Influencing Factors of Collaboration with Industry of Chinese Universities

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Abstract: From the view of university character, this study discussed the influencing factors of University-Industry collaboration. Using negative binomial regression and quantile regression model, the study empirically analyzed the U-I collaboration of 431 Universities in China. The results showed that: There are differences of influencing factors between high-quality and medium-quality universities and under the control of area and university type, the research quality and commercialization tendency are main influencing factors for university to collaborate with industry.

Key words: University-industry collaboration, University character, negative binomial regression, patent data

INTRODUCTION

Knowledge economy highlights the importance of university to be a knowledge source for industry. Many governments have treated U-I cooperation as strategic action to promote economic development (Mansfield and Lee, 1996; D’Este and Patel, 2007; O’Shea et al., 2006). Due to historical reasons universities in China brings together research resources and have different types, such as the national-deployment, province-affiliated and sector-deployment, this means understanding the characters of universities is important for Chinese governments developing diversity policies to promote U-I cooperation.

Many scholars have study the factors influence university to cooperate with industry from Resource-Based view and Embedded-Theory. Research quality, commercial tendency and involvement in local economy are founded main factors (D’Este and Patel, 2007; Giuliani et al., 2010). Yuan et al. (2009) identifies that university’s type affect the university to transfer knowledge in China. Other researchers study technology transfer and U-I cooperation in top university of China (Zhou and Zhn, 2007; Liu et al., 2011; Lei and Chen, 2011). Current study in China ignored the behavior of normal quality university. Mansfield and Lee (1996), D’Este and Patel (2007) and Giuliani and Arza (2009) research found that medium-quality university also have deeply cooperation with industry because of geographical advantages and funding needs. In this study, we choose 431 university in China not only included top-universities but also low-quality universities. We use quantile regression model to find the difference and factors.

BACKGROUND AND HYPOTHESES

U-I Performance: Scholars used to use funds or contract counts to measure technology transfer between university and industry cooperation (Zhou and Zhn, 2007; Yuan et al., 2009). Patent is another important data to measure knowledge transfer between university and industry (Motohashi and Yun, 2007). In this study we use the counts of invention patents which are applied by both university and industry to measure the cooperation performance of university.

RQ(Research Quality) and UIP(U-I Performance): From the Resource-Based View, research capability and research quality will influence university’s R&D cooperation with firm. Mansfield and Lee (1996) found that four top universities in American more closely linked with industry. High-research-quality university tend to attract funds from firms. Bruno (2003) concluded that research activities are not active because university research quality is low in Italy. Other research found that low-research-quality also can have deeply cooperation with industry. Mansfield and Lee (1996) found that second-class universities’ research cooperation with industry can be quite active. Different to top ones, their research cooperation focused on applied research and kept closely contact with local firms. D’Este and Patel (2007) found that low-research-quality universities tend to offer problem-solving research for industry because of lacking of funds. However, Giuliani and Arza (2009) indicated no matter with high or low Research quality, Universities can have closely contact with firms because of different institution.

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Hypotheses 1: Universities' research quality positively related to the U-I performance.

Size and UIP: The size of university is another factor that affect U-I performance. Schartinger et al., (2001) found U-shaped relationship between size and U-I performance. Big-size college have more resource to attract firm to cooperate, while low-size college have closely contract with industry in subdivided areas of science. But D'Este and Patel (2007) didn't find any relationship between college size and U-I relationship.

Hypotheses 2: Universities' research size positively related to the U-I performance.

CT(Commercial tendency) and UIP: Accord to Embedded-Theory, the environment will affect universities' action. D'Este and Patel (2007) found that universities' previous experience will affect them to later cooperate with industry. If scholars are in the atmosphere of lively U-I cooperation, he will tend to cooperate with firms (Giuliani et al., 2010). O'Shea et al., (2006) found that universities who focus on applied research have higher tendency of research cooperation. History of TTO and funds’ ratio from industry are often used to measure the tendency (Di Gregorio and Shane, 2003; D'Este and Patel, 2007). Colyvas (2002) found universities whose funds come from firms is tend to transfer technology to industry than those funds from public.


METHODOLOGY

Data collection: Data for this study were collected from University Rankings Data, Technology Statistical Data of universities and SIPO patent search database in China (PRC Ministry of Education, 2010; Shulian, 2010). We collected 431 universities in China to analysis the factors.

Measurement: U-I Performance is measured by the invention patents applied in 2006-2010 both by university and firms. Research quality derived from University Rankings Data (Wu et al., 2010) which are normalized. Commercial tendency is measure by "Enterprises and institutions entrusted funds" account for the university’s "science and technology funds" ratio which derived from Technology Statistical Data of universities and the data were normalized. Universities’ research size also derived from Technology Statistical Data of universities and data were normalized.

Reference to other researchs we use area and universities’ type as control variances (Balconi et al., 2004; Yuan et al., 2009). 31 provinces in China are divided into East (Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan), West (Neimenggu, Guanxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shangxi, Gansu, Qinghai, Ningxia and Xinjiang), Middle (Shangxi, Anhui, Jiangxi, Henan, Hunan and Hubei) and East-North(Liaoning, Jilin and Heilongjiang) accord to economical level. Universities’ type included polytechnic, agriculture and forestry, teacher, comprehensive, medical and other categories. We used comprehensive universities as reference category.

Methodology: Since dependent variable is counted number, we used negative binomial regression to test.

ANALYSES AND RESULTS

Descriptive statistics: In Table 1, we can see data are highly dispersed, indicating there is a big difference between universities of China. 75% of universities’ data are lower than the mean. Chinese universities have obviously "Matthew Effect". So we use quantile regression model to analysis. In Table 2, we can find there are 88 universities whose cooperating patent are bigger than 20.

In Table 3, we can see 27 universities whose UIP is more than 20 are "211" honored ("211" honored means top universities in China). In these universities, Zhejiang University of Technology is not "211" honored but it has 179 cooperating patents between 2006-2010 which has achieved strong UIP.

In Fig. 1 we analysis the invention patent applied by university and industry, we can see the U-I cooperation patent numbers increase by years, while the coefficient of variation which means difference between universities decrease by years. From Fig. 1, we can find that the
power are more attractive to industry and easier for technology transfer. Universities’ research size is not significantly impact on the cooperation with industry. The U-I relationship is significant impacted by other factors, such as universities’ research quality and regional institution.

No matter university is of any type or come from any area, more funding from firms reduce to higher commercial tendency and more closely to the industry. Thus the cooperation patent output are higher which means U-I performance are good. The result verified the research of Gregorio and Schartinger by using the data of China (Schartinger et al., 2001; Di Gregorio and Shane, 2003).

Where the university in is another factor to affect U-I cooperation. We can see from Table 4 that universities in east area is more active than ones in middle area, the result is different to the study of Yuan (Yuan and Jia et al., 2009). Firm in economically developed area have strong demand for technology and more inclined to university cooperation.

In Table 1, we can see Chinese universities’ research quality are not evenly distributed, the distribution was characterized by long-tailed. Minority universities’ research-quality are in high level, most of them are in the middle and low level. For different level universities have different motivation to cooperate, so we use quantile regression model to further analysis. In Table 5, we analysis the data by negative binomial regress at the percent of 75%, 50% and 25% and compare the difference between east area and middle-west area.

In Table 5, we can see that there are differences of factors between universities of middle-level research quality and high-level research quality. For middle-level universities, commercial tendency significantly affect the cooperation between university and industry, while research quality affection is not so significantly. Compared to highly-quality universities research resource is not in advantage for middle-level universities. Middle-level universities’ U-I depend on their closely

### Table 4: Negative binomial regression result

<table>
<thead>
<tr>
<th>Var</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ</td>
<td>1.7657***</td>
<td>1.2715***</td>
<td>0.5381*</td>
<td>0.5895**</td>
<td>0.6593**</td>
</tr>
<tr>
<td>CT</td>
<td>0.9459***</td>
<td>0.8827***</td>
<td>0.8641***</td>
<td>0.7016***</td>
<td>0.2822</td>
</tr>
<tr>
<td>SIZE</td>
<td>0.7310***</td>
<td>0.6592**</td>
<td>0.6925***</td>
<td>0.8007***</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td>-0.0108</td>
<td>0.0255</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East-north</td>
<td></td>
<td></td>
<td>-0.5649**</td>
<td>-0.5711**</td>
<td></td>
</tr>
<tr>
<td>Polytechnic</td>
<td></td>
<td></td>
<td></td>
<td>0.2385</td>
<td></td>
</tr>
<tr>
<td>A. and F. teacher</td>
<td></td>
<td></td>
<td></td>
<td>0.4169**</td>
<td></td>
</tr>
<tr>
<td>medical</td>
<td></td>
<td></td>
<td></td>
<td>-0.0861***</td>
<td></td>
</tr>
<tr>
<td>Cons.</td>
<td>1.7001***</td>
<td>2.0436***</td>
<td>2.0194***</td>
<td>1.7189***</td>
<td>1.7788***</td>
</tr>
<tr>
<td>Waldchi2(2) = 44.70</td>
<td>Waldchi2(3) = 220.59</td>
<td>Waldchi2(4) = 215.73</td>
<td>Waldchi2(7) = 363.82</td>
<td>Waldchi2(13) = 439.87</td>
<td></td>
</tr>
<tr>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.1, **p<0.05, ***p<0.01, Prob>chi2 equation significant test

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**Analytical results:** Table 4 is the result of negative binomial regression. Model 1 only regressed the variable of research quality, model 2 regressed the variables of research quality and commercial tendency, model 3 added the variable of size, model 4 added area dummy variables, model 5 added universities’ type dummy variables. We can see that after control area and type variables, research quality positively related to U-I performance, so hypothesis 1 was verified. Universities’ commercial tendency is in 99% confidence level related to U-I performance, so hypothesis 2 was verified. After control area and universities’ type, universities’ size not significantly affected U-I performance, so hypothesis 3 was rejected which extend the research of Yuan and D’Este (Yuan and Jia et al., 2009; D’Este and Patel, 2007).

From the result we can see that compared to universities’ size, research quality has a more significantly impact on U-I performance. Research quality often associated with technical power and reputation of universities. Universities with strong scientific and technological
Table 5: Quantile regression model

<table>
<thead>
<tr>
<th>Var.</th>
<th>Negative binomial regression</th>
<th>Quantile regression (RQ)</th>
<th>P75 (&lt;=0.05)</th>
<th>P50 (&lt;=0.50&lt;=0.95)</th>
<th>P25 (&lt;=0.75&lt;=1.05)</th>
<th>East area</th>
<th>Middle and West area</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ</td>
<td>0.6593***</td>
<td>0.6547***</td>
<td>2.2361</td>
<td>13.5827***</td>
<td>0.4173</td>
<td>0.0570***</td>
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</tr>
<tr>
<td>CT</td>
<td>0.7015***</td>
<td>0.5835***</td>
<td>0.372***</td>
<td>0.2010</td>
<td>0.7749***</td>
<td>0.0120***</td>
<td></td>
</tr>
<tr>
<td>SIZE</td>
<td>0.2822</td>
<td>0.3142**</td>
<td>1.3977***</td>
<td>-0.0158</td>
<td>0.3801</td>
<td>0.1245</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>0.8007***</td>
<td>0.5852***</td>
<td>0.2968</td>
<td>0.3883</td>
<td>0.0120***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>0.0255</td>
<td>0.0945</td>
<td>-0.3619</td>
<td>0.1560</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East-north</td>
<td>-0.5711***</td>
<td>-0.2959**</td>
<td>-1.4806***</td>
<td>-0.5623</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cons.</td>
<td>2.7788***</td>
<td>2.8115**</td>
<td>2.7456***</td>
<td>5.5217***</td>
<td>2.3775***</td>
<td>1.9728***</td>
<td></td>
</tr>
<tr>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td>Prob&gt;chi2 = 0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.1, **p<0.05, ***p<0.01; Prob>chi2 equation significant test

relate to local industry. We can concluded that different level universities have different character, U-I policy should be diversity accord to this difference. The area comparative analysis furthermore illustrate the effect of environment on regional university and its research activities.

CONCLUSIONS

In this study we use invention patent to analysis factors that affect university to cooperate with industry. The empirical results show that compare to university’s research size, the quality of research is more significantly affect the actor to cooperate with university. This shows that simple research investment will not enhance the depth of research cooperation with industry, only higher research quality with strong scientific power can be attractive to the industry.

There are different factors affect on different research-quality-level university to cooperate with industry. Research quality is not the only factor that determines the university to transfer knowledge to industry, closely interaction with regional industry also can be effective. Universities can adopt diversity development strategies to cooperate with industry, such as parts of the universities pay attention on scientific research or basic research, others focused on applied research. The policy guide should be diversity.

After control the area and university type, the quality of research and the commercial tendency of university are main factors that affect university to cooperate with industry. Local economical level is another factor to affect the cooperation.

While the reason why low-research-quality-level universities can achieve higher cooperation performance is not deeply analysis, future studies will pay attention to the case study to find out the reason.

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