Who Benefits from Investment in Universities?
Institutions, University Spillovers, and Firm Performance

by

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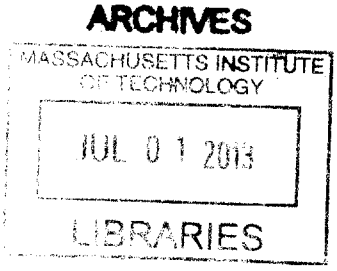

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ABSTRACT

This study examines the impact of local institutional arrangements on firm level spillover effects from universities. Specifically, I test the proposition of co-location with universities affecting firm performance, taking advantage of a major policy reform in China, to identify distinct university-influenced regions between 1998 and 2005. Together with a unique dataset from the National Bureau of Statistics of China, I find evidence, which suggests that relative to state-owned enterprises, domestic private firms in these regions experienced *performance decline*. Collectively, the results suggest that spillover effects from universities on industry are not unidirectional and uniform, and are specific to the unique institutional arrangements of each region and country. This finding raises some substantial welfare implications about the efficiency of public investments in universities when the benefits of such investments are offset by the institutional inefficiency of the state ownership.

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'Amidst today's acute competition on the international scene, universities are a major factor affecting a country's key competitive ability. Thus creating and running world-class universities should be one of the strategic foci of building up a country.'

~ Weifang Min, Party Secretary of Peking University, 2004,

"State-owned enterprises in China have taken the best of the economy for themselves, leaving the private sector drinking the soup while the state enterprises are eating the meat."

~Cai Hua, Vice Director of Chamber of Commerce, Zhejiang Province, 2010

1 INTRODUCTION

Universities are featured as key entities within some of the most innovative and entrepreneurial regions. For example in the United States, the successes of Silicon Valley and Boston's Route 128 corridor have been attributed at least in part to the presence of research universities (Saxenian, 1996). Such agglomeration of industrial activity may arise for a number of reasons, including shared inputs, local natural advantages, and skilled labor pooling (Marshall, 1961; Krugman, 1991). Another possibility is that proximity to universities generates knowledge spillovers by facilitating increased interaction between people and the speedy flow of ideas, compounding the positive externalities of knowledge production and encouraging locally concentrated entrepreneurship growth (Lucas, 1988). Universities as generators of new ideas and innovation are thus natural suspects as contributors to the local economy (Jaffe 1989).

As a result, the capacity of regions to support the *clustering of firms around universities* has been identified as a key source of competitive advantage in the development of an entrepreneurial and

innovative economy (Cooke, 2001; Storper, 1997). The transfer of innovative knowledge and skilled labor from universities to industry has taken a strong role within government policies at a number of levels - with many governments and their agencies turning their attention to the role of university knowledge commercialization in developing innovative, entrepreneurial and prosperous regional and national economies (Drucker and Goldstein, 2007).

Since 1995, in a series of sweeping reforms called the *Action Scheme for Invigorating Education in the 21st Century* reform, the Chinese government has called for selected universities to lead economic and social development in China, with the explicit aim of driving innovation, technical entrepreneurship and knowledge commercialization. The reforms encouraged universities to interact with firms by various means, especially through provision of skilled labor and knowledge transfer. These reforms also serve as a rich background to explicate the role of universities in economic development.

Thus far, industrial organizational researchers in university spillovers have ignored institutional frameworks in their work. However, no firm is immune from the institutional framework in which it is embedded (North, 1990; Hall and Soskice, 2001) because firm performances are not only driven by industry conditions and firm-specific resources, but they are also a reflection of the formal and informal constraints of the particular institutional framework that decision makers face (Scott, 2007; Oliver, 1991, 1997). To extend the study of university spillovers from an institution-based view, I examine the impact of heterogeneous institutional environments on firm performance in a transitional university led Chinese economy.

Based on a firm-level panel data of more than 7000 domestic high tech manufacturing firms in China over the 1998-2005 period, I do not find evidence that domestic firms in high-tech sectors have experienced an overall improvement in performance from university spillovers. However I find evidence, which suggests that university spillovers are targeted and specific to the firms' ownership status and by proxy as I claim here, their positions in the hierarchy of firms. Private firms relative to state owned enterprises, experienced a significant performance decline from colocation with universities. These results are robust to the inclusion of a range of firm-level controls, as well as a battery of fixed effects (region, industrial sector, and year). These results suggest that university-industry relationships are more complex and targeted than popular accounts suggest, and require careful examination of their particular institutional arrangements.

My paper complements the literature that studies the institutional complexities shaping China's economic development. For example, Huang (2008) demonstrated the effects of capital-market distortions on foreign direct investment inflows to China, and argued that under the dualist legal and financial institutions that favor foreign firms and state owned companies, domestic private firms find it difficult to borrow in the domestic credit market, because state-owned banks dominate it. Consistent with this argument, Guariglia and Poncet (2008) provide evidence that financial constraint on domestic private firms act as a "pull" factor for foreign direct investment. My study complements this line of thought on the hierarchy of firms in an economic landscape shaped by complex institutional forces.

2 RELATED WORK AND LITERATURE REVIEW

2.1 University Spillovers, Geographical Proximity and Firm Performance

Researchers in industrial and economic geography have been some of the most active in exploring the role of firm clustering in the creation of national or regional innovation systems (Nelson (1993) Lundvall (2010) Jaffe, Trajtenberg, and Henderson,1993; Saxenian, 1996; Acs and Varga, 2005; Audretsch and Feldman, 2004; Porter, 1996; Delgado, Porter, and Stern, 2010). In particular, much research focus on the knowledge spillovers as a key source of advantage that clustered firms can gain access to (Audretsch, 1995; Ellison, Glaeser, and Kerr, 2010) (Acs and Varga, 2005; Audretsch and Feldman, 2004).

More recently, Delgado, Porter and Stern (2010) found through a rigorous survey of US establishments that knowledge clusters are strongly associated with growth in new business formation. In another industrial organization study, Hausman (2010) made use of the Bayh Dohl Act of 1980 as a natural experiment, and found that university research positively influences employment among US counties in the geographical vicinity of the universities. In general the most prevalent and established finding in the spillover literature is that innovative output and growth is higher in the presence of knowledge inputs. However, this literature has been established only for a region or city as the unit of observation. Relatively little is known about the impact of geographic proximity to universities on the *performance at the firm level.*

There are several plausible ways university knowledge spillovers can potentially affect the performance of firms. For example, the presence of university knowledge spillovers may reduce the cost of R&D for firms, thereby improving their performance. (Scherer and Harhoff , 2000). In a related manner, universities may also help to improve the quality of products offered by clustered firms, thereby allowing them to command higher market prices (Griliches, 1998). A

general way to understand these mechanisms is casting university spillovers as positive externalities which can be accessed by firms (Harris, 2001; Jaffe, 1989). Further, we can expect the cost of accessing these externalities to increase with geographic distance, hence firms which are nearer the source should be expected to perform better (Scherer and Harhoff, 2000).

This geographical proximity argument has been well explored and defended in literature. Notably, Jaffe (1989) points out that geographical location is important in capturing the benefits of knowledge spillovers with regards to the transfer of knowledge because access channels are limited by geographic reach. As such, '... geographic proximity to the spillover source may be helpful or even necessary in capturing the spillover benefits' (Jaffe, 1989, p. 957). Otherwise, spatial distance between firms and universities is likely to act as the major barrier of interaction (Polt, Rammer, Gassler, Schibany & Schartinger, 2001). The distinct limits that geography impose on accessing knowledge clusters have been similarly demonstrated across a broad range of empirical results, such as patent citations, product licensing and entrepreneurial firm spawning.

Collectively, literature suggest that location proximity to universities should positively influences firm performance. The closer is the distance towards the nearest university; the higher is the likelihood that firms leverage knowledge and resources from the universities. Therefore, I would expect that firm performance improve with proximity to the universities.

Hypothesis 1: Firms in the vicinity of universities perform better.

2.2 Institutional Transformation in China

While several studies have documented with great detail the innovation "ecosystem" in different regions and industries along with the role of public sector policy choices, critics have pointed out that they have focused on the successful case studies while failing to address clusters which have failed, even those within the same country (Martin and Sunley, 2003; Bristow, 2005). These studies have also invariably been overwhelmingly positive in their description of spillover effects from universities, which have led to developing nations frequently adopting similar arrangements in their economic development policies (Lerner, 2009). However, these studies have typically failed to account for the fact that universities are frequently embedded in very different institutional arrangements, some of which may be more or less effectively aligned to transform universities into an engine of growth (Hall and Soskice, 2001).

Most existing research has been performed on developed and market driven economies, which do not typically exhibit large variation in their institutional landscapes. Transition economies on the other hand, are continuously experiencing changes in their institutional makeup, shaped by growing economies and rapid policy changes. As a result, I argue that transition economies such as China, provide a good setting to explain firm performance based on an institution-based view.

A main outcome of China's transition has been the diversity and complexity of the ownership structure. Ownership type has been recognized as one of the most important institutional arrangements because it represents the way the government can effectively exercise control, even to the firm level and, through different incentive structures, can also determine firm strategy and

performance (Boisot and Child, 1996; Nee, 1992; Peng and Heath, 1996; Tan, 2002; Tan, Li, & Xia, 2007).

Researchers have generally agreed that there are four types of Chinese enterprises based on manner by which property rights are assigned within the firm: (1) state-owned enterprises (SOEs), (2) collectively owned enterprises (COEs), (3) privately owned enterprises (POEs), and (4) foreign-invested enterprises (FIE). Different ownership types represent different levels of state control, and most critically different positions in the hierarchy of firms.(Huang and Di, 2004). More generally, these studies have argued that a pecking order of firms exists within China's institutional landscape, sorted by their ownership. A revealed outcome of the pecking order is that the government systematically favors SOEs over domestic private firms through both the design and implementation of laws and regulations. Furthermore the pecking order can also give firms the legitimacy, the prestige, and access to superior resources, new business operations, and additional decision prerogatives, according to their relative positions within the hierarchy. Walder, Li and Treiman (2000) found evidence that career mobility and choices are shaped by socialist state practices, which emphasizes the relative prestige of firms. This holds particular salience with regards to my study, given that manpower development is a key thrust of the Chinese university reformation.

There are a myriad of reasons for why SOEs are favored by the government. To the extent that SOEs are more productive, pro-state policies and enforcement of regulations can be justified by motives to enhance long-term growth. Another possibility is that SOEs are in fact more politically powerful than commonly assumed. Some analysts argue that the state-owned

conglomerates, built with state money and favors into global competitors, have now become political power centers in their own right (Wines, 2010). As of 2009, of the 129 major state enterprises, the central organization department of the Communist Party appointed more than half the chairmen and more than one-third of the chief executive officers. Many of them in turn serve on the party's Central Committee, which elects the ruling Politburo. Regardless of the precise arrangements, evidence is firm that SOEs are deeply entwined with the political establishment in China.

Against this landscape, I argue that SOEs will gain access to spillover benefits ahead of the disadvantaged private sector firms, as they are higher up on the political power ladder. Thus, I derive the following hypothesis:

Hypothesis 2: The higher a firm is on the political pecking order, the better it is able to assimilate spillover benefits.

3 EMPIRICAL METHOD AND SETTING

3.1 Setting: University Reforms in China

Making use of education and science to push forward China's modernization has been a major policy option for the post-Mao Chinese leadership. Along with the implementation of economic reforms and the 'open-door' policy, the post-Mao Chinese leaders began to recognize the important contribution that education can make to both economic growth and social development. For the purpose of producing enough educated human resources for economic modernization, an 'economic ideology of education' was developed by the post-Mao Chinese leaders. Under this

ideology, education and economic development are inseparable and interactive. In the views of the Chinese leaders, education is the essential tool for economic modernization, and must meet the needs of China's modernizing economy and its future development (Wei, Tsang, Xu, & Chen, 1999). With China's further integration into the world economy, the Chinese leadership has realized that China's future is based on a high technology knowledge economy, and that the international competitiveness of the state will depend upon educational development and scientific technology as well as the degree of knowledge innovation (Ministry of Education, 2007).

Establishing world-class universities as an economic development tool in China has become a strategic objective pursed by both Chinese universities and the government since the mid-1990s. Its formulation and implementation is the product of the post-Mao efforts of education reform. In autumn 1992, at the CCP's 14th National Congress, then General Secretary Jiang Zemin proclaimed that "it is essential for China to shift the economic construction to the track of depending on advancement of science and technology and the improvement of the quality of laborers."(Guo and Ngok 2008)

In February 1993, the Chinese authorities issued the 'Programme for Education Reform and Development in China', in which the Chinese government determined to focus all kinds of forces from the central and local governments on about 100 key universities and a batch of key academic disciplines and specialties, and enable them to reach a higher level in terms of education quality, research and management at the beginning of the new century. In May 1995, the CCP and the State Council, the cabinet of China, jointly promulgated the Decision to Speed

up the Advancement of Science and Technology, and decided to carry out the strategy of 'revitalizing China through developing science and education'.(Guo and Ngok 2008) Under these circumstances, the State Council launched the *'211 Project'* in 1995 (Zhou and Leydesdorff, 2006). Since then, a huge sum of earmarked money has been appropriated by the central government to finance the 211 Project.

The 211 Project represents the most ambitious goal of the Chinese government in higher education development since 1949. It was expected that after the completion of the Project, the selected group of universities will set up national standards in overall quality, with some of the key universities and disciplinary areas approaching or reaching the advanced international standards. During the Ninth Five-Year Plan period, the central government endorsed 112 universities to be developed under the 211 Project. 602 projects to be hosted in these universities were selected for the development of key fields of study. From 1996 to 2000, more than US$2.2 billion was disbursed under Project 2001, such that by the end of 2000, these institutions held 96% of the countries key laboratories, and utilize 70% of all total research funding(Guo and Ngok 2008). The disbursement amounts were also evenly distributed across the universities, in accordance to the policy's design. (Zhou and Leydesdorff , 2006). The full list of Project 211 Universities is appended in *Appendix A*.

By most popular accounts, the schemes have been successful. The scale of Chinese higher education has been expanded steadily since the late 1990s. In 1997, the gross enrollment ratio in China was 9.1%, but it increased to 9.8%, 10.5% and 11% respectively in 1998, 1999 and 2000 (Ministry of Education China, 2008). In 1999, the intake of regular higher education institutions

was 1.53 million, representing a 42% increase from 1.08 million in 1998. In the following years, quantitative growth continued. In 2000, the intake of higher education institutions reached 2.2 million, almost double the intake in 1998. In 2001, a total of 2,682,800 first-year students enrolled in 1225 regular tertiary institutions (Ministry of Education, 2007, 2008).

On the whole, the formation of the policy of building world-class universities in China reflects the ambition of both the Chinese government and Chinese universities to develop high-quality higher education in the context of globalization and the knowledge-based economy. Given the fierce international economic competition and China's rising international role, to establish world-class universities in China would be regarded as one of the strategic priorities for China to compete in the global economy.

3.2 Identification Strategy and Data

Isolating the effects of university research and innovation on local industry is methodologically, a fundamentally difficult task because most universities have developed together with their local economies over time, influencing each other and being influenced by similar area fundamentals. University and industrial activity are thus naturally correlated: communications technologies, for example, developed in firms like Federal Telegraph in the nascent Silicon Valley just as they were developing in Stanford University laboratories.

Use of a national shock to this system, like a radical university reformation, brings new identification to this long-standing measurement problem. These series of reforms in China

provide us with an identification strategy in choosing my treatment and control groups of prefectures (or regions), as the reforms only affected the selected universities. This strategy assumes that the industries and places I measure to grow the fastest after the reformation weren't already on faster growth trajectories, for reasons other than university research, before the reformation.

While previous studies (see for example Liu and White, 2001) have attempted to illustrate the important role university innovation play in the economic growth of China, they are largely based on anecdotal case studies and surveys due to a lack of reliable data. I overcome this limitation by utilizing a unique dataset. I utilized the *Chinese Industry Census (CIC) compiled by National Bureau of Statistics (NBS).* This database is the most detailed and *reliable* dataset on firm activities in China. It is an annual *census* of *all* industrial firms—regardless of ownership types of firms— with sales value above 5 million *yuan*. The advantage, compared with previous studies' data, is that the dataset is very comprehensive and this advantage is especially important because Western researchers often have to rely on survey data supplied by Chinese researchers who often do not disclose the details of their sampling procedures, which may contain known or unknown biases. Furthermore, unlike this database, few surveys cover firms of all ownership types.

For each registered company, the database records the detailed company characteristics ranging from company address to production and financial information, including research expenditure. One of the most significant advantages of CIC is that it contains detailed industry breakdowns. The Chinese standard of industrial classification (CSIC), modified in 1988, was adapted from

International Standard of Industrial Classification (ISIC). The CSIC in our dataset is at the four-digit level, detailed to the level of product groupings, such as leather shoes, as opposed to just shoes. Such fine industry classification allows us to control for technological and other dynamics at the near product level, and assists the precision in comparisons of firms within each industry. The panel structure further helps to eliminate any time-invariant industry-specific effects.

The CIC dataset is extremely detailed. It contains information about each company's identity, address, industry classification, incorporation year, total employment, annual payments of wage and fringe benefits, the hierarchical level the company answers to (regional, provincial, town-level, etc.), registration type (SOE, private, foreign-affiliated, or joint cooperative, and finer classifications in each of the aforementioned categories), three main products in the order of relative importance, and the production capacities for these three products, respectively.

Furthermore, I restrict my study to only firms in *high technology* sectors, a defined by China's National Bureau of Statistics. The reasons are twofold. Firstly, the overarching economic aim of the university reforms was ostensibly to drive the economy towards higher value added, high technology industry sectors. As such, I believe restricting my sample to only these sectors is in better alignment with the spirit of the university reforms. Secondly, by restricting my study to only high technology sectors, I avoid making over-homogenizing assumptions on the economy, as lower technology sectors are likely to be very different in terms of capital utilization and technologies. The full list of industry sectors defined as high tech industries is listed in *Appendix B*.

Geographical information on the universities under the university reform schemes was then collected. I conducted my analysis at the County-level[1] in China. Each County is typically assigned a band of unique postal codes at the 4-digit level, and the division is largely by size of the area. However in certain highly built up metropolitan areas, a few closely clustered (and smaller) counties can share the same band of postal codes. In these cases, I treat all counties that share the same band of postal codes as a single contiguous county.[2] This procedure allowed me to define 1264 unique *regions* in my sample.

In addition to detailed data on taxes, the dataset contains information on the value of equity owned by different types of investors, as well as firm registration type. This information allows us to examine the pattern of economic outcomes across firms with different ownership types, especially between SOEs and domestic private firms. I take advantage of this to form a unique dataset of all SOEs and domestic private firms in high tech industries. The benchmark group in which I am most interested is at the lowest of the political pecking order – domestic private firms.

The detailed dataset also allows us to include a set of firm-level control variables in my regressions, which include the firm's total current assets, total assets, employment, and age. To ensure that my empirical results are not driven by extreme outliers due to measurement errors, in my final sample I "winsorize" observations for which the dependent and the key independent

[1] The Constitution of the People's Republic of China provides for three levels: the province, county, and township. However, two more levels have been inserted in actual implementation: the prefecture, under provinces; and the village, under townships. The People's Republic of China administers 33 province-level regions, 333 prefecture-level regions, 2,862 county-level regions, 41,636 township-level regions and even more village-level regions.

[2] For example, Haidian District and Chaoyang District in Beijing City shared the same band of postal codes. These are clustered into a single region in my classification.

variables are larger than the 99 percentile or smaller than the 1 percentile of the corresponding variables in the sample. The "winsorized" sample contains 15200 firm year observations (on average about 1900 firms per year).[3]

3.3 Econometric Estimation

My main performance measure is *Profit per Employee.* I would expect this to be positively influenced by the spillover effects from university innovation and research. That is, I would expect the high tech firms' locations in treated regions to experience a boost in profitability, post reform.

Formally, for my baseline econometric model, I estimate an empirical specification in which the performance outcome of firm y of region r, industry sector i, year t is regressed on indicator variables $I\{uni\}$, and $I\{private\}$, along with their interaction. $I\{uni\}$ captures the presence of a university in the firm's region, equal to 1 when the firm is in a region with a treated university, and zero otherwise. Further, to ascertain the different marginal effects of these university spillovers on firms according to their different ownerships, I incorporate indicator variables $I\{private\}$, equal to 1 (and 0 otherwise) if the firm is classified as a privately owned firm, by the Chinese Statistical Bureau respectively, with the reference case being state-owned firms. This indicator is then interacted with the relevant university treatment indicator.

$$y_{rit} = \beta_0 + \beta_1(I\{uni\}) + \beta_1(I\{private\}) + \beta_3(I\{uni\}*I\{private\}) + X_{it} + \psi_t + \varphi_r + \Omega_i + \xi_{rit} \qquad (1)$$

[3] The procedure of winsorizing data to enhance data quality has become a common practice in empirical studies using firm-level data from developing countries. Importantly, the results of regressions using the non-winsorized sample are qualitatively the same.

The coefficient β_1 measures the effect of close location to universities on the performance of firms relative to regions without. It is expected to be positive if proximity to reformed universities has stimulative effects on the performance of firms. β_2 on the other hand, measures the performance of private firms relative to state owned firms. Lastly and most crucially, the coefficients β_3 on the interaction term measures the differential effect of position in the firm pecking order (as informed by the ownership status of the firms) on the performance of firms in treated regions. By proxy this serves to help us understanding which firms are relatively more successful in assimilating university spillovers.

I incorporated year, industry sector and region level fixed effects. These fixed effects will allow us to strip out any effects from exogenous economy wide shocks. Finally I specify a suite of firm-year level controls X_{it}, including the age of the firm, the total assets, total employment and its current year output. Errors are clustered at the region level, to take into account correlation between observations within the same region, in line with suggestions by Bertrand, Duflo and Mullinathan (2004).

My final unbalanced panel set consists of more than 15000 firm-year observations, across 1264 regions. Of the total of 1264 regions, 68 are treated. A total of more than 7000 high tech firms are represented in this study, across the sample years of 1998 to 2005.

Summary statistics and correlation matrix on all variables are listed in *Table A* and *Table B* respectively.

Insert Table A about here

Insert Table B about here

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4 RESULTS

Table C reports multivariate models.

Insert Table C about here

In column (1), I regress the natural logarithm of a firm's Profits per Employee (*lnprofitemp*) on the uni dummy (*uni*), signifying the region of the firm was treated with a reformed university. I find no statistically significant result indicating that firms in treated regions perform better. In column (2), to circumvent the firm size and age effects that are believed to be associated with greater bargaining power and thus better ability to assimilate spillovers, I add natural logarithms of a firm's employment, current and total assets, and age as regressors. I still do not find evidence of superior performance for firms in treated regions.

In column (3) and (4), using a firm's registration type to classify firm ownership type, I regress the natural logarithm of a firm's Profits per Employee (*lnprofitemp*) on the private firm dummy (*private*). Column (4) includes the same firm level regressors I had used in Column (2). I find that within a province-sector-year cell, private firms on average perform US$450-600 better than state owned firms. This relationship is statistically highly significant (at the 1% significance level).

In column (5), I then include the *uniprivate* interaction term, signifying if the firm was private and resided in a region that was treated with a reformed university. Again, the same firm level regressors and, sector, region and year fixed effects were incorporated. Interestingly, the interaction term between *uni* and *private* is negative. On average, private firms suffer a performance decline compared to state owned firms in a treated region. This is statistically significant at the 5% level.

In Column (6), I further include the natural log of the total output of the firms (*lntotal_output*) as another firm level regressor, to circumvent argument that the profitability of the firm might be related to the size of the output. Although the inclusion of output as a regressor reduced the magnitude of the *private* dummy coefficient substantially, private firms overall still continue to outperform state owned firms. And I again see that private firms in treated regions on average suffer performance decline relative to state owned firms.

In totality, I find no statistical support for *Hypothesis 1*. Firms in university reform treated regions on average do not outperform their counterparts in non-treated regions. This finding does not invalidate the general hypothesis of the university spillover effects. It does, however, point to the possibility that the university spillover effect can be institutionally dependent. In the second part of my empirical analysis, I indeed found evidence in support of this institutional dependency. I find statistical evidence that relative to state –owned firms, private firms in university reform treated regions suffer substantial performance declines, despite the fact that private firms, in general, outperformed SOEs. This finding offers support for *Hypothesis 2*, which ties the spillover effects to specific institutional configurations.

4.1 Robustness Check

So far I have been using a firm's registration type to classify its ownership. A potential criticism is that registration types may not represent the underlying ownership and control rights of the firms. Because Chinese policies and laws may not be grounded precisely on how a firm is registered, I consider other dimensions of a firm's "private ownership" in *Table D*.

Insert Table D about here

In column (1), I repeat the analogous final form regression analysis (column (6) in *Table 3*) with the private dummy equal to 1 if a firm has more than 50 percent private equity share, and 0 otherwise. I continue to find a negative coefficient on the interaction variable, and the results are

qualitatively very similar to my baseline results. In column (2), I run the same regression, but now raise the bar for private ownership – a firm is considered private if its private equity share exceeds 75 percent (inclusive). I find no substantive difference in the results, and private firms in treated regions continue to experience a performance decline relative to their state owned counterparts.

I continue this line of robustness checks by examining the state's share of the total capital. I set the private dummy equal to 1 if the state's share of the total capital is less than 50 percent, and repeated the analogous regressions. The same trends follow. These results hold even as I decrease the threshold of state's share of the total capital to as low as 25%.

As a further robustness check, I restricted the sample to regions ex Beijing and Shanghai. Beijing and Shanghai have a disproportionately large share of the reformed universities; exclusion of these regions will serve as a further robustness check on my claims of the effect of university reformation spillovers. The results are qualitatively the same as reported in *Table E*. In fact, the effects are even more pronounced.

Insert Table E about here

Finally, I also demonstrate a related but different way to measure proximity to universities. Using the zip code data of the universities and firms, I calculated the physical distance of the

firms to the universities. This allows us to define a new continuous variable *minimum,* the distance of each firm to the nearest reformed university in China. Using this I specify a similar econometric model as before, but replacing the previous *I{uni}* indicator with the continuous measure *minimum*.

$$y_{rit} = \beta_0 + \beta_1(minimum) + \beta_1(I\{private\}) + \beta_3(I\{uni\} * minimum\}) + X_{it} + \psi_t + \varphi_r + \Omega_i + \xi_{rit} \quad (2)$$

The coefficient β_1 measures the effect of proximity to universities on the performance of firms. It is expected to be negative if proximity to reformed universities has stimulative effects on the performance of firms. *The* coefficients β_3 on the interaction term measures the differential effect of proximity to universities on firm performance, given their ownership status. It is expected to be positive, in accordance with my previous sets of results. In other words, the closer private firms are to universities, their performance will decline relative to SOEs.

Indeed this set of results has coherence with my previous analysis. Interestingly, I also see there is some weak evidence that firms in general benefit from being closer to universities, thereby providing some support for *Hypothesis 1.* However, I see the same performance decline of private firms relative to SOEs, the closer they are to the universities.

Insert Table F about here

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5 DISCUSSION

If maximizing economic growth, driven mostly by the most dynamic private sector, is the main objective of the provincial governments, a positive relationship between private firms and the spillover effects from universities is expected. However I find no strong evidence supporting this hypothesis. Instead my results suggest that private firms in China were disadvantaged by university reformation, suffering significant falls in firm performance.

These results are somewhat surprising and potentially controversial. The complexity of spillover effects uncovered here challenges the standard view that university spillover effects are unidirectional and always beneficial. They speak in particular, to the growing literature on the institutional landscape of China. Although organizations increasingly operate following market rules, they are still embedded in the state hierarchy and a firm's position within the hierarchy may affect both its path and outcome. Moreover, the original socialist institutions have persistent effects on firm behaviors and outcomes during the transition to capitalism (Kogut and Zander, 2000). When the "iron fist" meets the "invisible hand," a unique institutional variation (*lishu*) plays an important role of a "visible hand," which may affect firm performance (Tan, Li, and Xia, 2007).

The unique institutional structure in the Chinese economy is characterized by firms being controlled by hierarchically structured governments, resulting in a hierarchy of firms. The control system in Chinese is called *lishu* (隶属 meaning "belonging or subordinate to" or "directly controlled by"). From an institutional perspective, *lishu* as a social, political, and economic institution exhibits a very original "Chinese characteristic." (Tan et al., 2007). After

two decades of reform, the unique "visible hand" is neither as ruthless as the former "iron fist" nor as laissez-faire as the "invisible hand." It has become a basic fabric constituting the hierarchy of firms and government agencies as well as other institutions in the Chinese economy. Both organizations and governments are embedded in the "nested institutional hierarchy" influencing the distribution of factor resources (Walder, 1992).

The level of the *lishu* relationship represented by a legal ownership structure can be viewed as a "distance" from the center of state control. While firms directly controlled by higher levels of government are almost all SOEs, private enterprises in China are the farthest from the center of state control and closest to the edge of the market (invisible hand). Based on such a characterization, traditional free market economic arguments would give performance advantages to private enterprises. Indeed, empirical studies have backed up this argument, asserting that proximity to the market renders private firms more flexibility relative to SOEs, making them more pro-active and innovative, with a stronger incentive to do well (see for example Tan, 2002). My results however, suggest that this characterization is nuanced and in certain circumstances such as accessing university spillovers, uncertain.

My results can now be clarified using this line of argument. There are at least two plausible mechanisms. First, the sudden shock to the university system may have resulted in a rush for newly created resources, especially in technically trained personnel. Private firms being lowest in the political pecking order may have suffered the brunt in a resource constraint shock. As such, according to this line of argument, it is plausible that a rapid expansion of the education sector in these treated regions could have resulted in a deluge of talented human resources from

private industry. Indeed, open-ended interviews with university-based employees echo this line of thought:

> "There were many administrator level jobs created when the 211 scheme started. It became an attractive career change for people in other industries. Project managers in private firms especially are sought after to serve as academic program administrators." (Interview with Miss Huang, administrator with a Beijing based 211 university)

> "I have always preferred administrative jobs. I naturally gravitated towards joining the university when the opportunity came... a nice change from my old engineer job in my (private sector) firm." (Interview with Mr Hu, administrator with a Beijing based 211 university)

The learning from the interview responses segues naturally to another plausible mechanism explaining my set of results. Again, private firms being lowest in the pecking order may have been the least preferred career choice of university graduates, at least compared to the higher ranked state owned enterprises. Similarly, interviews with recent graduates from a 211 university in Beijing support this line of thought:

> "I chose to join a state owned enterprise after graduating. It's a more prestigious job. I would have preferred a foreign firm even, but competition for that is even tougher." (Interview with Mr. Liu, engineer with a state owned enterprise in the IT sector)

> "My parents said no to me starting a company when I graduated... They preferred me joining a state owned enterprise or preferably the government. We are Chinese, and unfortunately, we like stable careers. " (Interview with Mr. Lin, project manager with a state owned enterprise in the agricultural sector)

I would be cautious about over-extrapolating this interview evidence. Further research needs to be done to ascertain the precise mechanisms underpinning the performance gap between state owned enterprises and private enterprises. Nevertheless they give insight into an interesting set of phenomenon, which is at the forefront of China's economic transformation, and speak cohesively with the quantitative results that are the central focus of this paper.

6 CONCLUSION

Sociologists and political economists have studied the multifaceted processes in the economic transformation of urban China. For example Huang (2008) has argued that China's economic transformation has been far more nuanced than generally perceived, and economic development has been accompanied with vastly different welfare implications.

My findings resonate with these streams of literature. It extends the varieties of capitalism literature (Hall and Soskice, 2001), by explicating the complex relationships between academic institutions and the economy. Spillover effects from universities on industry are neither unidirectional nor uniform in application. The unique institutional arrangements of each country therefore, call for a more directed and targeted set of innovation and economic development policies.

More broadly speaking, my findings also call attention to the unique institutional frameworks that have emerged from China's economic reform. As elucidated by North (North, 1990), institutions are "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction." As a result, institutions shape how economic agents produce, exchange and interact with each other. The contexts in which these individuals, resources and opportunities come together can affect the behavior and performance of individual actors.

China's institutional transition presents a unique laboratory to "tackle the harder and more interesting issues of how institutions matter, under what circumstances, to what extent, and in what ways" (Powell, Koput, & Smith-Doerr, 1996). Unique among the post Communist era transition economies, China has been prominent in introducing market-based institutions. Yet this is often contraindicated by an adherence to the control of the state, thereby giving rise to an almost unique institutional landscape that exhibits its influence in the economy. The welfare effects of cannot be understated. I argue that the role of universities as a core economic development tool in China has to be understood in light of the institutional landscape, as it influences the spillovers' direction of flow.

My study contributes to several strands of related literature. First, I bring new identification and clarification to the effect of university spillovers on the development of the local economy. Second, I bring institutional variance into the study of spillovers, by demonstrating that firms' successful assimilation of spillover benefits differ by ownership type. My examination into the

ownership type and its relationship in firms' assimilation of spillover benefits sheds light on an important, previously neglected, issue in firm performance in China's transitional economy. During its decades of rapid growth, China thrived by allowing once-suppressed private entrepreneurs to prosper, often at the expense of the old, inefficient state sector of the economy. Now, my evidence suggests that it is often China's state-run companies that are on the march.

The issue of state versus private control is a slippery one in China. After decades of economic reform, many big state-owned companies face real competition and are expected to operate profitably. The biggest private companies often get their financing from state banks, coordinate their investments with the government and seat their chief executives on government advisory panels. Chinese leaders also no longer publicly emphasize sharp ideological distinctions about ownership. But they never relaxed state control over some sectors considered strategically vital, including finance, defense, energy, telecommunications, railways and ports. China's private entrepreneurs have a catchphrase for such maneuvers: "国进民退," or "the state advances, the private sector retreats." My evidence backs up this position, where assimilation of university benefits is concerned.

Appendix A

List of 112 Institutions of Higher Learning under the "Project 211" Scheme

1. Anhui University
2. Beijing Foreign Studies University
3. Beijing Forestry University
4. Beijing Institute of Technology
5. Beijing Jiaotong University
6. Beijing Normal University
7. Beijing University of Aeronautics and Astronautics
8. Beijing University of Chemical Technology
9. Beijing University of Chinese Medicine
10. Beijing University of Posts and Telecommunications
11. Beijing University of Technology
12. Central Conservatory of Music
13. Central South University
14. Central University of Finance and Economics
15. Chang'an University
16. China Agricultural University
17. China Pharmaceutical University
18. China University of Geosciences
19. China University of Mining and Technology
20. China University of Petroleum
21. China University of Political Science and Law
22. Chongqing University
23. Communication University of China
24. Dalian Maritime University
25. Dalian University of Technology
26. Donghua University
27. East China Normal University
28. East China University of Science and Technology
29. Fourth Military Medical University
30. Fudan University
31. Fuzhou University
32. Guangxi University
33. Guangzhou University of Traditional Chinese Medicine
34. Guizhou University
35. Hainan University
36. Harbin Engineering University
37. Harbin Institute of Technology
38. Hebei University of Technology
39. Hefei University of Technology
40. Hohai University
41. Huazhong Agricultural University
42. Huazhong Normal University

43. Huazhong University of Science and Technology
44. Hunan Normal University
45. Hunan University
46. Inner Mongolia University
47. Jiangnan University
48. Jiangxi Agricultural University
49. Jiangxi Normal University
50. Jilin University
51. Jinan University
52. Lanzhou University
53. Liaoning University
54. Minzu University of China
55. Nanchang University
56. Nanjing Agricultural University
57. Nanjing Normal University
58. Nanjing University
59. Nanjing University of Aeronautics and Astronautics
60. Nanjing University of Science and Technology
61. Nankai University
62. National University of Defense Technology
63. North China Electric PoIr University
64. Northeast Agricultural University
65. Northeast Forestry University
66. Northeast Normal University
67. Northeastern University
68. NorthIst A&F University
69. NorthIst University
70. NorthIstern Polytechnical University
71. Ocean University of China
72. Peking Union Medical College
73. Peking University
74. Renmin University of China
75. Second Military Medical University
76. Shandong University
77. Shanghai International Studies University
78. Shanghai Jiao Tong University
79. Shanghai University
80. Shanghai University of Finance and Economics
81. Sichuan Agricultural University
82. Sichuan University
83. South China Normal University
84. South China University of Technology
85. Southeast University
86. Southwest University
87. Southwest Jiaotong University
88. Southwestern University of Finance and Economics

89. Sun Yat-sen University
90. Soochow University
91. Taiyuan University of Technology
92. Tianjin Medical University
93. Tianjin University
94. Tongji University
95. Tsinghua University
96. University of Electronic Science and Technology of China
97. University of International Business and Economics
98. University of Science and Technology Beijing
99. University of Science and Technology of China
100. Wuhan University
101. Wuhan University of Technology
102. Xiamen University
103. Xi'an Jiaotong University
104. Xidian University
105. Xinjiang University
106. Xinjiang Medical University
107. Xizang University
108. Yanbian University
109. Yunnan University
110. Zhejiang University
111. Zhengzhou University
112. Zhongnan University of Economics and Law

Appendix B

2710: Medicines and Chemical Reagents
2720: Pharmaceutical Preparations
2730: Chinese Medicines and Phamaceuticals
2740: Veterinary Medicines
2750: Biological Products
3615: Electrical Engineering Equipment
3617: Electronics Equipment
3619: Other Special Electromechanical Equipment
3651: Surgical Apparatus and Instruments
3652: Medical Apparatus and Equipment
3653: Diagnostic Products
3654: Medical Materials and Utilities
3771: Aircraft
3779: Other Aircraft and Spacecraft
3786: Aircraft Repairs
4027: Electronic Equipment Parts
4112: Communication Switching Equipment
4113: Communication Terminal Equipment
4119: Other Communication Equipment
4121: Radar
4122: Radar Parts
4130: Broadcast and Television Equipment
4141: Computers
4151: Vacuum Tubes
4153: Semi-conductor Devices
4155: Integrated Circuits
4160: Electronic Components
4190: Other Electronic Equipment
4212: Electrical Instruments and Meters
4230: Electronic Measuring Instruments
4242: Measuring Instruments

Table A

	mean	sd	min	max
lnprofitemp	0.93	2.26	-5.6	6
uni	0.23	0.42	0.0	1
private	0.61	0.49	0.0	1
uniprivate	0.10	0.30	0.0	1
lntotal_current_asset	9.09	1.51	0.0	16
lnage	2.08	1.11	0.0	8
lnemp	4.74	1.24	0.0	10
lntotal_asset	9.71	1.51	0.0	16
lntotal_output	9.68	1.42	0.0	16
N	15932			

Table B

	lnprofitemp	uni	private	uniprivate	lntotal_current_asset	lnage	lnemp	lntotal_asset	lntotal_output
lnprofitemp	1								
uni	0.046	1							
private	0.3294	-0.2222	1						
uniprivate	0.13	0.5987	0.262	1					
lntotal_current_asset	0.099	0.157	-0.2458	0.0164	1				
lnage	-0.2411	0.1536	-0.5981	-0.1458	0.3368	1			
lnemp	-0.1635	0.0405	-0.3029	-0.1004	0.7485	0.4016	1		
lntotal_asset	0.0838	0.1251	-0.2535	-0.0142	0.9457	0.3376	0.7824	1	
lntotal_output	0.2882	-0.0005	0.072	0.0386	0.721	0.1048	0.6747	0.7296	1

Table C
Dependent variable is natural log of *Profit per Employee*

	(1)	(2)	(3)	(4)	(5)	(6)
Uni Dummy	0.627	0.408			0.615	0.332
	(0.435)	(0.337)			(0.345)	(0.397)
Private Dummy			1.306***	1.062***	1.201***	0.592***
			(0.089)	(0.110)	(0.110)	(0.086)
Uni x Private					-0.393**	-0.457**
					(0.019)	(0.168)
ln(emp)		-0.731***		-0.725***	-0.730***	-1.171***
		(0.040)		(0.039)	(0.040)	(0.033)
ln(total_asset)		0.356***		0.364***	0.362***	0.290***
		(0.058)		(0.059)	(0.059)	(0.049)
ln(total_current_asset)		0.388***		0.384***	0.386***	0.070
		(0.053)		(0.052)	(0.052)	(0.058)
ln(age)		-0.319***		-0.146***	-0.146***	-0.069**
		(0.029)		(0.030)	(0.030)	(0.025)
ln(total_output)						0.813***
						(0.046)
Sector FEs (32)	Yes	Yes	Yes	Yes	Yes	Yes
Region FEs (1327)	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed (7)	Yes	Yes	Yes	Yes	Yes	Yes
Num. Obs.	15920	15122	15920	15122	15122	14943
R-squared	0.331	0.416	0.361	0.432	0.433	0.504

Notes:
a) All specifications include a constant, 32 sectors, 1264 regions, and 7-year fixed effects.
b) Standard errors, clustered at the region level, are reported in parentheses.
c) ***, **, and * denote 1%, 5%, and 10% significance levels, respectively

Table D
Dependent variable is natural log of *Profit per Employee*

	(1)	(2)	(3)	(4)
Private Ownership Definition	**Private Capital > 50% Equity Share**	**Private Capital > 75% Equity Share**	**State Capital < 50% Equity Share**	**State Capital < 25% Equity Share**
Uni Dummy	0.333	0.304	0.465	0.420
	(0.400)	(0.398)	(0.406)	(0.410)
Private Dummy	0.352***	0.308***	-0.496***	-0.441***
	(0.073)	(0.072)	(0.080)	(0.081)
Uni X Private	-0.413**	-0.371**	-0.564**	-0.513**
	(0.170)	(0.165)	(0.165)	(0.167)
Controls & Fixed Effects	Yes	Yes	Yes	Yes
Num. Obs.	147943	147943	147943	147943
R-squared	0.502	0.501	0.503	0.503

Notes:

a) All specifications include a constant, 32 sectors, 1264 regions, and 7-year fixed effects, and firm-level controls: ln(emp), ln(total_capital), ln(total_current_asset), ln(age), ln(total_output) (i.e., the specification of column (5) in Table 3).
b) Standard errors, clustered at the region level, are reported in parentheses.
c) ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table E
Dependent variable is natural log of *Profit per Employee*

	(1)	(2)	(3)	(4)
Sample of Firms	**All regions**	**All regions excluding Beijing**	**All regions excluding Shanghai**	**All regions excluding Beijing and Shanghai**
minimum	0.332	0.290	0.345	0.312
	(0.403)	(0.395)	(0.400)	(0.400)
Private Dummy	0.591***	0.628***	0.574***	0.615***
	(0.085)	(0.089)	(0.087)	(0.090)
minimum X Private	-0.457**	-0.418*	-0.492**	-0.469**
	(0.007)	(0.189)	(0.169)	(0.196)
Controls & Fixed Effects	Yes	Yes	Yes	Yes
Num. Obs.	14943	14026	14226	13309
R-squared	0.504	0.515	0.512	0.525

Notes:

a) All specifications include a constant, 32 sectors, 1264 regions, and 7-year fixed effects, and firm-level controls: ln(emp), ln(total_capital), ln(total_current_asset), ln(age), ln(total_output) (i.e., the specification of column (5) in Table 3).
b) Standard errors, clustered at the region level, are reported in parentheses.
c) ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table F
Dependent variable is natural log of *Profit per Employee*

	(1)	(2)	(3)
minimum	-0.004**	-0.003*	-0.003*
	(0.002)	(0.002)	(0.002)
Private Dummy			0.308**
			(0.118)
minimum x Private			0.002*
			(0.001)
ln(emp)		-0.731***	-1.167***
		(0.040)	(0.033)
ln(total_asset)		0.354***	0.286***
		(0.059)	(0.049)
ln(total_current_asset)		0.389***	0.070
		(0.053)	(0.048)
ln(age)		-0.319***	-0.068**
		(0.029)	(0.025)
ln(total_output)			0.811***
			(0.047)
Sector FEs (32)	Yes	Yes	Yes
Region FEs (1327)	Yes	Yes	Yes
Year Fixed (7)	Yes	Yes	Yes
Num. Obs.	15122	15122	14943
R-squared	0.331	0.416	0.504

Notes:
d) All specifications include a constant, 32 sectors, 1264 regions, and 7-year fixed effects.
e) Standard errors, clustered at the region level, are reported in parentheses.
f) ***, **, and * denote 1%, 5%, and 10% significance levels, respectively

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