. D.	Mean	S. D.
Humanities	277	1.69	2.65	0.81	3.09
Engineering	4613	0.80	1.83	2.68	5.02
Tour&rec	851	1.79	2.93	0.67	2.85
Business	3058	1.24	2.25	1.03	2.96
Design	670	0.87	2.25	0.34	1.19
Agriculture	61	3.16	4.25	1.67	2.17
Languages	689	0.97	1.75	0.16	0.85
Medicine	1494	1.37	2.64	1.65	3.60

TABLE 3 FUNDING CATEGORIES ACROSS DISCIPLINE

		Government funds		Industry funds		Other organization funds	
Discipline	N	Mean	S. D.	Mean	S. D.	Mean	S. D.
Humanities	277	1722304.60	6077597.86	85997.04	328049.74	302513.83	2053440.91
Engineering	4613	2196373.12	7540017.33	496311.21	2118321.52	115325.82	623921.09
Tour&rec	851	980549.90	4724648.45	189282.83	1030762.92	67741.20	604591.22
Business	3058	904116.56	4105884.29	165757.85	499481.51	38986.26	255513.79
Design	670	1783013.06	7825567.73	270954.06	609374.83	178131.68	956381.57
Agriculture	61	7145659.84	17612772.99	254763.93	605308.95	798222.95	4300579.99
Languages	689	391475.40	1133544.77	67164.48	132941.51	15849.21	80843.90
Medicine	1494	1433270.15	6141473.75	239976.64	962200.49	63410.25	587626.86

Table 3 shows mean of funding in different categories. College of agriculture, engineering and design rank the top three in government funding with the mean of 7145659.84, 2196373.12, 1783013.06 respectively. There is a giant gap between the first place and second place, implying the great government funding resource for college of agriculture. College of language has the least mean of government funding. These top colleges above stay high positions in industry funding rank as well, while college of engineering takes up the first place with a mean of 496311.21, followed by college of design 270954.06, and last college of agriculture 254763.93. These results reveal a difference demand between government and industry. Funding from other organizations present a partly different rank with college of tourism & recreation the second place and followed by college of medicine, college of agriculture maintains the first position either in this rank. Table 1 present rank of total funding across disciplines, college of agriculture keeps the first position with a mean of 8134189.26, college of engineering takes up the second place with a mean of 2825617.49, followed by college of design 1650014.17. College of language has the least mean of funding with only 390935.82.

IV. CONCLUSION

This study surveyed the performance of university-industry cooperation on productivity of patent, paper and resources of funding across eight academic disciplines in Taiwan technological and vocational institutions. The results reveal that college of agriculture, college of engineering and college of design perform quite well in university-industry cooperation with better mean of patent, paper and funding. College of tourism & recreation and college of humanities have better publication performance in non-I level journals. Funding resources concentrate on college of agriculture and engineering, there are, however, slight difference in concentrations from government and industries. These results present a general distribution of research productivities and funding resources, illustrating imbalances in between academic disciplines where science and engineering disciplines have great advantages in performance of university-industry cooperation. The results in this study can be referred to researchers and institutions and beneficial to industries and government investment, and finally, contributed to relevant studies and future researches as reference.

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