Market Value of Innovation: An Empirical Analysis on China's Stock Market

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Abstract—**In China, there is growing attention about innovation from both government and industry level, and the authorities also commit and emphasize the support of capital markets to industrial innovation. However, it's not clear whether China's capital markets have positive responses to enterprises' innovation input. Such issues have been studied a lot based on US and European database; nevertheless, few researchers investigate the market value of Chinese firms' R&D. In this paper, we use constructed panel dataset from three representative stock markets in China and then use intangible assets increment as innovation input indicator to examine the innovation performance in both manufacturing and service industries. By comparing the results of different stock markets, we find out the effect of R&D investment and increasing R&D input to market value is insignificant in all three markets, which may result from the weak protection for minority investors and loose regulation of information disclosure. Different constructions of intangible assets of listed firms on Main Board Market and Growth Enterprise Market account for market's relatively low efficiency to reflect real value of R&D investment. On industry-level, we conclude that R&D investment in both service and manufacturing sector contributes positively to market performance, and R&D investment in service industry shows stronger and more significant linkage to market value than manufacturing industry.**

I. INTRODUCTION

Since the first stock market in China - Shanghai Stock Exchange was established in 1990, the position of stock market has been changed from solving problems for State-owned Enterprises to allocating resources efficiently, motivating innovation and leading capital to promising industries. Shenzhen Main Board Market (MBM), Small and Medium-sized Enterprise Board Market (SMEM) and Growth Enterprise Market (GEM) are set for funding different types of enterprises. MBM requires listed firms with relatively large scale of capital and stable profitability but it has no thresholds regarding growth and innovation capability while GEM is demanding for capability of innovation and growth. Accordingly, firms on GEM invest more in R&D and investors are more tolerant with high risk, due to the fact that GEM emphasizes on prospect of innovative product and its development space and most of listed firms on GEM have limited shares outstanding and high level volatility of profitability [1]. SMEM is a transition between MBM and GEM.

In the recent years, China's authorities have been committing and emphasizing the support of capital market to industrial innovation. But few studies focus on the capital market value of Chinese firms' innovation input. In this paper, we make contribution by using data from three segmented Chinese stock markets to explore the relationship between R&D and market value in different board markets, and we also categorize all non-financial firms into manufacturing firms and service firms according to the GICS Industry Groups. Compared to past studies on effect of R&D investment on firms' market value in manufacturing industry and non-manufacturing industry, we employ the recent dataset from 2003 to 2013 to examine the linkage between R&D investment in Chinese manufacturing industry and service industry.

With the goal of measuring market value of R&D in three segment stock markets, our investigation is motivated by the well-planned structure in Chinese capital market to support high-tech companies. Understanding the effect of characteristics of stock market to the market value of R&D investment helps finding out the advantages and disadvantages for different types of firms. We use a number of indicators to examine the effect of R&D investment to market value of firms. Another motivation of this paper arises from the weak protection for innovations in China. By figuring out the favourable feature for maximize the value of R&D in each of the three stock markets, listed firms could better adapt its innovation strategy according to the feature of stock market in which it exchanges and better profit from R&D investment.

The paper is organized as follows: Section 2 presents the literature review. Section 3 describes the estimation model with Section 4 of data collection. Section 5 gives the results with discussion in Section 6.

II. LITERATURE REVIEW

The researches on how to appropriately value R&D investment and to what degree the R&D performance affects firm's market value have interested many scholars. They did studies based on empirical data on firm-level or industry-level from different regions. Griliches firstly began studying R&D valuation on US stock market, aimed at investigating the effect of R&D expenditure to firm's performance in equity market. Then similar questions have been researched and the findings are overall accordant: there exists a positive relationship between R&D investment and market value of US firms [7][14][15]. McCutchen and Swamidass [22] shows that in biotech industry, investment in R&D positively affects firm's market value, which is especially obvious for small biotech companies under 100 million-scale[22]. From the perspective of firm-specific level, technology innovation contributes to the increase of market value of the company, and the effect of high-tech innovation is superior after 9.11 terrorist attacked than before and service industry pays much more attention for the innovation effect on market value than manufacturing industry in US [10].

As for the research on market value of innovation in stock market of specific country, several scholars' findings imply that market value of innovation varies a lot in different countries. Investigation of listed firms in Israel shows that the growth of a company in the long run is backed by the continuous internal technology innovation instead of a favourable external environment, which is reflected by the stock valuation of relatively inferior firms [13]. Analysis on data of British stock market was studied by Blundell in 1999 and it demonstrates that market valuation of firm is positively affected by innovation. Empirical analysis of Japanese firms results that innovation in intangible assets is more obvious than innovation of tangible assets, in spite of the downturn of the overall Japanese stock market in the 1990s[4][16].

Regarding the factors to market valuation of innovation of given firms, investors' expectation for return of innovation is related to the market value of firms when controlling the company size and profit risk [21]. Hall and Oriani [16] ascribe the indistinctive market value of innovation in Italy to the lack of protection for investors. Due to the weak protection for minority shareholders and loose policy on information disclosure, controlling shareholders usually leads to ineffective allocation of resources [17][18]. Reference [4] points out that low-tech firms and high-tech firms differentiate in market valuation of innovation. For high-tech companies, technology innovation increases their market value, however for low-tech listed companies, their R&D expenditure decreases their stock valuation because that high-tech company R&D input is an active investment with expectations for new breakthrough while for low-tech company, and too much input in innovation is a sign that their current product is faced of a shrinking market. Reference [6] researches relationship between technology innovation and market share in Shanghai Stock Exchange, which illustrated an insignificant relationship.

Given the existing evidence of effect of R&D investment to market value, little attention is attributed to different R&D activities. Chauvin and Hirschey [5] point that impact of investment in different business activities such as manufacturing, marketing and R&D varies on market value of firms. Especially for R&D projects, manufacturing firms spend their capital resources on researching and developing new tangible products while service firms provide innovative intangible service through R&D process. According to [5], information on R&D investment is reflected on firm's market value because the disclosure of R&D input is released as a positive signal for individual investors and results in promising expectations. Reference [20] tests effect of R&D investment in manufacturing firms and non-manufacturing firms and finds out that stock of manufacturing firms performs better within 1-year horizon while service firms performs better in stock market on the average of 3 years performance after intensive input in R&D activity.

From the summary of former researches in market valuation of innovation, we find out researches are focused on stock markets in many different countries but China, in part because Chinese stock market is outcome of government policy in early periods with serious information asymmetry, weak protection for investors and majority of individual investors, while most of US and European stock markets are the outgrowth of private firms and market economy. This distinguishing background uncovers more complication of Chinese stock market [6].

III. RESEARCH DESIGN

A. Variables

Researchers who investigated US and European stock market mostly use R&D expenditure as indicator of technology innovation. Nonetheless in China, R&D expenditure data suffers a serious availability problem. If we use R&D expenditure as indicator, we are faced with severe lack of data. In order to represent technology innovation, intangible assets increment is another representative indicator. According to Heirman and Clarysse [19] , this is because firstly intangible asset in a firm is closely related to innovation activities and it includes mainly patents, non-patent technology, trademarks and copyrights. So the intangible assets increment is also strongly linked to outcome of innovation investment which reflects innovation activity. Secondly, R&D expenditure is not equal to the actual innovation investment, instead, it only covers limited portion of innovation investment without reporting human capital development, new technology import or technology adoption. Compared to R&D expenditure, intangible assets increments better show information of innovation investment. For the above two main reasons, we choose intangible assets increment as explanatory variable.

According to Hall and Oriani [16], market value of a firm consists of value created by tangible assets and value created by intangible assets. K_{it} implies total assets of firm *i* in *t* time and V_{it} implies market value of firm *i* in *t* time , refers to the return of firm scale and βA_{it-1} and γIA_{it-1} are increments of tangible and intangible assets in which β is the growth rate of tangible assets and γ is the growth rate of intangible assets:

$$K_{it} = A_{it-1} + IA_{it-1} + \beta A_{it-1} + \gamma IA_{it-1} \quad (1)$$

$$V_{it} = K_{it}^{\propto} * P_{it} * M_{it} = K_{it}^{\propto} * P_{it}(dta, size, at, dtl, ats) * M_{it}(tra, csh) \quad (2)$$

In Equation (2) P_{it} is the value generation function of assets of firm i in t time. P_{it} consists a set of controlling fundamental variables affecting the profitability level for intangible assets. Firstly, we use $dta, size, at, dtl, ats$ to respectively indicate debt to assets ratio, sales, assets turnover, degree of total leverage and assets to sales ratio. dta

indicates how firm leverage debt to run the business. Assets turnover is an important ratio to measure the capital management efficiency. We use at in our model as controlling variable because it represents the differentiation of the capital utilization. If assets turnover remains at low level, the firm needs to allocate redundant assets. This indicator is meaningful for high-tech firm as well because it provides a possible examination of the management quality of existing intangible assets [5][24]. Given R&D investment as one main type of intangible assets, in this paper, ratio of intangible assets to total assets states the current R&D intensity. Degree of total leverage reasonably estimates effect of changes of sales to EPS.

M_{it} in Equation (2) points market-related effects to market value of intangible assets. We choose tradable shares ratio and controlling shareholder ratio as controlling variables. It is essential to include these two variables as a result of unique characteristics of Chines stock market. There exist lots of non-tradable shares in Chinese capital market which would influence market valuation. Besides, we assume the presence of controlling shareholder is related to poor protection of minority shareholders, so that high controlling shareholder ratio could negatively affects the market value of R&D investment in China.

Then we introduce time dummy $year_i$ and industry dummy ind_i to control the tendency variation in some periods and control features of different industries. Preliminary researchers use *Tobin's Q* as dependent variable because *Tobin's Q* for the firm is the ratio of the firm's market value to book value of assets. In this paper, we define $Q_{it} = V_{it}/K_{it}$ as dependent variable for the final model.

Tobin's Q is still employed as the dependent variable and dIA_{it}/K_{it} as explanatory variable when investigating the difference between R&D investment in manufacturing and service industries and their effect to market value. As to better distinguish the difference among industries, we simplify the market-related variables and only use $size$ (firm size), dta (leverage ratio), csh (ratio of shares from top ten controlling shareholders) and *HHI* (Herfindahl-Hirschman Index as indicator of industry concentration) as control variables.

B. Estimation Model

Market value approach used in this paper is based on the assumption that firms are bundles of assets that are hard to detach or to price separately by capital market. These assets consist of tangible assets such as plants and equipment, and intangible assets such as knowledge assets, patents, trademarks and goodwill. The assumption is that the market value of firm's total assets equals to the present value of the sum of tangible assets and intangible assets. Due to Equation (1), A_{it} implies tangible assets of firm i in t time and IA_{it} implies intangible assets of firm i in t time, and K_{it} is total assets, namely book value of assets of firm i in t time. Since γIA_{it-1} is significantly less than K_{it}, we have the following approximate equation:

$$K_{it} = A_{it-1} + IA_{it-1} + \beta A_{it-1} \quad (3)$$

With the idea that market value of firm is the value created by both intangible assets and tangible assets, and definition of *Tobin's Q*, it is possible to represent *Tobin's Q* as a function of assets. P_{it} is the impact function of fundamental information of firm i to the market value of firm i in t time. M_{it} is the impact function of the market effect on market value of firm i in t time. The left side of Equation (4) is *Tobin's Q* under the constant return to scale $\alpha_i = 1$. Equation (4) is the basic model.

$$Q = (1 + \gamma IA_{it-1}/K_{it}) * P_{it}(dta, size, at, dtl, ats) * M_{it}(tra, csh) \quad (4)$$

Taking the natural logs of both sides of Equation (4) and adding the year dummy variable $year_i$, industry dummy ind_i and the error term ε_{it}, we have the final model as follows:

$$\begin{aligned}\ln Q =& \\ &\ln\gamma + \\ &\ln(IA_{it-1}/K_{it}) + \\ &\ln dta + \ln size + \ln at + \ln dtl + \ln ats + \ln tra + \ln csh + \\ &year_i + ind_i + \varepsilon_{it} \quad (5)\end{aligned}$$

The estimation of Equation (5) raises two validity issues, one due to our failure to obtain intangible assets for some firms and one due to the possibility of missing controlling variables related to R&D investment. The first problem is derived from sample selection bias, which is more severe in data from MBM because of limited information disclosure of some firm in early years of observation period. The second potential problem arising from our model is that the impacts of R&D investment on market value include industry-specific and time-specific effect that is correlated with explanatory variable. We add a set of year dummies and industry dummies to control these two types of effects. In order to control for unobserved firm-specific effects, we use fixed effects and estimate a random effects model along with the fixed effects model [6].

The simplified equation for the assessment of R&D investment-firm performance association in manufacturing and service sector is Equation (6).

$$\ln Q = \ln(dIA_{it-1}/K_{it}) + \ln size + \ln dta + \ln csh + HHI + year_i + \varepsilon_{it} \quad (6)$$

IV. DATA COLLECTION

A. Sample

Data sample regarding effect of R&D investment on China's capital market in this paper consists of all publicly traded firms in Chinese MBM, SMEM and GEM. For all companies traded in MBM, the period of observation goes from 2003 to 2013; for all companies traded in SMEM, the period of observation goes from 2004 to 2013; for all companies traded in GEM, the observation period goes from 2009 to 2013 due to that firms on GEM started trading in 2009. Firms are categorized into 10 different industries according to GICS first-level code. All the accounting data are gathered from CHOICE database, which are consolidated at the corporate level, so that they are consistent with market capitalization data of firm. Our final database is constructed by an unbalanced panel data from 856 publicly traded firms, 508 from Main Board Market, 195 from SME Board Market, 153 from Growth Enterprise Market. The relatively lower number of listed firms in GEM is due to the shorter period of trading.

To construct the panel dataset from 2003 to 2013 on industry sector level, we include 454 service firms and 1101 manufacturing firms which exclude all financial firms. Service firms account for 29% of the sample and manufacturing firms account for 71% of all sample firms. The categorization of industry sector is based on second level 4-digit GICS industry code.

B. Data sources and Descriptive statistics

Our data is identified through CHOICE database for the time period 2003-2013, which obtains fundamental information of firm itself, financial reporting information and trading information. In the dataset on stock market level, we remove ST stock and those firms that lack observation of intangible assets, total assets, total market value, debt to asset, degree of total leverage, assets turnover and sales, and only keep MBM-trading firms which have continuous 11 years observation, SMEM-trading firms which have continuous 10 years observation and GEM-trading firms which have continuous 5 years observation. In the dataset on industry level, we remove those firms that lack more than five years' market valuation and all financial firms.

Table 1 shows descriptive statistics for observation of main variables. There exists a striking difference of the mean value of *Tobin's Q* between MBM and GEM, while the difference between SMEM and GEM is not significant. The mean value of assets turnover of GEM is much higher than that of MBM while other firm-level variables are all lower than MBM. Firm size of MBM is obviously much larger than that of GEM.

Respective distribution of R&D investment for service firms and manufacturing firms and main variables used in the model on industry level are summarized in Table 2 and Table 3. The averaged *Tobin's Q* for service industry is 26.83 which is much greater than 2.43 for manufacturing industry. The total dIA_{it-1}/K_{it} averaged 0.0341 for service firms while 0.0196 for manufacturing firms. Firm size, leverage ratio and controlling shareholder's ratio do not diverge much between service sector and manufacturing sector but service industry concentration is more intense than manufacturing industry.

TABLE 1: SUMMARY OF MAIN VARIABLES

Variables	MBM			SMEM			GEM		
	Obs.	Mean	St.D	Obs.	Mean	St.D	Obs.	Mean	St.D
$Tobin'sQ$	5561	20.5330	875.5784	1549	2.4873	2.1116	648	3.2529	2.2516
γ	5317	0.1020	0.8517	1062	0.8619	3.8076	750	0.8423	0.9489
dIA_{it-1}/K_{it}	5255	0.0544	0.0713	1853	0.0437	0.0478	748	0.0428	0.0519
dta	5585	1.0237	14.2580	1950	0.4470	0.1895	765	0.2186	0.1573
$size$	5536	4.35e+09	1.09e+10	1950	1.68e+09	5.12e+09	765	5.62e+08	6.03e+08
at	5559	0.7149	0.6625	1950	0.9231	0.7141	765	22.0799	15.7474
dtl	5531	1.3605	139.4417	1877	-2.6317	239.9931	612	1.1167	14.9562
ats	5535	7.6741	107.2053	1950	1.9545	2.8377	765	2.7511	1.5770
tra	5565	0.6419	0.2573	1553	0.6353	0.2687	654	0.4404	0.1997
csh	5560	0.3254	0.4546	1552	0.3782	0.2096	650	0.3167	0.1981

TABLE 2: DISTRIBUTION OF R&D INVESTMENT FOR SERVICE FIRMS, 2003-2013

GICS	*Industry Description*	*Industry*	*Obs.*	*Tobin's Q*	dIA_{it}/K_{it}	*size*	*HHI*	dta	csh
1010	Energy	11.45%	52	1.74	0.0152	21.91	0.38	0.48	0.27
2020	Commercial &Professional Services	2.42%	11	6.91	0.0043	19.99	0.10	0.74	0.20
2030	Transportation	14.54%	66	1.55	0.0124	21.05	0.08	0.47	0.25
2530	Consumer Services	6.17%	28	2.61	0.0047	19.78	0.11	0.70	0.22
2540	Media	8.81%	40	12.28	-0.1435	20.47	0.07	0.43	0.19
2550	Retailing	17.62%	80	1.40	0.0067	21.40	0.04	0.56	0.22
3010	Food & Staples Retailing	3.30%	15	1.86	-0.0324	22.04	0.15	0.55	0.28
3030	Households &Personal Products	2.20%	10	1.67	0.0067	20.67	0.16	0.44	0.23
3510	Health Care Equipment &	7.49%	34	3.13	-0.1250	20.33	0.21	0.41	0.20
4510	Software &Services	6.83%	31	283.67	0.1468	20.15	0.08	1.18	0.21
5010	Telecommunication Service	2.42%	11	3.92	0.0401	20.51	0.97	0.25	0.21
5510	Utilities	16.75%	74	1.17	0.0053	20.99	0.08	0.56	0.23
	Total/Average	100%	454	26.83	0.0344	20.77	0.20	0.56	0.23

TABLE 3: DISTRIBUTION OF R&D INVESTMENT FOR MANUFACTURING FIRMS, 2003-2013

GICS	*Industry Description*	*Industry Percent*	*Obs.*	*Tobin's Q*	dIA_{it}/K_{it}	$size$	HHI	dta	csh
1510	Materials	28.16%	310	2.34	-0.0091	21.30	0.02	0.64	0.22
2010	Capital Goods	26.07%	287	2.42	0.0054	20.16	0.05	0.73	0.22
2510	Automobiles &Components	5.72%	63	1.44	0.0062	21.35	0.11	0.55	0.21
2520	Consumer Durable &Apparel	9.26%	102	1.81	0.0058	20.96	0.06	0.62	0.23
3020	Food, Beverage &Tobacco	0.91%	10	3.73	0.0068	20.12	0.04	0.73	0.18
3520	Pharmaceuticals, Biotechnology		148	3.10	0.0099	20.23	0.02	0.45	0.22
4520	Technology Hardware &Equipment	13.62%	150	2.50	0.0938	20.40	0.06	0.45	0.21
4530	Semiconductor &Semiconductor Equipment	2.82%	31	2.15	0.0134	19.96	0.08	0.40	0.22
	Total/Average	100%	1101	2.43	0.0196	20.56	0.06	0.47	0.21

V. RESULTS

As shown in the random effects model results in Table 4, our model has a fair amount of explanatory power in the expected direction, with γ is positively affects market value of R&D performing however the coefficient is slightly different from zero (0.0042; 0.0133; 0.0135), which implies increased R&D investment is not sufficiently valued on market value of firm in all three stock markets and the impact of R&D for market value on GEM is slightly more than that on the other two stock markets. Growth Enterprise Market is established as an important channel for high-tech firms in capital market and ninety percent of firms in GEM are high-tech companies, it is expected with much higher efficient valuation of R&D than other Chinese stock market, but our empirical result shows an insignificant relationship.

From Table 1, the mean value of ratio of intangible assets is 0.0544, greater than that of SMEM (0.0437) and GEM (0.0428). However, as shown in Table 2, the coefficient of IA_{it}/K_{it} -the ratio of intangible assets to total assets is negative for MBM (-0.0129), and not significantly above zero for SMEM (0.0016) and GEM (0.0593). This is caused by the different construction and disclosure of intangible assets. Intangible assets on MBM mainly consist of authority licenses, including franchises and profitable requirements, which account for major content of intangible assets and the disclosure level of this type of intangible assets is higher. Nevertheless, intangible assets on GEM are knowledge assets, including patents, proprietary technology and trademarks. This type of intangible assets reflects not only R&D expenditure, but also the premium expectation for these assets. Since the knowledge asset is closely correlated with the core competitive advantage, firms do not fully disclose it in financial reports, even in high-tech companies on Growth Enterprise Market. In spite of the positive effect of R&D investment on GEM, the insignificant coefficient of $\ln IA_{it}/K_{it}$ hints that the innovation input is not efficiently transformed into business capabilities with add-on value to the firm.

TABLE 4: MARKET VALUE REGRESSION WITH FIRM-SPECIFIC VARIABLE WITH CONTROL FOR TIME AND INDUSTRY

Model	Fixed Effects Model			Random Effects Model		
$Tobin'sQ$	MBM	SMEM	GEM	MBM	SMEM	GEM
γ	0.0055	0.0094	0.0208	0.0042	0.0133	0.0135
	(0.68)	(1.78)	(0.10)	(0.56)	(2.26)	(0.67)
dIA_{it-1}/K_{it}	-0.0129	0.0016	0.0593	-0.0056	-0.0070	-0.0341
	(-0.47)	(0.70)	(1.62)	(-0.31)	(-0.68)	(-0.14)
ln dta	-0.2786***	-0.2997***	0.0374	-0.2924***	-0.4659***	-0.1654**
	(-11.12)	(-13.22)	(-5.13)	(-13.00)	(-17.64)	(-5.70)
ln $size$	-0.5826***	-0.4179***	-0.0107	-0.4577***	-0.2810***	0.0231
	(-58.77)	(-8.30)	(-8.09)	(-61.07)	(-10.94)	(3.89)
ln at	0.3671***	1.2244***	0.0536	0.2749***	1.0355***	0.0291
	(0.51)	(0.27)	(3.74)	(2.19)	(0.14)	(3.00)
ln dtl	0.0173***	-0.0016	0.0098	0.0171***	-0.0107	0.0417*
	(2.76)	(-1.94)	(2.30)	(2.74)	(2.21	(3.11)
ln ats	-0.2803***	0.3458*	-0.6814**	-0.2323**	0.5867***	-0.2299**
	(-25.11)	(4.69)	(2.73)	(-25.41)	(6.31)	(-0.24)
ln tra	0.2911***	0.2261***	0.1085	0.2750***	0.1946***	-0.2570*
	(19.42)	(9.45)	(5.98)	(18.83)	(9.37)	(8.36)
ln csh	0.1194***	0.1248***	0.0371	0.1364***	0.1565***	0.1593**
	(15.56)	(5.56)	(2.14)	(16.55)	(6.01)	(2.07)
$Adj\ R^2$	0.65	0.66	0.67	0.64	0.63	0.59
$Sigma_u$	0.5396	0.4687	0.5715	0.4271	0.2463	0.3146
$Sigma_e$	0.3544	0.3248	0.3114	0.3544	0.3248	0.3114

****p<0.01; **p<0.05; *p<0.1*

According to Arrow [2] small and medium sized firms are more capable of technology innovation than big sized firms while Demsetz and Leah [9] conclude that big enterprise is more advantageous in technology innovation. Turning to the results of impact of size to market value of R&D investment, the coefficients for three markets are all negative in fixed effects model (-0.5826; -0.4179; -0.0107) and size is significantly correlated to *Tobin's Q* on Main Board Market and SME Board Market. The coefficient of size on GEM in fixed effects model is insignificant and coefficient of size on GEM in random effects model is positive (0.0231), which further shows that in market of highly-growth firms, larger scale of firm is better for effective market value of R&D investment. For the unique low-profit features in early stages of innovation activities, scale of firm provides continuous and sufficient investment until the innovation outputs pay off.

The coefficient of *csh* shows that controlling majority shareholder increases the valuation of R&D substantially. The hypothesis is that the valuation of R&D performing is determined by the ownership structure of the firm insignificantly [11]. In China, controlling shareholders better exploit R&D information disclosure asymmetries than minority individual shareholders. This is consistent with Aboody and Lev's findings that major shareholders gains from the information asymmetry about R&D investment [1].

As shown in Table 5, R&D investment generates positive returns on market value both for service industry and manufacturing industry (0.0039 for manufacturing firms; 0.0079 for service firms). The R&D-market performance relationship for service firms is stronger than that for manufacturing firms. We also found more significant effect of R&D investment on market value for segmented service sector than segmented manufacturing sector in the intra-industry regression analysis shown in Table 6 and Table 7. R&D investment in Pharmaceuticals, Biotechnology & Life science has most significant effect on market value among manufacturing industry but the effect coefficient is relatively small. Telecommunication and Software & Service are two intra-service sectors with relatively stronger innovation-firm performance association.

TABLE 5: EFFECT OF R&D INVESTMENT ON MARKET VALUE: OLS REGRESSION WITH ROBUST STANDARD DEVIATION

Dependent Variable: *Tobin's Q*	All firms	Manufacturing firms	Service firms
dIA_{it}/K_{it}	0.0059***(2.54)	0.0039*(1.44)	0.0079**(1.81)
ln dta	-0.4419***(-9.33)	-0.4241***(-6.42)	0.3675***(-7.28)
ln $size$	-0.0475***(-8.54)	-0.0444***(-8.17)	-0.1689(-6.03)
HHI	0.0665**(0.48)	-0.2771(-6.42)	0.4242***(2.60)
ln csh	-0.0019(-0.32)	0.0064(0.99)	0.0003(0.02)
$Adj\ R^2$	0.4327	0.4329	0.4610

****p<0.01; **p<0.05; *p<0.1*

TABLE 6: INTRA-SERVICE INDUSTRY EFFECTS OF R&D INVESTMENT TO MARKET VALUE FROM 2003 TO 2013

GICS	*Industry Description*	dIA_{it}/K_{it}	$size$	HHI	dta	csh
1010	Energy	-0.0065	-0.0588	7.6740***	-0.3004***	0.0017
		(-0.36)	(-1.60)	(3.00)	(-3.34)	(0.06)
2020	Commercial &Professional Services	0.0189	-0.2614***	-3.0636	-0.4701	0.0586
		(0.28)	(-2.89)	(-0.82)	(-4.07)	(0.66)
2030	Transportation	0.0147*	-0.1216***	11.5525	-0.4308***	0.0257
		(0.79)	(-1.91)	(0.72)	(4.51)	(0.58)
2530	Consumer Services	-0.0134	-0.0719	-3.5644	-0.5914***	-0.001
		(-0.56)	(-1.57)	(-0.18)	(-4.54)	(-0.01)
2540	Media	0.0059	-0.1014	-1.1516	-0.4021***	0.0616
		(0.24)	(-1.18)	(-0.49)	(-3.04)	(1.03)
2550	Retailing	0.0139	-0.2191***	31.3805***	-0.3855***	-0.0194
		(0.75)	(-4.77)	(4.45)	(-2.64)	(-0.42)
3010	Food & Staples Retailing	0.0289	-0.0987	-9.0291***	-0.7387**	-0.0353
		(1.01)	(-0.93)	(-4.38)	(-2.27)	(-0.76)
3030	Households &Personal Products &Services	0.0112	-0.4530***	-3.8841	-0.2491	0.1790***
		(0.21)	(-2.76)	(-1.10)	(-0.41)	(2.60)
3510	Health Care Equipment &	0.0395	-0.1127	-3.1019	-0.4971***	0.2498***
		(1.22)	(-1.26)	(-1.08)	(-3.14)	(4.25)
4510	Software &Services	0.0490**	-0.2141*	-3.0819	-0.3334*	0.1156**
		(1.52)	(-1.86)	(-1.36)	(-2.08)	(1.81)
5010	Telecommunication Service	0.1153***	-0.3674***	-32.9291	-0.0713	-0.3063**
		(3.53)	(-8.68)	(-2.05)	(-0.58)	(-2.43)
5510	Utilities	0.0058	-0.0166***	2.1271	-1.0354	0.0276
		(0.46)	(-3.09)	(0.57)	(-8.18)	(1.08)

****p<0.01; **p<0.05; *p<0.1*

TABLE 7: INTRA-MANUFACTURING INDUSTRY EFFECTS OF R&D INVESTMENT TO MARKET VALUE FROM 2003 TO 2013

GICS	*Industry Description*	dIA_{it}/K_{it}	$size$	HHI	dta	sh
1510	Materials	0.0135* (1079)	-0.2081*** (-10.62)	36.4647*** (2.67)	-0.6679*** (-12.52)	0.0610*** (3.52)
2010	Capital Goods	0.0045 (1.33)	-0.0358*** (-5.93)	3.0779 (0.15)	-0.3134*** (-2.66)	0.0235 (1.37)
2510	Automobiles &Components	0.0205* (1.62)	-0.1922*** (-7.74)	-0.4098 (-0.39)	-0.6162*** (-6.38)	0.0341 (0.86)
2520	Consumer Durable &Apparel	0.0039 (0.29)	-0.1854*** (3.80)	-19.4943 (-1.13)	-0.2721*** (-2.77)	0.0276 (0.88)
3020	Food, Beverage &Tobacco	0.0565 (0.67)	0.2131 (1.39)	504.6487 (0.70)	-0.5481** (-2.13)	0.2926 (1.55)
3520	Pharmaceuticals, Biotechnology &Life Science	0.0047** (0.46)	-0.1249*** (-2.99)	-24.6087*** (-2.85)	-0.2953*** (-6.22)	0.0958*** (3.29)
4520	Technology Hardware &Equipment	-0.0118 (-1.10)	-0.2363*** (-4.31)	-44.5818* (-1.91)	-0.1813* (-1.77)	0.0482* (2.29)
4530	Semiconductor &Semiconductor Equipment	-0.0248 (-0.99)	0.0289 (0.65)	-5.5535* (-1.67)	-0.3167*** (-4.30)	-0.0187 (-0.45)

****p<0.01; **p<0.05; *p<0.1*

VI. CONCLUSION AND DISCUSSION

The empirical analysis presented in this paper contributes to investigation on innovation-market performance association on China's market in the following regards. First, this research employs the database with long time-horizon and large sample of Chinese listed firms. Secondly, our study examined the effect of R&D input on market value based on the stock market level as well as industry level. Therefore our study provides an overall and clear outlook of the impact of R&D investment on three China's stock markets and in service industries and manufacturing industries. The further study area originated from this paper is to examine every segmented industry classified by traditional industry and hi-tech industry or to investigate representative firms to obtain firm-level evidence on the R&D-market performance association.

R&D investment is assumed to be strongly related to market value of listed firms. This paper refers to and adapts the original model from [16] and transformed model from [6] and employs the unbalanced panel data from Chinese stock market, to test for the comparative effect of R&D investment to market value on MBM, SMEM and GEM. We found out that none of three stock markets reflect effectively the value of R&D investment.

The results in this paper are based on three main reasons. First, intangible assets is not able to generate value separately, especially in firms on Growth Enterprise Market, the value generated by intangible assets (knowledge assets mainly) is partly determined by the value creation environment, assets management quality and profitability, as well as the firm's backgrounds and strategies. The construction of intangible assets is critical when affecting the market value of innovation. Second, the empirical study shows that firm-specific indicators do not have significant impact on market value. In this case, listed firms are on average low-efficient to profit from innovation technology. Although Growth Enterprise Market is highly demanding for the financial growth potential, according to [4][23], a large amount of innovation is low-quality, especially in big-sized firms, which is aimed at keeping the current market share instead of innovating breakthrough new product, which is passively correlated with the market expectation. Finally, weak protection for minority investors and serious R&D information asymmetry problems hinder more efficient resource allocation [3].

The empirical analysis we demonstrated affirms the positive effect of R&D investment on market value based on a broadly representative sample for Chinese market. Service firms show stronger effect on firm's market performance with regard to R&D input. Our reason for this finding is that Chinese government support innovation activities in both manufacturing firms and service firms, aiming at modern industry upgrading. Modern service industry acts as the core in modern industry system. The positive effect coefficient of R&D investment is related to innovation-oriented government policy. China's manufacturing firms used to be labor-intensive and service firms do not rely on tangible assets, so R&D investment in manufacturing firms is less significant for that service industry is better capable of quickly transforming R&D outcome into add-on value.

The intra-industry regression outcome demonstrates difference between traditional industry and hi-tech industry, which further suggests the potential for more segmented industry-level analysis or firm-level R&D-market performance association research. The above findings provide an overall picture of effect of R&D investment on market value on Chinese stock markets, from the perspective of stock market level and industry level.

The model used in this paper may present some limitation due to the different accounting standards and also the different maturity stage of China’s stock markets compared to those in the developed counties. However, by analyzing the difference between the stock market and industry, we shed some light on the understanding of China's market value effect of R&D investment for investors and policy makers.

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