Effect of Financing Structure on Technological Innovation for China's Industrial Software Industry: Case Study of Empyrean Technology Company

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Abstract. After being banned from using many important foreign industrial software, China promotes the development of domestic industrial software as a national strategic goal. There are many literatures analyzing the promotion effect of policy on technological innovation of China's industrial software, but there is still a gap in the research on the effect of financial structure. Taking Empyrean Technology Company as an example, this paper analyzes the effect of financing structure on technological innovation in company's different development periods. In entrepreneurship stage, the company's technological innovation is mainly driven by internal financing and government subsidy. In growth stage, equity financing plays a greater role in promoting technological innovation than debt financing. Therefore, the study suggests China's industrial software enterprises to actively apply for government subsidies in entrepreneurship stage and to explore equity financing channels in growth stage. Chinese central government can encourage more venture capital to be invested in industrial software industry by improving equity exit mechanism.

Keywords: Financing structure; technological innovation; Empyrean Technology; industrial software.

1. Introduction

As the basis of modern industrial development, industrial software is an important asset that reflects the potential of industrial development and an important area of competition between countries. In May 2019, Huawei was banned from using American Electronic Design Automation (EDA) software. In June 2020, Harbin Institute of Technology, a key scientific research institution in China's military industry, was prohibited from using Matlab. The ban on core industrial software prompted the Chinese central government to attach more significance to the development of China's industrial software industry. In May 2021, Chinese central government promulgated the "14th Five-Year Plan for Intelligent Manufacturing Development" in which Chinese central government clearly mentioned that it would issue fiscal policies to help finance Chinese industrial software companies and to help achieve the goal of manufacturing digitization [1]. However, there still exists a big gap between China's industrial software technology and foreign industrial software technology currently. In 2022, the global market share of China's industrial software is less than 10%, and China's industrial software is concentrated in the middle and low-end of the market [2].

Therefore, it is significant for Chinese industrial software companies to break through the technical bottleneck for high-end industrial software technology. Adequate capital investment is a necessary condition for technological innovation. The average cost per patent of high-end industrial software is about 50 times development cost of the normal patent [3]. And different financing ways such as debt financing and equity financing have different influences on technological innovation [4].

This paper focuses on Empyrean Technology Company, a Chinese EDA software company, to analyze the influence of its different financing structures on its technological innovation in different stages of the company. The financing structures that can largely accelerate the technological innovation of industrial software companies will also be explored. The study can provide useful guidance for industrial software companies to design optimal financing structures. Moreover, the results of the paper can provide ideas for Chinese central government in terms of making financing policies conducive to technological innovation for industrial software companies.

2. Literature Review

Many studies analyze the relevant factors that promote China's industrial software technological innovation. And the literature mainly focuses on the influence of national policies, intellectual property system and talent cultivation on technological innovation.

Few researches involve the interaction between financing structure and China's industrial software technological innovation. Xu and Yang compare the specific effects of different policies in promoting technological innovation of China's industrial software since 2013 [5]. Xu et al. find out that sound intellectual property rights system leads to more industrial software innovative activities in Henan Province [6]. Based on the research of the industrial software patents, Zhu and Hu propose that policy incentive is the main driving force for innovation in the field of China's industrial software currently [7]. Wang and Xiao carry out a comprehensive study on the financing environment of China's industrial software. Their research notes that current Chinese primary market of industrial software is dominated by state-owned funds and the financing rounds are concentrated around the B round [8].

Moreover, many studies compare the effects of equity financing and debt financing on technological innovation. Xin et al. adopt the sample of 225 listed Chinese computer equipment firms to study how debt financing affects radical innovation and incremental innovation. The results reveal that declining debt financing decreases radical innovation but does not affect incremental innovation [9]. Another empirical study by Zhang identifies the significant positive correlation between equity financing and technological innovation and the negative correlation between debt financing and technological innovation with data of 52 countries from 1996-2013[10]. Zhang et al. point out that equity financing has a more positive impact on innovation than debt financing because equity financing has higher risk tolerance [11].

However, the previous studies of the relationship between financing structure and technological innovation do not focus on the field of China's industrial software. The process of technological innovation differs between different industries [12]. The amount of required capital and the capital return rate of technological innovation are different for different industries [12]. Therefore, this paper will study the effects of financing structures on technological innovation of China's industrial software to fill a gap in this field. Moreover, current researchers only focus on equity financing and debt financing when studying the ways to finance innovation. In addition to debt financing and equity financing, the impact of internal financing and government subsidy on technological innovation will also be analyzed in this paper. According to enterprise life cycle theory, the financing structures of enterprises in different stages are quite different due to the change of capital scale and financing demand [13]. And Xu and Wu argue that Chinese industrial software companies display strong life cycle characteristics [14]. Therefore, the author will firstly divide Empyrean Technology Company into different stages. Then the relationship between technological innovation and financing structure for Empyrean Technology will be analyzed in each stage.

3. Case Description

Empyrean Technology Company was founded in 2009 in Beijing and went public in July 2022. The company mainly focuses on developing high-end EDA software. Empyrean Technology has made outstanding achievements in technological innovation. After 13 years of technological development and research, Empyrean Technology has developed EDA software which can be used for digital circuit design and wafer fabrication. According to Wind, a database of Chinese enterprises, Empyrean Technology Company has accumulated 201 patents and 73 software copyrights during 2009-2021.

Empyrean Technology is a leading enterprise in China's industrial software. According to the company's official website, it has been the leader in many national key scientific research projects. The company has won the 2020 China IC Design Achievement Award and the gold medal in 2019 China Software and Application Competition. As the current leader of Chinese EDA software

industry, Empyrean Technology's past financing structures for technological innovation have important implications for other EDA software companies.

Moreover, Empyrean Technology has a rich fundraising history. Table 1 lists the company's disclosed financing events. The company has received fund from debtors, venture capitalists and government several times. The data of number of patents and the value of intangible assets of Empyrean Technology can be used to evaluate the company's technological innovation performances. Combing the company's technological innovation performances and financing structures, the paper will analyze the impact of each financing method on Empyrean Technology's innovative behavior. And the channels by which each financing method influences technological innovation will be explained. Moreover, the optimal financing structures to accelerate technological progress of Empyrean Technology in company's different stages will be identified.

Table 1. Financing events of Empyrean Technology

Year	Financing event
2010	Sdic Tech invested 50 million RMB
2011	Received government subsidies 20 million RMB
2012	Received government subsidies 40 million RMB
2013	Borrow 0.3 million RMB from CITIC Bank
2014	Borrow 0.4 billion RMB from China Development Bank
2015	Received government subsidies 20 million RMB
2017	China Venture Capital and Shenzhen Capital Group invested 4 billion RMB
2018	Hua Capital and China Electronics Corporation invested 2 billion RMB
2019	Jianyuan Capital invested 0.8 billion RMB; Received government subsidies 40 million RMB
2020	China Integrated Circuit Industry Investment Fund invested 3.5 billion RMB

4. Case Analysis

4.1 Innovation and Intangible Assets

According to the cash flow division method of enterprise life cycle theoy, Empyrean Technology was in entrepreneurship stage during 2009-2013 [13]. It stayed in growth stage during 2014-2021. In addition, this study selects 10 comparable companies in the same industry with similar scale as Empyrean Technology. The average of these 10 companies' data constitutes the industry average level in Figure 1 and Figure 2. The 10 companies are Primarius Technologies Company, Cellixsoft Corporation, Caxa, SIE Information, YJK Building Software Company, Tianhe Intelligent manufacturing Technology Company, Beijing Rainfe Technology Company, Glorysoft Technologies, Semitronix Corporation, Pinming Technology Company.

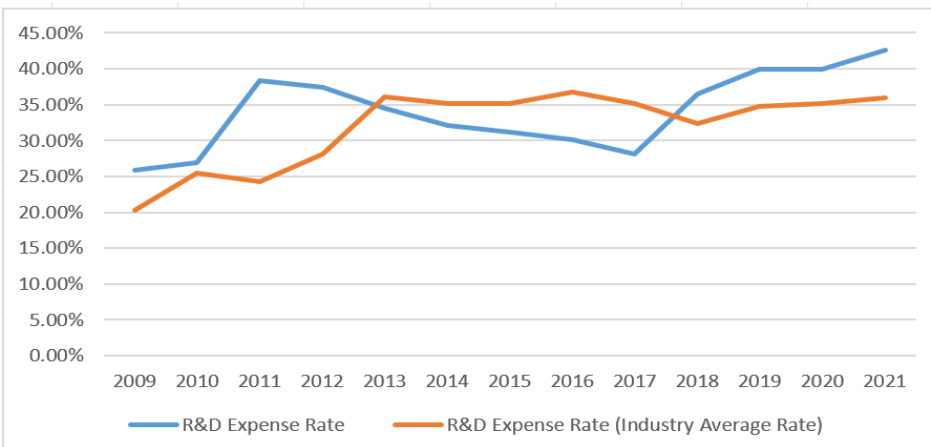

Fig. 1 R&D expense rate of Empyrean Technology and industry average level

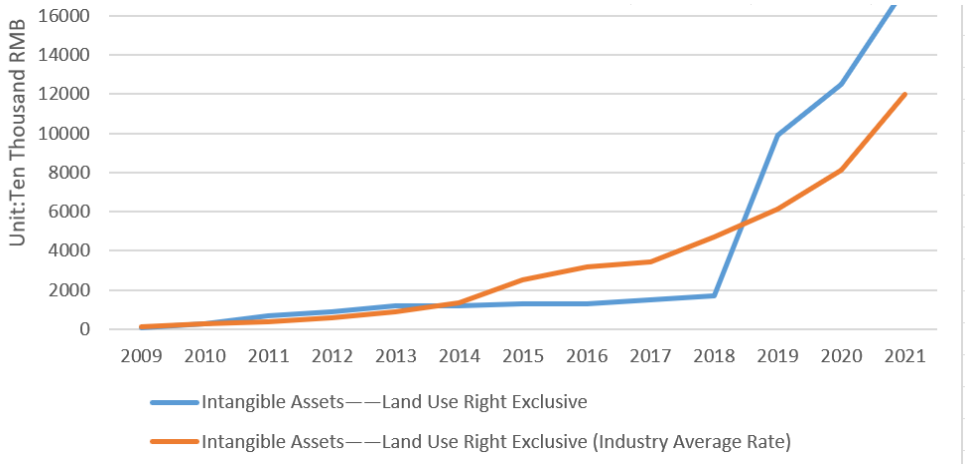

Fig. 2 Intangible assests (land use exclusive) of Empyrean Technology and industry average level

According to Figure 1 and Figure 2, the R&D expense rate and intangible assets of Empyrean Technology grew rapidly and were basically above the average industry level except from 2014-2017. Therefore, it can be inferred that the R&D investment of Empyrean Technology was effective in increasing the value of intangible assets in entrepreneurship stage. Although the annual number of new patents and software copyrights fluctuated, Figure 3 shows that the company produced 51 new patents and 21 new software copyrights in entrepreneurship stage. And 150 new patents and 52 new software copyrights were produced in growth stage.

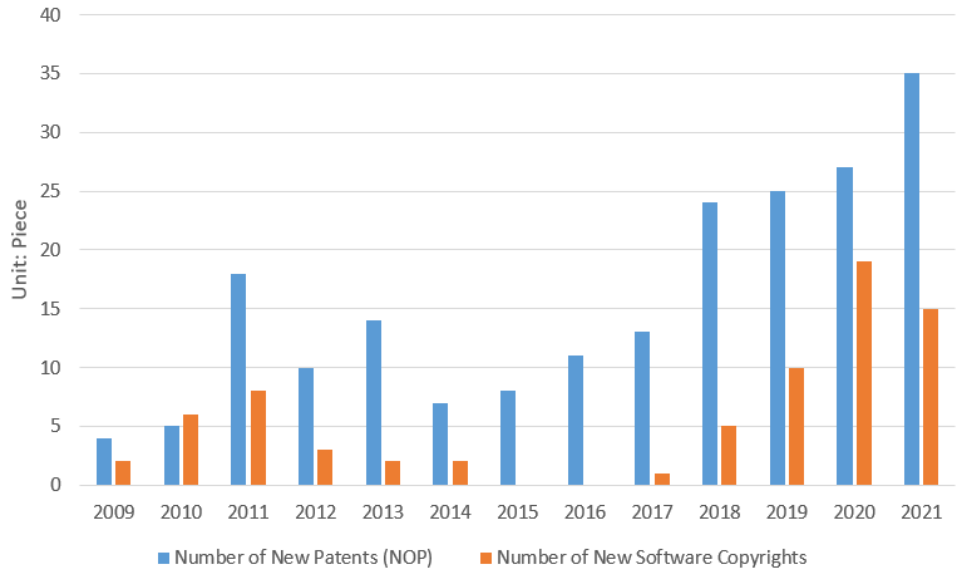

Fig. 3 Annual number of new patents & software copyrights of Empyrean Technology

4.2 Financing Structure

In terms of financing structure, Figure 4 indicates that the company did not carry out large-scale equity financing and debt financing in entrepreneurship stage. In addition, according to the continuous rise of government subsidy rate and increasing internal financing rate in Figure 5, it can be inferred that technological innovation was mainly driven by internal financing and government subsidies during entrepreneurship stage.

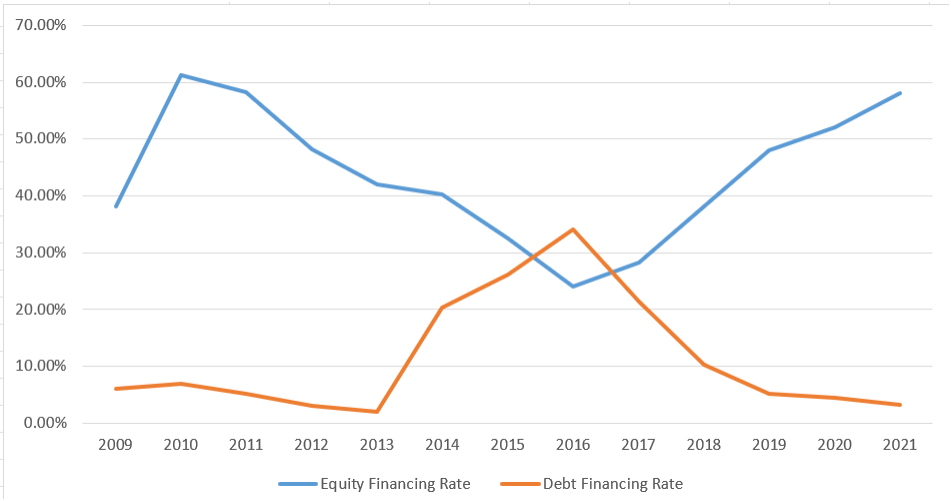

Fig. 4 Equity financing rate & debt financing rate of Empyrean Technology

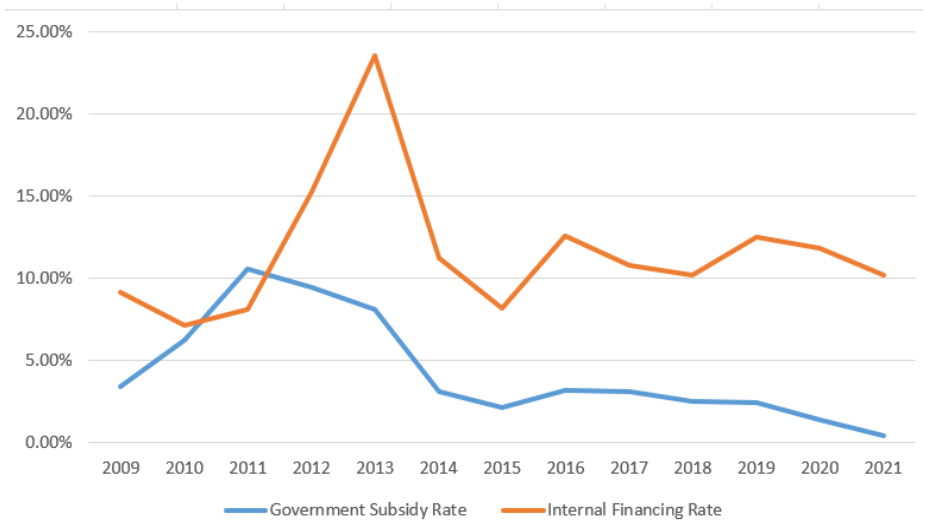

Fig. 5 Government subsidy rate & internal financing rate of Empyrean Technology

There are no restrictions on the use of funds obtained from internal financing. The company can decide the use of funds by itself. In addition, the founder of Empyrean Technology with technical background tends to invest the funds from internal financing in technological innovation. Therefore, internal financing can increase investment in technological innovation. And it can be inferred that more fund input will promote more technological innovation outputs. Government subsidies for industrial software are mostly distributed for special research programs. And the government will supervise the use of its subsidies. At present, more than 80% of government subsidies in China's industrial software industry can only be applied to research and development [15]. Therefore, government subsidies can promote innovation by directly providing funds for research and development.

4.3 Technological Innovation under Different Types of Financing

However, debt financing and equity financing had little influence on Empyrean Technology's technological innovation in entrepreneurship stage. The main reason is that the company had little venture capital and debt in entrepreneurship stage. As high-growth enterprises, industrial software companies are usually unwilling to give up too much equity at early stages. Empyrean Technology only had one experience of equity financing in entrepreneurship stage. In addition, the company has not established sufficient business credit in this stage, so it is difficult to obtain debt financing. Empyrean Technology had no large-scale debt financing during 2009-2013. Therefore, the difficulty

of obtaining venture capital and debt in entrepreneurship stage limits the influence of equity financing and debt financing on technological innovation.

Empyrean Technology was in growth stage from 2014-2021. During 2014-2017, Empyrean Technology underperformed than industry average level in terms of technological innovation. While from 2018-2021, Empyrean Technology outperformed the industry average level. This change is closely related to Empyrean Technology's changing financing structure. During 2014-2017, the company mainly focused on debt financing. The debt financing rate increased year by year and even exceeded the equity financing rate, while the equity financing rate has been declining. However, during 2018-2021, the company mainly focused on equity financing. The equity financing rate kept rising. The gap between equity financing rate and debt financing rate kept widening. Therefore, the deduction is that equity financing plays a more significant role in promoting Empyrean Technology's technological innovation than debt financing in growth stage.

Three reasons may support this deduction. First, venture capitalists have higher risk tolerance than creditors. The successful innovation of a company cannot increase the returns of creditors. But the value of the shares held by venture capitalists will increase. Therefore, venture capitalists often encourage the technological innovation performances. Creditors often restrict the use of their loans. Second, the continuity of venture capital matches the long-term technological innovation activities for industrial software companies. Development of industrial software requires a long research period due to the need for new software to be adapted to specific industrial processes. However, debt financing requires Empyrean Technology to repay principal and interests. Therefore, it is difficult to invest debts into technological innovation under the financial pressure of repayment. Funds raised by equity financing does not need to be repaid. These funds can support long-term technological research continually. Finally, software companies often have difficulty in obtaining sufficient debts to finance their technological innovation in growth stage. Software companies typically have few physical assets. Moreover, it is difficult to evaluate the value of their innovative products due to information asymmetry. Therefore, software companies often fail to meet the mortgage requirements of debt financing.

Moreover, in the growth stage, internal financing and government subsidies play a small role in promoting technological innovation of Empyrean Technology. Figure 5 indicates that government subsidy rate and internal financing rate both dropped below 15%, mainly due to the continuous increase of total assets. With the increasing cost of innovation, government subsidies can no longer satisfy the fund requirements for research and development. Additionally, internal financing cannot provide long-term and stable funding for technological innovation because the company cannot ensure its long-term profitability.

5. Conclusion and Suggestion

5.1 Conclusion

This paper takes Empyrean Technology as a case to study the relationship between the financing strategy and technological innovation in different stages for industrial software companies. In entrepreneurship stage, internal financing and government subsidies provided the main funds for its technological innovation. In growth stage, equity financing played a greater role in promoting technological innovation than debt financing. Moreover, in growth stage, due to the continuous increase of total assets of Empyrean Technology, its government subsidy rate and internal financing rate continued to decline. It cannot completely rely on government subsidy and internal financing to finance innovation. Therefore, industrial software companies can promote their technological innovation mainly through government subsidies and internal financing in entrepreneurship stage. After entering growth stage, industrial software companies should actively expand equity financing channels to raise funds for technological innovation. The government should also promote more venture capital to be used in innovation activities by perfecting the equity exit mechanism.

This study fills the gap of the research on the relationship between financing strategy and technological innovation in industrial software industry. it provides a theoretical basis for the subsequent quantitative research on financing innovation in industrial software industry. However, due to the underdevelopment of current Chinese industrial software industry, it is difficult to find an enterprise that has experienced the four company stages in enterprise life cycle theory. Empyrean Technology has not entered maturity stage. Therefore, this study only analyzes the innovation and financial situations of Empyrean Technology in entrepreneurship stage and growth stage. With the recent rapid development of Chinese industrial software industry, subsequent research can select companies which experience the four company stages for a more comprehensive analysis.

5.2 Suggestion

For Chinese industrial software companies, in entrepreneurship stage, companies can raise funds for technological innovation through internal financing and through applying for government subsidies. With the increase of innovation cost, companies cannot only rely on internal financing and government subsidies as technological innovation fund. After entering the growth stage, companies should set equity financing as the main financing strategy to promote the technological innovation. Meanwhile, with the growth in profitability, companies can also conduct debt financing appropriately, but they need to allocate funds reasonably according to the requirements of fund repayment.

For Chinese government, a capital market based on equity financing for industrial software industry should be established. The government can promote more venture capital to be invested in innovative activities by improving the equity exit mechanism. When companies encounter financial difficulties, the government can appropriately increase the amount of government subsidies to fund high-tech industrial software companies for continuous innovation. Moreover, commercial banks should be encouraged to improve the valuation of the innovation achievements of industrial software companies. Then the debt financing channels for high-tech low-asset industrial software enterprises can be expanded. The government can also establish R&D risk reserve to stimulate innovative activities of industrial software companies.

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