Performance and Growth of Large Firms in China

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This study examines the impacts of several factors, such as internal capital markets, technology transfer *via* FDI, and in-house R&D activities on the performance and growth of firms using data gathered from the top 200 companies in China during the period 1998-2003. A finance company, as an affiliate in the business group, is used as proxy for the internal capital market. The foreign joint venture firms and in-house research center are used as proxies for technology transfer and for the existence of in-house R&D activities, respectively. This paper finds that having foreign joint ventures is positively correlated with the firms' growth but not with the financial and market performance of firms. In contrast, doing in-house R&D activities is positively correlated with the financial and market performances, as well as the growth of firms.

Keywords: Finance company, Internal capital market, Joint venture, Technology transfer, R&D activity

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I. Introduction

A great deal of research has been done in identifying the factors that determine the performance and growth of firms in emerging economies, as well as in developing economies. There is also a series

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of articles which share the view that the business group makes up for the market failure in developing countries (Leff 1978; Goto 1982; Khanna and Palepu 1997). This line of research suggests that firms affiliated with a business group outperform standalone firms in certain conditions. In addition, it is well-known that technological progress is a critical factor for sustained economic growth and catch up (Barney 1991; Lee and Temesgen 2005; Choo, Lee, Ryu, and Yoon Forthcoming). Numerous studies are devoted to investigating the impact of technological progress on the performance and growth of firms.

China is one of the most successful emerging economies in the world. It has been growing at a fast rate over the last two decades and it has become a major economic player in the world. In the course of the economic development of China, capital and technology have been the most critical factors for sustained growth of the economy. The government has a clear understanding of the problem, and thus, has encouraged the FDI since the economic reform which started in the late 1970s. Two stock markets were established in December 1990 and July 1991 in Shanghai and Shenzhen, respectively, and the government also has driven the reform of 4 state-owned commercial banks in order to allocate capital more efficiently. The Chinese government also has promoted building joint ventures with foreign firms aimed at technology transfer from advanced countries and encouraged R&D investments for technical catch-up (de Bruijin and Jia 1993).

Further research has been done to explore the determining factors of performance of firms in China. However, a number of issues regarding growth and performance of firms have remained unexplored primarily because of the difficulties in getting access to appropriate data regarding the organizational details of these firms. This study uses the existence of a finance company as an affiliate within a business group as proxy for the operation of the internal capital market in that business group. This study also employs having joint ventures with foreign companies and R&D centers within the business groups as proxies for technology transfer and R&D activities, respectively. This study then aims to explore the impact of these variables, such as access to internal capital markets, technology transfer, and R&D activities, on the performance and growth of firms in China.

This paper is organized as follows. In the following section, we

briefly examine the nature of the finance company, the joint venture, and the R&D center in large-sized firms in China, and draw several hypotheses for empirical analysis. Section III provides a statistical profile of the top 200 firms that comprise our data set. The regression results and findings are provided in Section IV, and a conclusion is drawn in Section V.

II. Key Performance Factors and Hypotheses

A. Market Failures and Business Groups

a) The Literature

One theory that explains the existence of business groups is transaction cost economics with a focus on market failure. They contend that business groups emerge in order to make up for market failure in developing countries. This observation was first made by Leff (1978). He sees the business group as a microeconomic response to market failure and "an organizational structure for appropriating quasi rents which accrue from access to scarce and imperfectly marketed inputs" (Leff 1978). Under circumstances of market failure, guaranteeing access to capital by the business group is a critical condition for better performance and for sustaining the growth of a firm in less-developed countries. Goto (1982) also argues that the business group is "an institutional device designed to cope with market failure." He sees that under certain circumstances, the business group provides more efficient transactions among affiliated firms than markets do. When it comes to transaction of capital, firms can obtain broader and more secure opportunities to invest in member firms in the group by joining the group.

Khanna and Palepu (1997, 2000b) further developed this theory and proposed the concept of 'institutional voids' to explain the emergence and existence of the diversified business group in emerging markets. Since many of the institutions that support business activities are absent or not fully developed in emerging markets, the business group emerges to fill institutional voids. An intentionally developed enterprise in a large business group can function as an intermediary among individual entrepreneurs and imperfect markets. Business groups can smooth out income flows by using their broad scope and thereby provide their affiliates with access to internal finance. They point out that several kinds of

institutional voids include those of capital markets, product markets, and labor markets. They argue that, for example, almost all the institutional mechanisms that enable capital markets to function well in advanced economies are absent or ineffective in emerging markets. With little information and few safeguards, investors are likely to avoid putting money into new business. In this situation, business groups with large and well-established companies have superior positions in getting access to capital markets, so they can raise capital and supply funds for new enterprises more easily. Business groups also play the role of lending institution to existing member firms.

Similar problems take place in product markets. Buyers and sellers usually suffer from severe lack of information, not only because the communication infrastructure in emerging markets is underdeveloped but also because there are no mechanisms to confirm the claims made by sellers or consumers. As a result, firms in emerging markets confront much higher costs in building credible brands than their counterparts in advanced economies. In turn, established brands have strong power. A conglomerate with a reputation for quality products and services can use its group name to enter new businesses more easily. In the case of the labor market, most emerging economies suffer from scarcity of well-trained people. However, groups can create value by developing promising managers and can share efficient management throughout the businesses in the group.

There are many studies that argue that group affiliation enhances performance of firms in emerging countries with empirical evidence. Khanna and Rivkin (2001) examined the effects of group affiliation on profitability using data from 14 emerging markets in Asia, Latin America, and South Africa. They found that the mean of estimated group effects in three countries is positive and statistically significant, while that in one country is negative and statistically significant. These results show that in more countries, a group-affiliated firm outperforms an independent firm operating in the same industry and within the same time period. They also reported that group membership in 13 out of 14 countries is related to a statistically significant amount of variation in their profitability measures, which means that group effects collectively explain more of the variation than industry effects do in many countries. Keister (2000) shows that group affiliation enhances affiliated firms' financial

performance and productivity, using Chinese business group data from the late 1980s. She also found out that they performed better when they were members of more centralized groups.

The performance of group-affiliated businesses seems to be related to group size and group diversification (Khanna 2000). Using 182 listed firms' data in Korea, Chang and Choi (1988) found that business group affiliated firms outperform unaffiliated firms and that affiliates of the largest four Korean chaebol, the most diversified groups in their classification, perform better than smaller chaebol-affiliated and unaffiliated firms, after controlling some variables including firm size, annual growth, advertising, and intensity. Khanna and Palepu (2000a) analyze the data of 1309 public firms in India and report a curvilinear relationship between group diversification and performance using ROA and Tobin's q measure, which indicates that group affiliated firms only outperform unaffiliated firms beyond a certain threshold diversification level, but not under it. They also document similar results analyzing Chilean firms' data (Khanna and Palepu 2000b).

These studies, however, do not concentrate on capital market intermediation but on various intermediations including product markets and labor markets because this line of research takes into account that market imperfection in emerging economies is not a phenomenon confined to capital markets but applied to other markets as well (Khanna and Palepu 1997; Khanna 2000). Therefore, group affiliation itself or proxies for combined intermediation are used for their studies. However, some studies have been performed to examine the isolated effect of internal capital markets on firms' performance in emerging markets. Chang and Hong (2000) examined the effects of product and capital market intermediation separately and suggested that the internal market of business groups play some role in supplementing imperfect external capital markets. Using late 80's panel data on China's 40 largest business groups and their member firms, Keister (1998) showed that firms in business groups with a finance company experienced better performance than firms in groups without a finance company.

b) The Finance Companies in Chinese business groups

This study examines the effect of the internal capital market on firms' performance using data on the largest public companies in China. Some business groups in China have a finance company as

one of their affiliates. In the process of economic development in China, underdeveloped Chinese financial markets provided no guarantee that funds would be efficiently supplied or distributed. Finance companies (*caiwugongsi* in Chinese) emerged to facilitate their affiliates' access to capital markets as an alternative measure for underdeveloped capital markets in China. A finance company is a non-bank financial firm responsible for a business group's finance activity.[1] Group member firms (including the core firm) primarily create relationships with finance companies by doing equity investment over them.

The finance companies have several roles. First, the finance companies in business groups are supposed to manage the idle or extra financial resources of the affiliated firms of the business groups. However, they are prohibited by law to accept deposits from individuals who work for member firms but are allowed to get loans from the government through one of the state's four specialized banks. Based on these funds, they can make loans and provide other financial services to group member firms. By doing so, the finance companies make it possible for their member firms to meet production, research and development, and marketing needs that may not be satisfied without such access to capital.[2] Finance companies affiliated to a group are not allowed to lend funds to individuals or firms that are not member firms.[3] Furthermore, finance companies help member firms make proper investment decisions, regarding both intra-group investments and investment towards outside opportunities. They are expected to perform better based on their superior manpower in the areas of finance. Finally, the finance company plays a central role in coordinating the horizontal and vertical integration across firms and separation of some firms from the group (Keister 2000). In summary, the finance company has offered an alternative role to imperfect capital markets

[1] It is "an independent legal entity with an independent management system," and "solely responsible for its economic decisions" (Keister 2000).

[2] Member firms recognize that they deposit money in the finance company at higher interest than they do in commercial banks and lend money from it at lower interest rate than from commercial banks (Qingdao Heir Annual Report 2003).

[3] It was enacted as a part of bank reform after the 1993 inflation, reflecting the concern of the government, which considered the finance company to be a source of inflation by lending its reservoir to outside companies (Keister 2000).

TABLE 1
NUMBER OF THE TOP 200 FIRMS RELATED TO A FINANCE COMPANY

Year	1998	1999	2000	2001	2002	2003
No. of sample firms related to a finance company	27	31	34	38	39	38

Source: Authors'

in China by creating and running the internal capital market in a business group.

This study collects information about finance companies from annual reports of the top 200 listed companies. To examine how the internal capital market affects the performance and growth of firms, a dummy for access to the finance company is employed. Out of the top 200 companies, 27 are confirmed to be affiliated with business groups that have a finance company as a subsidiary in 1998, and the number has increased to 38 in 2003.[4]

As discussed above, the finance companies seem to play a role as an internal capital market for firms affiliated to business groups; thus, the use of a finance company within a business group the firm belongs to as a proxy for access to internal capital markets. This paper intends to test the following hypothesis.

Hypothesis 1: Access to an internal capital market run by the business groups and its finance company is positively correlated with the performance and growth of a firm listed in stock market.

B. Technology Transfer via FDI and R&D Activity

a) The General Literature

Technological progress is a critical ingredient for sustained economic growth and catch-up. In emerging economies, access to process-related knowledge, such as technology and operational know-how as well as access to capital, is a critical condition for sustained growth of firms (Barney 1991; Guillen 2000). Technology transfer refers to the transfer, absorption, and adaptation of technology, including technology know-how and technology services

[4] There were 74 finance companies that were affiliated with a business group in 2004 (China Banking Regulatory Commission, *Jingjicankaobao*, 2004. 5. 21).

(Andresosso-O'callaghan and Qian 1999). The essence of technology transfer is a learning process that allows the latecomer to narrow the technology gap by shifting the emphasis towards innovation, and ultimately to catch up (Shin 1996).

According to Mansfield (1975), there are three phases of technological transfer. The first phase refers to the so called 'material transfer' which involves the transfer of a new material or products to a country. The second phase corresponds to the transfer of designs and blueprints that facilitate the manufacturing process of the new product or material. The last phase refers to 'capacity transfer' and involves adapting a new item to the specific conditions of the recipient country. The last phase is much more difficult to achieve because of differences in markets, quality, tastes, and *etc*.

In relation to the first two phases, a direct form or pathway of spatial technology diffusion is represented by the acquisition of factories on a turn-key basis. The indirect form of technology transfer includes licensing, co-production, joint ventures with majority/ minority equity participation, and wholly or partly-owned subsidiaries established through the FDI.

b) The Chinese Case

The joint venture law was issued in 1979, and thereafter, China began to introduce laws and regulations to establish an institutional and legislative infrastructure in order to stimulate foreign investment. The Chinese government encouraged foreign investors to build up joint ventures with Chinese firms aimed at obtaining foreign exchange, increasing industrial efficiency, realizing import substitution, and creating new jobs.[5] In general, foreign investors have several motivations for creating joint ventures such as access to the Chinese market, utilization of low labor costs, and favorable treatment from the Chinese government (exemption, obtaining finance, and so on). The aims of Chinese firms for building up joint ventures are to obtain advanced technology, to get access to foreign markets, to have instruments for advancement in the local market, and to develop research and development capacity (de Bruijin and

[5] Due to WTO-related deregulations, foreign firms are no longer required to have Chinese venture partners to invest in most high-tech industries. As a result, more and more R&D facilities in China are wholly foreign owned (Lundin and Serger 2007).

Jia, 1993).

In the case of China, most of the technology has been transferred *via* the FDI, and more specifically with the help of joint ventures.[6] Technology transfer through joint ventures is very often associated with training of labor and management skills (Andresosso-O'callaghan and Qian 1999). In addition, a lot of recent studies report that foreign firms, including joint ventures, function as an important venue of technological transfer (Andreosso-Ocallaghan and Qian 1999; Hu *et al.* 2003). After these, many researchers have devoted themselves to exploring how technology transfer contributes to economic growth or, more specifically, how it affects productivity and/or indigenous innovation activity. However, the results vary.

Lundin and Serger (2007) report the R&D activities of most foreign firms are still predominantly development-focused, rather than research-focused, to support local business and customers, although large multinational enterprises (MNEs) have begun to locate innovative R&D in China in recent years. In contrast, they report both state-owned and private firms, which have higher R&D intensity than the FDI firms based on the analysis of a dataset of Chinese manufacturing firms for the period 1998-2004.

Motohasi (2006) reports similar findings. According to him, the R&D intensity of foreign-owned firms is relatively weaker than that of domestic firms, which stems from the fact that foreign-owned firms are operating by relying on technological capability at home. He confirms that the major motivation of foreign R&D in China is "market driven" instead of "technology driven" or "human resource driven" based on statistical analysis.

Hu, Jefferson, and Qian (2003) examined the contributions of each of the three avenues of technological advance, such as domestic R&D, technology transfer, and foreign direct investment as well as their interactions to productivity within Chinese industry using

[6] Joint ventures represented more than 70% of China's total production in 1995 (Andresosso-O'Callaghan and Qian 1999). Shanghai Volkswagen Automobile Corporation, a 50-50 joint venture between Volkswagenwerk AG and the Shanghai Automobile Industry Corporation founded in 1984, has become the largest joint venture in terms of sales of all recorded JVs in any industrial sector since 1990. European motor manufacturers have secured a strong foothold in China. According to Andresosso-O'Callaghan and Qian (1999), broadening technology transfer provided the basis for the early success of European motor firms.

firm-level data during a period of five years from 1995 to 1999. They measured foreign (domestic) technology transfer by a firm's expenditure on disembodied technology purchased from a foreign (domestic) provider, such as patent licensing and payment for blueprints of technology. They reported two interesting findings. The first one is that the effects of both domestic and foreign market-mediated technology transfer on firm productivity are significant only when they are combined with in-house R&D. The second finding is that the market-mediated technology transfer does not have any impacts on the FDI firms except when foreign market-mediated technology transfer is combined with indigenous R&D.

This last study seems to suggest the importance of indigenous R&D effort by local Chinese firms or partners, and the need to pay more attention of in-house R&D activities by local Chinese firms.

Before economic reform, firms had no incentive to perform R&D in China because the technology acquired as a result of the R&D had strong characteristics of public goods. Under the planned economy, government required enterprises to have "cooperation spirits," and thus, technology was commonly transferred free of charge. This free technology sharing existed for a long time even after the reform started (Kong 2003).

In March 1985, the Chinese government issued the Decision on S&T (science and technology) System, which became the landmark of Chinese S&T system reform. This decision shaped the transformation of corporate R&D in several ways. First, the government required that technology be transferred with fees. Second, the Chinese government encouraged technology development institutes to be combined with firms in several ways and encouraged S&T institutes to develop into firms or enter into firms.[7] Large firms were supposed to strengthen their technology exploitation departments or research organizations. Small firms under certain conditions could still have their own technology exploitation capabilities. Firms could allocate the technology exploitation fees into costs according to regulations and apply for technology exploitation loans from banks. Third, the government required that technology imports focus on production

[7] According to Kong (2003), many institutes entered into firms *via* other ways. In 1987, one third of 5568 research institutes entered into enterprises by entering into LMEs (large and medium sized enterprises) and business groups, forming small firms, participating and becoming industrial technology exploitation units, *etc*.

TABLE 2
RELATIVE R&D EXPENDITURE BY KEY ACTORS, %

	1990	1995	2000	2005
Research Institutes	50	42	29	21
Universities	12	12	9	10
Enterprises	27	44	60	68

Source: *China Statistical Yearbook on Science and Technology* (2001; 2004; 2006), Lundin and Serger (2007)

technology and firms renovate existing equipment. Cities near the coast and SEZs (special economic zones) became the leading places to import advanced technologies, and domestic R&D activities were needed to combine with technology imports very closely.

On the basis of 10 years' experience, the Chinese government issued the "Decision on accelerating the S&T progress" and the "Decision on deepening S&T system reform" in 1995. The main tasks of the reforms were to enforce institutes to face the market economy and to promote the "corporatization" of technology exploitation institutes. The decision emphasized that transformed institutes should set up a modern corporation system, which clarified the legal status of transformed institutes. As a consequence of the reform, the revenue structure of institutes profoundly changed. Reflecting the promotion of science and research activities through market mechanisms, such as technology exploitation, technology transfer, technology consultancy, and technology services, the share of transverse revenue of institutes increased a great deal.

The transformation of technology exploitation research institutes started in 1999. There were several paths for transformation. Some research institutes were merged into firms or business groups, some were transformed into S&T corporations and agencies, and others were merged into universities.

Reflecting the reform of the S&T system, there has been a large increase in R&D conducted by enterprises in the business sector, with accounting for from less than 30% in 1990 to over two thirds of the total R&D in 2005. This is an impressive structural shift during the past two decades from an innovation system dominated by research institutes to an enterprise-centered innovation system. Jin, Lee, and Kim (Forthcoming 2008) also reported the increasing importance of innovation as the engines of growth in China using

TABLE 3
NUMBER OF SAMPLE FIRMS WITH JOINT VENTURES AND R&D CENTERS

Year	1998	1999	2000	2001	2002	2003
No. of Firms with Joint Ventures	46	52	57	63	71	75
No. of Firms with R&D Centers	31	41	61	68	72	68

Source: Authors'

the cross-province regressions.

Table 3 shows the number of sample firms with foreign joint ventures and the number of sample firms with in-house R&D centers. Based on a collection of information from annual reports, the study confirms that 46 out of the top 200 firms had joint ventures as subsidiaries or with 50-50 equity ownership with foreign companies in 1998, and the number increased to 75 in 2003. Also, we found that 31 firms out of the 200 sample firms have in-house R&D centers in 1998; the number has increased to 68 in 2003.

Given the availability of data, this study will examine the impacts of these two factors on firm performance in China: 1) technology transfer *via* foreign joint ventures; and 2) in-house R&D activities. We hypothesize as follows.

***Hypothesis 2*:** Firms with foreign joint ventures as affiliates are positively correlated with better performance and growth.

***Hypothesis 3*:** Doing in-house R&D activities is positively correlated with performance and growth of firms.

III. Data and Summary Statistics

This study analyzes the top 200 non-financial firms in China that have been listed in one of the two markets, Shanghai and Shenzhen Stock Market, since 1998. The study selects the top 200 firms in terms of total sales in 1998 with their subsidiaries' sales included because public companies that own more than 50% of another firm's equity directly or indirectly are required to report both individual and consolidated financial statements by law in China. Furthermore, the panel data covers the period between 1998 and 2003. There are several reasons for choosing the method of data selection. First, the top 200 firms are selected because it is easy to get access on

detailed information for large firms and they have some characteristics that this study needs to examine. Second, this study chooses 1998 as the base year for the panel, taking data availability into consideration, and thus, only the firms which became public before or in 1998 in the two stock markets in China were selected. On the other hand, firms which did not maintain their public status until 2003 were excluded. Third, this study analyzes only non-financial firms, considering the fact that finance companies have different accounting principles.

This study uses the China Stock Market and Accounting Research Database (CSMAR) to obtain information such as accounting data and market prices, the industry in which a firm competes, and ownership structure.[8] The China Stock Market and Accounting Research Database (CSMAR) was developed by the China Accounting and Finance Research Centre of The Hong Kong Polytechnic University (the Centre) and the Shenzhen GTA Information Technology Limited (GTA IT Co., Ltd.). Annual reports of companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange, available in Shanghai Securities News (*zhengquanbao* in Chinese) and the China Securities Regulatory Commission (*zhenquanjianduguanliweiyuanhui* in Chinese), are used for collecting information, such as the ownership structure, existence of a finance company, joint ventures, and R&D centers.

Table 4 shows the distribution among industries of the top 200 firms compared to the whole of sample firms. A two-digit standard industry classification (SIC) system based on the China Securities Regulatory Commission is used in this study. However, to avoid a small sample problem, this study uses a one-digit SIC system for the industries, except the manufacturing industry (Seo 2006). Thus, one of 22 industries (12 industries based on one digit SIC + 9 manufacturing industries based on two-digit SIC) is assigned to each firm. The 200 sample firms analyzed in this study are distributed across 19 out of 22 industries. Industry dummies are assigned to every observation and a *t*-test is performed to test whether the sample of the top 200 firms has the same mean as that of the

[8] This study obtained equity ownership data of public firms by the top 10 shareholders during the 1999-2002 period from CSMAR. However, the equity ownership data during the rest of the years (1998 and 2003), and information about controlling shareholders were gathered by reviewing the annual reports.

TABLE 4

DISTRIBUTION OF INDUSTRIES OF SAMPLE FIRMS

Industry Code	Whole Sample		Top 200 (A)		Other Firms (B)		Difference
	No. of Firms	Percentage	No. of Firms	Percentage	No. of Firms	Percentage	*t*-test for mean
A	18	2.19	2	1.00	16	2.58	-1.58
B	6	0.73	1	0.50	5	0.81	-0.31
C0	38	4.63	13	6.50	25	4.03	2.47
C1	33	4.02	10	5.00	23	3.70	1.3
C2	1	0.12	0	0.00	1	0.16	-0.16
C3	17	2.07	0	0.00	17	2.74	-2.74*
C4	93	11.33	18	9.00	75	12.08	-3.08
C5	27	3.29	11	5.50	16	2.58	2.92*
C6	74	9.01	22	11.00	52	8.37	2.63
C7	129	15.71	37	18.50	92	14.81	3.69
C8	38	4.63	9	4.50	29	4.67	-0.17
C9	7	0.85	1	0.50	6	0.97	-0.47
D	31	3.78	6	3.00	25	4.03	-1.03
E	13	1.58	6	3.00	7	1.13	1.87†
F	25	3.05	1	0.50	24	3.86	-3.36*
G	43	5.24	9	4.50	34	5.48	-0.98
H	85	10.35	39	19.50	46	7.41	12.09***
I	0	0.00	0	0.00	0	0.00	0
J	29	3.53	6	3.00	23	3.70	-0.7
K	28	3.41	3	1.50	25	4.03	-2.53†
L	9	1.10	6	3.00	9	1.45	-1.45†
M	76	9.26	2	1.00	71	11.43	-8.93***
Total	821	100	200	100	621	100	

Notes: 1) †, *, **, and *** denote statistical significance at a 10 percent, 5 percent, 1 percent, and a 0.1 percent level, respectively.

2) Industry Code

A: Farming, Forestry, Animal Husbandry, and Fishery
B: Mining C0: Food and Beverage Manufacturing
C1: Textile, Apparel, Fur, and Leather Industry
C2: Wood products and Furniture C3: Paper and Printing
C4: Petroleum, Chemical, Plastic & Rubber
C5: Electronics C6: Metal, Non-Metal
C7: Machinery, Equipment & Instrument
C8: Medicine and Biological Products C9: Other Manufacturing
D: Utilities E: Construction
F: Transportation and Warehousing G: Information Technology
H: Wholesale and Retail Trade I: Finance and Insurance
J: Real Estate K: Social Services
L: Communication and Cultural Industries
M: Others

Source: China Securities Regulatory Commission

TABLE 5
CHARACTERISTICS OF TOP 200 FIRMS

Variable	Top 200 Firms		Other Firms		Difference
	Observation	Mean (Median)	Observation	Mean (Median)	Mean (Median)
Age (Year)	200	5.27 (5.33)	608	5.74 (5.59)	-0.47 (-0.26†)
Total Assets (Million *Yuan*)	200	2,890 (1,950)	610	855 (675)	2,035*** (1,275***)
Sales (Million *Yuan*)	200	1,950 (1,270)	608	282 (249)	1,668*** (1,021***)
ROIC (%)	174	9.69 (8.76)	533	8.24 (8.92)	1.45 (-0.16)
Tobin's *q*	200	2.20 (2.08)	609	3.00 (2.72)	-0.79*** (-0.64***)
Leverage	200	0.113 (0.042)	610	0.106 (0.025)	0.01 (0.02*)
Liquidity	200	1.62 (1.44)	610	2.14 (1.63)	-0.52*** (-0.19***)

Notes: 1) *t*-test and Wilcoxon *z*-test (Mann-Whitney) are performed to test the equality of the mean and median, respectively, between the panel sample and unselected firms.
2) †, *, **, and *** denote statistical significance at a 10 percent, 5 percent, 1 percent, and 0.1 percent level, respectively.

unselected firms. The result shows that the 200 sample firms do not exhibit any differences from the rest of the firms in industry distribution in 14 industries but are statistically different in distribution in the following 8 industries: paper and printing, electronics, construction, transportation and warehousing, wholesale and retail trade, social services, communication and cultural industries, and others.

Table 5 reports some important features of the panel sample compared with those of the other firms. The top 200 firms are younger than the rest at a 10 percent level. The mean/median of total assets and that of sales of the panel sample are significantly larger at a 0.1% level confirming that the panel sample comprises the top 200 firms.

This study employs return on invested capital (ROIC), which is defined as the sum of net income before tax plus interest payment (EBIT) during the year divided by total assets at the beginning of the

year, as a dependent variable to measure firm-level economic performance. Most studies analyzing financial performance of public firms in China use ROA. This study, however, uses ROIC as a proxy for cash flow return because this measure of performance enables us to analyze firms' performance without being biased by the different degrees of debt-equity ratios. Test results show that the mean/median ROIC of the panel is not different from the mean/median of the rest of the firms. A proxy for the Tobin's q, defined as the sum of the market value of equity plus book value of debt divided by book value of assets, is used for analyzing market performance. A more accurate measurement of the Tobin's q is not allowed because the required data are unavailable. According to the test results, the mean/median value of the Tobin's q of the top 200 firms is much smaller than that of the remaining firms.

This study also uses two variables, the indicator of liquidity and the level of debt carried by the firm, to control for the availability of capital raised (Myers 1977; Myers and Majluf 1984; Chang 2003). The leverage ratio is calculated by long term loans divided by the book value of equity while the liquidity ratio is defined as liquid assets divided by current liabilities. A high debt-equity ratio will increase the likelihood of bankruptcy and financial distress and thereby limit the firm's ability to finance its investment by borrowing (Froot, Scharfstein, and Stein 1994). It is expected that firms with more cash and debt-carrying capacity can finance their investment more easily; therefore, they experience higher performance (Chang 2003). The median value of the leverage ratio of the panel sample is bigger than that of the rest (significant at a 5% level). The top 200 firms have a lesser liquidity ratio compared to the unselected firms and the difference is statistically significant, which means the larger the firm the lesser the liquidity ratio.

IV. Results and Findings

A. Financial Performance: Cash Flow Return

Because the dataset used in this study covers a five-year period, it is necessary to employ an appropriate method to analyze the panel data. If X_{kit} is defined as the k^{th} independent variable of firm i at time t, the model can be expressed as follows.

$$\textit{Industry adjusted cash flow return}_{it}\ (IACR_{it}) = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + u_i + \varepsilon_{it}$$

where,

X_1: control variables,

X_2: variables capture firm's characteristics: explanatory variables

u_i: the firm individual effect, taken to be constant over time t and specific to the individual firm i.

ε_{it}: the reminder stochastic disturbance term, assumed independent of the X_{it} for all i and t. $\varepsilon_{it} \sim iid(0,\ \delta\varepsilon^2)$.

Two basic frameworks are used to generalize the panel regression. The fixed effects approach takes u_i to be a group specific constant term in the regression model while the random effects approach considers u_i as a group specific random disturbance, similar to ε_{it} except that it is constant through time (Greene 2002). Fixed effects always give consistent results; thus, it is reasonable to run fixed effects with panel data even when u_i is assumed to be correlated with X_{it}, but they may not be the most efficient model to run. Random effects will yield a better *P*-value as they are a more efficient estimator, but they can be used under the very strict assumption that u_i is not correlated with the firm's behavior X_{it}. In other words, it is recommended that one run random effects if it is statistically justifiable to do so. The Hausman test checks a more efficient model against a less efficient but consistent model to make sure that the more efficient model also gives consistent results.

Industry-adjusted cash flow, which returns to assets, is used as the dependent variable to examine the effects of explanatory variables on financial performance of a firm. It is practical to use the industry-adjusted measure in controlling industry-related factors as well as annual noises. As mentioned before, this study uses return on invested capital (ROIC) as a cash flow return measure, which is defined as pretax income plus interest payments (EBIT) during the year divided by total assets at the beginning of the year. Industry adjusted cash flow returns to assets is calculated by subtracting the industry median of cash flow returns to assets at time t from raw cash flow returns to assets at time t.

The natural log value of sales is used to control for firm size. This study adds the liquidity and leverage ratio of a firm, defined as liquidity assets divided by current liabilities at the beginning of year t and long term debt divided by equity at the beginning of the year t,

respectively, to control for the availability of capital raised.

Dummy variables for the characteristics of control shareholder are included as control variables. Many studies report that firms controlled by the state are outperformed by legal person-controlled firms in China (Xu and Wang 1999). Equity ownership by the top shareholder is also used as control variable. Wang *et al.* (2004) report that the degree of ownership concentration is positively correlated with the operating performance using public company data for the period 1994 to 2000.

The finance company captures the internal financial market. In regression analyses, if a firm is affiliated with a business group which has a finance company, 1 is assigned; otherwise, 0 is assigned. The joint venture captures technology transfer from firms in advanced countries and R&D centers capture indigenous R&D activities. The dummy value 1 is assigned to a firm, which has 50% or a greater percentage of ownership directly or indirectly of one or several joint ventures with foreign companies; 0 is assigned otherwise. If a firm has R&D departments or R&D centers in it or as a subsidiary, the dummy value is set equal to one. The last variable, outside guarantees, is built to capture resource exchanges between firms. This study assigns 1 as a dummy value when a firm provides a guarantee to outside companies. There is a good possibility of causality between performance and explanatory variables, such as the finance company, joint ventures, and R&D centers. To eliminate the causality problem, this study uses lagged variables of them in regression analysis.

Table 6 reports regression results. The panel regression analyzes almost 1,000 observations with 200 groups. As mentioned above, this study controls for firm size by including the log value of total sales. Results show that the firm size measured by the log of total sales is positively correlated with cash flow. Two variables, such as the leverage and liquidity ratio control the availability of capital raised. The estimated coefficients of the leverage ratio are negative and statistically significant in all regressions at least at the 5 % level, indicating that the leverage ratio has negative effects on cash flow return. These results are similar to those of Korean firms (Chang and Hong 2000). The estimated coefficients of the liquidity ratio are not statistically significant.

The state controlled firms as well as the state-owned legal person controlled firms are significantly outperformed by the legal person

TABLE 6

REGRESSION RESULTS OF FINANCIAL PERFORMANCE

	Regression (1)		Regression (2)		Regression (3)	
	Fixed	Random	Fixed	Random	Fixed	Random
Constant	-0.3352**	-0.4096***	-0.3530***	-0.4163***	-0.3224**	-0.4030***
	(-2.91)	(-6.41)	(-3.17)	(-6.37)	(-2.76)	(-6.18)
log(sales)	0.0167***	0.0191***	0.0163**	0.0194***	0.0160**	0.0188***
	(3.29)	(6.44)	(3.12)	(6.4)	(3.08)	(6.16)
Leverage	-0.0311**	-0.0254**	-0.0259*	-0.0226*	-0.0293*	-0.0230*
	(-2.73)	(-2.57)	(-2.25)	(-2.27)	(-2.56)	(-2.32)
Liquidity	0.0004	0.0018***	0.0018	0.0026	0.0010	0.0015
	(0.14)	(0.72)	(0.6)	(1.05)	(0.34)	(0.58)
State controlled	-0.0599***	-0.0292***			-0.0596***	-0.0276**
	(-3.67)	(-3.46)			(-3.67)	(-3.17)
SLP controlled	-0.0683**	-0.0402***			-0.0694**	-0.0394***
	(-2.86)	(-3.67)			(-2.91)	(-3.56)
Top shareholder	0.0006	0.0005**			0.0006	0.0005**
	(1.23)	(2.76)			(1.23)	(2.95)
Fnc_cmpnyl			-0.0025	-0.0072	-0.0016	-0.0072
			(-0.19)	(-0.97)	(-0.12)	(-0.97)
Jnt_venturel			0.0179	0.0013	0.0160	0.0012
			(1.61)	(0.21)	(1.44)	(0.19)
R&D_cnterl			0.0112	0.0051	0.0132†	0.0061
			(1.49)	(0.9)	(1.76)	(1.06)
Guarantee			-0.0101	-0.0075	-0.0106	-0.0066
			(-1.38)	(-1.42)	(-1.47)	(-1.27)
No_obs	988	988	960	960	960	960
No_groups	200	200	200	200	200	200
F/Wald chi^2	5.59***	68.66***	3.39**	55.56***	4.18***	73.34***
R-squared	0.0776	0.1003	0.0661	0.09	0.0717	0.1071
Hausman chi^2		6.75		6.04		11.99
Prob>chi^2		0.3442		0.5353		0.2854

Notes: 1) "State controlled" refers to the firms whose control shareholder is the state. "SLP controlled" stands for the firms controlled by the state legal person shareholder. "Top shareholder" indicates equity ownership by the top shareholder. Fnc_cmpnyl, Jnt_venturel, and R&D_cnterl denote lagged variables for the finance company, the joint venture, and the R&D center, respectively.

2) Fixed effects regression and random effects generalized least square regression are performed and Hausman test results are reported. Numbers in parentheses are *t*-values.

3) †, *, **, and *** denote statistical significance at 10 percent, 5 percent, 1 percent, and 0.1 percent level, respectively.

controlled firms, which is in line with the results of previous studies. The signs of estimated coefficients of the dummy for financial companies are all negative but none of them are statistically significant, indicating that Hypothesis 1 is not supported. Thus, the market imperfection theory is not supported. The estimated coefficients of the joint venture are all positive in 3 regressions but are not statistically significant. The results suggest that technology transfer through joint ventures is not very successful; thus, its existence does not have significant effects on the performance of firms in China. However, the R&D center has significant and positive effects on it when the variables capturing the ownership structure are controlled in regression 3; thus, the results support Hypothesis 3.

B. Stock Market Performance: Tobin's Q

As mentioned before, this study constructs a proxy for the Tobin's q, which is defined as (market value of equity + book value of debt) / book value of assets, to examine market performance. The industry adjusted Tobin's q, calculated by subtracting the industry median of the Tobin's q from the raw Tobin's q of the firm, is used as the dependent variable in the regression analysis to control for industry-related factors as well as annual fluctuations. The control variables are firm size measured by the logarithm of sales and age of the firm expressed in the number of years.

The regression is carried out on the 200 panel firms. Regression results in Table 7 show that firm size, measured by log value of total sales, is negatively correlated with market performance. Further, market performance is a positive function of firm age. In contrast to financial performance analysis, variables capturing ownership structure have no significant effect on a firm's performance. Estimated coefficients of ownership concentration (captured by variable "Top shareholders") have significant values in random effects in regression (1) and (3), but results of the Hausman test lead us to reject the null hypothesis that the coefficients estimated by the efficient random effects estimator are consistent at the 5% level.

The estimated coefficients of the finance company are positive, but none of them are statistically significant. The joint venture has positive coefficients, but statistically insignificant ones. The R&D center is positively correlated with market performance in regression (2)-(3), which support Hypothesis 3. Market performance is a

TABLE 7
REGRESSION RESULTS OF MARKET PERFORMANCE

	Regression (1)		Regression (2)		Regression (3)	
	Fixed	Random	Fixed	Random	Fixed	Random
Constant	7.7205***	6.5401***	7.7468***	7.0077***	8.3191***	6.8224***
	(4.82)	(6.4)	(5.1)	(6.73)	(5.08)	(6.51)
log(sales)	-0.4267***	-0.3756***	-0.4424***	-0.3760***	-0.4459***	-0.3934***
	(-5.84)	(-7.75)	(-5.99)	(-7.66)	(-6.02)	(-7.94)
log(Age)	0.7033***	0.4423***	0.7652***	0.3627***	0.7278***	0.4523***
	(5.77)	(4.88)	(6.38)	(4.18)	(5.56)	(4.81)
State controlled	-0.2833	-0.1381			-0.3184	-0.1032
	(-1.15)	(-0.95)			(-1.29)	(-0.69)
SLP controlled	-0.1286	-0.0865			-0.2096	-0.1192
	(-0.37)	(-0.46)			(-0.6)	(-0.62)
Top shareholder	-0.0002	0.0088*			-0.0035	0.0092**
	(-0.02)	(2.53)			(-0.41)	(2.62)
Fnc_cmpny			0.1702	0.0493	0.1913	0.0054
			(0.78)	(0.39)	(0.87)	(0.04)
Jnt_venture			0.0963	0.1236	0.0955	0.1351
			(0.62)	(1.19)	(0.61)	(1.28)
R&D_cnter			0.2512*	0.1754†	0.2602*	0.1731†
			(2.24)	(1.94)	(2.31)	(1.90)
Guarantee			-0.2032†	-0.0322	-0.2042†	-0.0365
			(-1.89)	(-0.38)	(-1.9)	(-0.43)
No_obs	993	993	967	967	967	967
No_groups	200	200	200	200	200	200
F/Wald chi^2	9.75***	73.34***	10.15***	73.60***	7.27***	80.76***
R-squared	0.0571	0.0918	0.0531	0.0812	0.0458	0.0954
Hausman chi^2		23.52***		36.13***		34.01***
Prob>chi^2		0.0006		0.0000		0.0002

Notes: 1) Fnc_cmpny, Jnt_venture, and R&D_cnter denote the dummy variable for the finance company, the joint venture, and the R&D center, respectively.
2) Numbers in parentheses are *t*-values.
3) †, *, **, and *** denote statistical significance at the 10 percent, 5 percent, 1 percent, and 0.1 percent level, respectively.

negative function of the guarantee over outside firms.

C. Growth: Performance

There is a great deal of research on growth of firms in the

advanced economies. Gibrat (1931) argues that firm growth is independent of firm size. Mansfield (1962) reports that the firm size is negatively correlated with the firm growth and raises the possibility of departure from Gibrat's law. Jovanovic (1982) argues that the firms uncover their true efficiencies over time through learning in his theory and suggests an inverse-relationship between the firm age and growth.

In classical works on firm growth in advanced economies, Evans (1987a, 1987b) found that the firm age and size are important determinants of firm growth because firm growth decreases with firm age and size. He also found that the relationship between firm growth and firm size is highly nonlinear; thus, the growth-size relationship varies over the size distribution of firms. These papers deal with the classical question of the relationship between the size, age, and growth of the firm.

For developing countries, Shanmugam and Bhaduri (2002) examined the effects of firm size and age on firm growth using the data of Indian firms, following tradition. Tybout (2000) performed an important survey on firms in developing countries, focusing on the impact of regulatory and protection regimes on technical efficiency and turnover. Sleuwaegen and Goedhuys (2002) examined firm growth related to certain other factors, such as access to capital market, resources, infrastructure and financial services. Lee and Temesgen (2005) explored the effects of various resources at different levels, such as physical capital, human capital, managerial capital, and R&D capital, on firm growth using data from 8 developing countries.

According to Evans (1987a), firm growth is given the following function:

$$S_{t+1}=[G\ (A_t,\ S_t)]^d\,(S_t)\,e_t \tag{1}$$

where S_t denotes size at time t,
A_t denotes age at time t,
d stands for time difference$=t'-t$
e_t is a log normally distributed error term with possibly a non-constant variance.

From Equation (1), we get the following regression framework.

$$(\ln S_{t'} - \ln S_t)/d = \ln G\ (A_t,\ S_t) + u_t \qquad (2)$$

where S_t stands for size at time t,

u_t is normally distributed with mean zero and possibly a non-zero constant variance and is independent of size and age.

Taking a second order logarithmic expansion of $\ln G(A, S)$ yields

$$\ln G = b_0 + b_1 \ln S + b_2 \ln A + b_3 (\ln S)^2 + b_4 (\ln A)^2 + b_5 (\ln S)(\ln A) + u \qquad (3)$$

Equation (2) can be modified as follows:

$$(\ln S_{t'} - \ln S_t)/d = \ln G(A_t,\ S_t) + BX_t + u_t \qquad (4)$$

where, BX_t is the vector of firm specific characteristics that affect firm growth including dummies for the finance company, joint venture, and research center.

From Equations (3) and (4), the following equation for the regression analysis used in this study can be obtained:

$$(\ln S_{t'} - \ln S_t)/d = a_0 + a_1 \ln S_t + a_2 \ln A_t + a_3 (\ln S_t)^2 + a_4 (\ln A_t)^2 + a_5 (\ln S_t)(\ln A_t) + BX_t + u_t$$

The dependent variable, $(\ln S_{t'} - \ln S_t)/d$, denotes average growth rate of sales of a firm for the period. The sample used in this study spans a period of five years, 1998 to 2003. Data used in this regression are analogous to those in the previous sections. Age is calculated by deducting the birth date of a firm expressed in year terms from the time when our analysis period started.

This study employs industry-adjusted measures to eliminate industry-related effects from the observed actual values. The industry medians of average growth rates for the period are calculated among the firms that operate in each industry. The industry adjusted value is calculated by deducting the industry median from the actual value.

Explanatory variables are defined as follows. If the median value of the lagged dummy value of the finance company during the 5-year period is one, one is assigned and zero, otherwise. Example, if a firm

TABLE 8
REGRESSION RESULTS OF FIRM GROWTH

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-5.6724 (-0.6)	-5.7282 (-0.6)	-3.6394 (-0.38)	-6.0347 (-0.65)	-6.2970 (-0.65)	-5.0791 (-0.51)
log(Sales)	0.4239 (0.48)	0.4251 (0.48)	0.2179 (0.24)	0.4487 (0.51)	0.4782 (0.53)	0.3386 (0.37)
log(Age)	1.2845* (2.2)	1.3107* (2.2)	1.5224* (2.56)	1.4394* (2.46)	1.3797* (2.34)	1.7544** (2.84)
log(Sales)* log(Age)	-0.0669* (-2.37)	-0.0679* (-2.35)	-0.0791** (-2.73)	-0.0749** (-2.64)	-0.0714* (-2.49)	-0.0901** (-2.98)
$(\log(\text{Sales}))^2$	-0.0068 (-0.33)	-0.0068 -0.32	-0.0016 (-0.08)	-0.0072 -0.35	-0.0079 (-0.38)	-0.0040 (-0.19)
$(\log(\text{Age}))^2$	0.0355* (2.18)	0.0339* (2.03)	0.0395* (2.35)	0.0385* (2.34)	0.0354* (2.16)	0.0398* (2.37)
Fnc_cmpny5		-0.0274 (-0.79)				-0.0272 (-0.8)
Jnt_venture5			0.0645* (2.31)			0.0536† (1.92)
R&D_cnter5				0.0539* (2.06)		0.0470† (1.83)
Guarantee5					-0.0245 (-1.02)	-0.0286 (-1.18)
Number of observations	200	200	200	200	200	200
F-statistic	3.24**	2.82**	3.64***	3.28***	2.88**	2.92***
Prob>*F*	0.0011	0.0027	0.0002	0.0006	0.0023	0.0007
R-squared	0.091	0.0947	0.1198	0.1108	0.0955	0.1413
Root MSE	0.15769	0.15778	0.15557	0.15637	0.1577	0.15489

Notes: 1) Fnc_cmpny5, Jnt_venture 5, R&D_cnter5, and Guarantee5 denote the median value of the lagged dummy value of the finance company during the 5-year period, the median value of the lagged dummy value of the joint venture during the same period, the median value of the lagged dummy value of the R&D center during the same period, and the median value of the dummy value of guarantees during the same period, respectively.

2) White's heteroscedasticy-consistent *t*-statistics are reported in parentheses.

3) †, *, **, and *** denote statistical significance at the 10 percent, 5 percent, 1 percent, and 0.1 percent level, respectively.

has more than three ones as lagged dummy values for the finance company during the 5-year period, one is assigned to the firm. On the other hand, if it has less than two ones as lagged dummy values, zero is assigned. Dummy values for the joint venture and the R&D center are assigned in the same way.

Table 8 reports the regression results. Results show that age is positively correlated with a firm's growth. This finding is different from that of Evans (1987a, 1987b). The difference may arise from the fact that our data only consist of large firms in China while Evans uses the dataset including small firms in the U.S. The estimated coefficients of the finance company are not significant; thus, the market imperfection theory (Hypothesis 1) is not supported.

The joint venture has positive and significant estimators in regression (3) and (6) at the 5% and 10% level, respectively, supporting Hypothesis 2. These results are in contrast to those of the financial performance and market performance reported before. The coefficients of the R&D center are positive and significant in regression (4) and (6) at the 5% and 10% level, respectively. These results support Hypothesis 3.

VI. Summary and Concluding Remarks

This study analyzes the impacts of several variables, such as access to internal capital markets, technology transfer *via* the FDI, and in-house R&D activities, on performance and growth of large-sized firms in China. The existence of a finance company as an affiliate in the business groups, having foreign joint ventures as affiliates, and establishment of in-house R&D center, are respectively used as proxies for the internal capital market, technology transfer, and R&D activities. Three performance variables are used, such as financial performance measured by the returns on invested capital (ROIC), stock market performance measured by the Tobin's *q*, and firm growth measured by average growth rates of sales.

Main findings are as follows. First, access to internal capital markets has no impact on financial performance, market performance, or growth of firms. However, this result needs to be interpreted with caution given the imperfect nature of the proxy for internal capital markets. Second, technology transfer *via* FDI is found to have significant effects on a firm's growth while it does not have any significant effects on financial and market performance.

Third, in-house R&D activities are found to have significant impacts on financial performance and market performance as well as on growth of firms.

These results imply that in-house R&D activities have strongest impacts on performance and growth of large firms in China, compared to technology transfer *via* the FDI or access to internal capital markets. This result is consistent with the recent policy re-direction or initiatives by the Chinese government putting more emphasis on indigenous firms and their innovation capabilities, as compared to the past emphasis on FDI. Furthermore, foreign firms in China also started to increase and deepen their R&D activities in the country in order to consolidate securely their presence in the Chinese market (Gaulier *et al.* 2005). This study is limited only the on largest firms, which are analyzed here, and therefore, further studies with larger data on other types of firms are still needed.

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Comments and Discussion

*Comments by Shiyong Zhao**

This is a very standard economic research. First, the author derives five hypotheses based on three economic theories, namely, market imperfection theory, agency theory, and resource-based view. By the way, the author did a very good literature review on the three theories. Interestingly, hypotheses derived from these theories are conflicting. And then the author uses the panel data of the Chinese large-sized public firms to test (either to confirm or refute) the hypotheses.

This paper identifies capital and technology as two most important factors affecting the growth and performance of firms. With regard to capital, we know capital sources of firms are various, but the author only considers the internal capital market with finance company as the proxy. I think it is not enough that is probably why the regression results do not support the conflicting hypotheses of 1 and 1′.

The author gives an excellent description about the role of finance companies. There is no problem that the author uses finance company as the proxy for internal capital market of large firms. But the role of finance company substitutes part of the commercial banks, so it is very hard for business groups to get approval for establishing a finance company. So I guess there are two few firms that have finance companies. The other two constructions, joint venture and R&D investment as proxies for technology transfer and technology accumulation, make good sense and thus are convincing, in my opinion.

The paper finds that "joint ventures have significant effects on firm growth. It is partially because joint ventures are related to foreign markets as well as technology transfer." This result is consistent

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with the reality, according to my knowledge, because Chinese exporting products are mainly produced by foreign-invested enterprises (FIEs), including joint ventures. Moreover, the paper also finds that "the research center or R&D investment has significant effects on not only performance but also growth of firms in China." This implies that China has caught up with advanced technologies in many industries. Otherwise, the role of R&D should not be so significant. These are important findings.

Another critic is that, according to the content of the paper, the focus is on the determinants that might affect the growth and performance of Chinese largest firms. So the title performance and growth of the largest firms in China is a little bit too general and vague.

Another limitation of the paper is that it is not very convincing just to use 200 public companies listed on the stock market to represent the population of Chinese largest firms. Moreover, most of the firms in the sample are state-owned enterprises (SOEs). So the findings of the research cannot be extended to all large firms in China, since private firms are playing a more and more important role in the Chinese economy. But private firms hesitate to list on the stock market because of the stringent requirements such as information disclosure, financial standardization, *etc*.