

On the Correlation between Enterprises' Value and Their Technological Property Right

-- Empirical evidences from China's high-tech industries

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Abstract—The paper aims to research technological property right's contribution to enterprise's value. Choosing three maturity high-tech industries in China, the paper selects two indexes as substitute variables of technological property right of enterprise: the value of technical intangible assets and the number of firm's patents. Using stock market value in the end of a year as substitute variable of enterprise's value, the paper studies the correlation between enterprises' value and their technological property right using Ordinary Least Square method. We find that both the value of technical intangible assets and the number of firm's patents has significant positive effect on enterprise's value. From subgroup analyses we find that the number of patents has more positive influence on enterprise's value in private enterprises whereas the value of technical intangible assets contribute more in state-owned enterprises. And in computer and communication industries, technologic property rights has more contribution to improve enterprise's value than that in instrument and meter industries, and in pharmaceutical manufacturing industry, the number of patents is the solely significant factor that positively influencing enterprise's value in technical intangible assets.

Keywords—*technological property right; enterprise' value; technical intangible asset; patent*

I. INTRODUCTION

Firms' intangible assets can be divided into two types: technical intangible and non-technical intangible assets. Technological property right belongs to technical intangible assets which including patent, non-patent technologies and industrial copyrights, and they carry out excess profit owing to their technologic and competitive advantage which is difficult to be imitated by competitors, and corresponding protecting laws helps enterprises who owned technological property right to form technological barriers. Therefore, theoretically speaking, technological property right might improve enterprises' value through generating excess profit.

According to international assessment data, intangible assets of a firm should be four times or five times larger than tangible assets, and it accounts 18% of total assets in America in early 1980s while accounts 80% at the beginning of the 21st

century^[1]. In the end of 1990s, the proportion of intangible assets in China's listed companies is very low, and various usage rights, especially usage rights of land, accounts for 80% of proportion of the intangible assets, and technological intangible assets accounts for only 7.61% of total assets^[2]. With development of China's science and technology, the proportion of enterprises' intangible assets has some change, and their effect to the value of enterprise aroused more interesting.

There exist different results at home and abroad on effect of technological intangible assets to the value of enterprises. Lidia Oliveira, Lúcia Lima Rodrigues and Russell Craig (2010)^[3] researched correlation between intangible assets and firms' stock price in Portugal from year 1998-2008, and found that the value of intangible assets had significant positive correlation to the value of stock price, but had little influence on investing decision for local stock investors. John Goodwin and Kamran Ahmedb (2006)^[4] collected data of 476 firms from year 1975-1999 in Australian, and found that revenues of which capitalized their intangible assets were more than which hadn't capitalized intangible assets. In China, Wang Huacheng, Lu Chuang and Li Chunling (2005)^[5] studied on intangible assets' contribution to enterprises' performance, and found there exists significant positive correlation between them. Shao Hongxia and Fang Junxiong (2006)^[6] divided intangible assets into two types: technical intangible assets and non-technical intangible assets, they want to know if they have differences influence on profit and value of enterprises, and found that technical intangible assets had no use to improve enterprises' profit, but in high-tech industries, technical intangible assets had significant positive correlation with value of firms' stock price, while in not high-tech industries, non-technical intangible assets such as land usage rights have significant positive correlation to firms' stock price. Xue Yunkui and Wang Zhitai (2001)^[2] studied listed companies in Shanghai stock security from year 1995-1999, and found that the effect of intangible assets had higher correlation with firms' performance than that of fixed assets, and firms that disclosing intangible assets' detail information had a higher performance than that hadn't disclosed them. Liu Yuchun (2013)^[7] studied listed companies in China's New OTC market. He found that the value of intangible assets hadn't significant correlation with firm's value. And Gan Cenlu

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(2006)^[1] studied listed companies in information service industry from year 2003-2012, and found that proportion of intangible assets had a trend to increase in past ten years, and intangible assets had significant positive correlation with firms' value, while fixed assets were quite contrary.

According to *Chinese Categories orientation of Listed companies*, the paper chooses listed companies from following three maturity high-tech industries: computer and communication industries, pharmaceutical manufacturing industry and instrument and meter industries, and analyses effect of their technological property right to the value of enterprise, and discuss the developing trend of technical intangible assets' effect on value of enterprise in high-tech industries.

II. RESEARCH DESIGN

A. Samples selection and data resource

The paper chooses samples in stock market from year 2011-2015 which are from three kinds of maturity high-tech industries, they are computer and communication industries, pharmaceutical manufacturing industry and instrument and meter industries. And data are mainly from Guo Taian data base, and some of data are searched from SooPAT, which is a patent search web. The paper selecting samples abiding to following principles: (1) Eliminating samples with incomplete data; (2) Eliminating samples of ST companies; (3) Eliminating samples which were listed between year 2011-2015. And we finally gained 229 samples.

B. Research approach

Firstly, the paper researches correlation between enterprises' value and their technological property rights for listed companies in above three high-tech industries. Secondly, we divided the samples into private enterprises and state-owned enterprises according to their ultimate controller, and engaged in group research for their correlation between enterprises' value and their technological property rights respectively. Thirdly, dividing samples into three groups according to industries they belonged to, we study correlation between enterprises' value and their technological property right in different sample groups.

C. Variable-definition

1) Explained variable

Enterprise's market value: refer to literatures of Chen Xiude (2011), Shao Hongxia and Fang Junxiong (2006), we choose index of market value of shares in the end of a year to substitute index of enterprise's value. We use symbol of EV to represent the company's stock value at the end of the year, and the symbol will be used in our Ordinary Least Square analysis models.

2) Explaining variables

Because the paper aims to research correlation between enterprise's value and their technological property right, two indexes are used to substitute technological property right as explaining variables here, there are value of technical intangible assets (TIV, symbol of the variable in paper's OLS models, following same) and number of patents in a firm (patent). Considering the fact that usage right of land

accounts for most proportion of intangible asset in China's enterprises, by subtracting the value of land's usage right from the total value of intangible assets, we obtained the value of firm's technical intangible assets. And refer to literatures of Chen Xiude (2011), we take number of authorized patents one year in a firm as another explaining variable to substitute the variable of technological property right.

3) Control variables

Referring to literatures of Zhang Xiaoyou (2011), Wu Danni and Li Xiaojian (2013), Wei Suyan and Zhang Hong (2006), we choose control variables as follows: rate of return on common stock holders' equity (roe), rate of return on total assets (roa), asset-liability ratio (dta), operating income growth rate (growth), cash flow of operating activity (cashflow) and the proportion of the first largest shareholder (amount).

D. Equation

We use Ordinary Least Square (OLS) regression model to analyses correlation between enterprises' value and their technological property right. The regression model is shown as following Eq.(1).

III. EMPIRICAL RESULTS AND ANALYSIS

A. Descriptive statistics

TABLE I. DESCRIPTIVE STATISTICS OF VARIABLES

| stats | min | mean | P25 | P50 | P75 | max |
|----------|-----------|----------|---------|---------|---------|----------|
| EV | 1 | 572.0009 | 286 | 572 | 858 | 1144 |
| TIA | 0 | 16.1945 | 15.2569 | 16.6977 | 17.9358 | 21.8161 |
| patent | 0 | 15.0794 | 1 | 3 | 10 | 988 |
| roe | -467.6025 | 7.6386 | 3.2267 | 7.4488 | 13.1141 | 57.6171 |
| roa | -32.1678 | 5.7860 | 2.1149 | 5.1182 | 8.8051 | 46.4040 |
| dta | 0.7513 | 33.9974 | 17.1220 | 32.2552 | 47.7051 | 180.6089 |
| amount | 0.0389 | 0.3254 | 0.2243 | 0.3017 | 0.4157 | 0.7156 |
| growth | -68.9402 | 17.1160 | 1.0011 | 14.0742 | 26.3729 | 334.8087 |
| cashflow | -3.8356 | 0.3469 | 0.0625 | 0.2780 | 0.5932 | 3.9433 |
| IN/TA | 0.0005 | 0.0489 | 0.2155 | 0.0368 | 0.0609 | 0.7950 |
| TIN/IN | 0 | 0.3265 | 0.0621 | 0.2314 | 0.5475 | 1 |

To observe the change of intangible assets' proportion to total assets and technical intangible assets' proportion to total intangible assets, we adds two indexes in descriptive statistical analysis, there are IN/TA, which means the proportion of intangible assets to total assets, and PA/IN, which means the proportion of technical intangible assets to total intangible assets. Table I provides an overview of descriptive statistics of various variables.

From table I we can see that in high-tech industries in China, the maximum of technical intangible assets' proportion to total intangible assets nearly reached 100%, and its mean value had reached 32.65%. Comparing to early 1990s', it appears great progress. And the maximum of intangible assets' proportion to total assets had reached nearly 80%, but its mean

value is only 4.89%, which illustrating a fact that even in high-tech industries in China, the value of intangible assets accounts very small proportion to total assets. And table I still reveals that enterprise value of maximum, minimum, mean, 25% points, 50% points and 75% points are relatively balanced. And for indexes of technical intangible assets, number of patents, rate of return on common stock holders' equity, rate of return on total assets, asset-liability ratio, and operating income growth rate, their maximum, minimum, mean, 25% points, 50% points and 75% points have great difference. And indexes of proportion of the first largest shareholder and cash flow of operating activity are at middle. And we are happy to find that the maximum number of authorized patents is 988, and its mean value reaches 15.0794. This shows that the quality of technical intangible assets in China's enterprises has been improved.

B. Result of OLS Regression

We make white variance correction for all regression models; firstly, it appears that there is no problem of different variance in regression models. And then we make VIF value test of variance inflation factor for independent variable, and analyses multiple co linearity between them, and results are shown in table II as follows.

TABLE II. VARIANCE INFLATION FACTOR OF INDEPENDENT VARIABLES

| variable | TIA | patent | roe | roa |
|----------|------|--------|--------|----------|
| VIF | 1.05 | 1.07 | 1.6 | 2.02 |
| variable | dta | amount | growth | cashflow |
| VIF | 1.17 | 1.08 | 1.12 | 1.22 |

From table II we can see that VIF of all variables are less than 10, and there didn't exist independent variables' multicollinearity in regression models.

1) OLS regression on enterprises' value

The paper analyses correlation between enterprises' value and their technological property right here, and we get results of regression as shown in table III.

From table III we can see that both value of technical intangible assets and number of patents has significant positive effect on enterprises' value at the 1% lever, both of them had very important influence on enterprises' value, and technical intangible assets seems has a larger weight for contribution to enterprises' value than that of patent.

2) OLS regression on enterprises' value: group research for private enterprises and state-owned enterprises

TABLE III. OLS REGRESSION ON ENTERPRISES' VALUE

| | EV |
|----------|------------------------|
| TIA | 0.0508*** (5.56) |
| patent | 0.0030*** (7.56) |
| roe | 0.0017 (1.02) |
| roa | 0.0462*** (5.31) |
| dta | 0.0074*** (4.17) |
| amount | 0.3361** (2.05) |
| growth | 0.0007 (0.80) |
| cashflow | 0.2809*** (5.16) |
| cons | 20.8949*** (124.49) |
| R2 | 0.3209 |
| F | 56.2831 |

*p<0.1, **p<0.05, ***p<0.01

The paper analyses correlation between enterprises' value and their technological property right respectively in private enterprises group and state-owned enterprises group, and the results are shown in table IV as follows.

TABLE IV. OLS REGRESSION ENTERPRISES' VALUE ON :PRIVATE ENTERPRISES AND STATE-OWNED ENTERPRISES

| | Private enterprises group | State-owned enterprises group |
|----------|---------------------------|-------------------------------|
| | EV | EV |
| TIA | 0.0420*** (4.35) | 0.0807*** (3.20) |
| patent | 0.0037*** (4.77) | 0.0019*** (3.56) |
| roe | 0.0018 (1.00) | -0.0018 (-0.39) |
| roa | 0.0407*** (4.09) | 0.0623*** (5.63) |
| dta | 0.0062*** (2.74) | 0.0081*** (3.72) |
| amount | 0.2847 (1.44) | 0.3613 (1.25) |
| growth | 0.0014 (1.43) | -0.0012 (-0.62) |
| cashflow | 0.3430*** (4.65) | 0.1632** (2.47) |
| cons | 21.0459*** (110.96) | 20.4717*** (52.57) |
| R2 | 0.2955 | 0.3727 |
| F | 33.1783 | 21.1645 |

*p<0.1, **p<0.05, ***p<0.01

From table IV we find that both in private and state-owned enterprises, whether their technical property rights or patents have Significant positive effect on enterprises' value at the 1% lever. And in both groups, the technical intangible assets has a larger weight for contribution to enterprises' value than that of patent, but patent's contribution to enterprises' value in private group seems larger than that in state-owned group, while technical intangible assets' contribution to enterprises' value in state-owned group is larger than that of private group.

3) OLS regression on enterprises' value: group research for different industrial group

In this part, the paper analyzes correlation between enterprises' value and their technological property rights respectively in computer and communication industries, pharmaceutical manufacturing industry and instrument and meter industries. The results of those three groups' regression are shown in table V.

TABLE V. REGRESSION ON ENTERPRISES' VALUE: GROUP RESEARCH OF THREE KINDS OF HIGH-TECH INDUSTRIES

| | computer and communication industries | pharmaceutical manufacturing industry | instrument and meter industries |
|----------|---------------------------------------|---------------------------------------|---------------------------------|
| | EV | EV | EV |
| TIA | 0.0569*** (5.44) | 0.0316** (2.46) | 0.1037* (1.70) |
| patent | 0.0027*** (6.78) | 0.0140*** (3.32) | -0.0103 (-1.25) |
| roe | 0.0012* (1.68) | 0.0139 (1.47) | 0.0695 (0.66) |
| roa | 0.0475*** (6.30) | 0.0250* (1.68) | -0.0590 (-0.43) |
| dta | 0.0110*** (6.39) | 0.0014 (0.61) | 0.0053 (0.37) |
| amount | -0.0149 (-0.07) | 0.4932** (2.18) | 1.6665* (1.90) |
| growth | 0.0003 (0.26) | 0.0012 (0.85) | 0.0068 (1.58) |
| cashflow | 0.1524*** (2.87) | 0.3810*** (4.07) | -0.5156** (-2.24) |
| _cons | 20.8293*** (111.96) | 21.3292*** (85.78) | 19.2958*** (18.77) |
| R2 | 130 | 90 | 9 |
| F | 0.3640 | 0.3124 | 0.4029 |

*p<0.1, **p<0.05, ***p<0.01

From table V we find that in computer and communication industries, both technical intangible assets and patents have significantly positive effect on enterprises' value at the 1% lever. And in pharmaceutical manufacturing industry, the number of patents has Significant positive effect on enterprises' value at the 1% lever, the influence of technical intangible assets on enterprises' value is relatively small, and it illustrates a fact that authorized patents is so important in pharmaceutical manufacturing industry. And in instrument and meter industries, only the value of technical intangible assets significantly improves enterprises' value at the 10% lever, and the number of patents' influence hasn't appeared significant.

The above results also imply that computer and communication industries and pharmaceutical manufacturing industry can be representatives of high-tech industries in China.

IV. CONCLUSION

Generally speaking, both the value of technical intangible assets and the number of patents has significant positive effect on enterprises' value in high-tech industries in China. And whether in private enterprise or in state-owned enterprises, the value of technical intangible assets and the number of patents all have a significant positive effect on enterprises' value in high-tech industries, but the number of patents has a greater influence to improve firm's value for private enterprises than

that of state-owned enterprises. From group researches for three kinds of maturity high-tech industries in China, we find that in computer and communication industries, both the value of technical intangible assets and the number of patents has more significant positive effect on enterprises' value than that in instrument and meter industries. And the number of authorized patents plays a more important role to improve enterprises' value in pharmaceutical manufacturing industry and this has revealed a characteristic of the industry. And in instrument and meter industries, technological property rights seem has less effect on the value of their enterprise. Finally, we can conclude that the number of authorized patents has a great positive impact to private enterprises and firms in computer and communication industries, and computer and communication industries and pharmaceutical manufacturing industry can be representatives of high-tech industries in China, and increasing the intensity of technological innovation and getting more authorized patents would help firms in those industries to increase their market value and carry out more earnings to their shareholders.

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