



DRUID
ASIA

Paper to be presented at
DRUID-Asia, Singapore, February 23-25, 2016
Co-organized by DRUID, NUS Business School and SMU - Lee Kong Chian
School of Business.

Universities capabilities in facilitating spin-outs: A empirical study based on university-run enterprises evolutionary changes in china

LinBo Sun
National Tsing Hua University
Institute of Technology Management
linposun@gmail.com

Abstract

The last decade, some university spin-outs companies have begun to substantially contribute to the industrial transformation of China's economy. The existing literature, however, does not yet deal with spin-outs activities of Chinese universities in a comprehensive and theoretically. This paper building on an organizational capabilities perspective, we add to the literature on university-run enterprises evolutionary changes and historical resources by exploring how the china-context special organizational capabilities impacts the creation spin-outs process. Moreover, we develops a framework for studies on spin-outs examined the relationship between organizational capabilities and creation spin-outs in china universities. Through a dataset of 46 university in china over 2008-2012, the results revealed in china-context special some universities are more successful than others at generating spin-outs companies duo to organizational capabilities(institutional capabilities, entrepreneurial capabilities, research capabilities, technology transfer capabilities) propensity and regional innovation environment support. Each capability is particularly important for specific paths in the new-venture process. Based on the finding of our empirical study, we propose integrating organizational capabilities based on Continue to deepen the reform of university-run enterprises to facilitate the creation new-venture process.

Universities capabilities in facilitating spin-outs: A empirical study based on university-run enterprises evolutionary changes in china

a b s t r a c t

The last decade, some university spin-outs companies have begun to substantially contribute to the industrial transformation of China's economy. The existing literature, however, does not yet deal with spin-outs activities of Chinese universities in a comprehensive and theoretically. This paper building on an organizational capabilities perspective, we add to the literature on university-run enterprises evolutionary changes and historical resources by exploring how the china-context special organizational capabilities impacts the creation spin-outs process. Moreover, we develops a framework for studies on spin-outs examined the relationship between organizational capabilities and creation spin-outs in china universities. Through a dataset of 46 university in china over 2008-2012, the results revealed in china-context special some universities are more successful than others at generating spin-outs companies duo to organizational capabilities(institutional capabilities, entrepreneurial capabilities, research capabilities, technology transfer capabilities) propensity and regional innovation environment support. Each capability is particularly important for specific paths in the new- venture process. Based on the finding of our empirical study, we propose integrating organizational capabilities based on Continue to deepen the reform of university-run enterprises to facilitate the creation new- venture process.

Keywords: university spin-outs university-run enterprises organizational capabilities china-context special

1. Introduction

Recent research underscores the importance of universities in contributing to local economic development, leading edge research, high value jobs and innovation (Etzkowitz, 2002). Unfortunately, for many countries, especially in Asian countries efforts to make universities more entrepreneurial have not had sufficient impact (O'Shea et al.2004). In china universities spinouts behavior has a significant increase with the process of university-run enterprises evolutionary changes. As a consequence, many universities today are looking to improve their strategies for dealing with the vestiges of academic entrepreneurship and play more important role in innovation. Universities are setting up institutional arrangements such as technology transfer offices (TTOs), university science parks, entrepreneurship centers, and campus seed funds to increase the commercialization of research (Rasmussen et al., 2006).Many countries and universities have emphasized the creation of university spin-off firms (USOs) as an important tool for the commercialization of academic (Shane, 2004; Wright et al., 2007).

Against this backdrop, policy makers and researchers have searched globally for the best practices in order to draw policy implications from them. In china, most people believe university should play a more important role in the region economic growth. Some authors refer to the spinoff strategies, In particular, the case of Massachusetts Institute of Technology(MIT) is the reference example have attracted interest in china . As a result, many chinese

universities are now playing a third mission in society through creation new spinouts (Kinsella and McBrierty, 1997; Leitch and Harrison,2005). In fact, many successful Chinese high-tech companies, such as Lenovo, Founder, Tsinghua Tongfang, and Dongruan in the IT industry, originate from academic institutions (universities or public research institutes) (Eun et al.,2006). However, it might be somewhat misleading to interpret those Chinese firms' achievements as the success of 'university spin-offs (ASOs)' in China. Kroll and Liefner (2008) find some similarities between the Chinese AREs and the 'sponsored ASOs,' a special type of ASO, and underemphasize the Chinese characteristics in the AREs.

As several studies have pointed out, the ability of universities to create USOs is path dependent (Kenney and Goe, 2004; O'Shea et al., 2005) and is likely to be a result of a historically high USO rate (Shane, 2004) and favorable regional conditions (Roberts and Malone, 1996). Thus, the characteristics and conditions of successful universities such as MIT (O'Shea et al., 2007) may be impossible for other universities to emulate? Consequently, we propose that despite having unfavorable characteristics, many Chinese universities may be able to develop capabilities that increase their spin-outs. More specifically, we investigated the following research questions: why some universities are more successful than others at generating spin-outs companies in china-context special ?

This paper based on organizational capabilities perspective, proposes research framework for studies on china-context special spin-outs on the process of university-run enterprises evolutionary changes argues this framework is more appropriate to explain the Performance drivers (organizational capabilities) of china-context special spin-outs.

The structure of the paper is following. The background of Chinese university academic commercialization is discussed in Section 2.1. Examines the unique nature of the Chinese AREs and evolutionary changes of UREs is illustrated in Section 2.2. Spin-outs With Chinese characteristics is described in Section 2.3. A theoretical framework development of university spin-out in china-context special is illustrated in Section 2.4. The data collection, data analysis and definition of variables are elaborated in Section 3. The descriptive statistics and regression models are shown in Section 4. The similarities and differences of the research results comparing to previous studies are discussed in Section 5. Finally, conclusions and managerial implications are suggested.

2. Framework development: University spin-out companies in china-context special

2.1 The background of Chinese university academic commercialisation

In the past two decade years, Chinese higher education system has a structural change, transform the traditional model gradually, witnessed that encourage the academic commercialisation. The former teaching-oriented university system originated in the planned economy. It has only gradually and partially developed into a research-oriented system capable of offering research results relevant for the industrial sector (Kroll, 2006; Mohrman, 2003; Chen, 2002). Chinese universities became adopt Market-oriented in 1998, into the 21st century, the rise of entrepreneurial-oriented university in china, Technology commercialization and launch spin-outs as the marked. Entrepreneurial universities in the China became a key indicator of a university's competitiveness and its contribution to economic development after the passage of the "amendments to the Law Governing Promotion of Science and Technology" of 2008, China governments have encouraged universities to engage in patenting and licensing activities to convert the outcomes of research conducted on their campuses into commercially viable applications. Major changes in intellectual property and patent laws now permit universities to participate in active entrepreneurial business (Carlsson and Fridh 2002). As the result, universities now make intensive efforts to

manage their intellectual property to stimulate regional growth and economic development, as well as their own financial bottom line.

The Chinese universities seeking to emulate these effective knowledge diffusion systems from U.S. and Europe to launch spin-offs. Before 2008, university technology Intellectual property rights belong to the state, the Chinese universities pursue economic gains, exist a mechanism of variation in china-context special-- University-run Enterprises (UREs). Moreover, in the planned economy university personnel was officially prohibited entrepreneurial activity. Consequently, there will be no U.S.style spin-off creation. So the Chinese AREs are not simply an imitation of the university spin-offs.

2.2 The evolutionary changes of UREs: from UREs to UOEs

We can trace their origins of UREs back to “the great leap forward” of 1958 , when the Chinese universities imitate Soviet education, were strongly encouraged to directly engage in the “socialist economic construction” (zhang,2003), University directly to build factories, the teachers and students directly engaged in production. The Chinese universities began to destroy the American general education, extended their function beyond the traditionally accepted missions of teaching and research by running their own farms and industrial plants, Peking University and tsinghua university began to setup some factory , combine historical origins, Chinese AREs are distinctive , it 's outcome of Left-leaning. In “the Great Cultural Revolution”, generate a new system” university and factory combine”, this is the source of today UREs suffered from the excessive interventions of the mother university. In the end of the Cultural Revolution, teaching and research as core mission, the UREs has a brief decline. After the reform and opening in china, especially in the 1990s, after university return to a normal status , appeared serious financial difficulties for development. At this time, major of university restore do a business directly in order to increase financial income and improve the teachers' salaries, e.g. Lenovo, Founder, Dongruan, and Unisplendour. Especially after Deng XiaoPing made his southern tour, the UREs was at peak, University setup the enterprises, even departments also setup its own enterprises, many of the high-tech enterprises setup this time use of mother university resources and unfair competition(e.g. Tax breaks, Designated supply) become a well-known company, e.g. APTECH(Peking University), Founder (Peking University), Tongfang(Tsinghua University), Sinobioway (Peking University), Fuhua(Fudan University), Haina(Zhejiang University) , etc, there are different social public opinion evaluation of UREs. However, The government announced china want to establishment some world-class university (985 Top university project), more government funding into the university. University's propensity to change (Eun et al.,2006), The position of UREs in university began to decline. With the development of UREs, the original institutional advantages was lost gradually, and even become the restrict factors of UREs sustainable development. Due to ownership is not clear and corruption, Both should bear the social pressure of public opinion .Relationship between mother university and UREs facing new challenges.

By examining AREs definition, we can further unearth the distinctiveness of Chinese AREs, particularly the ARE reform initiated in 2001, The reform was both a consequence of the preceding gradual changes and a facilitator for further changes. No. 58 command under the state council of 2001, Requirements of tsinghua university and Peking University as a pilot, The main idea of the Memorandum is to separate universities from daily operation of their business firms (xiao qi fen kai), and to relieve them from unlimited liability for those firms. More fundamentally, the Chinese government tries to clarify the ownership arrangement between the academic institutions and their AREs, which have been just an extension of the former without a clear endowment

of their legal status. The future governance mechanism that is blueprinted in the Memorandum and further elaborated by subsequent measures of Tsinghua and Peking University sets up a holding company(asset management company or property management company) in 2003,the definition of asset management company as follows: Choose a blue-chip wholly-owned UREs become an asset management company ,authorized operation, entrusts the university's business assets(e.g. patents), On behalf of the university to deal with capital operation and investment(e.g. launch spin-outs). In 2005 the ministry of education officially released regulations, Since 2006 the university was ordered must be setup an asset management company, University Can not be to set up the company in the name of the university, The asset management company exerts rights and takes (limited) responsibilities as a stockholder (or an investor) for the existing AREs. And Individual AREs are restructured as limited liability companies. Direct links between university (or departments) and AREs are cut off in principle. The traditional university — ARE relationship based on administrative subordination — is to be transformed to the relationship based on equity holding. In other words, the UREs is evolutionary changes to UOEs (university-owned enterprise).

--Include Figure. 1 about here--

Ownership problem has been resolved, university designate staff to enter board and board of supervisors, no longer assume the risk of enterprise operation directly, Moreover it could be good news for the AREs because they could be freed from the managerial interference and all sorts of responsibilities for the university, it more difficult to use the university brand names. After the reform of UREs since 2001, although the number is diminishing, but income is increasing (see Fig. 1), so the competitiveness are also promoting gradually.

--Include Figure. 2 about here--

University-owned enterprise asset management company (UOEAMC), also called administrative department of university-run enterprise. The number of UOEAMC representative tendency and performance of URE reform (see Fig. 2) , by the end of 2012 ,only 45% university setup UOEAMC. since it setup, became play the role of the incubator, setup university science park company, and then launch spin-outs, most of the university science park company is UOEAMC wholly-owned, Fewer is holding company cooperation with local government. In 2015, China's ministry of education promulgate a decree, Promoting reform of the university innovation and entrepreneurship, university should use (for free or in preferential terms) various resources to facilitating entrepreneurship, to set up a campus entrepreneurial venture fund, to launch spin-outs. After half a century of evolutionary changes, university from establish factories directly to the only ownership, and then to provide a platform of incubation and technology transfer, this is the process of university setup firms in china-context special, it has the unique characteristics. University setup enterprise directly for pursue economic gains, Provide a platform to assist others to setup enterprise, both Financial gains and social responsibility, and more profitable. This is an important characteristic for Chinese university academic entrepreneurship.

2.3 spin-outs With Chinese characteristics

In the last decade, the commercialisation of university activities has become a key part of the agenda for chinese governments and universities. From AREs reform for more adapt to the new entrepreneurial economy, to there has been a substantial rise in the creation of university spin-out companies.

The define of university spin-outs as new ventures that are dependent upon licensing or assignment (Lockett and Wright, 2005). This definition is consistent with that used by Association of University Technology Managers

in the US. In some cases, where permitted, the university may own equity in the spin-out in exchange for patent rights it has assigned or in lieu of license for fees. Several previous China UREs studies, before we proceed, let us briefly mention the characteristics of the UREs. Although many authors have equated the UREs with university spin-offs, or at least did not make a clear distinction between the two (e.g. Gu, 1994, 1999; Francis, 1999), we would like to emphasize that the UREs in China differ from the ordinary university spin-offs. Unlike ordinary spin-offs that are usually set up by individual-academicians with personally raised funds and off-duty inventions (Roberts, 1991), UREs in China are typically established, staffed, funded, and managerially controlled by universities. UREs are usually use various assets including research outcomes or resources, Eun et al.(2006) argue that UREs are “spin-arounds”. But another authors Kroll and Liefner(2008) disagree, following the suggestion of Carayannis et al. (1998) to specify the concept of spin-off according to the objective of the study. To analyse the differences of spin-off formation under different institutional framework conditions, a suitable definition of spin-off venture is the one offered by Pirnay et al. (2003): “New companies created from universities to exploit knowledge produced by academic activities in a profit-making perspective.” So Kroll and Liefner(2008) believe UOTEs(university-owned based on Science and technology enterprise) is the notion of sponsored spin-offs (Wallin and Dahlstrand, 2006).

We believe the start-ups in chinese national university science park , They use various university research outcomes or resources, such as financial resources(UOE asset management company) , physical spaces, manpower(The entrepreneurial mentors or technical support), social links (Campus vc),and Various preferential from government to university. The University acquire equity stake or gain feedback fund. we define a university spin-out as a start-up company whose formation is dependent on the formal transfer of technology from the university(Wright et al., 2006) and in which the university holds an equity stake(Through the UOE asset management company) or gain feedback fund(Through the Incubator company). We focus on those USOs that, in principle, may be expected to have high growth prospects but which may face difficulties in obtaining finance and other resources to realize these prospects, thus universities can provide these resources.

In a word, Before reform, the URE use various assets and resources, and capital source from university, called “spin-arounds” (Eun et al., 2006), but the technology based UOE like sponsored spin-offs(Kroll and Liefner,2008), More accurately, the start-ups based UOE that are dependent upon university technology transfer, University acquire equity stake or the feedback fund, we adopted define university spin-outs(USOs). Forming spin-out companies is one of a number of mechanisms by which chinese universities drive forward their academic commercialisation outcomes. Spin-outs provide a means of further developing products and engaging with the market place through a dedicated vehicle. For specific technologies, far greater returns can be achieved by this route than would have been possible through direct licensing.

--Include Figure. 3 about here--

The tendency and results of URE reform, have an interesting phenomenon, the number of URE is diminishing, but the number of university spin-outs(USOs) is increasing.(see Fig. 3). This tendency Conform to the mainstream trend of academic entrepreneurship all over the world.

2.4 Framework development

A large share of the studies of entrepreneurial activity at the university level is based on cross-sectional data linking university characteristics with USO creation. Such studies imply that an increase in these characteristics should lead to the creation of more USOs. This knowledge is useful in predicting USO formation and gives

important insight into favorable conditions, but it does not explain how USOs are created (Rasmussen and Borch,2010). This knowledge is useful in predicting USO formation and gives important insight into favorable conditions, but it does not explain how USOs are created. USOs are heterogeneous (Mustar et al., 2006), and a too-static view of the factors influencing the USO process seems to put limitations on the development of theories explaining USO firm formation (Rasmussen and Borch,2010). Previous research stream has relied on resource-based perspectives (Penrose, 1959; Wernerfelt, 1984) to examine why some universities create more USOs than others (Druilhe and Garnsey, 2004; Heirman and Clarysse, 2004; Lockett and Wright, 2005; O’Shea et al., 2005; Powers and McDougall, 2005; Vohora et al., 2004; Rasmussen and Wright, 2015), not full explain how universities deal with different impact and dynamic processes such as USO formation.

Organizational capabilities be regarded as an extension of the resource-based view, in which not only an organization’s assets but also its capabilities lead to organizational performance (Wernerfelt, 1984; Winter, 2003). an organizational capability refers to the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result” (Helfat and Peteraf, 2003),In china-context, commercial environment and resource is not good enough, universities that have the appropriate capabilities to facilitate launch USO will be more successful in doing so.

Some capabilities are most important during the earliest phases of the entrepreneurial process, when the university serves as an incubator platform for the nascent USO (Clarysse et al., 2005). In emerging countries (e.g. china), entrepreneurial capabilities is more important. The incubator in a university is regarded as an effective measure to accelerate the spin-offs (Mian, 1996). Clarysse et al. (2011) investigate UK universities and reveal that academics who have a high degree of entrepreneurial capability and entrepreneurial experience will be more involved in entrepreneurial initiatives created by others or in founding entrepreneurial ventures themselves than academics without these capabilities and experiences. Especially the organizations, the failures case in the entrepreneurial process may learn a lesson to avoid the same mistake again. Internal entrepreneurial funds were the important indicator of entrepreneurial policies in U.S. universities (Di Gregorio and Shane, 2003). The campus entrepreneurial fund were suggested as the important impetus in fostering equity participation in USOs.

As mentioned before, academics, dedicated to basic research, serve as suppliers of innovations for economic growth. Adequate Research capabilities become a key to establishing an intellectual property inventory for university technology transfer or licensing. Patent grants were used as the proxy of research commercialization since it is considered as the first step of university-based research commercialization (Mowery and Ziedonis, 2002). Previous research on patenting indicates that they can be a valuable organizational capabilities for competitive advantage and predictive of firm performance (e.g., Deeds et al., 1999) ,Several empirical analyses have demonstrated the significance of research capabilities for university commercialization activity (Carlsson and Fridh, 2002; Siegel et al., 2003; Link and Siegel, 2005; Chapple et al., 2005;kim,2013). University patent importance will be positively related to the number of startup companies formed.(Powers and McDougall, 2005).

The integration of internal and external resources has been important for technology commercialization (Zahra and Nielsen, 2002). Eun et al. (2006) argued that china university duo to the underdeveloped intermediary institutions lead to established their own firms. Given that faculty typically know relatively little about the business of technology commercialization but usually have a high degree of psychological ownership for their inventions, TTO professionals are key players in the commercialization of a technology, often in their role as arbiters between the higher education and industry cultures. Moray and Clarysse (2005) find that the resource

endowments of USOs are influenced by the way in which technology transfer is organized within the parent organization and that research organizations can go through a learning process that increases their ability to facilitate USOs. As TTO offices gain experience, they are more willing to consider equity in spin-outs companies.

The uniqueness of historical conditions, where by firms are intrinsically historical and social entities, can be the basis for sustained competitive advantage (O'Shea et al., 2005), Barney (1991) argued that the firm obtains valuable and rare resources because of its unique path through history, it will be able to exploit those capabilities in implementing value-creating strategies that cannot be duplicated by other firms. Each of UREs has different background and institutional heritage, these are the unique capabilities, especially to deal with U-I relationship. Universities that have a tradition and history of spinning out technology-based companies are more likely to be successful generators of spinoff activity (O'Shea et al., 2005).

Mutual integration the capabilities of university facilitate the creation of USOs are related to the university's ability to initiate and promote the new venture launch process. University's financial condition and Mutual integration the organizations capabilities, the results will effect on university's "propensity" to pursue economic gains (Selectivity). In addition, the policy is always uncertain, will have a profound impact to the results in China, Previous research (Wu et al., 2008) show the level of "regional innovation environment" is a prerequisite of chinese University commercial activities.

This paper based on organizational capabilities perspective, proposes research framework (see Fig. 4) for studies on china-context special spin-outs on the process of university-run enterprises evolutionary changes argues this framework is more appropriate to explain the Performance drivers (organizational capabilities) of china-context special spin-outs.

--Include Figure. 4 about here--

3. Research Methodology

3.1. Sample and data collection

To determine the key factors driving china's spin-out based university technology, it is necessary to verify the appropriateness of the factors extracted from related literature in accordance with china's university research context. So, this study attempts to evaluate the appropriateness of the extracted factors before determining their relative importance.

The data for this study was obtained through database and survey sources on China universities. The key source of our data is the Technology commercialization activities Statistics report, which is conducted annually by the network of china Ministry of Education, Science and technology development center (CERNET). There are three another data source: The data regarding china universities incubator from Ministry of Science and technology, Department of High and New Technology Development and industrialization (THTIDC); The data regarding University Performance in the china from The China academy of Management Science(CAMS); National Bureau of Statistics of China(NBS) produces the annual of the national science and technology and regional innovation capabilities index. All this database is the only comprehensive and national source of data on spin-outs activity. The Second-hand data to ensure this research results is objective and it can be copied.

This unique survey provides us with useful data on universities' commercialization activities for 46 universities out of 76 the national key university directly under the Ministry of Education in china over 2009–

2013, Information on spin-outs counts is missing by 30 universities, The approach is to drop all universities with incomplete records or replaces missing observations with the mean number value of yearly spinouts for these universities. Results for the two different estimation strategies do not vary substantially, which supports our view that we observe a representative sample of china institutions and the recoding of missing observations is not an issue. The national key university is representative of the majority outcomes of china university-owned enterprise UOE). On average it which account for the great majority of sales volume (87%) and total assets (86%).

In addition we have been be accessed on Website of 46 university and their university affiliated science parks(USPs) to obtain university and USPs policies to support the launch of spin-outs. First, on whether or not the university has a programme to help researchers or students to launch spin-outs. Second on whether the USPs has a stake in a risk capital fund to finance the early stages of spin-outs. And third, on whether preferential policies for the incubation performance of USPs.

Our sample consists of 230 (46×5) university year observations. Although the precise number of Assets management company volume in a given year in the china is unknown, the sample appears to account for the vast majority of the population of such firms (DiGregorio and Shane, 2003). Therefore, selection bias should not hinder analysis.

3.2. Dependent variable

We adopted define university spin-outs but this is synonymous with the term spin-out used in US literature, as new ventures that are dependent upon licensing or assignment of the institution's intellectual property for initiation, or university put into resource to incubation in embryonic industries (Siegel et al., 2003a), first, universities equity ownership (Siegel et al., 2003a), Second, universities gain feedback fund in a USO as an attractive alternative to licensing technologies. In china context specific, we define a USO as a start-up company whose formation is dependent on the formal transfer of technology from the university(Wright et al., 2006) and in which the university holds an equity stake(Through the UOE asset management company) or gain feedback fund(Through the Incubator company). We focus on those USOs that, in principle, may be expected to have high growth prospects but which may face difficulties in obtaining finance and other resources to realize these prospects, thus universities can provide these resources.

3.2.1 URE income

Such top PC makers in China companies as Founder, Tongfang, dongruan, they are University-run enterprises (UREs) that have been established and operated by universities, i.e. Peking and Tsinghua University, respectively. Lenovo is a similar type of firm that was established by the Chinese Academy of Sciences. So today we discuss an academic entrepreneurship in china, UREs is the Keywords. Eun et al.(2006) argued that the Chinese universities since the market-oriented reform had strong propensity to pursue economic gains and strong internal (R&D and other) resources to launch start-ups, and thus established their own firms(i.e. UREs), now the URE is not only an important outcomes of academic entrepreneurship, but also the important performance drivers of spin-outs.

3.2.2 UOEAMC total assets

The relative importance of UREs in the Chinese economy to be changing, Since 2000, Chinese universities have been in the reform for UREs, The university gradually exit the Operating from UREs, Instead, is University-own enterprises(UOEs) (Eun et al., 2006).since 2006,The university set up asset management

companies(UOEAMC) gradually, also called “administrative department of university-own enterprise”.

UOEAMC is the property management company of university, more is an investment company. They investment set up incubator companies to management university science parks (USPs), unless the university have not been established UOEAMC.

3.2.3 Number of spin-outs

Universities may not be able to capture the full value of their technology through a licensing arrangement and therefore may seek a more direct involvement in the commercialization of new technology through spinning-out a company (Franklin et al., 2001).Corporate spin-out have more entrepreneurial spirit of and more focus due to lower bureaucracy and more co-operation possibilities to complement know-how(Festel,2013), there is growing interest in the role that university spin-out companies may play in the commercialization process. (DiGregorio and Shane, 2003; Wright et al., 2002; Wright et al., 2004a,b; Siegel and Phan, 2005), In China, the spin-out company is also increasing year by year, Because the university provides the resources , Intellectual capital ,social capital And preferential policies , These are requirements of entrepreneurship in current China.

3.3 Independent variables

3.3.1 Institutional resources

Due to the particularity of dependence variable, we need to test it on history institutional hypothesis, in this study, universities lies in the different past University established enterprises with era characteristics. According to this perspective, institutional advantage from the past generates benefits in the present and future, therefore making spin-outs creation a path-dependent process. URE income and UOEAMC total assets representative the two different period of the institutional, it will accelerate or block to launch spin-outs, this study will give the answer.

3.3.2 Research capabilities

In recent decades, Chinese university research has increased as the government has taken a lead in providing resources. The development of key universities has been looked upon as a measure to fulfill effective indigenous technological innovation. (Zhou & Peng, 2008). Patent grants were used as the proxy of research commercialization since it is considered as the first step of university-based research commercialization (Mowery and Ziedonis, 2002). This study measured annual domestic patent acquired by university during the period of 2007-2011.One-year duration was chosen for the researchers as a more accurate reflection of the time lag for patenting procedure. University research quality we measured by the academic rankings of university's science and engineering (One of them is the number of publications in top scientific journals per researcher and national key laboratory), is expected to positively affect performance as universities generating higher quality research could more easily commercialise it(Caldera & Debande,2010). The research quality index scores ranges from a low of 1.0 to a maximum of 10.0.

3.3.3 Technology Transfer Capabilities

In line with the existing literature, we expect Technology Transfer Capabilities to positively affect university performance (e.g. Thursby and Kemp,2002; Link and Siegel ,2005; Chapple et al., 2005). In larger TTOs staff may specialise in those areas where they have a specific expertise. Older TTOs should be more experienced in the management and valorisation of technology transfer (Conti and Gaule, 2011).In this study, we measure the annual university technology transfer income and Technology Transfer office's Quality. Technology Transfer office's

Quality representative the TTO's experience and Capabilities, we according to Awarded "National technology transfer demonstration institution" in time sequence, it covers university TTO's policies, experience, size and performance. During the period of the sample (2008-2012) they have five times appraise, the TTO quality index scores ranges from a low of 1.0 to a maximum of 5.0.

3.3.4 Entrepreneurship Capabilities

To measure the Capabilities of Entrepreneurship dedicated to Innovation and incubation efforts, we measure the entrepreneurial experience and campus incubation venture capital. The creation of university spin-out companies that create wealth is a major policy objective of governments and universities. Finance is a catalyst of this wealth creation yet access to venture capital is a major impediment faced by these companies (Wright et al., 2006). We measure the presence of a university venture capital by a dummy variable taking the value 1 if the universities' incubator has a venture capital and 0 otherwise. The entrepreneurial experience of universities, accumulated similar experiences, we choose total number of graduated Enterprise from university incubator center (university science parks), it means off the university science parks Successfully. These is two key success factor of launch spin-outs in china.

3.3.5 Regional Environment

Much of the empirical research suggests that the contributions of university-based research tend to be geographically concentrated. As a consequence, a university's ability to generate spin-out companies may depend on knowledge spillovers from the industry sector (Friedman & Silberman, 2003). The regional's innovation environment, industrial infrastructure, skilled workforce are more important for emerging countries such as China, the local government's policy support will be effect on launch spin-out companies. To measure the degree of innovation index in china regions(the province of university location,1-32), we draw from the Chinese Academy of Science and Technology for Development's Regional Ranking survey produced in 2008-2012 from Ministry of Science and Technology, This value is the ranking, Regression results explanation should be the opposite. R & D intensity representative absorptive capacity of location industrial firms, this data from National Bureau of Statistics and (2008-2012).

3.3.6 Propensity

In china universities prefer to set up UREs, consists of the following three factors: university's propensity to pursue economic gains (or earn money), internal resources, and the external environment (Eun et al.,2006), So we expect the research funding will effect on the propensity of universities, Regarding the university's propensity to pursue economic gains, we observe that a certain level of propensity is a prerequisite to selective to set up enterprise.

3.4 Control variables

In addition, we controlled for alternative explanations for university spin-outs activity.

3.4.1 University Reputation

Internal resource that is relevant to launching a firm, we assume that a university with stronger brand power and technological knowledge would be more prone to set up a firms (Eun et al., 2006). To measure the degree of university reputation, we draw from China academy of Management Science's "The Universities evaluation report", Reputation Ranking in 2008-2012.

3.4.2 Polytechnic

To conclude, we control for university research orientation with two dummy variables: polytechnic and medical school. A polytechnic university dummy, takes the value 1 if the university is polytechnic and 0 otherwise. Discipline type may be related to the culture of the university with respect to encouraging university entrepreneurial activity (Curi et al., 2012), The university's technical orientation is expected to influence performance, as universities specialised in fields like biotechnology or technical sciences will be more likely to generate valuable research output for the business sector than universities specialised in social sciences (Siegel et al., 2003; Thursby & Kemp, 2002; Kim, 2013).

3.4.3 Medicine

The presence of a medical school effect is based on the proposition that medical inventions have greater market ability than inventions from other disciplines (Kim, 2013). A medical school dummy taking the value 1 if the university has a medical school and 0 otherwise, this data was collected from The Center of higher education in the ministry of education.

3.4.4 Faculty

The process of university spin-out begins with scientific discovery (Siegel et al., 2003). The faculty members and researchers of a university dedicate themselves to discovering cutting-edge technologies. Additionally, faculty quality has been shown to be one of the key factors in other studies related to the performance of university technology licensing (Thursby & Kemp, 2002; Friedman & Silberman, 2003; Belenzon and Schankerman, 2009).

3.5. Empirical model and estimation method

In order to investigate the determinants of university spin-outs performance we estimate a series of performance equations where university spin-outs outcomes are expressed as a function of the main determinants identified by the previous literature (Lach & Schankerman, 2004, 2008; Chukumba & Jensen, 2005; O'Shea et al., 2005; Caldera & Debande, 2010). A number of studies use frontier analysis instead and construct a best practice frontier using data on universities' inputs and outputs (e.g. Chapple et al., 2005; Thursby and Kemp, 2002; Sun, 2015). Two methods are typically used to estimate the best practice frontier: data envelopment analysis (DEA) and stochastic frontier estimation (SFE). However, both of these methods have well-known drawbacks (Van Biesebroeck, 2007). In my previous study (Sun, 2015), we use DEA to evaluate efficiency of Chinese academic commercialization (patenting, university-industry collaboration, technology transfer, and spin offs) The results indicate that (1) patenting has experienced a rapid growth in the study period; (2) the technical efficiency of spin-off is the most efficient among four commercial activities; and (3) the efficiencies of U-I collaboration and technology transfer have some rooms to be improved. But DEA is deterministic, thus sensitive to measurement errors and outliers, which can lead to upwardly biased estimates of the technical efficiency scores by attributing all deviations from the frontier to technical inefficiency (Van Biesebroeck, 2007).

For this reason we prefer to use linear regression analysis, to test degree to the china-context specific university spinouts are affected by different sets of Capabilities and resources, the following model is estimated:

$$Y_{it} = f(\beta_0 + \beta_1 INST_{it} + \beta_2 RESE_{it-r} + \beta_3 TECH_{it} + \beta_4 ENTR_{it} + a_{it} + \rho_{it} + \nu_{it}) \quad (1)$$

where Y_{it} is the count of spin-outs companies produced in university i at time t and is a function of institutional resources which a successful history and tradition at setup firms activity representing the dynamic effort ($INST_{it}$) and Research capabilities ($RESE_{it-r}$) into the research process, technology transfer intermediary institutions associated ($TECH_{it}$) with the university entrepreneurial effort ($ENTR_{it}$). Region fixed effects a_{it} for regional

differences in economic conditions, Propensity fixed effects pit take into account the above four organizational capabilities shocks, such as changes in national policies or revenue shocks affecting university propensity, η_i are university specific control variables and ν_{it} represent university and time unobservable differences.

We estimate Eq. (1) pooling the data over the sample period and clustering the error terms at university level to control for intra-university serial correlation. The equations having as dependent variable the logs of income of URE and assets volume of UOEAMC are estimated by OLS. The equations having as dependent variable the count of the number of spin-outs, are estimated using a Negative Binomial model. The Negative Binomial specification, which is a generalisation of the Poisson distribution, to take into account over-dispersion may be more appropriate.

--Include Table 1 about here--

4. Results

Table 1 presents the basic descriptive statistics over 2008-2012. We observe quite some variations in performance among universities. From the 46 universities analyzed in our study, an average of 17 spin-outs were generated on an annual basis over the time period 2009–2013. The highest number of spinouts generated per year was recorded by zhejiang university producing a total of 106 spinouts in 2011. They have differences in performance among universities are even larger in the number of spinouts, and especially in terms of income of university-run enterprises and the assets volume of asset management companies of university-own enterprises. In what follows, we investigate formally the determinants of university performance in income of URE, assets volume of UOEAMC and spin-outs creation using regression analysis. The inter-correlations for all variables are less than 0.65, the correlations among the independent variables and other diagnostic tests conducted suggest no problem of multicollinearity ($VIF < 1.90$). And the values of Cronbach's alpha ranging from 0.79 to 0.85 support the reliability of the independent variables.

--Include Table 2 about here—

--Include Table 3 about here—

--Include Table 4 about here--

Table 2-4 present the results of regression analysis. All regressions take into account interuniversity correlations clustering the error terms at university level. Each column of Table 2-4 reports alternative specifications of Eq. (1) where the various explanatory variables enter subsequently. The different specifications are controlled university specific resources and discipline type fixed effects. Models 1,3 and 5 examined the main effects of resources and capabilities on URE, UOE, and spin-outs respectively. Models 2, 4, 6 were added to study the effects of the control variables on URE, UOE, and spin-outs.

The results show that university reputation (or university brand power) tend to increase more URE sales volume and impede more UOE assets volume. Moreover, those with more university faculty tend to increase more UOE assets volume. The polytechnic type university tend to produce less spin-outs. Specifically, in Table 2, the Patents grants showed negative and statistically significant relationships with URE income ($\beta = -0.519$ and -0.478). There exist positive and statistically significant relationships between the patent grant, the Technology transfer income ($\beta = 0.236$ and 0.223), Research Funds ($\beta = 0.685$ and 0.468) and the R & D intensity ($\beta = 0.229$ and 0.329). As seen in Table 3, there are positive and statistically significant relationships between the total assets of

UOEAMC, Technology transfer income($\beta= 0.085$ and 0.080), Research Funds($\beta= 0.072$ and 0.103), and The entrepreneurial experience ($\beta= 0.266$ and 0.310), It is strange that when R&D Quality added to the effects of the control variables, it is became positive and statistically significant ($\beta= 0.228$). The region innovation environment showed negative and statistically significant relationships with ($\beta=0.015$ and 0.020).

Moreover, in Table 4, there are positive and statistically significant relationships between the number of spin-outs, the region innovation environment ($\beta= -0.011$ and -0.016), Patents grants ($\beta= 0.001$ and 0.007), campus incubation venture capital ($\beta= 0.177$ and 0.208), and TTO Quality ($\beta= 0.271$ and 0.274). The Research Funds showed negative and statistically significant relationships with spin-outs ($\beta=-3.290$ and -2.950)

With the use of panel data, a key finding of our study is evidence that the different of development paths in explaining university spinout outcomes. The independent variables as predicted number, In particular, the coefficients for both models (4) and (6) show positive and significant effects ($p < 0.001$ and $p < 0.001$ levels), respectively.

5. Discussions

In this study, the relative importance of each performance driver is acquired through three procedures. First, to evaluate the appropriateness of performance drivers extracted from related literature. In the second step, to identify the interdependent relationship among the appropriate performance drivers Combined with the china-context special. Finally, the Regression is used in this study to identify relative importance of each performance driver.

This study is based on previous research ((Eun et al., 2006; Kroll & Liefner,2008), present a research framework for studies on the China Context specific spin-outs, empirical model with regression approach to test, the research finding is different from previous studies. Eun et al. (2006) argued that the Chinese universities since the market-oriented reform had strong propensity to pursue economic gains to launch start-ups, if lack of the research funds, university tend to launch spin-outs, when university have enough research funds tend not to launch spin-outs, but in our study, as seen in Table 2,3,4 present there are positive and statistically significant relationships between propensity and the URE sales volume and impede more UOE assets volume, Only spin-outs is showed negative and statistically significant relationships with the Research Funds. We believe that the purpose of Presence UREs is economic gains (university as a company), but spin-outs based on UOE in order to show the social responsibility of university, Conform to the trend of the academic commercial.

In my study, we measuring the Chinese industrial firms' absorptive capacity and evaluating the development of intermediary institutions in China, the research finding is china's Technology transfer "intermediary institutions" facilitate knowledge flows between universities and industrial firms, as seen in Table 2,3,4 present there are positive and statistically significant relationships between Technology transfer "intermediary institutions" and the URE sales volume, impede more UOE assets volume, spin-outs, especially TTO Quality. Previous research on TTOs identifies a number of key factors impacting spin-outs productivity (e.g. Belenzon & Schankerman, 2009; Chukumba & Jensen, 2005; Coupe, 2003; Siegel et al., 2003; Thursby & Kemp, 2002). This research shows that successful spin-outs not only depends on the quality of the research, but crucially also on the quality and the experience of the TTO. The development of Technology transfer intermediary institutions in China has the rapid growth and improvement since 2008.

The relationships between the Chinese industrial firms' absorptive capacity and URE is to be measured,

Cohen & Levinthal (1990) argument that the industrial firms' absorptive capacity and R & D intensity has a close relationship. R & D intensity will help to improve industrial firms' absorptive capacity. Eun et al. (2006) predict that due to the low absorptive capacity of industrial firms, the university had to setup a firm. But in this empirical study, table 2 present there are positive and statistically significant relationships between the local industrial firms R & D intensity and the URE sales volume.

The campus entrepreneurial fund and incubator facility were suggested as the important impetus in fostering equity participation in academic spin-outs. The finding is consistent with Di Gregorio & Shane (2003), who argued that internal entrepreneurial funds were the important indicator of entrepreneurial policies in U.S. universities. Fund raising is a key criterion to convince the external investors the market potential of the opportunities (Druilhe & Garnsey, 2001). External investors feel more comfortable if campus entrepreneurial funds involve in the ownership of spin-off equities as well (Chang et al., 2009). Campus incubation venture capital. Moreover, in this study, all spin-outs in incubator centers (university-affiliated science parks) explains why the facilities provided a platform for technology transferring between industrial sectors and academic patent inventors. Our research finding show campus incubation venture capital and the volume of UOEAMC total assets are both positive and statistically significant relationships with spin-outs. In addition, The entrepreneurial experience of universities is very important, accumulated similar experiences, will improve the success of university setup firms in china context, in this study total number of graduated enterprise from university incubator center(university science parks) Proved to be related to UOEAMC setup spin-outs show positive and significant effects ($p < 0.001$ levels).

In addition, our study found an interesting phenomenon, university reputation (brand power) effects on URE, UOE, spin-outs reduce gradually ($p < 0.01$, $p < 0.1$, and non-significant levels) · the results, accord with recently initiated reform measures of the UREs in China, This is a trend of short-term and long-term impact of the reform on Chinese UREs.

6. Concluding

This paper advances our research framework to explain in china-context special why some universities are more successful than others at generating spin-outs companies from a organizational capabilities perspective. Based on the process of university-run enterprises evolutionary changes with Objective secondhand data for empirical research in spin-outs across China, we have identified several interesting Performance drivers of the UREs, as well as the ongoing reform's impact on the UREs. In a word, the paper explains the process of university setup firms with the integration of different Performance drivers in China, it is necessary to understand the dynamics of the process in a broader(the special historical background) context.

Based on the previous analysis, some finding can be derived as follows. (1) The university's propensity to pursue economic gains will not weaken, due to the reform of UREs. Major university choose entrepreneurial because of financial distress, propensity weaken when abundant funds (Eun et al., 2006), but china UREs not so. We believe that the purpose of Presence UREs is economic gains(university as a company), but spin-outs based on UOE in order to show the social responsibility of university, Conform to the trend of the academic commercial. (2) A developed technology transfer intermediary institutions will facilitate university launch a firm in china, not only UREs, but also spin-outs. Eun et al. (2006) has argued that university established their own firms when underdeveloped technology transfer intermediary institutions. The results of theories predict and empirical

research is instead, due to after 10 years of the UREs reform, Universities must take balance fame and economic gains for UREs, Assuming that has changed, the results will be different. (3) The innovation environment of the local Plays the role of accelerate university launch a firm in china. (4) Entrepreneurship Capabilities(campus incubation venture capital and entrepreneurial experience) is important performance drivers to spin-outs.

Finally, some managerial and policy implications for improving university launch a firm in china are suggested. With regard to reform of Chinese AREs, the reform was both a consequence of the preceding gradual changes and a facilitator for further changes, from UREs to UOEs is an only route, Long-term goal is to establish spin-outs based on UOEs. The results indicates that Chinese AREs will go through a painful metamorphosis in the near future. After the reform, however, Chinese university might revert to ordinary spin-offs/outs rather than stay as UREs. In order to outperform the university spin-outs, universities should provide clear and abundant organizational supports to setup a firm. To promote the regional environment support and to develop entrepreneurial capabilities for university are indispensable. This paper a central aspect of our analysis, which has been neglected in previous studies, is the distinction between UREs and UOEs in china-context special, and the evolutionary change to setup spin-outs.

This paper has a number of limitations that may help explain some of the insignificant findings and which suggest areas for further research. The lack of significance of variables maybe associated with statistical and methodological issues relating to the relatively small sample size, sample selection, measurement problems and construct validity. These difficulties raise potentially interesting avenues for further research. Moreover, future research will focus on to compare UREs and USOs impact on the regional economic development.

References

- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, 17(1), 99-120.
- Belenzon, S., & Schankerman, M. (2009). University knowledge transfer: private ownership, incentives, and local development objectives. *Journal of Law and Economics*, 52(1), 111-144.
- Caldera, A., & Debande, O. (2010). Performance of Spanish universities in technology transfer: An empirical analysis. *Research policy*, 39(9), 1160-1173.
- Carayannis, E. G., Rogers, E. M., Kurihara, K., & Allbritton, M. M. (1998). High-technology spin-offs from government R&D laboratories and research universities. *Technovation*, 18(1), 1-11.
- Carlsson, B., & Fridh, A.-C. (2002). Technology transfer in United States universities. *Journal of Evolutionary Economics*, 12(1-2), 199-232.
- Chang, Y.-C., Yang, P. Y., & Chen, M.-H. (2009). The determinants of academic research commercial performance: Towards an organizational ambidexterity perspective. *Research policy*, 38(6), 936-946.
- Chapple, W., Lockett, A., Siegel, D., & Wright, M. (2005). Assessing the relative performance of UK university technology transfer offices: parametric and non-parametric evidence. *Research policy*, 34(3), 369-384.
- Chen, D. Y. (2002). A study on the amalgamation of Chinese higher educational institutions. *Asia Pacific Education Review*, 3(1), 48-55.
- Chukumba, C., & Jensen, R. (2005). University invention, entrepreneurship, and start-ups: National Bureau of Economic Research.
- Clarysse, B., Tartari, V., & Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research policy*, 40(8), 1084-1093.
- Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., & Vohora, A. (2005). Spinning out new ventures: a typology of incubation strategies from European research institutions. *Journal of business venturing*, 20(2), 183-216.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative science quarterly*,

- Conti, A., & Gaule, P. (2011). Is the US outperforming Europe in university technology licensing? A new perspective on the European Paradox. *Research policy*, 40(1), 123-135.
- Coupe, T. (2003). Science is golden: academic R&D and university patents. *The Journal of Technology Transfer*, 28(1), 31-46.
- Curi, C., Daraio, C., & Llerena, P. (2012). University technology transfer: how (in) efficient are French universities? *Cambridge Journal of Economics*, bes020.
- Deeds, D. L., & Decarolis, D. M. (1999). The impact of stocks and flows of organizational knowledge on firm performance: An empirical investigation of the biotechnology industry. *Strategic Management Journal*.
- Di Gregorio, D., & Shane, S. (2003). Why do some universities generate more start-ups than others? *Research policy*, 32(2), 209-227.
- Druilhe, C., & Garnsey, E. (2001). Academic spin-off ventures: a resource-opportunity approach.
- Druilhe, C., & Garnsey, E. (2004). Do academic spin-outs differ and does it matter? *The Journal of Technology Transfer*, 29(3-4), 269-285.
- Etzkowitz, H. (2003). *MIT and the Rise of Entrepreneurial Science*: Routledge.
- Eun, J.-H., Lee, K., & Wu, G. (2006). Explaining the “University-run enterprises” in China: A theoretical framework for university–industry relationship in developing countries and its application to China. *Research policy*, 35(9), 1329-1346.
- Festel, G. (2013). Academic spin-offs, corporate spin-outs and company internal start-ups as technology transfer approach. *The Journal of Technology Transfer*, 38(4), 454-470.
- Francis, C.-B. (1999). Bargained property rights: the case of China’s high-technology sector. *Property rights and economic reform in China*, 226-247.
- Franklin, S. J., Wright, M., & Lockett, A. (2001). Academic and surrogate entrepreneurs in university spin-out companies. *The Journal of Technology Transfer*, 26(1-2), 127-141.
- Friedman, J., & Silberman, J. (2003). University technology transfer: do incentives, management, and location matter? *The Journal of Technology Transfer*, 28(1), 17-30.
- Gu, S. (1995). *Spin-off Enterprises in China: Channeling the Components of R & D Institutions Into Innovative Businesses*: United Nations University, Institute for New Technologies.
- Gu, S. (2004). *China's industrial technology: Market reform and organisational change*: Routledge.
- Heirman, A., & Clarysse, B. (2004). How and why do research-based start-ups differ at founding? A resource-based configurational perspective. *The Journal of Technology Transfer*, 29(3-4), 247-268.
- Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: capability lifecycles. *Strategic Management Journal*, 24(10), 997-1010.
- Kenney, M., & Goe, W. R. (2004). The role of social embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford. *Research policy*, 33(5), 691-707.
- Kim, Y. (2013). The ivory tower approach to entrepreneurial linkage: productivity changes in university technology transfer. *The Journal of Technology Transfer*, 38(2), 180-197.
- Kinsella, R., & McBrierty, V. (1997). Campus companies and the emerging techno-academic paradigm: the Irish experience. *Technovation*, 17(5), 245-251.
- Kroll, H. (2006). *Entstehung und Entwicklung universitärer Spin-off-Aktivitäten in China: eine regional vergleichende Analyse*: LIT Verlag Münster.
- Kroll, H., & Liefner, I. (2008). Spin-off enterprises as a means of technology commercialisation in a transforming economy—Evidence from three universities in China. *Technovation*, 28(5), 298-313.
- Lach, S., & Schankerman, M. (2004). Royalty sharing and technology licensing in universities. *Journal of the European Economic Association*,

2(2-3), 252-264.

- Leitch, C. M., & Harrison, R. T. (2005). Maximising the potential of university spin-outs: the development of second-order commercialisation activities. *R&d Management*, 35(3), 257-272.
- Link, A. N., & Siegel, D. S. (2005). University-based technology initiatives: Quantitative and qualitative evidence. *Research policy*, 34(3), 253-257.
- Lockett, A., Murray, G., & Wright, M. (2002). Do UK venture capitalists still have a bias against investment in new technology firms. *Research policy*, 31(6), 1009-1030.
- Lockett, A., & Wright, M. (2005). Resources, capabilities, risk capital and the creation of university spin-out companies. *Research policy*, 34(7), 1043-1057.
- Mian, S. A. (1996). Assessing value-added contributions of university technology business incubators to tenant firms. *Research policy*, 25(3), 325-335.
- Mohrman, K. (2003). Higher Education Reform in Mainland Chinese Universities: An American's Perspective. Hong Kong America Center, Chinese University of Hong Kong, Hong Kong, China.
- Moray, N., & Clarysse, B. (2005). Institutional change and resource endowments to science-based entrepreneurial firms. *Research policy*, 34(7), 1010-1027.
- Mowery, D. C., & Ziedonis, A. A. (2002). Academic patent quality and quantity before and after the Bayh–Dole act in the United States. *Research policy*, 31(3), 399-418.
- Mustar, P., Renault, M., Colombo, M. G., Piva, E., Fontes, M., Lockett, A. Moray, N. (2006). Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. *Research policy*, 35(2), 289-308.
- O'Shea, R., Allen, T. J., O'Gorman, C., & Roche, F. (2004). Universities and technology transfer: A review of academic entrepreneurship literature. *Irish Journal of Management*, 25(2), 11.
- O'shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of US universities. *Research policy*, 34(7), 994-1009.
- O'Shea, R. P., Allen, T. J., Morse, K. P., O'Gorman, C., & Roche, F. (2007). Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience. *R&d Management*, 37(1), 1-16.
- Penrose, E. (1959). *The theory of the growth of the firm*, Basic Blackwell: Oxford.
- Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: observations, synthesis and future research. *Journal of business venturing*, 20(2), 165-182.
- Pirnay, F., & Surlemont, B. (2003). Toward a typology of university spin-offs. *Small Business Economics*, 21(4), 355-369.
- Powers, J. B., & McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. *Journal of business venturing*, 20(3), 291-311.
- Rasmussen, E. (2008). Government instruments to support the commercialization of university research: Lessons from Canada. *Technovation*, 28(8), 506-517.
- Rasmussen, E., Mosey, S., & Wright, M. (2015). The transformation of network ties to develop entrepreneurial competencies for university spin-offs. *Entrepreneurship & Regional Development*, 27(7-8), 430-457.
- Roberts, E. B. (1991). *Entrepreneurs in high technology: Lessons from MIT and beyond*: Oxford University Press.
- Roberts, E. B., & Malonet, D. E. (1996). Policies and structures for spinning off new companies from research and development organizations. *R&d Management*, 26(1), 17-48.
- Shane, S. A. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*: Edward Elgar Publishing.
- Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university

technology transfer offices: an exploratory study. *Research policy*, 32(1), 27-48.

Sun, L.B., (2015,11). Evaluating Efficiency of Academic Commercialization: Empirical Evidences of the Key Universities in China. Paper Presented at conference on Chinese Society for Management of Technology, Hsinchu, Taiwan.

Thursby, J. G., & Kemp, S. (2002). Growth and productive efficiency of university intellectual property licensing. *Research policy*, 31(1), 109-124.

Van Biesebroeck, J. (2007). ROBUSTNESS OF PRODUCTIVITY ESTIMATES*. *The Journal of Industrial Economics*, 55(3), 529-569.

Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research policy*, 33(1), 147-175.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, 5(2), 171-180.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, 24(10), 991-995.

Wright, M. (2007). *Academic entrepreneurship in Europe*: Edward Elgar Publishing.

Wright, M., Lockett, A., Clarysse, B., & Binks, M. (2006). University spin-out companies and venture capital. *Research policy*, 35(4), 481-501.

Wu, Zhang, Shi, Jiang (2009). Research on the efficiency of knowledge transfer of University based on knowledge supply chain. *Journal of Jiangsu University of Science and Technology*. 23(2).163-167

Zahra, S. A., & Nielsen, A. P. (2002). Sources of capabilities, integration and technology commercialization. *Strategic Management Journal*, 23(5), 377-398.

Zhang, B (2003). A Study on the Development of the Chinese University S&T Industry (Zhongguo Gaoxiao Gaoxinjishu Chanye de Fazhan Yanjiu). Wuhan: Huazhong Keji Daxue Chubanshe.

Zhou, C., & Peng, X.-m. (2008). The entrepreneurial university in China: nonlinear paths. *Science and public policy*, 35(9), 637-646.

Figure 1. Number of URE and total income of URE in chinese university 2002-2012

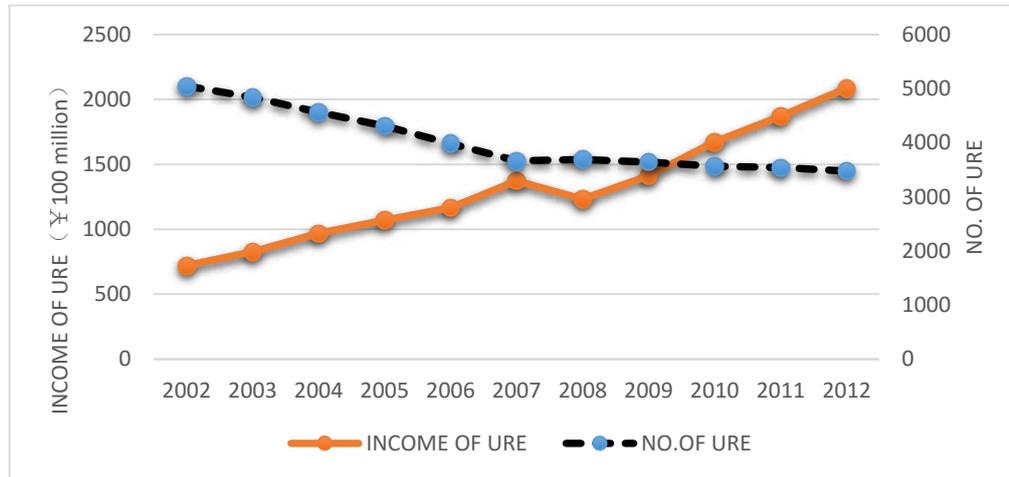


Figure 2. Total asset management company of UOEs in chinese university 2007-2012

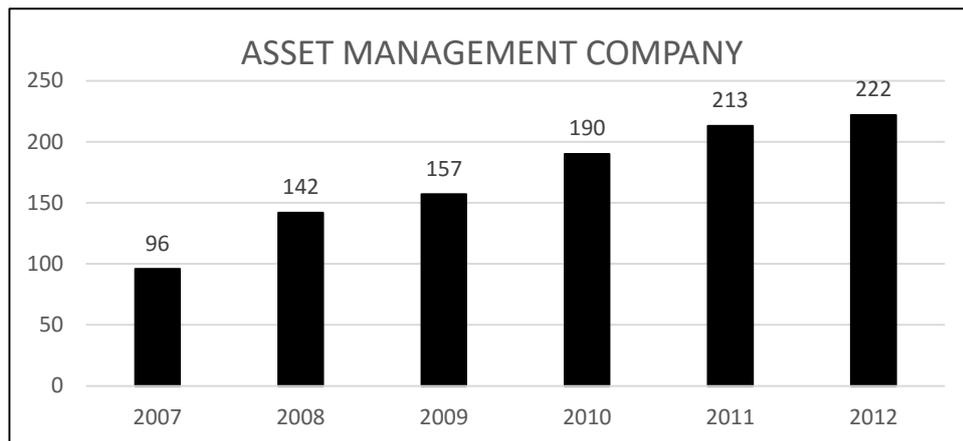


Figure 3. Total URE and total spin-outs in china university 2002-2012

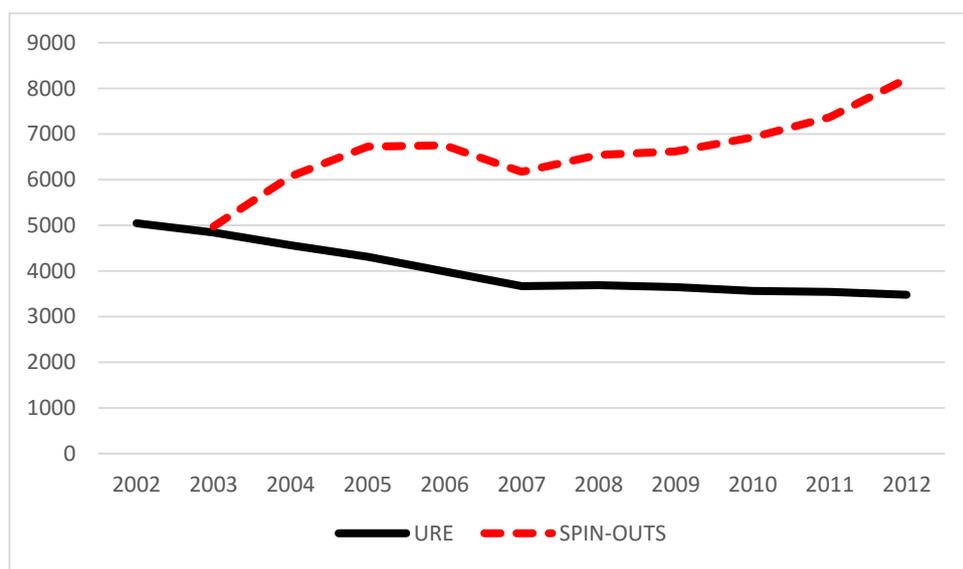


Figure 4. Research framework for studies on the China Context specific spin-outs

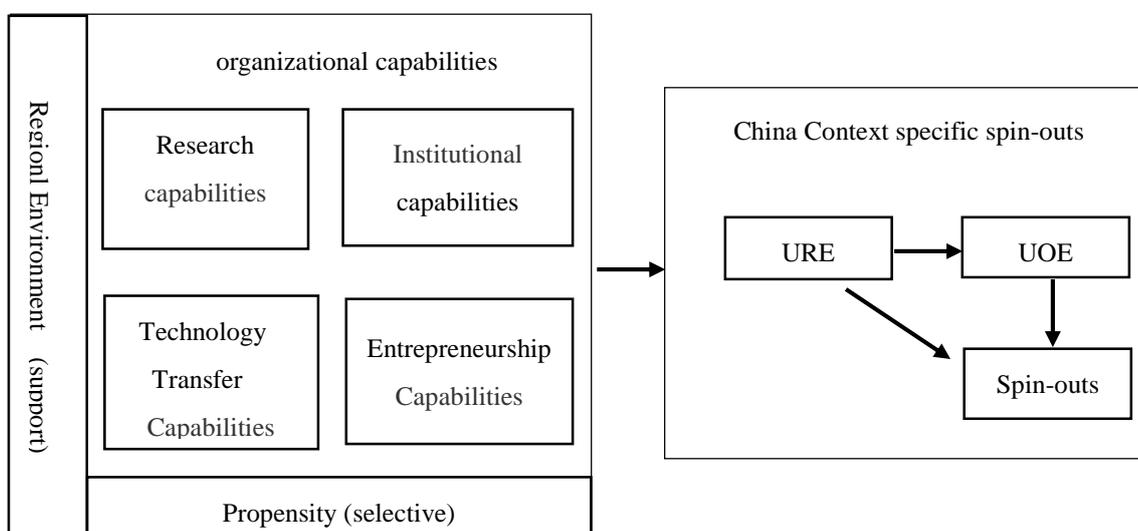


Table 1. Summary statistics for period 2009–2013

Variables	Definition	N	Min	Max	Mean	S.D.	Data source
UOEAMC total assets	Total assets of asset management company of university-owned enterprise (¥ 0000)	230	50	9687609.00	388777.98	1285925.75	CERNET ^a
URE income	Income of university-owned enterprise (¥ 0000)	230	19	7004775.65	304106.33	1014500.26	CERNET
NEW spin-outs	Number of spin-outs enterprise	230	0	106.00	17.18	15.43	THTIDC ^b
University Reputation	University rating (1–10 rating index)	230	1	10.00	6.08	2.55	CAMS ^c
R & D intensity	R & D intensity of university location(%)	230	0.82	5.95	2.69	1.67	NBS ^d
TTO Quality	National technology transfer institution (1-5 Time sequence)	230	1	5.00	2.57	1.54	THTIDC
Faculty	Number of faculty(university wide)	230	260	5126.00	1299.74	891.20	CERNET
Research Funds	Total Research funding (¥ 000)	230	65534	3891182.00	866398.66	630274.04	CERNET
TTO Income	Income of technology transfer (¥ 000)	230	0	554753.00	26019.00	72228.39	CERNET
Region	Regionl innovation rating index (1-32, the province of university location)	230	1	28.00	7.50	5.82	CASTED
Patents grants	Number of patents grants	230	2	1234.00	205.24	219.73	CERNET
Medicine	Presence of medical school(1 = yes)	230	0	1.00	0.39	0.49	CERNET
Polytechnic	Polytechnic university status (1 = yes)	230	0	1.00	0.52	0.50	CERNET
OFF-USP Enterprise	Total NO.of gtaduated Enterprise from university incubator center	230	0	283.00	67.70	56.59	THTIDC
R&D Quality	Quality rating index of science and engineering (1–5 rating index)	230	1	5.00	3.22	1.12	CAMS
VC Funds	incubator venture capital((1 = yes)	230	0	1.00	0.63	0.48	THTIDC

^a The Financial resource data regarding china universities can be accessed on Ministry of Education, Science and technology development center Website.

^b The data regarding china universities incubator can be accessed on Ministry of Science and technology, Department of High and New Technology Development and Industrialization.

^c The China academy of Management Science produces the annual The Universities evaluation report a project established to Measure University Performance in the china.

^d National Bureau of Statistics of China produces the annual of the national science and technology investment.

Table 2. Regression results for URE income

Dependent/Independent variables	URE income	
	Model 1	Model 2
Patents grants	-0.519 (0.099) ***	-0.471 (0.097) ***
TTO Income	0.236 (0.065) ***	0.223 (0.064) ***
R & D intensity	0.229 (0.056) ***	0.329 (0.059) ***
Research Funds	0.685 (0.102) ***	0.468 (0.119) ***
Controls		
University Reputation		0.266 (0.088) **
Polytechnic		-0.013 (0.075)
Medicine		0.078 (0.087)
Faculty		-0.009 (0.076)
R-squared	0.35	0.41
Observations	230	230

Notes: Number of observations, 230; number of universities, 46. Results from estimating Eq. (1) with URE income as dependent variables.

The income equations are estimated by OLS, while the number equations are estimated using a Negative Binomial model. All regressions include a constant and a complete set of region and year dummies. Standardized coefficients are shown, Standard errors in parenthesis.

+ $p \leq 0.10$.

* $p \leq 0.05$.

** $p \leq 0.01$.

*** $p \leq 0.001$.

Table 3. Regression results for UOEAMC total assets

Dependent/Independent variables	UOEAMC total assets	
	Model 3	Model 4
URE income ^a	0.919 (0.012)***	0.923 (0.012)***
Region	0.015 (0.010) ⁺	0.020 (0.011) ⁺
TTO Income	0.085 (0.012)***	0.080 (0.012)***
Research Funds	0.072 (0.012)***	0.103 (0.016)***
OFF-USP Enterprise	0.266 (0.065)***	0.31 (0.065)***
R&D Quality	0.039 (0.098)	0.228 (0.065)***
Controls		
University Reputation		-0.029 (0.016) ⁺
Polytechnic		0.007 (0.014)
Medicine		0.020 (0.017)
Faculty		-0.031 (0.015) [*]
R-squared	0.34	0.79
Observations	230	230

Notes: Number of observations,230; number of universities, 46. Results from estimating Eq. (1) with UOEAMC total assets as dependent variables. The income equations are estimated by OLS, while the number equations are estimated using a Negative Binomial model. All regressions include a constant and a complete set of region and year dummies. Standardized coefficients are shown, Standard errors in parenthesis. ^a URE income is the predicted number

+ p≤.10.

* p≤.05.

** p≤.01.

*** p≤.001.

Table 4. Regression results for Spin-outs

Dependent/Independent variables	number of spin-outs	
	Model 5	Model 6
URE income ^a	-1.320 (4.100)***	-1.290 (4.010)
UOEAMC total assets ^a	0.332 (0.064)***	0.272 (0.068)***
Region	-0.011 (0.006)*	-0.016 (0.006)**
TTO Quality	0.271 (0.029)***	0.274 (0.027)***
Research Funds	-3.290 (1.170)**	-2.950 (1.210)**
VC Funds	0.177 (0.078)**	0.208 (0.076)**
Patents grants	0.001 (0.001)**	0.007 (0.002)**
Controls		
University Reputation		-0.008 (0.0223)
Polytechnic		-0.291 (0.098)**
Medicine		0.003 (0.112)
Faculty		0.001 (0.001)
Log likelihood	-863.3005	-775.2505
Constant	2.353 (0.170)***	1.850 (0.131)***
Observations	230	230

Notes: Number of observations,230; number of universities, 46. Results from estimating Eq. (1) with number of spin-outs as dependent variables. The income equations are estimated by OLS, while the number equations are estimated using a Negative Binomial model. All regressions include a constant and a complete set of region and year dummies. Standardized coefficients are shown, Standard errors in parenthesis. ^a URE income and UOEAMC total assets is the predicted number

+ $p \leq .10$.

* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$