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Innovation and R&D Activities in China's Biotechnology and Pharmaceutical Sectors

Tao Zeng*

School of Business and Economics, Wilfrid Laurier University, Waterloo, Ontario, Canada

Abstract

This paper examines innovation and R&D expenditures in China's biotechnology and pharmaceutical sectors. We found that R&D spending for these industries was much lower than spending in operating activities, which suggests a suboptimal allocation of resources. We also found that the proportion of intangible assets to total assets (including patents, trademarks and licenses) were also much lower than those in industrialized countries such as Canada and the U.S. We also examined other factors that were associated with R&D spending in these sectors. Using the China Stock Market Financial Statement Database and the SINA financial database, it was found that Chinese biotechnology and pharmaceutical firms' expenditures in R&D activities are positively associated with ownership structure, but negatively associated with firm size, and with investments in other assets including inventory and fixed assets.

Keywords: Intangible assets; R & D activities; Biotech and pharmaceutical firms; Ownership

Introduction

Innovation has been a central theme for the growth and development of firms in nearly all developed and developing economies. The question of why some firms spend large amounts on R&D while others do not is one that interests both policy-makers and academics. This study examines innovation and R&D expenditures among biotechnology and pharmaceutical firms in China.

China is one of the world's largest investors in research and development. According to the OECD, Chinese spending on R&D increased 19% per year between 1995 and 2005, reaching US$30 billion in 2005 and ranking China sixth in the world in R&D spending. When we adjust this spending on the basis of purchasing power parity between different countries, China would actually rank third in the world behind only the U.S. and Japan. However, in terms of GDP per capita, R&D spending in China is quite low, far lower than the OECD average [1]. Many researchers have suggested that R&D expenditures are not used efficiently in China and point to the low output of internationally-valuable patents. According to Oxford Analytical, while United States Patent Office (USPTO) patents issued to Chinese companies increased twenty-fold over the last 15 years, China still ranked only 12th in USPTO patents received in 2008. But it was actually foreign firms, rather than domestic firms, that lead this innovation activity. From 2003 to 2007, multi-national corporations generated 1,125 USPTO patents where the lead inventor on the patent was located in China. In contrast, Chinese domestic firms and institutes created only 244 lead inventor patents [2].

This study is motivated by the lack of research on R&D investment in China. A large body of literature exists that focuses on innovative activities in the U.S., Japan and other industrialized countries [3-6]. For example, Falk [7] investigated the determinants of business-sector R&D intensity using a panel of OECD countries and found that tax incentives for R&D have a significant and positive impact on business R&D spending. Griffiths and Webster [8] traced the innovation pathways of new creations from R & D activity and found that R&D activity is a highly path-dependent process that relies heavily on firm specific effects such as managerial style, use of incentive schemes for employees, debt ratio etc.

A few studies have shown that while managers have a tendency to under-invest in R&D, institutional investor ownership influences firms to increase investment in R&D [9-13].

One current study examines the impact of environmental uncertainty (such market, technological, or competitive uncertainty) on a firm's investment in R & D [14]. Using a survey study of Chinese firms, it found that market uncertainty, as well as technological and operations capability, had positive influences, while competitive intensity and marketing capability had negative effects on R&D investments.

This paper is the first of its kind for China. It is also the first study to compare intellectual property between China and Canada. Using the China Stock Market Financial Statement Database (CSMAR) and the SINA financial database (www.sina.com), we found that spending in R&D activities is much lower than spending in other activities such as advertising, entertainment, conferences, and the like, which suggests a suboptimal allocation of resources in R&D. When compared with industrial countries such as Canada, we found that the proportion of intangible assets to total assets, including patents, trademarks and licenses, is much lower among companies in China.

Also, while the top 10 Canadian biotechnology and pharmaceutical firms have an average of 30% of their intangibles assets situated in Canada and the top 10 American biotechnology and pharmaceutical firms have an average of 23% of their intangibles assets situated in the U.S., the top 10 Chinese biotechnology and pharmaceutical firms have an average of only 0.8% of their intangible assets situated in China. Further analysis showed that in China, expenditures by biotechnology and pharmaceutical firms in R&D are positively associated with ownership structure, but negatively associated with firm size, and with investments in other assets, including inventory and fixed assets.

In the next section, we discuss data collection and present results.

***Corresponding author:** Tao Zeng, Associate Professor, School of Business and Economics, Wilfrid Laurier University, Waterloo, Ontario, Canada, E-mail: tzeng@wlu.ca

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Data Collection and Preliminary Results

Financial data was collected from the China Stock Market Financial Statement Database (CSMAR). We also collected corporate ownership information and preferential tax rates from the SINA finance database. The SINA finance database covers accounting and economic data of listed Chinese firms, such as financial statements and footnotes, financial analysis, ownership structure, top ten shareholders, etc. The firms selected for this study were all involved in the biotechnology or pharmaceutical sectors.

We selected the 10 largest Chinese biotechnology and pharmaceutical firms (according to total assets) in 2009. We then calculated the ratio of intangible assets over total assets; original cost and net balance for intangible assets were obtained from balance sheets; intangible assets included innovation-related assets and non-innovation-related assets; innovation-related assets included patents, trademarks, and licenses; non-innovation-related assets included the rights to use land and building. We excluded non-innovation-related assets from intangible assets.

Part I of Table 1 shows the intangible asset ratio. It shows that on average, the cost of intangible assets is 0.8% of total assets and that the net balance of intangible assets are 0.3% of total assets. The maximum intangible cost ratio is 3.6% and the intangible net value is 1.2% while the minimum intangible cost ratio is 0.3% and the intangible net value is 0.

We also selected the 10 largest Canadian and the 10 largest American, biotechnology and pharmaceutical firms (according to total assets) in 2009 and calculated the ratio of intangible assets over total assets. Part II of Table 1 presents the intangible asset ratio. It shows that on average, the cost of intangible assets are 32% and 23% respectively of total assets in Canada and the U.S., while the net balance of intangible assets are 21% and 17% respectively of total assets in Canada and in the U.S. The maximum intangible cost ratio is 87% and the intangible net value is 65% while the minimum intangible cost ratio is 0.6% and the intangible net value is 0. Table 1 indicates that the intangible asset ratio is much lower in Chinese firms than in Canadian and American firms.

Next, we examined the allocation of funds among R&D activities and other business activities. We collected cash outflows related to other operating activities from the footnotes of financial statements in 2009; cash outflows include spending on advertising, promotion, travel expenses, conference expenses, office expenses, utilities, rent, entertainment, transportation, R&D, etc.

We were able to find cash outflow information on 42 firms accounting for about one-third of all firms in the biotechnology and pharmaceutical sectors. Table 2 sets out the proportion of cash outflows in advertisement and promotion, conferences, entertainment and R&D spending. It shows that in 2009, there was more spending in advertising, promotion, conferences or entertainment than in R&D. On average, R&D spending was about 5% of total cash outflow of other operating activities and about one-third of firms did not spend any money on R&D. This suggests that although firms complained of a shortage of public funding, they did not an optimally allocate their internal resources. Firms preferred to spend on advertising, entertainment and conferences, rather than on innovation.

To determine what is associated with a firm's R&D spending in the biotechnology and pharmaceutical sectors, we designed the following regression model, whereby we regressed intangible assets on firm ownership structure (including ownership concentration, state ownership and inside ownership), firm characteristics (including size, leverage, profitability, inventory intensity, fixed asset intensity), and government tax and subsidies. This is consistent with the methodology of previous studies [15-22].

$$R\&D_t = \alpha_0 + \alpha_1 OWN_t + \alpha_2 STA_t + \alpha_3 INS_t + \alpha_4 SIZ_t + \alpha_5 LEV + \alpha_6 ROA + \alpha_7 INV + \alpha_8 TAX + \alpha_9 FIX + \alpha_{\bullet} SUB + \varepsilon_t$$

Where:

$R\&D_{it}$: intangible assets (including patents, trademarks and licenses) measured as intangible assets net of the right to use land, divided by total assets, for firm i in year t.

OWN_{it}: Ownership concentration, measured as the percentage of shares held by the 5 largest shareholders for firm i in year t.

STA_{it}: State ownership, measured as the number of shares owned by the state over the total number of outstanding shares, for firm i in year t.

INS_{it}: Equal to 1 when there are shares held by management, and 0 otherwise, for firm i in year t.

SIZ_{it}: Firm size, measured as a log of total assets, for firm i in year t.

LEV_{it}: leverage, measured as the sum of short- and long-term debts over total assets, for firm i in year t.

ROA_{it}: return on assets, measured as profit over total assets, for firm i in year t.

INV_{it}: inventory intensity (being the ratio of inventory to total assets) for firm i in year t.

FIX_{it}: Capital intensity (being the ratio of fixed assets to total assets) for firm i in year t.

TAX_{it}: Statutory tax rate for firm i in year t.

SUB_{it}: government subsidies, measured as other cash inflows relating to operating activities, reduced by total assets, for firm i in year t.

α_0 is the intercept, α_1 and α_{10} to are coefficients of the explanatory variables.

The ownership concentration variable is defined as the percentage of shareholdings by the top 5 shareholders. The state ownership variable is defined as the percentage of shares held by the state over the total number of outstanding shares. T he inside ownership variable is a dummy variable, taking 1 if some of the firm's shares are held by key officers, senior managers, etc, and 0 otherwise.

Firm's statutory tax rates (*TAX*) can be equal to the nominal tax rate of 33% (25% since 2008), or lower if a preferential tax rate is applied. Preferential tax rates can be granted to firms in specific regions (e.g., special economic zones), or to firms from specific industries (e.g., farming or high-technology). Preferential rates can be as low as 24%, 18%, 15%, or even 7.5%. Statutory tax rates are disclosed in the income statement footnotes.

For the regression model we used data for the years of 2001-2005 because footnotes to financial statements are available in the SINA financial database only after 2000, while ownership structure and any changes thereto, are disclosed in the SINA financial database only up to 2005. After 2005, shares are merely described as tradable or non-tradable.

Part 1	(Million Yuans)	(Million Yuans)	(Million Yuans)		
	Total asset	**Intangible asset (cost)**	**Intangible asset (net)**	**Intangible cost/TA (%)**	**Intangible net/TA (%)**
Shanghai Fosun	11527	32	18	0.28	0.16
Harbin Pharma	10007	80	17	0.80	0.17
North China Pharma	7301	98	67	1.34	0.92
Jilin Aodong	7162	36	14	0.50	0.20
Chongqing Taiji	6523	68	10	1.04	0.15
Guangdong Kangmei	6217	11	0	0.18	0
Joincare Pharma	6146	221	72	3.60	1.17
Northeast Pharma	6079	14	7	0.23	0.12
Yunnan Baiyao	6005	18	0.6	0.30	0.01
SinoPharma	5465	3	3	0.05	0.05
Average				0.83	0.29
Part II	**(Million Cnd$)**	**(Million Cnd$)**	**(Million Cnd$)**		
	Total asset	**Intangible asset (cost)**	**Intangible asset (net)**	**Intangible cost/TA (%)**	**Intangible net/TA (%)**
Valeant Pharma	2067	1805	1335	87.32	64.59
Patheon Inc.	791	5	3	0.63	0.38
Atrium Innovations	634	187	186	29.50	29.34
QLT Inc.	420	0	0	0	0
Angiotech Pharma	370	204	131	55.14	35.41
Cangene Co.	345	53	42	15.36	12.17
Paladin Labs	235	106	43	45.11	18.30
GLG Life Tech	230	25	23	10.87	10
Aeterna Zentaris	86	42	17	48.84	19.77
Cardiome Pharm	71	22	16	30.99	22.54
Average				32.37	21.25
Part III	**(Million US$)**	**(Million US$)**	**(Million US$)**		
	Total asset	**Intangible asset (cost)**	**Intangible asset (net)**	**Intangible cost/TA (%)**	**Intangible net/TA (%)**
Pfizer	212949	90196	68015	42.36	31.94
Merck & Co.	112090	50481	47656	45.04	42.52
Johnson & Johnson	94684	21180	16323	22.37	17.24
Abbott Laboratories	52417	10800	6292	20.60	12.00
Amgen	39629	5301	2567	13.38	6.48
Bristol-Myers	31008	4839	2865	15.61	9.24
Eli Lilly	27461	4369	3700	15.91	13.47
Baxter International	17354	1029	513	5.93	2.96
Genzyme	10061	3689	2313	36.67	22.99
Gilead Sciences	9699	1112	1062	11.47	10.95
Average				22.93	16.98

Data Source: EDGAR database, SEDAR database, SINA financial database – www.edgar.com; www.sedar.com; www.sina.com

Table 1: Intangible Property/Total Assets in Biotechnology and Pharmaceutical Firms: Canada, China and the United States.

Table 3 reports results from the regression model. It shows that state ownership (*STA*) is positively related to R&D, which suggests that firms owned by the state invest more in R&D. This result is consistent with arguments that state ownership provides an incentive for government shareholders to closely monitor management to pursue long-term goals; and in so doing, reduce agency costs. Hence state ownership has positive effects on R&D spending [18,23]. It may also suggest that a good reputation for heavy investment in R&D activities benefits management such that these managers are more likely to receive a promotion and a promising political career. This result is consistent with the criticism that state-owned firms account for a large share of R&D spending while there is a shortage of R&D spending in private firms.

Table 3 also shows that the coefficient of *SIZE* is negative and significant, which does not provide support for economies of scale in R&D investment. Further, the coefficients in *INV* and *FIX* are negative and significant, which suggests that inventory-intensive and capital-intensive firms spend less on R&D; it implies that *INV* or *FIX* is a substitute for R&D. Other variables, such as ownership concentration, inside ownership, return on assets, government subsidy, applied tax rates, and debt-asset ratio were not found to be significant.

Conclusion and Summary

In this study, we found that Chinese firms spend more on activities such as advertising, entertainment, or conferences than they do in R&D, which suggests a suboptimal allocation of resources for R&D. When compared with industrial countries such as Canada and the U.S., we

Stock code	Advertisement/Cash (%)	Conference/Cash (%)	Entertainment/Cash (%)	R&D/Cash (%)
000513	2.13	3.04	68.17	3.81
000518	13.67	0	9.24	10.6
000538	22.87	0.15	1.43	1.29
000566	28.06	0	4.8	4.63
000597	20.74	26.64	2.38	0
000606	8.6	5.2	1.43	0
000661	0.47	0	0.71	2.46
000739	26.58	0	6.82	15.46
000750	0.08	0	1.44	0
000915	2.59	0.81	1.33	0.70
000990	2.38	0	7.92	3.89
002030	0.91	1.45	3.55	0
002038	0	2.48	2.48	52.49
002252	0	3.32	5.18	0
002275	50.15	11.1	3.09	2.3
002287	38.91	12.88	7.56	4.99
002349	0	0	0.97	5.83
300009	6.25	14.76	3.11	9.04
300026	8.74	17.1	8.17	13.1
300049	0	0	0	0.08
600161	20.85	12.65	9.66	5.03
600196	3.1	18.58	5.58	11.06
600329	16.88	29.78	2.03	5.14
600351	32.09	15.56	1.82	0
600380	51.31	2.32	1.86	2.6
600385	0	6.6	6.1	0
600422	6.68	30.28	2.17	2.14
600488	2.81	0	1.76	11.22
600521	2.71	7.56	4.79	34.58
600530	40.79	0	1.54	4.18
600535	13.28	16.2	7.87	0
600594	3.96	14.4	1.33	1.21
600613	0	0	5.04	0
600664	39.45	17.99	0.6	1.31
600671	16.67	19.69	2.27	0
600706	2.01	0	16.5	0
600771	0	0	4.57	0
600781	0	0	8.21	0
600789	10.93	12.88	7.98	6.43
600829	4.1	3.55	2.13	0.26
600869	0.27	7.17	3.34	0
600976	51.22	0	0	3.58
Average	13.15	7.48	5.64	5.22
Total # of firms	42			
%firms with zero R&D	33.3			
% firms with AD greater than R&D	64.3			
%firms with conference greater than R&D	52.4			
%firms with entertainment greater than R&D	61.9			

Table 2: Cash Flow Related to Operations: Chinese Biotechnological and Pharmaceutical Firms.

found that the proportion of intangible assets to total assets (including patents, trademarks and licenses) are much lower among Chinese firms. While the top 10 Canadian biotechnology and pharmaceutical firms have an average of 30% of their intangibles assets situated in Canada, the top 10 Chinese biotechnology and pharmaceutical firms have an average of only 1% of their intangible assets situated in China.

The reason why Chinese firms have minimal innovation and R&D investment, as explain by Wiki, the free encyclopedia, is that these firms lack the autonomic intellectual property and financial resources to develop their own brand products, and they rely on a repetitive production of low-value added or imitation drugs [24].

Further analysis showed that in China, biotechnology and pharmaceutical firms' expenditures in R&D are positively associated with ownership structure; but negatively associated with firm size and with investments in other assets such as inventory and fixed assets. However, ownership concentration, inside ownership, tax rate, government subsidy, profitability, and leverage are not significantly associated with R&D spending.

Parameter	Est value	St dev	t student	Prob(>|t|)
Intercept	0.24	0.06	4.00***	0.00
OWN	-0.02	0.02	-0.86	0.39
STA	0.01	0.01	2.10**	0.04
INS	-0.01	0.01	-1.38	0.17
SIZE	-0.02	0.01	-3.11***	0.00
LEV	-0.02	0.02	-0.98	0.33
ROA	0.01	0.00	1.48	0.14
INV	-0.11	0.04	-2.94***	0.00
TAX	0.01	0.03	0.32	0.75
FIX	-0.07	0.02	-3.23***	0.00
SUB	-0.04	0.03	-1.59	0.11
R2	0.18			
R2(adj)	0.14			

*** significant at 0.01 level; ** significant at 0.05 level; * significant at 0.1 level based on two-tail t-test

OWN: ownership concentration, measured as the percentage of shares held by the 5 largest shareholders
STA: state ownership, measured as the number of shares owned by the state over the total number of outstanding shares
INS: equal to 1 when there are shares held by management, and 0 otherwise
SIZE: firm size, measured as a log of total assets
LEV: leverage, measured as the sum of short- and long-term debts over total assets
ROA: return on assets, measured as profit over total assets
INV: inventory intensity, measured as the ratio of inventory over total assets
FIX: capital intensity, measured as fixed assets over total assets
TAX: statutory tax rate
SUB: government subsidies, measured as other cash inflows relating to operating activities, reduced by total assets

Table 3: Regression Results**:** The dependent variable is R&D, intangible assets (including patents, trademarks and licenses) measured as intangible assets net of the right to use land, divided by total assets

These findings are interesting and important. But they should also be treated with some caution as they are not robust to changes in the measurement, the sample, and the time period covered by this study. Future studies may collect more updated data and include both national and multi-national firms in China.

This study is of interest to policy-makers, corporate management and academics who wish to examine corporate R&D and innovation activities to determine what motivates firms to spend on R&D. Future studies should examine if government subsidies are efficiently used to encourage R&D and examine what role tax policy can play in encouraging firms to spend more on R&D.

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Authors' Biography

Tao Zeng is an Associate Professor and CGA. She obtained her PhD degree at Queen's University in 2001. She has many publications in academic journals including Accounting Perspectives, Canadian Journal of Administrative Sciences, Chinese Management Studies, Canadian Tax Journal, Asian Review of Accounting, etc. She is an Associate Editor of British Journal of Economics, Management & Trade, on Editorial Board of Journal of Financial Studies and Research and Journal of Business and Financial Affairs. Her teaching interest is taxation. Her research interests are capital market and international business and tax.

References

1. OECD observer (2007) Chinese innovation: China can rekindle its great innovative past, though some reforms may be needed first. Science & Technology Section: 263.
2. http://www.researchrecap.com/index.php/2010/03/18/.
3. Stemberg R, Amdt O (2001) The Firm or the Region: What Determines the Innovation Behavior of European Firms? Economic Geography 77: 364-382.
4. Dushnitsky G, Lenox MJ (2005) When Do Firms Undertake R&D by Investing in New Ventures? Strategic Management Journal 26: 947-965.
5. David P, O'Brien JP, Yoshikawa T (2008) The Implications of Debt Heterogeneity for R&D Investment and Firm Performance. Academy of Management Journal 51: 165-181.
6. Hall BH, Lotti F, Mairesse J (2012) Evidence on the Impact of R&D and ICT Investment on Innovation and Productivity in Italian Firms. Economics of Innovation and New Technology 22: 300-328.
7. Falk M (2009) What Drives Business Research and Development (R&D) Intensity Across Organisation for Economic Co-Operation and Development (OECD) Countries? Applied Economics 38: 533-547.
8. Griffiths WE, Webster EM (2004) The Determinants of Research and Development and Intellectual Property Usage among Australian Companies, 1989 to 2002. CIES, Innovation Systems and Industrial Organisation Program, University of Adelaide, Adelaide, Australia, Discussion paper no. 0415
9. Baysinger BD, Kosnik RD, Turk TA (1991) Effects of Board and Ownership Structure on Corporate R&D Strategy. Academy of Management Journal 34: 205-214.
10. Hansen GS, Hill CWL (1991) Are Institutional Investors Myopic? A Time-series Study of Four Technology-driven Industries. Strategy Management Journal 12: 1-16.
11. Kochhar R, David P (1995) Institutional Investors and Firm Innovation: A Test of Competing Hypotheses. Strategic Management Journal 17: 73-84.
12. Franko LG (1989) Global Corporate Competition: Who's Winning, Who's Losing and the R&D Factor as a Reason Why. Strategic Management Journal 10: 449-474.
13. Zahra SA (1996) Goverance, Ownership, and Corporate Entrepreneurship: The Moderating Impact of Industry Technological Opportunities. The Academy of Management Journal 39: 1713-1735.
14. Su Z, Xie E, Peng J (2010) Impacts of Environmental Uncertainty and Firm's Capabilities on R&D Investment: Evidence from China. Innovation: Management, policy and Practice 12: 269-282.
15. Kelm KM, Narayanan VK, Pinches GE (1995) Shareholder Value Creation during R&D Innovation and Commercialization Stages. Academy of Management Journal 38: 770-787.
16. Hitt MA, Hoskisson RE, Johnson RA, Moesel DD (1996) The Market for Corporate Control and Firm Innovation. Academy of Management Journal 39: 1084-1119.
17. Hundley G, Jacobson CK, Park SH (1996) Effects of Profitability and Liquidity on R&D Intensity: Japanese and U.S. Companies Compared. Academy of Management Journal 39: 1659-1674.
18. Hess K, Gnuasekarge A, Hovey M (2008) State Dominant and Non-state Dominant Ownership Concentration and Firm Performance: Evidence from China. Working Paper, University of Waikato, New Zealand.
19. Lin H-C, Zeng T (2011) Ownership structure and R&D spending: evidence from China's listed firms. Chinese Management Studies 5: 82-93.
20. Kato T, Long C (2006) Executive Turnover and Firm Performance in China. The American Economic Review 96: 363-367.
21. Li H, Zhou L-A (2005) Political Turnover and Economic Performance: the Incentive Role of Personnel Control in China. Journal of Public Economics 89: 1743-1762.
22. Innovation Lags in China despite R&D Investment Growth. Guest Post by Oxford Analytical.
23. Bos D (1991) Privatization: A Theoretical Treatment. Clarendon Press, Oxford, UK.
24. Pharmaceutical Industry in China. Wikipedia: The Free Encyclopedia.