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University-Industry Partnership in New Energy Vehicle Industry in China

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Abstract: As universities gradually became the center of society's knowledge production system, their role in innovation becomes more diverse. In the pursuit of such a role, universities are encouraged to establish a university-industry collaboration context that supports faculties and students to engage in entrepreneurial activities. The intention of this paper is to investigate the drivers of such collaborations in China in new energy vehicle industry. The current theory is supported by the outcomes of Probit regression, putting emphasis on R&D intensity, openness to Research and Development as determined by the variety of partners and higher access to information channels of R&D.

Keywords: University-Industry Collaboration, New Energy Vehicles, Drivers of Collaboration

1. INTRODUCTION

Universities and government agencies play a major role in companies' Research and Development operations. The company's staff obtains a major part of their knowledge in the organization throughout practice and learning (Marshal, 1990) (Penrose, 1959). Institutions are considered a significant place of knowledge that companies obtain by recruiting university students, subcontract training projects and R&D activities to create new product and service. Apparently, as the evolutionary economists indicated in a market and non-market establishments have equal importance in defining the motives of the research partnership between University and Industry.

After economic reform in China in 1985, to optimize the diffusion and the use of new knowledge government highly encouraged collaborative innovation between private and public sector through series of its science and technology (S&T) programs. As a result, there has been growing evidence that many Chinese companies engaged in collaboration with research institutes and universities by mutual Research and Development projects, consulting, technology licensing, internships, and so on. For local enterprises to carry out joint research activities, universities became the main collaborative objects, because they had enough research resources and highly qualified personnel.

The important factor for the successful diffusion of new energy vehicles is the NEV development knowledge. Both public and private R&D activities are the way to create knowledge. University-industry collaboration considered as an important mechanism for building up innovation capacity. The interaction between firm-university-research institutes has a significant impact on innovation processes and performances. The firm connection between them has become a determinant factor leading to the success of industrial innovation. The plan puts lots of emphasis on accelerating the establishment of a justified development system for NEVs. The government aims to lead companies to increase investment in Research and Development in the target areas as well as encourage the creation of cross-sectoral NEV technology development partnerships to stimulate the construction of common technology platforms.

Lately, there has been some significant, large-scale UICs between Foton, Beijing bus group, United States Eaton Corporation, CITIC Guoan Meng Lee, IEE of Chinese Academy of Science, Tsinghua University, and Beijing Polytechnic University.

For example, Protean Electric, the global leader of an advanced in-wheel electric drive, are collaborating with the Department of Automotive Engineering ("DAE") of Tsinghua University in the research of distributed traction control on new energy vehicles using in-wheel electric motors. Tsinghua University and Protean Electric are collaborating to build a demonstration vehicle as a comprehensive dynamic test platform for conducting a series of research and study.

Beijing Electric Vehicle Co., Ltd. (BAIC BJEV) signed a strategic cooperation agreement with Dresden University of Technology (TUD) to create the Sino-German Automotive Light Weighting Technology Joint R&D Center (China Association of Automobile Manufacturers).

Business must set its perceptions on the long-term, reflect total honesty and integrity, recognize the values of the community in which it runs, and contribute to the well-being of all its workers, shareholders, and local communities if it is to succeed. The enterprise must concern itself with maintaining a competitive edge; its long-term lifeblood resides in generating new and profitable products and that at the end of the day it must show profits. Hard work must earn success and profit at the end, originality, creative expression, and dedication, conviction of the value of one's worth and commodities, new and better ways of doing things, new experience, and responsiveness to the needs of others.

This paper examines the motives and the degree of UIC in China. In section two we discuss relevant literature. Part three shows the methodology applied to collect data. Part four and five provides analyses of the results, conclusions with research implications presented in section 6.

2. LITERATURE REVIEW

Significant work has been done to support the importance of UIC in encouraging R&D activities in companies. However, the importance of specific variables in encouraging collaborations between firms and universities for R&D activities is less. Findings from evolutionary economists suggest that in developed countries such relationships are stronger, where the high-tech infrastructure is strong. However, it is evident that more research activities companies are dealing with the stronger the supporting knowledge infrastructure. There are fewer R&D partnerships in locations where the high-tech environment is not strong. Less research has been done about what results in motivating UIC for R&D operations in developing countries.

Findings of what reasons are important for research partnership are numerous (Chen, 1994). Various reasons have been identified in these studies, defining the establishment of collaborative links between universities, industry and other research institutions. In this part, we analyze the related findings and establish a theoretical framework with testable hypotheses for the study.

2.1 R&D Intensity

The significant determinant for partnerships is the stock of existing knowledge to dissolve the results effectively from other economic representatives. Kaimen and Zhang (2000) indicated that accepting R&D as a proxy of absorptive capacity; it will correlate positively with collaboration. Similarly, (Kleinnecht & Reijnen, 1992), (Hagedoorn, Link, & Vonortas, Research partnerships, 2000) showed generated indications of R&D intensity deciding cooperative research with firms' external partners. Other works which investigate the tie between a level of technological intensity and the number of partnerships involved, (Koza & Lewin, 1998), (Beise & Stahl, 1999). For example, (Beise & Stahl, 1999) suggest that company's internal research activities reflect the firm's capability to recognize the public research outcomes which are significant for cooperation. The argument on the positive impact of Research and Development on partnership is due to the complementary effects of company's research activities with the University.

2.2 Partner Diversity

For suitable R&D partnerships and for firms to collaborate, partner diversity offers necessary openness. Partner diversity also explains openness and willingness of companies to cooperate for research projects. Companies are more likely to accept academia as possible research and development partners if the partners or the sources of information gained from other associates are more diverse. (Fontana, Geuna, & Matt, Factors affecting university-industry R&D projects: The importance of searching, screening and signaling, 2006). Fontana discovered that openness of companies is critically affecting the partnership with state research institutions. Similarly, (Laursen & Salter, 2004) found that companies looking for innovative strategies and use various external sources of information for innovation, the possibility that they will consider academic knowledge are higher. Findings based on the multiple case study approach suggest that the key parameters for successful university-industry collaboration are trust and balanced mutual interests (Numprasertchai & Barbara, 2005). This work suggested academia in developing countries to develop more cooperative activities with different associates to succeed. The concept is that variety supports various choices for the realization of knowledge synergies. Sanchez and Tejedor's (1995) work suggested that open businesses not receiving any support from government agencies and large companies ready to cooperate more with academia. One of the most important steps in the establishment of any cooperation is the selection of the partner, and if the alliance is in R&D collaboration, the right choice is critical for success (Eden and Hitt, 2008).

2.3 The significance of Academic Collaboration

It is not likely that companies will set up academic collaborations until they know the advantages of cooperation. Many theoretical studies show that important motives for collaboration are learning by interacting, implementation of properly designed tactics which concentrated on communication with industry as well as discovering the right communication channels. Study of Drejer and Jorgenson (2005) argues that the result of the low dynamic of collaboration between public and private organizations is the absence of adequate mechanism. Such mechanisms as, information channels, to make sure the enterprises know the advantages of partnerships, directions for arranging cooperative research, public-private co-funding mechanism, and conflict-solving mechanism for private and public participants.

In China, collaboration partners for firms are Chinese academies and the Institute of Chinese Academy of Sciences (CAS). According to companies, there are not many differences between universities and CAS institutes. The most underlined difference is that CAS is better in applied research than the universities, they have more resources for research, and on the other side, universities are more flexible in collaboration. Alliances with Chinese universities need more time and human resources than those in other countries (Survey results).

2.4 Information Channels

Firms' access to more university and research institution (URIs) information can stimulate U-I research partnerships. Fontana (2006), argues that company's access to information through publications and engagement in government policies decides the level of UIC. However, involvement in consulting and accessing the publications only cannot offer necessary commercialized partnership. Mckelvey's (2008) study shows that universities in Sweden have stronger Research and Development links with companies and most of the knowledge generated centralized in contrast with universities in the USA; however, the number of publications and patents are higher in America. The opposing evidence could be the result of the lack of mechanisms to capture knowledge flows from academia to industry. Where the links are formal, the filings of patents as well as the commercialization of the outcomes are reachable for investigators to assess.

2.5 R&D Strategy

Another important determinant of UIC is the strategy of R&D and the mode of cooperation. There are several ways of collaboration, for example, firms may completely outsource R&D research to universities, undertake in public research institutes and universities, form a joint venture for collaboration, involve specific researchers in a project or simply undertake it inside the company. Best (2001) and Audrestch (2002) showed that decentralization and diversity are the key drivers of companies' R&D operations in the USA. Hence, the company's Research and Development plan can affect the strength, outcome, and nature of the partnership. Fontana (2004) shows that businesses that outsource Research and Development expense and patent to protect innovation have a higher degree of cooperation with URIs.

3. METHODOLOGY

The UIC variable is given a qualitative nature. To identify the drivers the choice of appropriate model is important. Therefore, before finding the acceptable independent variables, we use descriptive statistics to analyze R&D intensity, the level of cooperation and other variables in our research. We use a probit model to examine the motives of UIC in the electric vehicle industry. Our survey was carried out in China; there are 200 electric vehicle manufacturers (source China Association of Automobile Manufacturers) we contacted to 120 firms and received data from 69 new energy vehicle manufacturers. Table 1 displays the feedback percentage of the questionnaire.

Table 1: Sample Data, NEV Manufacturers in China

Questionnaires sent	120
Response received	69
Feedback rate	57.5

In the survey, companies assessed the reasons for cooperation by giving one as value if the reason is not important to the value of 4 if it is very important, to evaluate the level of collaboration. The motives for companies to collaborate are technology transfer, consulting, dissolve information about technology, get access to engineers, R&D trends, and scientists, research contracting as complimentary for company's R&D, the research that the company cannot undertake alone, conduct product quality testing, hire graduates to support research. The average value of significance, considering the ten motives explored, give an indication of the degree of cooperation with companies and universities. Therefore, considering sample mean as a threshold value, we formed two countervailing variables low, and high collaborator (1) value is zero and (2) value is one.

Hence, we measure the dependent variable as:

CLLB = 1 if high collaboration (1) and 0, otherwise

3.1 Descriptive Variable

Here we classify variables such as R&D strategies, nature of links, and other descriptive variables related to R&D.

- R&D intensity

The ratio of R&D expenses over sales measured using the survey results where companies reported the percentage of R&D spending over sales during last three years. The study uses the equation of R&D intensity.

RD = (R&D Spending /Income) %

- Company's R&D strategy

Companies during the interviews pointed out the frequency of research activities and the way it is organized. Companies were asked to provide details on their R&D activity if it is frequent or seldom and if it is centralized or decentralized. We may propose two dummy variables showing the nature of company's strategies. We distinguished two different strategies for R&D:
S1 = 1 if companies undertake frequent R&D activities and, 0, otherwise
S2 = 1 if companies with centralized R&D activities and, 0, otherwise

- Research Partner Diversity

Our survey shows that companies pointed out the information channels about URIs research activities to be important for UIC. Here also companies were given the questionnaire to rate the significance of other information channels for research activities by giving the value of 1 if not significant to 4 if the channel is very important. We outlined 11 channels which are patents, published articles and reports, informal information exchanges, conferences and meetings, recruitment of technicians, technology licensing, joint ventures, contract research, reverse engineering, industry associations, and trade shows. If the average value of all the sources of information is high, then it shows that companies have many information channels from various partners. Hence, partner diversity (PD) is measured as:

PD = ∑score of all sources /11

- The significance of Academia for Companies

We use Likert-scale to assess perceived importance of academia as a source for research activities for companies. Companies were asked to evaluate the level of importance of University as a collaboration partner. Which includes factors such as companies have necessary own research activities, lack of understanding of firms' business in universities or in research institutes, a difficulty of contract agreements, trust issues, unsatisfactory research quality, geographical distance, communication problems, and patent problems. As the factors, we outlined have a negative meaning, the significance of university we measured using the mean values of all factors as a source of information for company's research activity. To scale the perceived significance of URIs we use the following equation:

SU = ∑score of significance of university and public institute /10

- Information Channel

Likert-scale was implied to evaluate the accessible information channels. Companies chose values from 1 to 4, not important to very important to decide how much each of the university's information channels contributes to their research activity (totally 15 channels were tested). The channels we withdraw are publications, patents, interactions in conferences and expert groups, informal exchange of information, recruitment of university students, licensed technology, consulting, contracts, equity partnerships, and university networks, human capital mobility, incubators, Silicon Valley, spin-offs, and university-owned companies. The mean value of the scores implied to represent the channels of information (INF) which was measured as:

INF = ∑score of all channels of information /15

3.2 Analytical Model

The suitable estimation model will be logit or probit because the dependent variable is dichotomous (Green 2003). We will use the probit model as follows:

$$\text{Prob}(Y_i = 1 \mid X_i) = \int_{-\infty}^{x'\beta} \varphi(t)dt = \varphi(X'_i\beta)$$

The company is either great collaborator ($Y_i = 1$) or low collaborator ($Y_i = 0$) and the range depending on vector X. Hence, this reflects adjusting a Probit model for collaboration (CLLB) depending on the equation below:

$$Prob[CLLB = 1] = F(constant, RD, S1, S2, PD, SU, INF)$$

Where:
CLLB - low or no partnership (0) and high collaboration (1)
RD - average ratio of R&D spending over income for last three years
S1 - companies with infrequent R&D (0) and frequent R&D (1)
S2 - companies with decentralized R&D strategy (0) and centralized strategy (1)
PD – R&D partner diversity
SU - significance of university as R&D source
INF – information channels about university research

4. UNIVERSITY-INDUSTRY R&D COLLABORATION

The purpose of collaboration in some way is to help each actor to perform their mission better. Industry must respect universities' norms and values and also must be realistic regarding its expectations. The collaboration is apparently will not succeed, and the results will be disappointing, if the industry considers university only as a source of obtaining new profitable products, or as a fountain of innovative ideas that it can get patents to, or merely as a way of using particular knowledge and skills to exploit some applications better.

The important developments in science despite their place of origin should always be available to everyone. There should always be competitions for small and incremental innovations or in finding and innovating original applications of new findings. The ongoing collaborations should, in particular ways, provide those directly involved in research or the association with a broader perspective, an increased level of excitement, an increased challenge and motivation to do whatever actors would be normally expected to do and to do it better.

Though R&D expenses at large organizations globally fell in 2014 to the second lowest rate in the past ten years, at Chinese enterprises spending grew and had reached U.S. $29.96 billion in 2014 (National Bureau of Statistics). Improving research at China's university and research institutes (URI) has been a significant component of the national science and technology strategy, and URIs dispersed 26% of China's total expenditure on R&D in 2015 (China Statistical Yearbook). The R&D spending by Chinese enterprises valued for 4.63 percent of total innovation 1000 R&D spending in 2014. Since 2000, China's universities have received more than 50% of their R&D funding from the government. In 2006, there were 4.1 million Chinese engaged in scientific and technological activities, including 2.8 million scientists and engineers (China Statistical Yearbook, 2015).

Besides, China's advancement of a system of peer-reviewed, merit-based competitive funding for primary research and for measuring science and technology outcomes have the chance to stimulate more innovative and world-class research efforts at China's URIs in the future. Today, collaboration with local URIs enables firms to take advantage of high-level scientific resources at reasonable cost.

Universities have been expected to contribute to the national economy in a more direct way in the past 20 years by conducting more applied research and making the results available for commercial use. The Chinese government has consistently advocated a use-driven science policy requiring URIs to serve the national economy by solving practical problems for industry

(Hong 2008). The extensive involvement of public research in industrial R&D in China is an important feature of its NIS.

We used the univariate method to analyze the key variables. Access to R&D information of academia (INF) is 2.04. In terms of R&D activities, the score in table 2 shows that during past three years 7% of the income is spent for research activities. Partner diversity is relatively higher with the score 2.21.

Table 2: Descriptive statistics

NEV Firms (n = 69)				
	Mean	SD	Min	Max
INF	2.04	0.57	1.00	3.40
RD	0.07	0.04	0.00	0.20
PD	2.21	0.80	1.00	4.00
SU	1.82	0.97	1.00	4.00
CLLB	2.45	0.57	1.00	3.20

Note: the sample size n<N (survey responses) because some companies sent back unfinished questionnaires.

The mean of the total Likert-scale values on ten reasons mentioned for partnership is the average value of collaboration. This average score is used to distinguish two types of companies, low collaborator, and high collaborator. The mean value of CLLB is 2.45. The next section established the reasons why this is the case and its relationship with the descriptive variables of R&D intensity, partner diversity, perceptions of scientific and technological capabilities in URIs, and information channels.

5. DRIVERS OF COLLABORATION

This part explores the motives of UIC to analyze the significance of the descriptive variables discovered by other researchers. The outcomes passed the White test for heteroskedasticity and the chi-square (X^2) for model fit. Table 4 shows that the correlation coefficient test made a strong and important relationship between some and therefore six different models were run for the sample.

The results in Table 3 present the correlation between R&D intensity and the possibility of cooperation is strong and has positive effects. Otherwise stated, the possibility of companies to set up cooperative ties with academia rise as R&D intensity in companies increases implying that to carry out innovative collaborative activities with external associates, companies need internal R&D capability, that approves the absorptive capacity argument of Cohen and Levinthal (1990).

Company's strategy on research partnership was unimportant as the coefficients of both S1 and S2 were statistically important. Perceived significance of URIs as significant sources of R&D (SU) is statistically important, and every model in a sample has positive coefficients.
Partner diversity (PD) and the scope of information channels (INF) were insignificant in the sample. This result does not support the findings of Marco, Huerta and Bayona (2001).

Table 3: Estimated Probit Regression

	M1	M2	M 3	M4	M 5	M6
Variables	Coefficient					
C	-4.406(1.332)***	-4.189(1.273)***	-3.662(1.316)***	-3089(1.226)**	-3.864(1.262)***	-3.598(1.218)***
RD	6.467(3.295)**	7.028(3.457)**	-	-	-	-
S1	-	-	0.129(0.708)	0.084(0.736)	-	-
S2	-	-	-	-	0.486(0.668)	0.639(0.660)
SU	0.842(0.371)**	0.878(0.397)**	0.526(0.240)**	0.483(0.241)**	0.531(0.241)**	0.512(0.244)**
INF	0.138(0.472)	-	0.534(0.367)	-	0.476(0.377)	-
PD	-	0.044(0.364)	-	0.304(0.295)	-	0.298(0.293)
LR(X^2)	19.284***	19.216***	10.787**	9.789**	11.325**	10.821**
Log Likelihood	-19.066	-19.099	-23.314	-23.813	-23.045	-23.297
Pseudo R-squared	0.336	0.335	0.171	0.171	0.197	0.188

Note: ***<0.01; **<0.05; *<0.10. Figures in parenthesis are the standard error. Due to high correlation between PD and INF, and S1 and RD, separate restricted models (model 1-6) were estimated.

Table 4: Correlation matrix

	INF	PD	RD	SU	S2	S2
INF	1.000					
PD	0.708**	1.000				
RD	0.102	0.155	1.000			
SU	-0.455**	--0.374**	0.125	1.000		
S2	0.195	0.042	0.231	-0.061	1.000	
S1	0.040	0.292	0.460**	-0.139	0.270	1.000

Note: ** p<0.01; * p<0.05; n=69

6. CONCLUSION

This paper aimed to find out the significant motives of university-industry partnership in New Energy Vehicle companies in China. We used Probit model to examine the effect of Research and Development intensity, detected the significance of university as a source of knowledge for companies, diversity of partners, channels of information and company's R&D strategy. We discovered that in EV Industry Company's strategy and partner diversity with the scope of information channels does not support the previous findings. The outcomes support the evidence that company’s R&D capability is significant for encouraging R&D partnership with academia. The findings show that the relationships between R&D intensity and the possibility of the research partnership with universities are strong in NEV industry. Moreover, the outcomes showed the probability of companies cooperating with universities relies on their sensed significance of academia as a source of innovation. To foster university-industry cooperation, universities should think to promote themselves as innovation centers. The favorable impression generated by academia is likely to pull more industrial cooperation. Consequently, academia trying to promote university-industry partnership must consider companies endowed with research operations to set up links. Academia’s technology transfer units in China must have a stimulus duty in generating access to the communication channels of academia’s innovative practices. The results offer policy relevant implications for strengthening university-industry collaboration. Universities should create a strategy that takes cognisance of companies’ demand when trying to initiate and reinforce research partnership.

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