

Explaining the “University-run enterprises” in China: A theoretical framework for university–industry relationship in developing countries and its application to China[☆]

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Abstract

This paper explains and evaluates the evolution of the UREs (University-run Enterprises) in China by building a new theoretical framework on the university–industry relationship. Unlike the Triple Helix or the New Economics of Science that advocates a certain type (integration or separation) of university–industry relationship, we take a *contingent* or context-specific perspective on the relationship, having the context of developing countries in mind. The framework developed in this paper explains in what condition universities would keep distance from industry or become entrepreneurial to take a part in the functions of industry (i.e. setting up and running their own business enterprises). In this typology the basic determinants are internal resources of university, absorptive capacity of industrial firms and existence of intermediary institutions, as well as the propensity of university for UREs. The paper has 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), given the low absorptive capacity of industrial firms and the underdeveloped intermediary institutions. The recent adjustment of the UREs in China can also be understood in terms of changes in the above three factors, such as universities’ weakened propensity to pursue economic gains, relative decline of superiority of university resources, and improved external environment.

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1. Introduction

Knowledge has increasingly become recognized as a key source of economic growth and firms’ competitiveness. With this trend, as universities are the source of new knowledge, the university–industry relationship (or UIR hereafter) has become an important issue, subject to diverse views and contending perspectives on the appropriate relations between universities and industries. In other words, at the heart of the UIR-related debates lies

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a frequently asked question, “What role should universities play in a national economy?”

A group of scholars (Etzkowitz, 1998, 2002; Etzkowitz and Leydesdorff, 1997, 1999; Etzkowitz et al., 2000; Slaughter and Leslie, 1997; Viale and Etzkowitz, 2004) argue that universities should form direct links with industry to maximize “capitalization of knowledge”, and that academia should be (and is now being) closely integrated with the industrial world. This view is largely referred to as the “Triple Helix” thesis.¹ In contrast, another group of scholars have expressed some concern about the “too” close relations or integration between university and industry. Most prominently, the so-called “New Economics of Science” put forward by Dasgupta and David (1994, p.493) warns that short-run policies that aim to shift resources toward commercial applications of scientific knowledge may seriously jeopardize a nation’s capacity to benefit from scientific advances. Dasgupta and David observe that “Open Science” (academia) and “Proprietary Technology” (industry) are distinctively organized and functionally differentiated spheres, and that a proper division of labor between the two should be maintained in order to maximize the social benefit. Others have echoed this philosophy of the New Economics of Science, such as Rosenberg and Nelson (1994), Stephan (1996), Mowery and Sampat (2004), and Lundvall (2002, 2004). Some in this group also point out that one of the most important roles of universities is to produce academically trained high skill workers, and this observation stems from the belief that indirect links (or arm’s length relationship) between university and industry work quite well.

The contrasting views on the ideal UIR and the role of university have often perplexed policy makers and practitioners in related fields. This is more so from the point of view of those in developing countries, because both views seem to have a common drawback in terms of their *applicability to developing countries*. This is the departing point of this paper.

The core idea of the Triple Helix group is that the “nature of knowledge” in newly emerging industries (typically in biotechnology) is different from that in tra-

ditional industries, and this difference makes it necessary to form a new institutional setup, i.e. the “Triple Helix” comprised of university, industry, and government. To the extent that this group assigns importance to the nature of newly emerging industries, we can say that it has minimum relevance for the situation in most of the developing countries that tend to inherit mature industries from the advanced countries to produce standardized products.

The New Economics of Science has a similar problem in terms of pertinence to developing countries, although it supports the *division* of labor between university and industry rather than *integration* of the two. It assumes that universities make *scientific breakthroughs* and provide *generic knowledge* upon which industry bases its, more or less, trivial applied research. However, this assumption remains problematic in many developing countries where research capacity of universities is backward. Even in more successful developing countries (e.g. Japan in the 1960s and 1970s and Korea in the 1980s), industrial firms (especially, large conglomerates) had a stronger research capacity than local universities. Moreover, universities in developing countries often devote their resources to undergraduate education that mostly utilizes knowledge that is imported from advanced countries, or to applied researches that can easily be adopted by local industrial firms, as in the case of China in the 1980s and the early 1990s.

It is our view that neither the Triple Helix nor the New Economics of Science provides a precisely realistic platform for discussion of the UIR in the *developing countries*. Although some authors (e.g. Jie and Lu, 1995; Turpin and Garrett-Jones, 1997; Min and Ma, 1999; Qiu, 2002; Etzkowitz and Mello, 2004) have addressed the UIR in developing countries (implicitly) by referring to either the Triple Helix or New Economics of Science, they did not critically examine nor compare the two competing views, both of which have underlying assumptions that are more suitable to the *advanced countries*. Thus, many of them have, somewhat arbitrarily, endorsed either of the two views, while neglecting the different context of developing countries. There comes a need to develop a theoretical framework that can explain better the UIR in *developing countries*. More recently, Chang et al. (2005, 2006) have explored the recent changes in the role of universities and the UIR in Taiwan with brief comparisons to neighboring countries (i.e. Korea and Japan). Although they contribute insights to the UIR in East Asian countries, their studies do not make much theoretical distinction between the situation in the *developed* and *developing* countries, either.

Given the lack of a guiding framework suitable for developing countries, academicians and policy makers

¹ The intertwined three in the ‘Triple Helix’ are university, industry, and government. Triple Helix scholars interpret recent trends as follows. Universities and industry, up to now relatively separate and distinct institutional spheres, are each assuming tasks that were formerly largely the province of the other. Governments are offering incentives and encouraging academic institutions to go beyond performing the traditional functions of cultural memory, education and research, and to make a more direct contribution to ‘wealth creation’ (Etzkowitz and Leydesdorff, 1997; p. 2).

in developing countries have experienced a sort of confusion. For instance, China, where universities have run their own business firms (i.e. University-run enterprises, or UREs), has become a “benchmark” for some East Asian countries (esp. Korea and Japan) where universities have had only weak and indirect links with industry. Thus, for instance, Korean universities were suddenly under pressure to try to establish their own companies. On the contrary, however, the Chinese government has recently urged the separation of UREs from universities, and this effort seems to have gained social consensus against the backdrop of allegedly increasing problems. In order to alleviate, if not eliminate, the confusion about the desirable role of university in developing countries, this paper tries to develop a new conceptual framework based on a wide range of literature as well as our own fieldwork in China.

The rest of the paper is organized as follows: Section 2 introduces the recent development of UREs in China. Section 3 develops both a *macro-level framework* that is a *typology* of various governance forms of knowledge industrialization and a *micro-level framework* that explains an individual university’s behavior to set up UREs. In Section 4, we explain the Chinese UREs using the frameworks developed in Section 3. Section 5 further extends the original framework and discusses a broader set of technological development strategies in developing countries including not only the knowledge industrialization through UREs (or “forward engineering”) but also “reverse engineering” and “parallel learning.” We also derive some policy implications for the university–industry relations in developing countries. Section 6 concludes the paper.

2. University-run enterprises in China

Such companies as Lenovo, Founder, and Tongfang had been, by the end of 2002, the top three PC makers in China, although multinational PC makers such as Dell and HP have recently emerged as strong competitors for these local champions. One interesting fact is that both Founder and Tongfang are 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 another academic institution, the Chinese Academy of Sciences.

Besides these PC giants, the first listed software company in China is also a URE, i.e. Dongruan which is run by Dongbei University in Shenyang, the capital city of Liaoning province. In fact, UREs are widespread in China and can be found in every province. According to the statistics of the Chinese Ministry of Education,

by the end of 2001, there were 5039 UREs throughout China. Some of them have already grown to become big companies or listed in stock markets. About 40 UREs are already listed on the stock markets in Mainland China and Hong Kong (see Table 1). The relative importance of the UREs in Chinese industries can also be seen from the fact that 14 out of the Chinese 100 S&T firms in year 2002 were UREs (see Table 2).² According to a recent survey (conducted by Zhongguancun Science Park Information Center and E-business Center of Peking University, 2003), 10.04% (867 firms) of all the firms registered in Zhongguancun district are firms run by universities and public research institutes.

However, the relative importance of UREs in the Chinese economy seems to be changing. The total number of UREs has decreased since the late 1990s (see Table 3)³; the UREs have raised less and less capital through IPOs and the financial performance of many listed UREs have been deteriorating in recent years (Chinese University Technology Transfer, 2002.8, 2002.10). As a consequence, only seven UREs managed to remain in the list of the Chinese 100 S&T firms in year 2005 (Digital Times, August 2005).

Furthermore, the central government seems to have changed its attitude toward UREs. There are no more ambitious promotions of the UREs that can be seen from the “Resolution on accelerating S&T Development,” a joint promulgation of the State Council and the Chinese Communist Party in 1995.⁴ The “Resolution” in 1995 encouraged universities and research institutes to establish high-tech firms using their own S&T capacity, and promoted the formation of strong linkages between academy and industry (Ministry of Education, 1999, p. 90). On the contrary, however, in November 2001, the State Council issued the “Memorandum on the Experiment of Standardizing University-run Enterprises Management at Peking University and Tsinghua University”, which actually calls for separation of UREs from universities.⁵

² The Chinese top-100 S&T firms are selected among the companies listed on the Shanghai and Shenzhen stock exchanges (firms listed on the Hong Kong stock exchange excluded). To select the top-100 firms, the Chinese Ministry of Information applies (with minor modifications) four criteria (i.e. shareholder return, return on equity, revenue growth, revenues of the previous year), which “The Business Week” uses for the ‘Info Tech-100’. The announced rankings mainly represent the previous year’s business performance.

³ In addition, an increasing number of UREs are now more like “spin-offs” that are quite independent from their mother institutions.

⁴ Guanyu Jiasu KexueJishu Jinbude Jueding.

⁵ Guanyu Beijingdaxue Tsinghuadaxue Guifan Xiaobanqiye Guanlitizhi Shidianwentide Tongzhi.

Table 1
UREs listed on the stock markets

Stock code ^a	Abbreviated firm title	Major stockholder
600076	Qingdao Huaguang	Peking University
600091	Mingtian Keji	Peking University
600100	Tsinghua Tongfang	Tsinghua University
600136	Daobo Gufen	Saier Wangluo
600181	Yunda Keji	Yunnan University
600255	Xinke Cailiao	Hefei Polytechnic University
600392	Taigong Tiancheng	Taiyuan Ligong University
600530	Jiaoda Angli	Shanghai Jiaotong University
600601	Fangzheng Keji	Peking University
600624	Fudan Fuhua	Fudan University
600657	Qingdao Tianqiao	Peking University
600661	Jiaoda Nanyang	Shanghai Jiaotong University
600701	Gongda Gaoxin	Haerbin Polytechnic University
600718	Dongruan Gufen	Dongbei University
600730	Zhongguo Gaoke	36 Universities ^b
600750	Jiangzhong Yaoye	Jiangxi Chinese Medical University
600797	Zheda Wangxin	Zhejiang University
600806	Jiaoda Keji	Xian Jiaotong University
600846	Tongji Keji	Tongji University
600857	Gongda Shouchuang	Haerbin Polytechnic University
600892	Huda Keji	Hunan University
000004	Beida Gaoke	Peking University
000150	ST Maikete	Peking University
000532	Aohuadian	Shenzhen Tsinghua University
000537	Nankai Gede	Nankai University
000551	Keda Chuangxin	Chinese S&T University
000590	Ziguang Shengwu	Tsinghua Ziguang
000790	Huashen Jituan	Chengdu Chinese Medical University
000836	Tianda Tiancai	Tianjin University
000915	Shanda Huate	Shandong University
000925	Zheda Haina	Zhejiang University
000938	Tsinghua Ziguang	Tsinghua University
000988	Huagong Keji	Huazhong S&T University
000990	Chengzhi Gufen	Tsinghua Tongfang
H-418	Fangzheng Konggu	Peking University
H-618	Fangzheng Shuma	Peking University
H-8045	Nanda Soft	Nanjing University
H-8095	Beida Qingdao	Peking University
H-8102	Fudan Weidiansi	Fudan University
H-8106	Zheda Lande	Zhejiang University
H-8205	Jiaoda Huiqu	Shanghai Jiaotong University
H-8231	Fudan Zhangjiang	Fudan University

^a Stock codes that start with '600' indicate firms listed on the Shenzhen stock exchange, 'H-' on the Hong Kong stock exchange, and the rest on the Shanghai stock exchange.

^b Zhongguo Gaoke was founded by an alliance of 36 Chinese universities including Shanghai Jiaotong University and Fudan University, etc.

Table 2
UREs in the Chinese top-100 S&T firms (2002)

Ranking	Abbreviated firm title	Mother institution
3	Tsinghua Tongfang	Tsinghua University
12	Zheda Wangxin	Zhejiang University
15	Dongruan Gufen	Dongbei University
18	Qingdao Tianqiao	Peking University
25	Fangzheng Keji	Peking University
38	Nankai Gede	Nankai University
41	Qingdao Huaguang	Peking University
46	Tianda Tiancai	Tianjin University
48	Yunnan Keji	Yunnan University
59	Huagong Keji	Huazhong S&T University
88	Beida Gaoke	Peking University
89	Tsinghua Ziguang	Tsinghua University
95	Jiaoda Angli	Shanghai Jiaotong University
98	Fudan Fuhua	Fudan University

Source: Digital Times, August 2002.

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 the mother institutions (i.e. universities). Moreover, UREs are usually endowed with the *de facto* right to exclusively take advantage of the mother institutions' various assets including research outcomes or resources, such as financial resources, physical spaces, manpower, social links, and even the title of the university as a commercial brand. Thus, we argue that UREs are "spin-arounds" rather than "spin-offs", because they are not really spun "off" from the universities but, on the contrary, remain strongly connected to the mother institutions through a sort of "umbilical cord".

Table 3
University-run enterprises in China (1997–2004)

Year	Number of UREs
1997	6634
1998	5928
1999	5444
2000	5451
2001	5039
2002	5047
2003	4839
2004	4563

Source: Ministry of Education (2002, p.10), Ministry of Education (2004, p.13), Ministry of Education (2005).

3. A new theoretical framework

In order to provide a theoretical explanation of the URE-related phenomenon in China, this section builds a macro- and a micro-level framework.

3.1. Macro-level framework: a typology of university–industry linkages

The URE can be considered as a kind of “governance form”⁶ through which S&T knowledge flows from university to industry, namely knowledge industrialization. Besides the URE, there exist many other governance forms that mediate S&T knowledge flow from university to industry, for example, technology sales, patent licensing, joint research projects (or joint research centers) co-sponsored by universities and firms, joint conferences, spin-off firms, university science parks, and education.⁷ Some of these governance forms are based more on a “market” mechanism, while others are based more on “hierarchical” or “hybrid” mechanisms: the URE can be considered as one of the most hierarchical form, and at the opposite extreme are the technology sales; joint research projects and joint research centers can be characterized as hybrid forms; spin-off firms are at least less hierarchical than the UREs. From this perspective, we can see that the wisdom accumulated in the theory of the firm (e.g. transaction cost economics, resource-based view of the firm) can be useful in understanding a university’s choice among alternative forms of governance for knowledge industrialization. The question as to where to draw the boundary of university, i.e. how to specify the roles of university (for instance, whether a university should establish UREs or not), sounds analogous to the question of firm boundary that the theory of the firm addresses.

⁶ Although Williamson (1999) used this term to discern his own view from the Competence-based View (or Resource-based View, RBV), we use the term in a neutral and broader way. That is, the usage of the term “governance form” in this paper does not necessarily imply that we support Williamson’s transaction cost economics (TCE) in opposition to alternative views in the theory of the firm, which comprises not only TCE but also RBV and others.

⁷ We regard education itself as an alternative governance form of knowledge industrialization because S&T knowledge, embodied in graduates, is transferred to industry when they come to find jobs in industrial firms, although the process is quite indirect and time-consuming. In this sense, our notion of “knowledge industrialization” is a broader concept than other similar terminologies like “capitalizing knowledge” (Etzkowitz et al., 1998) and “academic capitalism” (Slaughter and Leslie, 1997).

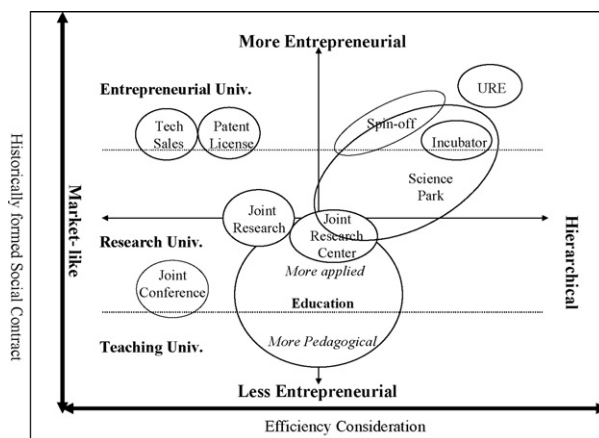


Fig. 1. Macro-level framework. Source: the authors.

However, we must be cautious in applying the theory of the firm to the issue of the governance form of knowledge industrialization, because the focus of our interest is not the boundary of the *firm*, but of the *university*. One of the most salient differences between the firm and the university is the fact that decision-making within the firm is typically guided by economic efficiency, whereas that of university is not always so. According to Branscomb et al. (1999) and OECD (2002), the role of university in a society is determined not only by the economic logic, but also by the “social contract” concerning the division of labor between different organizations (e.g. universities, public research institutes, and industrial firms, etc.). Thus, in discussing a particular governance form of knowledge industrialization that is chosen by a university, we must take into accounts both “economic efficiency” and “social contract.”

The above discussion implies that the various governance forms of knowledge industrialization could be located in a *two dimensional space*, of which one axis represents the economic efficiency consideration and the other axis, the social contract in a given society. Furthermore, we assume that the economic efficiency consideration is reflected in the governance choice between *market and hierarchy*,⁸ and that the social contract in a given society can be captured by examining how *entrepreneurial universities* are. Fig. 1 illustrates the two

⁸ We regard market and hierarchy not as a “dichotomy” but as the two extremes of a “continuum”. Williamson (1975, 1985) has often been criticized for his dichotomy by network theorists (e.g. Chesnais, 1996; Mo, 1996). But, in more recent versions, Williamson himself modified his original dichotomy by adding “hybrid” between the “market” and “hierarchy” (1991). Although Williamson’s “trichotomy” is still under heavy criticism, we try to assimilate, at least in part, his new idea and further extend it into a “continuum”.

dimensional space, or a typology of governance forms of knowledge industrialization.⁹ Different degrees of entrepreneurship of universities (i.e. vertical axis) could be classified into the so-called three different university regimes¹⁰: “Teaching University,” “Research University” and “Entrepreneurial University” (see Fig. 1).

In the typological map, the UREs are placed at the upper right corner (see Fig. 1). This is to say that the URE is an extremely hierarchical form of knowledge industrialization usually adopted by highly entrepreneurial universities. We can locate other forms of knowledge industrialization on the typological map using the same criteria.¹¹ This typology constitutes our macro-level framework, which helps us to determine the environment in which UREs would emerge and grow. Also, the macro-level framework provides a basis for the micro-level framework that is to be developed in the following section.

3.2. Micro-level framework: individual university's decision-making rules

In the previous sub-section, we have constructed a macro-level framework by synthesizing discussions in two different fields of research—theories of the firm and university–industry relationship. Now, we try to develop a micro-level framework that explains an individual university's behavior of setting up UREs.

For this, we will limit our focus to the upper-right corner of the macro-level framework, where the UREs are located. Actually, the very location of the UREs in the macro-level framework gives us a clue to the question of why the URE emerged in China: because the Chinese universities were “highly entrepreneurial” and they preferred “hierarchy” rather than “market” in industrializing their own S&T knowledge.

Yet, this explanation is incomplete in that it does not answer the question, “Why have Chinese universities preferred a hierarchical form (i.e. UREs) to more market-based mechanisms in industrializing their S&T knowledge?”

This question is *similar* but *not equal* to the question of firm boundary, as we have already discussed above. Based on the *similarity*, we might refer to the theories of the firm. In the theories of the firm, however, there co-exist conflicting views (most prominently, transaction cost economics and resource-based view) on the determining factor of the firm boundary. Furthermore, the *dissimilarity* between the questions necessitates the consideration of those characteristics that distinguish the university from the firm. Therefore, prior to constructing the micro-level framework, we will first examine the applicability of the transaction cost economics (hereafter, TCE) and the resource-based view (hereafter, RBV) to the issue of UREs, and incorporate an additional consideration on the uniqueness of the university.

3.2.1. Transaction cost economics versus resource-based view

There has been considerable controversy between TCE and RBV regarding the main determinants of firm boundary. Williamson (1975, 1985, 1991, 1999) elaborated and operationalized the concept of transaction costs initially formulated by Coase (1937). He examined the conditions under which firms choose to abandon market in favor of hierarchy (or integration). He argued that the potential for “opportunistic behavior” is the main determinant of the firm boundary (or vertical scope) and that opportunism is more probable when the “asset specificity” (the degree of sacrifice in productive value when an asset is redeployed to alternative uses and by alternative users) is high.

On the other hand, the RBV of the firm, which has its roots in Penrose (1959) and Richardson (1972), emphasizes the importance of internal resources in guiding firm action. Penrose (1959) explained how companies grow in directions set by their capabilities and how these capabilities themselves slowly expand and alter. Richardson (1972) found that firms tend to specialize in activities for which their capabilities offer comparative advantage, which may, nevertheless, lead the firms into a variety of markets and a variety of product lines. Based on this observation, he argued that what firms would choose to do inside the organization would be “similar activities,” or activities that require the same capability for their undertaking. Penrose and Richardson's idea has been further developed by their followers

⁹ One should not regard the left end of Fig. 1 as representing the “pure market”. Although we regard that governance form as more market-like than others at its right, we do not suggest that the ones at the left end of Fig. 1 (e.g. technology sales) are pure market mechanisms. Actually, what they are based on is not “pure market” but “organized market” (Lundvall, 1985).

¹⁰ For a more detailed discussion, refer to Etzkowitz (1998), Etzkowitz and Webster (1998), and Etzkowitz et al. (2000). Etzkowitz and Webster (1998) named the transition of regimes from a teaching university to a research university the “first academic revolution”, and that from a research university to an entrepreneurial university the “second academic revolution”.

¹¹ Some governance forms have relatively large variations within their categories. For instance, university education includes various forms that require different degrees of entrepreneurship (e.g. pure science and arts versus engineering, MBA, and other practical and applied programs) for the university and different degrees of hierarchy. This variance is illustrated with the size of the circles in Fig. 1.

		TCE	
		Probability of Opportunistic Behavior	
RBV		Low	High
Internal Resource	Strong	(O, X) (i)	(O, O) (ii)
	Weak	(X, X) (iii)	(X, O) (iv)

Fig. 2. Transaction cost economics (TCE) vs. resource-based view (RBV). Note: (1) the ‘O’s or ‘X’s on the left in the parentheses show the forecasts of RBV and those on the right show the forecasts of TCE. (2) ‘O’: internalize the additional activity; ‘X’: outsource the additional activity. Source: the authors; adaptation of Conner and Prahalad (1996, p. 489).

(e.g. Wernerfelt, 1984; Barney, 1986; Conner, 1991; Langlois, 1992; Kogut and Zander, 1992; Conner and Prahalad, 1996) and eventually evolved into an alternative theory of the firm. Furthermore, their core idea is largely shared by “the evolutionary theory of the firm” (Nelson and Winter, 1982).

Due to the differing ideas on the main determinant of firm boundary, TCE and RBV are not always consistent with each other when forecasting a firm’s behavior (see Fig. 2). In a situation where the probability of opportunistic behavior is high (i.e. market transaction cost is high) and the firm has enough relevant resources (i.e. strong internal resources), both TCE and RBV forecast that the firm would internalize the additional activity under consideration (see situation ii in Fig. 2). In the exact opposite case of situation ii (see situation iii), the forecasts of TCE and RBV are also congruous. However, in a situation where the market transaction cost is low, but the internal resources of the firm are strong, TCE forecasts that the firm would outsource the activity, whereas RBV forecasts that the firm would internalize it (see situation i). In the opposite case of situation i, TCE and RBV forecast conversely to the previous example (see situation iv). In sum, in situations i and iv, the forecasts of TCE and RBV are quite different.

Thus, before we apply a theory of the firm to the issue of the UREs, we should either select one of the two views, or reconcile them. Below, we will show that RBV is more suitable in explaining universities’ choice of governance forms of knowledge industrialization, especially at the level of individual organization (i.e. micro-level).

First, we have some reservation about considering “knowledge industrialization” as an ordinary “trans-

action.” We believe that knowledge industrialization, which naturally accompanies *interactive learning*,¹² cannot simply be regarded as an ordinary transaction. Furthermore, the *static* nature of TCE (Chesnais, 1996; Mo, 1996; DeBresson and Amesse, 1991) makes it harder for us to adopt this view in analyzing the *dynamic* processes of knowledge industrialization. On the contrary, RBV, which addresses the way that organizations grow in directions corresponding to their capabilities and how these capabilities themselves expand and alter, is better equipped to deal with the interactive and dynamic processes.

Another drawback of TCE comes from the view’s innate characteristics. TCE asserts that firm boundary is fundamentally determined by the *distribution of the costs* among alternative governance forms (i.e. market, hybrid, hierarchy) for a specific activity under consideration, because economic actors will choose (through estimating and comparing the costs of different governance forms) *the most cost-saving governance form* for the activity. Moreover, according to Williamson, TCE regards the costs of governance forms as being mainly determined by the *asset specificity* of the activity under consideration. That is to say, TCE argues that the *objective* state of things concerned with a specific activity dominates the individual firms’ decision-making on their boundaries, *regardless of individual firms’ different conditions and subjective perceptions* on the internal (i.e. intra-firm) and external states of affairs. In a similar context, Demsetz (1993) criticized Williamson’s TCE by saying that, “The emphasis that has been given to transaction cost . . . dims our view of the full picture by implicitly assuming that all firms can produce goods or services equally well” (1993, p. 64). This aspect of TCE is disadvantageous to our effort to construct a micro-level framework that aims to explain each individual organization’s decision-making concerning its own boundary, i.e. whether to setup UREs or not. The RBV, on the other hand, emphasizes the *heterogeneity* that allows different capabilities and different subjective perceptions among various individual organizations. Thus, we will develop our micro-level framework mainly on the basis of RBV and regard the “internal resource” of the university as one of the most important factor that influences the decision-making related to setting up UREs.

However, RBV also has its relative weaknesses. In contrast to TCE, which explicitly manifests itself as

¹² Note that our concept of knowledge industrialization is broad and encompasses UREs, spin-offs, science parks, joint conference, and even education.

a “comparative institutional point of view,¹³” RBV devotes attention to the *internal* aspect of individual organizations (i.e. internal resources, competence, or capability) with only limited (or implicit) consideration of the *external* environment, which we believe is an unrealistic approach. For instance, even if a firm’s internal resource gets stronger, the firm boundary could remain unchanged or even contract in a situation that the availability of more market-based governance forms is drastically improved due to changes in the external environment. In the same vein, Porter (1994) criticized that RBV is “overly introspective” in that it downplays the importance of external variables. Thus, although we develop the micro-level framework on the basis of RBV, we will explicitly take into account the “external environment” for the university as well.

We decompose the external environment that affects universities’ decision-making on the setting up of UREs (or choosing a governance form of knowledge industrialization) into two elements: (1) the “absorptive capacity”¹⁴ of industrial firms and (2) the “intermediary institutions” that facilitate knowledge flows between universities and industrial firms, for instance, brokerage organizations, IPR protection, related laws and regulations, etc. The first element represents the situation at the counterpart of the university in knowledge industrialization, and the second is the institutional environment that surrounds the knowledge producers (i.e. universities) and knowledge users (i.e. industrial firms). If industrial firms have stronger absorptive capacity and the intermediary institutions are well developed, universities would find it easier to transfer their S&T knowledge to industrial firms without having to setting up UREs themselves.

3.2.2. An additional factor and micro-level framework

So far we have examined TCE and RBV in search of a suitable theoretical basis to explain the boundary of universities. However, we cannot fully explain the behaviors of universities by resorting to the theories of the firm alone. Universities are more than pure economic

¹³ In TCE, the amount of market transaction cost does not solely determine firm boundary. Rather, a firm’s decision on whether to internalize or outsource an additional activity is based on the *comparison* between the cost of “market transaction” and that of “internal coordination”. Williamson (1991) stresses that TCE never examines organization forms separately, but always in relation to alternatives. In this context, he characterizes TCE as “comparative institutional point of view”.

¹⁴ Cohen and Levinthal (1990) insisted that firms need to equip a certain level of related knowledge to absorb external knowledge, and conceptualized the internal capability as “absorptive capacity”.

		External Environment*	
		High	Low
Propensity	Strong	(i) O (X)	(ii) O
	Weak	(iii) X	(iv) X(O)
Threshold		(v) X	(vi) X

Fig. 3. Micro-level framework. *External environment consists of industrial firms’ absorptive capacity and the intermediary institutions. Therefore, the “high” and “low” in this category indicate the levels of absorptive capacity and the development of intermediary institutions. O: would establish UREs; X: would not establish UREs. Source: the authors.

actors. If they are not willing to pursue economic gains for some reason or another, they could simply remain in the “ivory tower.” In other words, they would not set up UREs regardless of the internal resources and external environment. Therefore, we should consider university’s “propensity to pursue economic gains” as an additional factor.

Based on the preceding discussion, we now construct the micro-level framework. Meyer-Krahmer and Schmoch (1998) observe that there are various channels that could link university and industry (e.g. contract research, collaborative research, informal contacts, seminars, education, etc.) and that the relative importance of each channel differs from sector to sector and from country to country. Extending this insight, we maintain that the differences could be explained by several factors. Our micro-level framework (Fig. 3), which aims to determine the circumstances under which individual 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*. Regarding the first factor of the university’s “propensity” to pursue economic gains, we observe that a certain level of “propensity” is a *prerequisite* (or a necessary condition) for a university to set up a URE. The second factor is the university’s “internal resource” that is relevant to launching a firm. We assume that a university with stronger internal resource relevant to launching a firm (e.g. technological knowledge, brand power, skilled manpower, trust among the members, and accumulated similar experiences, etc.) would be more prone to setup a URE. The third factor is the “external

environment.” We presume that low absorptive capacity of industrial firms and underdeveloped intermediary institutions would constitute an external environment that induces universities to set up their own business firms (i.e. UREs). Also, we observe that the signal of “internal resource” would be more dominant over (but, not without exceptions) that of “external environment” especially when the two contradict each other. The main points of the micro-level framework could be summarized as follows:

- Universities with an above-threshold level of propensity to pursue economic gains and strong internal resources are prone to establish UREs (situations i and ii). In addition, if the external environment is barren (i.e. industrial firms’ absorptive capacity is low and intermediary institutions are underdeveloped), universities will set up UREs without hesitation (situation ii). However, if the external environment allows universities other governance forms of knowledge industrialization (thanks to the strong absorptive capacity of industrial firms and well-developed intermediary institution), they will not always pursue UREs (situation i).¹⁵
- Universities with above-threshold propensity to pursue economic gains, but whose internal resource is weak, are not prone to establish UREs (situation iii and iv). However, some would establish UREs when the external environment induces them to do so (situation iv).
- Universities, in which the level of propensity to pursue economic gains is below the threshold, will not establish UREs *regardless of* the strength of internal resources and external environment (situations v and vi).

4. Explaining the emergence and growth of the UREs in China

As mentioned before, UREs have become an important part of Chinese economy especially in high-tech sectors by the late 1990s. Now, we are to answer the question, “Why have UREs emerged in China?” For this, we will show that the Chinese situation during the mid 1980s

to the 1990s could be characterized as situation ii of the micro-level framework (Fig. 3), where UREs would surely emerge and grow. As shown in Fig. 3, situation ii is characterized by three conditions: strong propensity of universities to earn money, strong internal resource, and barren external environment (i.e. low absorptive capacity of industrial firms and underdeveloped intermediary institutions). We examine each of the three conditions in what follows.

4.1. Strong propensity to pursue economic gains

In the mid 1980s, the Chinese government shifted the focus of the “Reform and Open Door Policy” (*Gaige Kaifang*) from the agricultural sector to the industrial sector and to science, technology, and education.¹⁶ In March 1985, the Central Committee of the Communist Party promulgated the “Resolution on the Reform of Science and Technology System”.¹⁷ The “Resolution” attempted to materialize the, so-to-speak, *Yikao-Mianxiang* guideline proposed by the central leadership in 1982, which proposed that economic development must ‘rely on’ (*Yikao*) S&T, while S&T research must ‘turn to’ (*Mianxiang*) economic construction. Moreover, as a practical measure of the Resolution, the central government in China started to reduce grants for academic institutions.

Under the strong influence of the Resolution, Chinese universities were encouraged to engage in “socialist economic construction”. The financial difficulties caused by the grant cut especially pressured universities to find alternative sources of funds in order to survive, and also to consider setting up their own enterprises, i.e. UREs. In other words, since the mid 1980s, “academic entrepreneurship” in Chinese universities has been supported by “social contract”, and the propensity of individual universities to engage in economic activities has been heightened.

4.2. Strong internal resources

Another condition for the emergence and growth of the UREs is the existence of “strong internal resources” in universities. Such strong internal resources in Chi-

¹⁵ The parenthesized ‘O’ or ‘X’ in Fig. 3 indicate the university’s decision based on the external environment (i.e. availability of alternative forms). Although we believe that the internal factors (i.e. propensity and internal resources) would dominate over the external factor (i.e. availability of alternative forms) in an individual university’s decision-making, we do not exclude the possibility that the university decides based on the external signals.

¹⁶ Many start-up companies have emerged during the mid 1980s. By 1985, there were about 100 such enterprises clustered in northwestern Beijing, *Zhongguancun*, where many of the best R&D institutes and universities in the country were located. But the phenomenon was not restricted to Beijing. Many similar firms appeared in other large cities, starting around 1984–1985 (Gu, 1999, pp. 35–36).

¹⁷ *Guanyu Kexue Jishu Tizhi Gaigede Jueding*.

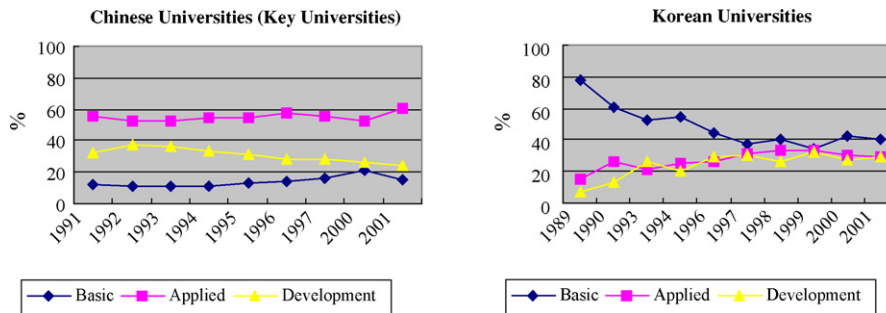


Fig. 4. Nature of research in the Universities of China and Korea. Source: National Bureau of Statistics and Ministry of Science and Technology (various years), Ministry of Science and Technology (various years).

nese universities originated from (1) an application- and development-oriented research tradition, and (2) *de facto* property rights and social capital nourished in the universities, which are related to the concept of “*Danwei* (work unit), a very China-specific condition.

4.2.1. A tradition of application and development-oriented R&D

The Chinese universities (even major research universities) have primarily focused on applied research and development rather than basic research. The share of applied research and development in total R&D expenditure of the Chinese National Key universities (*Zhongdian Daxue*) exceeded 80% until very recently.¹⁸ We could see a clear contrast when Chinese universities were compared to Korean counterparts. The share of basic research in Korean universities was as high as around 80% in 1989. Despite a rapid decrease during the early 1990s, the share of basic research in Korean universities has remained at around 40% since the late 1990s (see Fig. 4).

This downstream tendency of Chinese universities originated from the very unique and specific division of labor across different institutions such as the university, public research institute, and industrial firm. Under the planned regime, the Chinese firms took up only a single function on the value-added chain, which is manufacturing, in addition to some other social security functions (housing, medical service, education, etc.), which are outside of the value-added chain (Naughton, 1997, p. 187). The Chinese firms lacked such functions as strategy formulation, R&D, and marketing that have been taken up by the ministries in charge of these firms. In this sense, they resembled “branch plants” rather than

corporations that are responsible for their own destiny in an uncertain market environment. Furthermore, for such firms that are narrowly specialized (at least viewed from the standpoint of the value-added chain), the Chinese academic institutions often had to produce actual “prototypes,” or “samples,” of the final products that the firms would reproduce on a larger scale. Through the practice of those downstream activities, the Chinese universities were able to accumulate experience and know-how related to actual production, which then generated valuable internal resources in setting up UREs.

In other words, the pre-existing tendency of the Chinese universities toward downstream activities (i.e. applied and developmental research and practice of manufacturing prototypes) has facilitated their establishment of UREs. This is in line with Richardson (1972)’s notion of “similar activities” which lead to the expansion of organizational boundary.¹⁹

4.2.2. De facto property right and social capital nourished in “*Danwei*”

In discussing the internal resources of Chinese universities, the social or cultural factor specific to China should be considered together. Every urban organization in China, including universities, is considered a *Danwei* which is often translated into work unit. As Naughton (1997, p. 170) puts it, it is a microcosm of urban society in China, into which individuals are born, live, work, and die in China²⁰. Furthermore, the *danwei* is a self-sufficient and multifunctional social community

¹⁸ Unfortunately, statistics before 1990 were not available. However, we have good reasons to believe that basic research was not active even in the 1980s when universities were just recovering from the Cultural Revolution that devastated the intellectual world.

¹⁹ Richardson (1972) argued that an organization tends to integrate additional activities, or perform them inside the organization, when they are “similar” to the original/traditional mission of the organization.

²⁰ According to Lü and Perry (1997, pp. 5–6), *danwei* has the following attributes: (1) personnel power, (2) communal facilities (often in the form of a compound with living quarters physically separated from the outside by walls), (3) independent accounts and budgets, (4) urban or nonagricultural purview, and (5) public sector.

that excludes those who are not members, while at the same time provides a basis for integrating those within it into an effective social, economic, and political unit (Bjorklund, 1986; Lü and Perry, 1997).

Due to this nature of the *danwei*, Chinese universities as a *danwei* have been able to exercise “*de facto* property rights” (including intellectual property rights) over the assets in (or the assets newly generated in) the institutions (i.e. universities), even though those property rights, in principle, belong to the “nation” or the “Chinese people as a whole.” Here, we can observe the interesting fact that Chinese universities have enjoyed an IPR regime that is similar to that of the United States after the Bayh-Dole Act. Chinese universities have been able to commercially exploit intellectual properties generated from their research projects (including ones funded by the central government). Although the Chinese version of the Bayh-Dole Act was officially promulgated as late as 2002, there has long been a *de facto* Bayh-Dole regime (even before the Chinese patent law was legislated in 1985).²¹ This *danwei* nature of the Chinese universities is one factor that is distinct in comparison with the former Soviet Union or East European Socialist countries.

Another important resource that the Chinese universities enjoy as a *danwei* is “trust,” or “social capital.” *Danwei* members usually reside together in a specific geographic boundary. As a consequence, extended contacts among the *danwei* members during on- and off-duty hours are believed to contribute to strengthening trust among them. In many empirical studies, *danwei* members proved to be highly reliable partners, inferior only to family members and best friends in terms of trustworthiness (Li and Liang, 2002; Wang and Liu, 2002). Trust has been widely accepted as an essential social capital for successful innovation (Hofstede, 1994; Kim, 1997; Fukuyama, 1995; OECD, 1992). The same might be true for the formation of a high-tech firm.

4.3. Barren external environment for transferring S&T knowledge

As mentioned in Section 3.2, universities are assumed to consider the external environment in deciding whether or not to set up UREs. Furthermore, we argued that the external environment that affects universities’ decision-making on UREs (or choosing a governance form of knowledge industrialization) could be understood by

examining the “absorptive capacity” of industrial firms and the “intermediary institutions” that facilitate knowledge flows between universities and industrial firms.

Measuring the Chinese firms’ absorptive capacity and evaluating the development of intermediary institutions in China require extended research that is beyond the scope of this paper. However, by adopting some simple and frequently used proxies for them, we could conceive a picture of the external environment for the Chinese universities during the mid 1980s to the late 1990s. R&D intensity and education intensity show that the absorptive capacity of the Chinese firms has not been strong at least until the late 1990s (see Fig. 5). Also, existing studies on China’s technology exchange market (Lu, 2004) and IPR protection (Potter and Oksenberg, 1999; Eun, 2004) support the argument that the development of intermediary institutions in China is still at the primary stage, despite the rapid growth and improvement since the late 1990s.

Furthermore, through a series of interviews with directors in universities and public research institutes, we have verified that the external environment surrounding the academic institutions was barren in the early post-reform period in China. According to the directors of academic institutions, setting up UREs often seemed to them the only feasible means of knowledge industrialization until around the mid (or late) 1990s. A director of the department of engineering physics at Tsinghua University, who played a pivotal role in launching Tsinghua Tongfang Nuclear Energy Ltd., said:

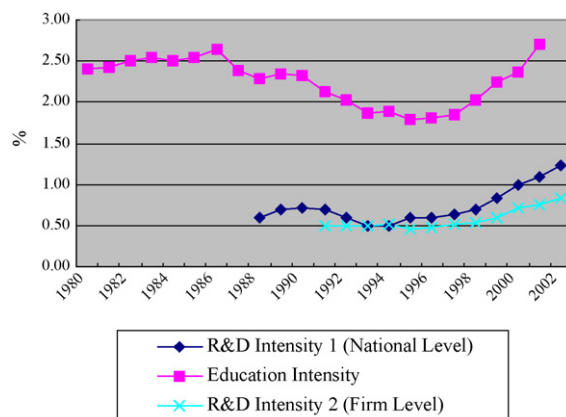


Fig. 5. Education and R&D intensity of China. Note: (1) education intensity = government budgetary expense for education/GDP (%). (2) R&D intensity (National level) = GERD/GDP (%). (3) R&D intensity (firm level) = R&D expenditure/sales revenue (in LMEs) (%). Source: calculated from the figures in National Bureau of Statistics and Ministry of Science and Technology (2002, 2003), National Bureau of Statistics (2004), Ministry of Science and Technology (2003).

²¹ GuanyuGuojiaKeyanJihuaXiangmuYanjiuChengguoZhishiChan-guanGuanlideRuoganGuiding.

It was very hard to find a firm that has a capability to commercially develop our technologies, thus, setting up an URE was actually the only feasible means of knowledge industrialization. Professors and researchers were dispatched to the newly founded URE in order to commercialize the very technology that they initially created at the university lab. This was called “transplanting with soil” (*DaituYizhi*). We thought this was inevitable in the specific condition at those days (the authors’ interview, 2003.10).

In the same context, a vice president of the General Research Institute for Nonferrous Metals (or GRINM) explained:

We had tried licensing our technologies to outside firms. But, few of them were successful. They even failed to pay royalties that agreed upon at the time of contracts. So, we have considered first exploiting our technology for ourselves, before transferring to other firms (the authors’ interview, 2004.4).

5. Beyond knowledge industrialization

5.1. Extending the framework

Up to now, we have focused on the “knowledge industrialization through UREs,” which Lu (2000) labeled as “forward engineering,” pointing to the fact that new or nascent S&T knowledge in university labs is processed in *top-down* fashion until it is applied to commercial uses (e.g. final products). However, forward engineering is only one form of technological development strategy for developing countries. Besides forward engineering, the literature includes many works on a more traditional technological development strategy, namely “reverse engineering”. This refers to a *bottom-up* mode of technological development strategy that entails the acquisition of technological principles by autopsying final (typically, imported) products. Actually, it is well-known that some East Asian economies (e.g. Japan, Korea) achieved technological catch-up through reverse engineering (Kim, 1997). Furthermore, we could also think of “parallel learning” as a third technological development strategy. It is a *horizontal* process between industrial firms rather than a vertical (*top-down* or *bottom-up*) one between upstream knowledge generators (i.e. universities) and downstream knowledge users (i.e. industrial firms). A close example of this parallel learning would be the case of indigenous development, and later mass production by the Great Dragon Company (Julong), of digital automatic telephone switches in China with “parallel” learning from a foreign joint venture, Shanghai-Bell (Mu

and Lee, 2005). In sum, there seem to be at least three different technology development strategies: forward engineering, reverse engineering, and parallel learning.

Although the framework developed in the previous sections was devised in order to address the knowledge industrialization through UREs (or forward engineering), it could be extended to cover diverse technology development strategies (i.e. forward engineering, reverse engineering, and parallel learning). The extension is possible because there is a crucial link that relates all the three distinct technology development strategies. The crucial link is the absorptive capacity of industrial firms, which affects the feasibilities of each of the three strategies.

On the one hand, as discussed in Section 3, the absorptive capacity of industrial firms is one of the major elements that constitute the external environment, which is one of the three factors that determine the emergence and growth of UREs.²² Therefore, *ceteris paribus*, a strong absorptive capacity of existing firms would result in less UREs, as has been the case in Korea. If existing industrial firms have a strong absorptive capacity for the knowledge generated and disseminated from universities, it would be less probable that universities would set up their own business firms (i.e. UREs) for themselves. Rather, the universities would choose other channels (i.e. alternative governance forms) of knowledge industrialization.

On the other hand, the absorptive capacity also plays important roles in reverse engineering and parallel learning. Many authors have pointed out that the assimilation of outside technologies, i.e. the technologies embodied in (imported) final products in the case of reverse engineering and other advanced companies (typically, foreign or multinational firms) in the case of parallel learning, is heavily dependent upon the development of domestic absorptive capacity (Tolentino, 1993; Kim, 1997; Young and Lan, 1997; Gabriele, 2001; Huang, 2003; Chen and Chen, 2004).²³

Furthermore, Tolentino (1993) insists that there exists a “threshold” level of domestic technological competence (or absorptive capacity), below which foreign direct investment might stifle the domestic-capability building process and thus provoke underdevelopment or dependent development, or even technological decline.

²² Meyer-Krahmer and Schmoch (1998) point out that the interaction between universities and industrial sectors is largely determined by the absorptive capacity in each institution, which makes interaction possible in the first place.

²³ Kim (1997) insists that Korea’s relatively high level of education played a very important role in Korea’s successful reverse engineering and catching-up.

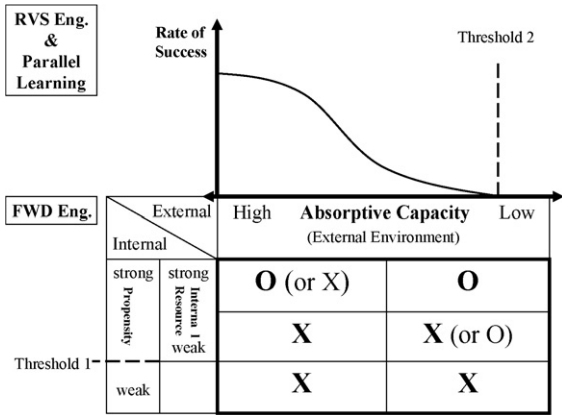


Fig. 6. Extended framework. Source: the authors.

Although the concept of a threshold is not seen in the literature of reverse engineering, we believe it is quite natural to conceive that there exists a threshold in reverse engineering that is similar to that of parallel learning. Thus, we reason that the rate of success in reverse engineering and parallel learning would increase as the domestic firms’ absorptive capacity is getting stronger above a certain threshold level.

By summing up the above discussions on forward engineering, reverse engineering, and parallel learning, we can devise an extended framework that encompasses the three different technology development strategies, as shown in Fig. 6. The lower half of the extended framework represents the discussions on forward engineering, and the upper half represents the discussions on reverse engineering and parallel learning. As one can see in this figure, the absorptive capacity forms a crucial link between the different technology development strategies.

Furthermore, if we shed light on the “feasibility” (or probability of success) of each technology development strategy in a specific situation, the 3 × 2 matrix at the bottom of the extended framework can be redrawn as in Fig. 7. The striped areas in Fig. 7 indicate feasible zones of three distinct technology development strategies. Matrix (c) in Fig. 7, which synthesizes the two matrixes above it, could be understood as another version of the extended framework. As we will show in the following, matrix (c) could be used as a map in evaluating the UIR in a given country.

5.2. A preliminary evaluation of the recent change in the UREs

As mentioned earlier in this paper, the Chinese UREs have recently experienced a sort of downturn. Accord-

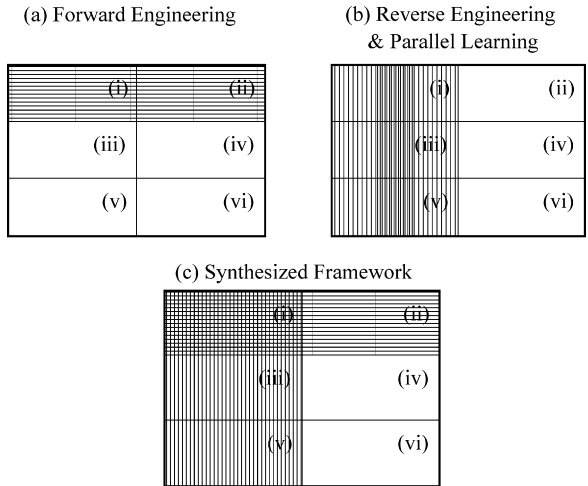


Fig. 7. Map of feasible zones of different technological development strategies. Source: the authors.

ing to our frameworks, the recent trend can also be interpreted in terms of the changes in the three pivotal factors (i.e. propensity, internal resources, external environment) that contributed to the emergence and growth of the UREs in China.

Firstly, the propensity of Chinese academic institutions to directly engage in economic activities has been weakened. As the Chinese government has recently increased investment in higher education, universities (esp. key research-oriented universities) have been relieved from acute financial difficulties that they had experienced until the late 1990s.²⁴ Subsequently, the pressing need for universities to make money for survival has naturally been diminished. Also, increasing reports about unsuccessful UREs have discouraged the universities from engaging in business activities. Even in universities of which UREs have been performing quite well, many faculty members became critical of devoting too much time and energy to establishing and managing UREs. Many graduate students have also grumbled over by-jobs of their professors. The critics argue that the quality of education could deteriorate as a large share

²⁴ The Chinese central government has recently launched the so-called “211 project”. The project aims to breed 100 world-class universities in China. For this, the government has provided considerable financial support to 100 top universities. Also, several key universities have received special 3-year grants for quality improvements in 1998 (for example, Peking and Tsinghua University each received 1.8 billion RMB. Fudan, Zhejiang and Nanjing University each received 1.2 billion RMB. Zhongshan University received 300 million RMB from the central government and 900 million RMB from the provincial government) after former President Jiang Zemin announced the goal of building world-class universities in China (Mohrman, 2003).

of limited resources in universities is devoted to UREs. This criticism was sometimes shared by and reinforced by high-ranking university officers.²⁵ Against this backdrop, the government's initiation of URE reform has considerably weakened the propensity of universities to directly engage in economic activities.²⁶

Secondly, the relevant internal resources available to universities for the establishment and operation of business enterprises seem to have been relatively weakened by the growth of industrial firms and the huge influx of multinational enterprises with global brands and state-of-the-art technologies. Furthermore, as reform of the *danwei* system continues, the unique strength of university as a *danwei* appears to be gradually diminishing²⁷. In addition, the above-mentioned criticism on the UREs raised by university people (i.e. faculty members and students) indicates the fact that the activity of running business enterprises is not so 'similar' (refer to Richardson, 1972) to the main tasks (i.e. scientific research and education) of the university.²⁸

Thirdly, the recent reduction in the number of new UREs in China could also be attributed to the enhanced absorptive capacity of industrial firms and improved intermediary institutions.

The above-mentioned changes can be illustrated on the map of feasible zones (i.e. Fig. 7) as in Fig. 8, where

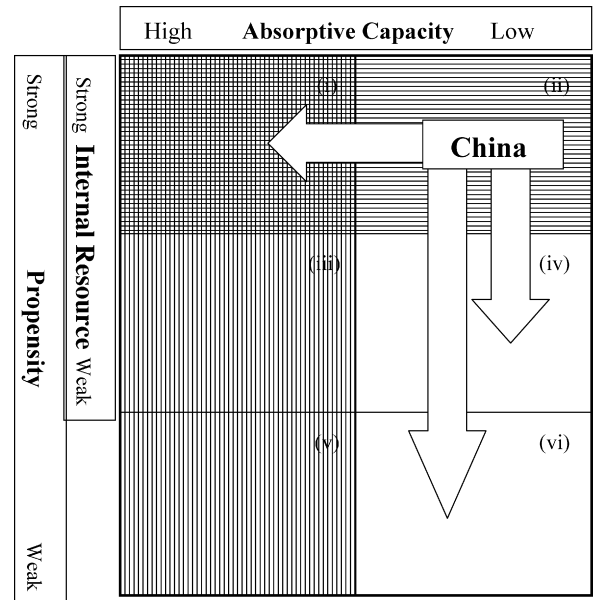


Fig. 8. Recent changes in internal and external conditions of Chinese universities. Source: the authors.

the leftward arrow represents the improvement of the external environment; the short downward arrow, the weakened internal resources; the long downward arrow, the decline in the propensity of universities to engage in economic activities.

The exact location of the recent China in Fig. 8 can be identified by combining the three vectors (i.e. arrows). However, the exact length of each vector (i.e. degree of change in each of the three factors) has not been determined here and requires an empirical study that goes beyond the scope of this paper. Nevertheless, some interesting implications can be drawn from the above discussion.

First, if the enhanced absorptive capacity of industrial firms (i.e. leftward vector) were the driving force of the recent downturn of UREs, China might expect more reverse engineering and parallel learning from now on. This indicates that the downturn of UREs does not necessarily mean bad news for China. Actually, the Japanese (in the 1960s and 1970s) and Korean (in the 1980s and 1990s) universities have contributed to national economic growth not by conducting forward engineering but by providing well-trained graduates in a large scale and catalyzing reverse engineering and parallel learning in industrial firms (Japan and Korea in their fast growing stages could be located at situation iii or v in Fig. 8).

Second, if the downward vectors were the driving forces of the recent change, China would have difficulties not only in forward engineering but also in reverse engineering and parallel learning, falling into the danger

²⁵ Professor Zhang Weiyong, advisory officer for the president of Peking University, argued that university leaders had spent too much time in taking care of UREs, and that they should not spend more than 5% of their working hours to UREs in his speech at the year 2003 opening ceremony of Peking University (<http://kjcy.pku.cn/lunt/2003tbh/tbh-zhangweiyong.htm>).

²⁶ In November 2001, the State Council issued the "Memorandum on the Experiment of Standardizing University-run Enterprises Management at Peking University and Tsinghua University". This memorandum is widely accepted as a milestone for the reform of UREs. As indicated in the title of the memorandum, the reform is now on the initial (experimental) stage. Detailed measures to reform the UREs are still at large. However, it is quite clear that the government's general inclination is to separate the intertwined relationship between the firms and mother academic institutions to a certain degree. The main idea of the memorandum is to separate universities from the daily operation of their business firms (*XiaoqiFenkai*), and to relieve them from unlimited liability for those firms.

²⁷ The Chinese *danwei* system, of which a salient characteristic is its closeness or exclusiveness, is now being restructured toward a more open and regional (rather than vocational) community-based system. For details, refer to Cheng (2000), Sun (2003, 2004).

²⁸ Since the late 1990s, major Chinese universities have placed greater importance to basic research (or upstream research) rather than quick-to-use applied research and development (or downstream research) in response to the '211 project' (refer to footnote 24) and the so-called 'Invigorating China through Science and Education Strategy' (*kejiaoxingguo*) initiated by the central government and top leadership.

of “dependent development” and even “technological decline” that Tolentino (1993) and other authors have warned against. The undesirable situation could be found in Latin American countries. Latin American universities have often been criticized for being elitist and just “ivory towers,” and for being disconnected to domestic industries²⁹ (Arocena and Sutz, 2001). This means that Latin American universities have had below-threshold propensity to respond to industrial needs and to pursue economic gains. Furthermore, the role of Latin American universities as technology transfer agents for domestic industrial firms has been further minimized as many domestic firms were crowded out by multinational companies in the 1990s. On the other hand, Latin American firms have been relatively weak in their absorptive capacity, at least partly due to the small-scale and elitist higher education system. This indicates that the situation of Latin American countries could be represented by situation vi in Fig. 8, where none of the three technology development strategies (i.e. forward engineering, reverse engineering, parallel learning) could be strong.

Above discussion indicates that the recent downturn of Chinese UREs *per se* could be either good or bad news for China. Rather, it should be evaluated in terms of the causes for the changes and in comparison with the extent of reverse engineering and parallel learning: if reverse engineering and parallel learning have become more active and strong based on the enhanced absorptive capacity of industrial firms and they are causing the UREs to shrink, it is a good news for the Chinese economy as a whole. On the contrary, if the decline of UREs has been driven by weakened propensity and internal resources of the universities but not accompanied by intensification of reverse engineering and/or parallel learning associated with stronger absorptive capacity of industrial firms, it would be a bad news.

Also, directly from the above discussion, we could draw a policy implication that China and other developing countries should at least avoid the *gloomy* situation that none of the three technological development strategies is feasible (illustrated by situations iv and vi in Fig. 8) and that they should pay a special attention to enhancing the absorptive capacity of industrial firms.

6. Conclusions

This paper explains and evaluates the evolution of the UREs (University-run enterprises) in China by building

a new theoretical framework on the university–industry relationship. While Triple Helix advocates, and New Economics of Science criticizes, close integration of university and industry, we take a context-specific perspective on the relationship. In the context of developing countries, the relative strength of universities and their roles as a knowledge generator vis-à-vis firms tend to vary by country and change over the courses of economic development in a country, and thus diverse forms of UIR are possible, between integration and separation, depending upon the ever-evolving context of the countries’ specific economic conditions. The Chinese path shows a journey from close integration to gradual separation within the period of less than two decades.

The framework developed in this paper explains in what condition universities would keep distance from industry or become entrepreneurial to take a part in the functions of industry (i.e. setting up and running their own business enterprises). In this typology the basic determinants are internal resources of university, absorption capacity of industrial firms and existence of intermediary institutions, as well as the propensity of university to pursue economic gains.

The paper has 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), given the low absorptive capacity of industrial firms and the underdeveloped intermediary institutions. The recent adjustment of the UREs in China can also be understood in terms of changes in the above three factors, such as universities’ weakened propensity to pursue economic gains, relative decline of superiority of university resources, and improved external environment.

The whole process of emergence, growth and changes of the UREs in China can also be considered in relation to the alternative strategies for technological development, i.e. forward engineering, reverse engineering, and parallel learning that is discussed in the extended version of the theoretical framework of the paper. If reverse engineering and parallel learning are active based on strong absorptive capacity of industrial firms (as in Japan and Korea), underdevelopment of UREs is not something deplorable. In contrast, in a specific condition that resembles China in the 1980s and 1990s, forward engineering could be a realistic technology strategy. This implies that any success story of UREs should be taken with a grain of salt because there is a sort of trade-off between forward engineering on the one hand and reverse engineering and parallel learning on the other hand. Furthermore, Chinese universities have not managed UREs without costs, and

²⁹ This is in line with the notion of the “social loneliness” of Latin American universities suggested by Arocena and Sutz (2001).

the costs included the lost time for academic research and education.

Also, it is quite straightforward that developing countries should be careful lest they are trapped in a situation where none of forward engineering, reverse engineering, and parallel learning is active. Also, the extended framework indicates that a sure dose for avoiding this dismal situation is to enhance absorptive capacity of industrial firms. In this case, the role of universities in developing countries is also to provide academic training to future or potential workers, who would then contribute to enhancing absorptive capacity of the industry. This policy remarks is also applicable to China where UREs seem to be on a downturn recently.

The universities in China have played important roles in technological development of the country by establishing UREs when absorptive capacity of industrial firms was weak and intermediary institutions were underdeveloped. However, the URE model (university–industry integration) seems neither to be free of costs and nor to be sustainable forever. Thus, developing countries had better strike a balance between the “supply-side” technology policy that emphasizes the direct involvement of university in technological development and the “demand-side” policy that attaches importance to the role of university in building capabilities of S&T knowledge users (e.g. industrial firms) through education. Of course, the Chinese URE model could be applicable in some emerging science-based sectors (e.g. Biotechnology) or in countries that share the conditions of 1980s and 1990s of China (e.g. post-socialist countries). Further research on the cases of more sectors and countries are to come in the future.

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References

- Arocena, R., Sutz, J., 2001. Changing knowledge production and Latin American universities. *Research Policy* 30, 1221–1234.
- Barney, J.B., 1986. Organizational culture: can it be a source of sustained competitive advantage? *Academy of Management Review* 11, 656–665.
- Bjorklund, E.M., 1986. The Danwei: socio-spatial characteristics of work units in china's urban society. *Economic Geography* 62 (1), 739–758.
- Branscomb, L.M., Kodama, F., Florida, F. (Eds.), 1999. *Industrializing Knowledge: University-Industry Linkages in Japan and the United States*. The MIT Press, Cambridge, MA.
- Chang, Y.-C., Chen, M.-H., Hua, M., Yang, P.Y., 2005. Industrializing Academic Knowledge in Taiwan. *Research-Technology Management* 48, 45–50.
- Chang, Y.-C., Chen, M.-H., Hua, M., Yang, P.Y., 2006. Managing academic innovation in Taiwan: towards a ‘scientific-economic’ framework. *Technological Forecasting and Social Change* 73, 199–213.
- Chen, J., Chen, Y., 2004. The impact of FDI on the regional innovation capability and competitiveness: evidence from China, Paper Presented at the 2nd Globelics Conference. Beijing, China, October.
- Cheng, S.W., 2000. Reform of the Chinese Shiye Danwei (in Chinese). Minzhu yu Jianshe Chubanshe, Beijing.
- Chesnais, F., 1996. Technological agreements, networks and selected issues in economic theory. In: Coombs, R., Richards, A., Saviotti, P.P., Walsh, V. (Eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*. Edward Elgar, Cheltenham, pp. 18–33.
- Chinese University Technology Transfer, 2002.8.
- Chinese University Technology Transfer, 2002.10.
- Coase, R., 1937. The nature of the Firm. *Economica* 4, 386–405.
- Cohen, W.M., Levinthal, D.A., 1990. Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, vol. 35 (1), Special Issue: Technology, Organizations, and Innovation, pp. 128–152.
- Conner, K.R., Prahalad, C.K., 1996. A resource-based theory of the firm: knowledge versus opportunism. *Organization Science* 7 (5), 477–501.
- Conner, K.R., 1991. A historical comparison of resource-based theory and five schools of thought within industrial organization economics: do we have a new theory of the firm? *Journal of Management* 17 (1), 121–154.
- Dasgupta, P., David, P.A., 1994. Toward a new economics of science. *Research Policy* 23, 487–521.
- DeBresson, C., Amesse, F., 1991. Networks of innovators: a review and introduction to the issue. *Research Policy* 20, 363–379.
- Demsetz, H., 1993. The theory of the firm revisited. In: Williamson, O.E., Winter, S.G. (Eds.), *The Nature of the Firm: Origins, Evolution, and Development*. Oxford University Press, New York, pp. 159–178.
- Digital Times, August 2002.
- Digital Times, August 2005.
- Etzkowitz, H., Leydesdorff, L. (Eds.), 1997. *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations*. Pinter, London.
- Etzkowitz, H., 1998. The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. *Research Policy* 27, 823–833.
- Etzkowitz, H., Leydesdorff, L., 1999. “The future location of research and technology transfer”. *Journal of Technology Transfer* 24, 111–123.
- Etzkowitz, H., Webster, A., 1998. Entrepreneurial science: the second academic revolution. In: Etzkowitz, H., Webster, A., Healey, P. (Eds.), *Capitalizing Knowledge: New Intersections of Industry and Academia*. State University of New York Press, Albany, pp. 21–46.
- Etzkowitz, H., Webster, A., Gebhardt, C., Terra, B., 2000. The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy* 29, 313–330.
- Etzkowitz, H., Webster, A., Healey, P., 1998. *Capitalizing Knowledge: New Intersections of Industry and Academia*. State University of New York Press, Albany.
- Etzkowitz, H., 2002. *MIT and the Rise of Entrepreneurial Science*. Routledge, London.

- Etzkowitz, H., Mello, J., 2004. Rise of Brazilian triple helix. *International Journal of Technology Management and Sustainable Development* 2 (3).
- Eun, J.-H., 2004. The actual state of the IPR protection in China: problems, structural causes, and implications for Korea (in Korean). *Intellectual Property Review* 1 (2), 74–98.
- Francis, C.B., 1999. Bargained property rights: the case of China's high-technology sector. In: Oi, J.C., Walder, A.G. (Eds.), *Property Rights and Economic Reform in China*. Stanford University Press, California, pp. 226–247.
- Fukuyama, F., 1995. *Trust*. Translated by S.H. Koo into Korean, 1996. Seoul: Korea Economic Daily Press.
- Gabriele, A., 2001. *Science and Technology Policies, Industrial Reform and Technical Progress in China: Can Socialist Property Rights be Compatible with Technological Catching up?*, UNCTAD Discussion Paper No.155.
- Gu, S.L., 1994. Spin-off Enterprises in China: Channeling the Components of R&D Institutions into Innovative Businesses, UNU/INTECH Working Paper No.16.
- Gu, S.L., 1999. *China's Industrial Technology: Market reform and organizational change*. Routledge, London.
- Hofstede, G., 1994. *Cultures and Organizations*. Harper Collins Publishers, London.
- Huang, Y., 2003. *Selling China: Foreign Direct Investment during the Reform Era*. Cambridge University Press, Cambridge.
- Jie, J.H., Lu, X.Z., 1995. Inquiry into the barriers in S&T collaboration between university and enterprises (in Chinese). *Keyan Guanli* 16 (6), 43–47.
- Kim, L.S., 1997. *Imitation to Innovation: The Dynamics of Korea's Technological Learning*. Harvard Business School Press, Boston.
- Kogut, B., Zander, U., 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science* 3 (3), 383–397.
- Langlois, R.N., 1992. Transaction cost economics in real time. *Industrial and Corporate Change*, 99–127.
- Li, Liang, 2002. Particular trust and general trust: structure and characteristics of the Chinese people's trust. In: Zheng, Y.F. (Ed.), *Trust in Chinese Society* (in Chinese). Zhongguo Chengshi Chubanshe, Beijing, pp. 184–208.
- Lu, Q.W., 2000. *China's Leap into the Information Age: Innovation and Organization in the Computer Industry*. Oxford University Press, Oxford.
- Lu, W., 2004. IPRs Institutions' Important Roles in Promoting China's Industrial Competitiveness, delivered to High-level workshop on intellectual property rights and economic development in China: Meeting challenges and opportunities following WTO entry, organized by OECD, SIPO, and DRC.
- Lü, X.B., Perry, E.J. (Eds.), 1997. *Danwei: The changing Chinese workplace in historical and comparative perspective*. M.E.Sharpe, Armonk.
- Lundvall, B.A., 1985. *Product Innovation and User-Producer Interaction*. Aalborg University Press, Aalborg.
- Lundvall, B.A., 2002. *The University in the Learning Economy*, DRUID Working Paper No 02-06.
- Lundvall, B.A., 2004. *The University and the Learning Economy*, mimeo.
- Min, W.F., Ma, W.H., 1999. The role of university in the era of knowledge economy: experience and prospect of peking university (in Chinese). *Jiaoyu Fazhan Yanjiu*, 65–67.
- Ministry of Education (Ed.), 1999. *China University Science and Technology 50 years* (in Chinese). Gaodeng Jiaoyu Chubanshe, Beijing.
- Ministry of Education (Ed.), 2002. *Year 2001 Statistical Report of University-run Industry in China*. Xinan Jiaotong Daxue Chubanshe, Chengdu.
- Ministry of Education (Ed.), 2002. *Year 2003 Statistical Report of University-run Industry in China*. Xinan Jiaotong Daxue Chubanshe, Chengdu.
- Ministry of Education, 2005. *Year 2004 Statistical Report of University-run Industry in China*, <http://www.edu.cn>.
- Ministry of Science Technology, 2003. *China Science and Technology Indicators 2002*. Kexue Jishu Wenxian Chubanshe, Beijing.
- Mohrman, K., 2003. *Higher Education Reform in Mainland Chinese Universities: An American's Perspective*. Chinese University of Hong Kong America Center.
- Mu, Q., Lee, K., 2005. Knowledge diffusion, Market Segmentation, and Technological Catch-up: the case of the Telecommunication Industry in China. *Research Policy* 34, 759–783.
- Meyer-Krahmer, F., Schmoch, U., 1998. Science-based technologies: University-industry interactions in four fields. *Research Policy* 27, 835–851.
- Ministry of Science Technology 1991–2002 (various years). *Science and Technology Yearbook*. Ministry of Science and Technology, Seoul.
- Mo, Y., 1996. Understanding 'strategic alliances': the limits of transaction cost economics. In: Coombs, R., Richards, A., Saviotti, P.P., Walsh, V. (Eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*. Edward Elgar, Cheltenham, pp. 165–179.
- Mowery, D., Sampat, B.N., 2004. *Universities in national innovation systems*, paper Presented at the 1st Globelics Academy. Lisbon, Portugal, May.
- National Bureau of Statistics, 2004. *China Statistical Abstract 2004*. Zhongguo Tongji Chubanshe, Beijing.
- National Bureau of Statistics and Ministry of Science and Technology, 1991–2002 (various years). *China Statistical Yearbook on Science and Technology*, Zhongguo Tongji Chubanshe, Beijing.
- National Bureau of Statistics and Ministry of Science and Technology, 1991–2003 (various years). *China Statistical Yearbook on Science and Technology*, Zhongguo Tongji Chubanshe, Beijing.
- Nelson, R., Winter, S., 1982. *An Evolutionary Theory of Economic Change*. Harvard University Press, Cambridge, MA.
- Naughton, B., 1997. *Danwei: The Economic Foundations of a Unique Institution*. In: Lü, X.B., Perry, E.J. (Eds.), *Danwei: The Changing Chinese Workplace in Historical and Comparative Perspective*. M.E.Sharpe, Armonk, pp. 169–194.
- OECD, 1992. *Technology and the Economy: the Key Relationships*. OECD, Paris.
- OECD, 2002. *Benchmarking Industry-Science Relationship*. OECD, Paris.
- Porter, M.E., 1994. *Toward a dynamic theory of strategy*. In: Rumelt, R.P., Schendel, D.E., Teece, D.J. (Eds.), *Fundamental Issues in Strategy*. Harvard Business School Press, Boston, MA.
- Potter, P.B., Oksenberg, M., 1999. A Patchwork of IPR Protections. *The China Business Review*, 8–11.
- Penrose, E., 1959. *The Theory of the Growth of the Firm*. John Wiley, New York.
- Qiu, Q., 2002. Analysis on the property rights arrangement in Chinese university-owned hi-tech enterprises (in Chinese). *Zhongguo RuanKeXue*, 117–121.
- Richardson, G.B., 1972. *The Organization of Industry*. *The Economic Journal* 82 (327), 883–896.
- Roberts, E.B., 1991. *Entrepreneurs in High Technology: Lessons from MIT and Beyond*. Oxford University Press, New York.

- Rosenberg, N., Nelson, R.R., 1994. American universities and technical advance in industry. *Research Policy* 23, 323–348.
- Slaughter, S., Leslie, L.L., 1997. *Academic Capitalism: Politics, Policies and the Entrepreneurial University*. The Johns Hopkins University Press, London.
- Stephan, P., 1996. The economics of science. *Journal of Economic Literature* 34, 1199–1235.
- Sun, L.P., 2003. *Cleavage: Chinese Society Since 1990s* (in Chinese). Social Sciences Documentation Publishing House, Beijing.
- Sun, L.P., 2004. *Transformation and Cleavage: Structural Changes in Post-reform China* (in Chinese). Tsinghua University Press, Beijing.
- Tolentino, P.E.E., 1993. *Technological innovation and Third World multinationals*. Routledge, London.
- Turpin, T., Garrett-Jones, S., 1997. Innovation networks in Australia and China. In: Etzkowitz, H., Leydesdorff, L. (Eds.), *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations*. Pinter, London, pp. 21–32.
- Viale, R., Etzkowitz, H., 2004. *Third Academic Revolution: Polyvalent Knowledge; The “DNA” of the Triple Helix*. mimeo.
- Wang, Liu, 2002. Basis of trust: a rational explanation. In: Zheng, Y.F. (Ed.), *Trust in Chinese Society* (in Chinese). Zhongguo Chengshi Chubanshe, Beijing, pp. 209–249.
- Wernerfelt, B., 1984. A resource-based view of the firm. *Strategic Management Journal* 5 (2), 171–180.
- Williamson, O.E., 1975. *Markets and Hierarchies*. Free Press, New York.
- Williamson, O.E., 1985. *The Economic Institutions of Capitalism*. Free Press, New York.
- Williamson, O.E., 1991. Comparative economic organization: the analysis of discrete structural alternatives. *Administrative Science Quarterly* 36 (2), 269–296.
- Williamson, O.E., 1999. Strategy research: governance and competence perspectives. *Strategic Management Journal* 20 (12), 1087–1108.
- Young, S., Lan, P., 1997. Technology transfer to china through foreign direct investment. *Regional Studies* 31 (7), 669–679.
- Zhongguancun Science Park Information Center and E-business Center of Peking University, 2003. *A Study on the issue of University-run Enterprises at Zhongguancun* (Development Report on Zhongguancun Science Park: Special Subject II) (in Chinese), mimeo.