LICENSE INCOME OF TECHNOLOGY COMMERCIALIZATION:  
THE CASE OF U.S. UNIVERSITIES

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Abstract

After the Bayh-Dole Act launched in 1980, the activities of technology transfer between academic and industries were dramatically boosted thereafter. What factors influence the performance of technology transfer were propose by some pervious researches, most of them thought researches expenditure, patents, and published articles had significant weight. According to some case studies of famous journal pointed out patent had no contribution, this study uses AUTM licensing survey to figure out the relationship between issued patents, published articles, and technology commercialization. The result of the study shows that published articles do have effect, but patents issued do not make significant effect on technology commercialization.

Keywords: technology transfer, license income, patent issued, invention disclosure, published articles

Introduction

The Association of University Technology Managers (AUTM). The annual investigation data of AUTM show that all American universities can be realized by The status of technology transfer in American universities highly emphasize
academic researches. The research funds of all universities in America were 13 billion US dollars in 1991, but it increased almost three times within 10 years. The level of funds reached to 35 billion US dollars in 2002, and there were more outstanding increase in the following four years. The research expenditure in 2006 even broke 45 billion US dollars. Regarding the doubts of different inputs of research funds generating different performance of outcome, AUTM also investigated several indicative numbers of research results. Based on the issued patent numbers and patent application numbers, the investigation results suggested that the number of application cases increased year by year, while the patent numbers of each university don’t grow at the same trend, and the research expenditure and license revenue of each universities don’t reduce.

Crepon et al. (1998) put forward that there was a positive correlation between the output of business patent and the input of research expenditure. However, American universities are non-profit organizations, and they don’t need to be responsible for shareholders. AUTM’s data in 2006 showed that license revenue for College of William & Mary and University of Montana was zero, but their input of research expenditure was even higher than the ones of other universities, whose license revenue was not zero, but the two universities’ input of research expenditure continuously increased year by year, and there was no actual license revenue. It disclosed that whether there is an apparent correlation among the input of universities’ research expenditure, the research output, and the license revenue or not, it still needs a deep exploration.

On the basis of the motive and background above, the purpose of the study is to treat the mode of license revenue of technology transfer in American universities and to try to find out the mediating factors, which can raise the license revenue, as the preparation direction before the technology transfer. And then, there is a review of the affection of research input and output on license revenue. In light of these concerns, this study has three purposes: (a) to treat the affection of resource input and output on license revenue of technology transfer; (b) to find the roles of published articles and issued patent numbers and invention disclosure numbers in the process of technology transfer; and (c) to find out the important factors, which have great affection on license revenue.

Literature Review

Technology Transfer

Mansfield (1975) deemed that technology transfer is the technology used by a certain organization or country, and the technology is introduced to other countries, regions or organizations for further application. Zaleski and Wienert (1980)
thought that technology transfer is a process, in which, an organization or country transfers its new innovative products or technology tips to other organizations or countries for use. Hameri (1996) considered that technology transfer is an active and ambitious process to spread or obtain technology knowledge, data or experience by the procedure of authorization, external investment, and purchase.

*Research Input and Research Outputs*

Adams and Griliches (1996) took American universities as research subjects, and studied the relationship among paper numbers, cited paper numbers, research expenditure, and the numbers of scientists and engineers. The research suggested that there are two main outputs, new scientists and new concepts generated by academic researches. The number of scientists is more easily measured. However, new concepts are more abstract and difficult to be measured so that paper numbers and cited paper numbers are the measurement indicators of new concepts. The research result proves that the raise of research expenditure is helpful to generate more paper numbers, and the $\beta$ value of cited paper numbers is higher than the one of paper numbers. This means the raise of research expenditure is with a positive affection on paper quality.

Adams and Griliches (2000) further explored related issues of research outputs and paper numbers. The research expenditure was similarly treated as research input, and paper numbers and cited paper numbers were treated as research outputs. The phenomenon of decreasing returns to scale was found in the research output of American universities, and there was a higher level of output in private universities than in public universities. Nevertheless, if all schools were analyzed, there were still fixed returns to scale. Furthermore, data envelopment analysis was employed by Geraint and Johnes (1993) to analyze the research efficiency of economic departments of 36 universities in UK from 1984 to 1988. The results presented that if research expenditure is regarded as input, it will improve the efficiency of decision-making units, and this explains the affection of research expenditure on research input.

In the research of R & D expenditures, invention outputs and patent numbers, Pakes and Griliches (1980) ever analyzed the data of 121 large-scale enterprises from 1968 to 1975. The outcome showed that there is an apparent relationship between research expenditure and patent numbers, so parent numbers can be used to measure the economic benefit of research input. Acs and David (1987) verified that patent numbers can be as indicators to measure the performance of research development. When Griliches (1991) collated American enterprises’ data from 1954 to 1987, he found that there was a link between research expenditure and patent numbers. Griliches (1994) fur-
ther pointed out that when it’s not easy to get related data of R & D, abundant patent numbers can be an indicator to measure the invention input and output.

Patent Licensing and License Fees

The so-called patent license means patentees still possess the complete right of patent, and only one or whole part of the execution of the patent is licensed to others under specific conditions. The content of license includes manufacture, sale, importation, usage or some of them, and depends on different cases. Patentees still own original rights, so patent license is to make licensed persons stay in a legal position of using patent rights and avoid to be charged with patent infringement. Cho (1988) definition of technology license is a behavior that an enterprise sells its technology or management skills to get rewards from the other party. Nevertheless, Millman (1983) defined technology license as a certain period, in which, one party transfers proprietary technology, such as patent, trademark, and various methods to the other party to obtain rewards.

The right of license can be divided into exclusive license and non-exclusive license. Exclusive license is usually limited to the application of product or to the sales in certain areas or region. While enterprises get the technology license from schools, they still need to have a long-term input in R & D to commercialize the technology. Small or new enterprises have much higher proportion of exclusive license than larger ones. Theoretically, more businesses prefer non-exclusive license because it is much more competitive and allows invention to have an extensive application. Owing to this, many scholars and experts question the appropriateness of exclusive license. Mowery et al. (2001) pointed out that exclusive license of American universities doesn’t comply with the fair spirit of public investment, and if it can be put into public domains, it may generate more benefits.

The Establishment of Assumption and the Definition of Variables

Research Expenditure and Output Of the Research

According to the above-mentioned documents, we know that research expenditure usually been taken for one of the variable of research output. The total number of dissertation announcement and number of the published dissertation estimated for objective evidence of the college research output is an important standard to acquaint with the performance of college academic research. The patent issued number is also one of the research output indexes. Besides, not every research result will present by patent, so the times of invention disclosure could be supplanted the part which can’t expound of patent issued number. Therefore, this study makes some hypothesis below.

$H1$ : The research expenditure has the
remarkable positive effect on the research output.

H1a: The research expenditure has the remarkable positive effect on published articles.

H1b: The research expenditure has the remarkable positive effect on the number of patent issued.

H1c: The research expenditure has the remarkable positive effect on the number of invention disclosures.

The Research Output and the License Incomes

To translate the measured method of enterprise management performance into the measured method of technology transfer performance, university acts just like the general enterprise. The university research output is similar to the product of industries. It takes research output as the input of technology transfer and the license incomes is the output of the technology transfer. Therefore, we can measure the technology transfer performance which comes from the technology provider by measuring the financial index. Base on the above-mentioned document, this study makes some hypotheses below.

H2: The research output has the remarkable positive effect for the license incomes.

H2a: The result of dissertation announcement has the remarkable positive effect on the license incomes.

H2b: The number of patent issued has the remarkable positive effect on the license incomes.

H2c: The number of invention disclosures has the remarkable positive effect on the license incomes.

This study is about to discuss how the research expenditure affect the license incomes, but the research expenditure belong to research input. Published articles, the number of patent issued and the number of patent issued invention disclosure is the research output. The research output can be license incomes by passing many processes of technology transfer. So the research use the this three research output which are published articles, the number of patent issued and the number of patent issued invention disclosure for the mediating variable between research input and license incomes. Therefore, this makes some hypothesis for the relation between mediating variable and license incomes below.

H3: The research expenditure through mediating effect of research output has the remarkable effect on li-
Combining the above mentioned hypothetical ratiocination, the structure of this study is shown on Figure 1.

![Figure 1. The Structure of Research](image)

Research Method

The date come from three sources: the date of research expenditure, patents issued, invention disclosure and License incomes come from AUTM licensing survey, the data of research expenditure comes from AUTM licensing survey of 2005, the data of published articles, invention disclosure and license incomes come from AUTM licensing survey of 2006 and the data of published articles come from ARWU’s investigation of 2006.

This study is about to discuss how the research expenditure affects the license incomes which use the data of 2006; The samples based on the AUTM licensing survey summary compare with top 500 universities which must be investigated by ARWU. Because of the huge variation of license incomes among those universities, this study uses the regression analysis after logging the license incomes.

This study finally put the simple data in order that is the top 102 universities’ outcome of technology transfer. This study uses simple regression and multiple regression analysis. H1 used simple regression and H2 which has two more independent variables uses multiple regression analysis. Examining the mediating effect of published articles, patents issued and invention disclosure, Baron and Kenny (1986) brought up the mediating effect method which confirms the existence of the mediating effect form research output.

**Regression Analysis**

In terms of hypotheses testing, this study takes the models of hypotheses to do the regression analysis. The models of each hypothesis are following.

**Model 1:** Doing the simple regression analysis of single independent variable toward three intervening variables (published articles, patents issued, and invention disclosures). **Model 2:** Doing
simple regression analysis of three intervening variables toward single independent variable.

Model 1: The result of research input and research output with regression analysis.

β-value of research expenditure toward published articles is 0.788, and after adjusting R2 is 0.616. β-value of research expenditure toward patents issued is 0.690, and after adjusting R2 is 0.471. β-value of research expenditure toward invention disclosures is 0.771, and after adjusting R2 is 0.591. The three patterns have positive correlation significantly.

According to the results above, the results show the research expenditure toward the three research outputs have quite big positive effects, and the explanatory power of the three patterns is quietly high. It also represents that the research expenditure is the important variable of published articles, patents issued, and invention disclosures. Hypothesis 3 was supported.

Model 2: The result of research output and license income with regression analysis.

β-value of published articles toward license income is 0.627, and after adjusting R2 is 0.386. β-value of patents issued toward license income is 0.453, and after adjusting R2 is 0.198. β-value of invention disclosures toward license incomes is 0.557, and after adjusting R2 is 0.304.

There are all positive effects toward license income, and achieve the significant level. Also, the explanatory power is quite high. It represents the published articles, patents issued and invention disclosures are the important variables of license income. Hypothesis 2 was supported.

Hypothesis 3 predicted a mediating effect of research output between research expenditure and license incomes.

Step 1: Prove that significant relationship between research expenditure and published articles, patents issued invention disclosures. This step of this procedure was substantiated by the regression results shown in Figure 2.

Step 2: The direct effect of research expenditure and license incomes was examined. The result shown in Figure 3.

Step 3: All the three research outputs were entered solely to its direct effect on license incomes. Published articles, patents issued and invention disclosures are significantly, positively related to license incomes.
Step 4: Both the research expenditure and all the three research outputs were entered to evaluate the mediating effect. When research expenditure and all of the interaction terms of research outputs were entered, the results showed just one of the interaction item (patents issued) of research output variables was not significant. The influence that Research expenditure to License incomes is drew by Published articles and Invention disclosures. It proves Published article and Mediating effect exist. However, Patents issued turns to be not evident. That shows patents issued ($\beta = -0.121$, $p > 0.05$) is not simultaneously mediating variable among published articles and invention disclosures. Therefore, Hypothesis 3 was partly supported.

Conclusion

The purpose of the study is to treat the affection of research input and output on loyalty fees of technology transfer and to further realize important factors, which affect license incomes, through the research output of published articles, issued patent number and invention disclosure number.

Relationship Between Research Input...
Research expenditure is taken as the measurement of research input. Research expenditure means the amount invested into research by schools, and research outputs are measured by the results of published articles, issued patent number and invention disclosure number. The outcome demonstrates that research expenditure and the scale of schools have a positive relationship to the results of published articles, issued patent number and invention disclosure number. It suggests that the increase of research expenditure can make the results of published articles, issued patent number and invention disclosure number go up. Expenditures are important inputs of production. If without considering efficiency, more inputs bring more outputs. Although the result in the study is same as the one of previous scholars, the study confirms that the results of published articles, issued patent number and invention disclosure number are significant research outputs.

![Figure 5. The mediating effect result](image)

**Relationship Between Research Output and License Incomes**

After the demonstration of regression analysis, the above three research outputs have a positive relationship to license incomes. It signified that the three research outputs also affect the license incomes. This conclusion is similar to the one of Crepon et al. (1998).

Published articles represent the research outcomes of schools, and research outcomes can be as a bargaining chip to negotiate royalty fees in the process of technology transfer to raise the amount of royalty. Patents are more specific subjects to be licensed. The more patent rights schools have, the more subjects they can license, and the probability of license incomes will be higher. Invention disclosure is a way to deal with potential licensed patents, but there won’t be a necessary patent in the end.

The source of royalty fees is not just from patents, but also from commercial secrets or copyright transfer, and invention disclosure enhances the opportunities...
of technology or right to be licensed.

Besides, the analysis outcome of the published articles accounts for 40% explanatory power, invention disclosure number 30%, and issued patent number 20%. The outcome has a gap with general perception. Published articles were an indicator to evaluate academic achievement in other literatures, and invention disclosure number and license incomes were seldom discussed. Patent seems to be the most outstanding influencing factor to license incomes. However, according to the research result in the study, patent number is still apparently related to license incomes though their explanatory power is weaker than other two variables.

**Mediating Variables With Effect on License Incomes.**

After the examination, published articles and invention disclosure are really mediating variables, but issued patent number is not. That means only parts of the assumptions are correct. Research expenditure and the input of human resource of schools will produce positive affection on license incomes via published articles and invention disclosure number instead of via patent number. The outcome is surprising because it’s different from the concept of patents generating revenues. In order to realize the reason, an extra examination of mediating variables is made in the study, and a regression analysis is done based on the three variables and license incomes.

The outcome shows that the model has 42% explanatory power. When the published articles and invention disclosure number are simultaneously considered, issued patent number won’t be that outstanding. Even, there is a trend of negative relation to issued patent number, and this implies that the affection of issued patent number on license incomes is very weak on the basis of the three variables. The result reverses the thought of patents creating income.

![Figure 6. Extension of hypothetical model](image)

Nevertheless, the study is analyzed by the sole model of taking patent number as mediating factor. Figure 6 is its extension of hypothetical model. After the two models are testified by mediating effect, the result equally proves issued patent number not to be a mediating variable, and this makes the role of issued patent number have different explanation in the procedure of technology transfer. In term of the result, it implies that there is still a long way to go by taking advantage of
issued patents to proceed with technology transfer or even to produce revenue. Proprietary of patent is not the guarantee of the increase of license incomes.

While other research studies explored this topic deeper, similar concepts like this study are found, and the general perception of patent being a key in technology transfer needs to be reviewed. Patent may play a significant role in the procedure of technology transfer. However, it could be a sufficient condition absolutely not a necessary condition. Some similar researches were found by Colyvas et al. (2002) after they undertook a study to American universities.

Consequently, the concept of the study is that patent number is not the guarantee of license incomes in the process of technology transfer. Revenues from licensed patent are affected by the process of technology transfer instead of the simple concepts that more patents create more revenues. For the reason, there should be other complementary measures for patent-based technology transfers to bring benefits, for instance, excellent technology transfer personnel or the stimulation of government policy. Even though it’s generally believed that academic researches are still far away from the formation of business opportunity, the results in the study reveal that more technology transfer opportunities could be created by the application of research expenditure to academic or technology research, and the increased effect of license incomes might be higher than general awareness. So, schools could then rethink about intellectual strategies for technology transfer in accordance with the results.

References


