Doctor of Economics

Research on the Effects of Tax Preferences on Firm Innovation ---- Evidence from China

The Graduate School of the University of Ulsan

Department of Economics

WANG TIEPING

Research on the Effects of Tax Preferences on Firm Innovation ---- Evidence from China

Supervisor: Prof. Yoo Dongwoo

A Dissertation

Submitted to

The Graduate School of the University of Ulsan

In partial fulfillment of the Requirements

for the Degree of

Doctor of Economics

by

WANG TIEPING

Department of Economics

Ulsan, Korea

August 2022

Research on the Effects of Tax Preferences on Firm Innovation ---- Evidence from China

This certifies that the dissertation
of WANG TIEPING is approved

Jang Dooseok

Committee Chair Dr.

Yoo Dongwoo

Committee Member Dr.

Hong Jihoon

Committee Member Dr.

Cho Cheolkeun

Committee Member Dr.

Cho Cheolkeun

Committee Member Dr.

Department of Economics

Ulsan, Korea

August 2022

Acknowledgements

First of all, I would like to thank my supervisor, Professor Yoo Dongwoo, and the professors of the Department of Economics for their support and excellent guidance. The serious teaching attitude of the professors has benefited me a lot.

Secondly, I am very grateful for the help and timely administrative support provided by the international office and department administrators of Ulsan College during my entire study period.

Last but not least, I want to thank my good friends and family for their support to me, especially my husband Zhu Lei.

Abstract

uses invention as the proxy variable of innovation, verifies the positive effect of tax preferences on firm innovation, compares the effect of tax preferences on innovation between SMEs and l Until June 2019, China has successively launched 89 tax preferences mainly based on corporate income tax. As the transfer of fiscal revenue, the effect of tax preferences needs to be tested. This paper arge firms, and analyzes the difference in results between SMEs and large firms. The results are as follows.

(1) The effect of tax preferences on firm innovation.

Stepwise regression preliminarily shows the positive correlation between tax preferences and innovation. Tax preferences have a significant effect on innovation. Innovation needs a large amount of investment. Firms are more likely to respond to sustained and substantial tax preferences. The intensity and persistence of tax preferences significantly affect firm innovation. The firm value is proportional to the innovation. Firms with a large debt ratio will take on greater risks, which is easy to restrict finance and reduce innovation. It is more significant in non-state-owned firms and eastern firms. The study provides experience support for tax preferences.

(2) The effect of tax preferences on innovation for SMEs and large firms.

SMEs are important in the national economy. The number of SMEs is huge, accounting for 99% of the total number of firms. China's SMEs vary from industry to industry, mainly according to the size of the firm, operating income and employees are classified. Due to the difficulty of data collection, this part divides the samples into SMEs and large firms according to relevant standards. The above part investigates the positive effect of tax preferences on innovation. This part further explores the difference between SMEs and large firms in the effect of tax preferences on innovation. The empirical test is carried out from the benchmark regression and the impact of sustained tax preferences. The results show that tax preferences for large firms are more sensitive to innovation than SMEs.

(3) Financial constraints, tax preferences and firm innovation.

In the positive effects of tax preferences on innovation, there are significant differences between SMEs and large firms. The paper introduces financing constraint coefficients KZ index. The interaction term KZ*tax is set in the FE model to estimate the effect of financial constraints on tax preference and innovation. The results show that financing constraints have a negative effect on the tax preferences of SMEs. The reason for the difference in the effects of tax preferences between SMEs and large firms is that the financing constraints of SMEs are too severe; financing constraints inhibited the positive effects of tax preferences on innovation.

Key words: Tax preferences; innovation; SME; financial constraints

Abstract in Korean

2019 년 6 월까지 중국은 법인 소득세를 중심으로 89 개의 세제혜택을 연속적으로 시행하였다. 재정수입의 이전이라는 측면에서, 세제혜택의 효과는 검증될 필요가 있다. 이 논문에서는 혁신의 대리변수로 발명을 사용하여, 세제혜택이 기업 혁신에 미치는 긍정적인 효과를 검증한다. 또한 세제혜택의 긍정적 효과가 중소기업과 대기업에 미치는 영향을 비교하고, 그 차이점을 분석한다. 분석결과는 다음과 같다.

(1) 세제혜택이 기업 혁신에 미치는 효과

단계적 회귀 분석의 기초결과는 세제혜택과 혁신 간에 양의 상관관계가 있음을 보여준다. 세제혜택은 혁신에 큰 영향을 미친다. 혁신은 많은 양의 투자를 필요로 하고, 기업은 지속적이고 큰 세제 혜택에 반응할 확률이 높다. 세제혜택의 강도와 지속성은 기업 혁신에 상당한 영향을 미치며, 기업 가치는 혁신에 비례한다. 부채 비율이 높은 기업은 더 큰 위험을 감수할 것이며, 이는 자금조달을 제한하고 혁신을 감소시키기 쉽다. 세제 혜택의 효과는 기업별로 달랐다. 비국영 기업과 동부 기업에서 세제혜택은 더 중요한 것으로 나타났다. 이 논문은 세제혜택에 대한 경험적 근거를 제공하고 있다.

(2) 세제혜택을 통한 혁신이 중소기업과 대기업에 미치는 영향

국가경제에서 중소기업은 중요하다. 중소기업은 전체 기업수의 99%를 차지할 정도로 많다. 중국의 중소기업은 산업별로 다르게 분류되고, 주로 기업규모, 영업실적 및 직원수에 따라 분류된다. 데이터 수집의 어려움으로 인해 이 논문에서는 표본을 관련기준에 따라 중소기업과 대기업으로 구분하였다. 앞의 논문에서는 세제혜택이 혁신에 미치는 영향을 분석하였고, 이 논문에서는 더 나아가 세제혜택이 혁신에 미치는 영향이 중소기업과 대기업에서 다르게 나타나는 것을 분석하였다. 실증분석 검증은 벤치마크 회귀분석과 세제혜택의 지속성과 관련하여 실시하였다. 분석 결과 대기업이 세제혜택에 대해 중소기업보다 더 민감하게 반응하는 것으로 나타났다.

(3) 자금조달 제한, 세제 혜택과 기업 혁신

세제혜택이 혁신에 미치는 긍정적인 영향은 중소기업과 대기업 간에 상당한 차이가 나타난다. 이 논문에서는 자금조달 제약 계수인 KZ 지수를 도입한다. 상호작용 변수인 KZ*tax 는 FE 모형에서 자금조달 제약이 세제혜택과 혁신에 미치는 영향을 측정하기 위해 설정되었다. 자금조달 제약은 중소기업에서 세제혜택이 혁신에 미치는 영향을 감소시켰다. 세제혜택의 긍정적인 효과가 다르게 나타나는 것은, 중소기업의 심각한 자금조달 제약 때문인 것으로 나타났다. 자금조달 제약은 세제혜택이 혁신에 미치는 긍정적인 효과를 가로막고 있다.

키워드: 세제혜택, 혁신, 중소기업, 자금조달 제약

Table of Contents

Chapter1 Introduction

China is transforming from “Made in China” to “Created in China”, and pays more attention to firm innovation. Innovation promotes technological progress and increases social productivity (Scherer 1983; Acs et al. 1994). Innovation is important for firms to improve the market competitiveness, and it is also a major driver of long-term productivity growth (Guinet and Kamata 1996). R&D spillovers are crucial for steady economic growth (Griliches 1991); (Su and Su 2017). However, innovation is often below the optimal level because private returns to knowledge production are lower than social returns (Arrow 1962).The government should promote the innovation investment of firms (Fabiani and Sbragia 2014). Tax preferences can be seen to subsidize innovation, which is conducive to R&D and innovation investment (Hall 2020). Until June 2019, China has successively launched 89 tax preferences. The effect of tax preferences on such a large scale is worth studying in depth. This paper does research on tax preferences and firm innovation. As a transfer of national income, will tax preferences encourage innovation? Do tax preferences have the same impact on SMEs (small and medium sized firms) and large firms? These practical problems need to be solved urgently in academia and industry.

The paper verifies the positive effect of tax preferences on innovation. Innovation requires a large amount of investment. Firms are prone to respond to ongoing, substantial tax preferences. The intensity and durability of tax preferences significantly affect firm innovation. The paper further analyzes the positive effects of tax preferences for SMEs and large firms on innovation, and points out the reason for the different results between SMEs and large firms. This research provides empirical support for tax preferences and innovation theory.

The contributions of this paper are as follows: First, the paper’s research object is China, rather than developed countries in other research. Secondly, unlike previous studies that used R&D costs to measure innovation, this paper uses invention patents as an innovation proxy

variable to better reflect the quality and quantity of innovation. At last, the paper further compares the effects of tax preferences for SMEs and large firms on innovation and further explores the causes of the differences. This paper has certain theoretical and practical significance for improving tax preferences and promoting innovative research.

The limitation of this paper lies in that the data of SMEs are limited to the listed firms that can be collected. However, 99% of Chinese firms belong to SMEs, and most of them do not meet the listing conditions, so there may be some deviation in the empirical results.

Chapter2 Literature review and theoretical basis

2.1 Literature review

(1) Innovation promotes economic growth.

Schumpeter put forward the famous innovation theory in "Theory of Economic Development". Innovation is "the behavior of economic organizations to improve efficiency by establishing a new production function and using new combinations of production factors to conduct production and business activities" (Schumpeter 1934). Schumpeter emphasized the important role of technological innovation in economy.

The neo-classical economic growth theory (Solow 1956) and the new economic growth theory (Romer 1986) show that innovation is important to the developing micro-firms and macro-industry, region, and country. It is conducive to maintaining a position of relative competitive advantage for the firms. Innovation is the main source for firms' development. Fama and Laffer (1971) illustrated that solving economic problems mainly requires improving labor productivity, increasing technological innovation. Lucas (1988) confirmed that people would react rationally to fiscal and taxation policies. He advocated that fiscal and taxation policies should maintain their stability and that fiscal and taxation policies should be made public to convince people. A large number of empirical documents have proved from different angles that technological innovation is the guarantee of delayed industrial recession (Roberts and Amit 2003; Jones 2003; Fontana and Nesta 2009). Zachariadis (2003) took the US manufacturing firm as an example to do research on the technological progress and economic growth. The study results confirmed that the intensity of R&D and patents have contributed to economic growth. Wagner and Cockburn (2010) pointed out that to ensure the development of the industry, it is necessary to maintain the design of leading products at the forefront of technology through technological innovation and to promote incremental innovation through patent research and development. Few papers believe that innovation does not help industrial development and economic growth.

(2) Innovation needs government support.

The endogenous growth theory in the mid-1980s pointed out that innovation is endogenous to economic development and relies on labor factors and capital factors. In short period, the enhancement of firm innovation activities only needs to increase the input of labor and capital. The government needs to formulate policies to intervene and support the technological innovation activities of firms (Manso 2011). Hall and Van Reenen (2000) suggested that the inherent high risks of innovation and the asymmetry of market information decrease the firms' independent innovation investment, and the government should adopt tax preferences to encourage firms' independent innovation activities. Innovation output benefits from innovation input, and innovation has the characteristics of public goods such as non-exclusiveness, non-competitiveness, and externality. At the same time, there are also high risks, extremely high uncertainties and information asymmetry. Nelson(1959) showed that without the protection of an intellectual property, the cost of imitating related technologies and learning new knowledge is extremely low. Arrow(1962) clarified that innovation activities have market failures. Due to the publicity, uncertainty, externality of innovation activities, under the condition of relying on the market, innovation-related resources cannot be optimally allocated. As a result, the government must intervene in innovation activities. Mani (2004) reported that if innovation is not effectively protected, other firms will benefit from the technological innovation activities at a low cost. This will cause a decline in the income of the innovation subject and the spillover effect of technological innovation. The enthusiasm of firms for innovation has decreased, leading to insufficient investment in innovation and hindering technological innovation. The government needs to intervene in market failures, use policies to encourage firm innovation and promote the economic growth.

Fiscal and taxation policies can directly make up for the lack of corporate resources to promote corporate innovation. Fiscal and taxation policies can make up for the lack of corporate funds, and achieve the goal of stimulating corporate innovation (González and Pazó 2008; Hussinger 2008; Carboni 2011). From the perspective of signal transmission, the government passes the support of firms to other investors through fiscal and taxation policies,

which is conducive to firms to obtain the resources needed for innovation and carry out technological innovation (Kleer 2010). Batjargal et al.(2013) found that the signaling function of government fiscal and taxation policies will help reduce the uncertainty and information asymmetry of technological innovation activities. Obtaining government tax preferences can be regarded as the encouragement from the government to relevant firms and their industries, which will promote firms to obtain resources from other investors for innovation.

(3) The impact of tax preferences on corporate innovation.

The government's role in supporting corporate innovation is to make up for R&D investment, share R&D risks, and improve corporate technological innovation capabilities (Czarnitzki 2006). Bessant (1982) believed that innovation policies have multiple dimensions, and firms need to selectively enjoy relevant policies based on internal realities, and the innovation management capabilities of firms can be improved in this process. Bernstein(1986) collected Canadian data and used the production structure analysis method to find that every dollar increase in tax expenditures will bring more than one dollar in new capital. Griffith(1996) analyzed the correlation between tax preferences in various OECD countries and R&D investment, and found that differences in the degree of economic development, market environment and institutional environment in various countries have led to the effectiveness of tax policies. Estache and Gaspar (1995) used the analysis method of marginal effective tax rate based on Brazilian data and find that the extensive use of tax preferences may cause distortions in the tax system. Hall and Van Reenen (1999) used price elasticity estimation method based on data from seven western countries and found that a US$1 tax credit can increase the R&D cost by US$1. Busom (2000) found that innovation funding policy measures increase the R&D spending in Spanish firms. Samuelson(1954) found that tax preferences are conducive to promoting firms to introduce new products, and the favorable information transmitted by tax preferences makes firms win the favor of foreign investment. Eickelpasch and Fritsch (2005) inspected the innovation-related policies of the Federal Republic of Germany and found that the policy aims to increase the intensity of corporate competition and make the selected firms more sensitive. Czarnitzki and Hottenrott

(2011)used the method of non-parametric matching to estimate the effects of tax preferences on innovation. Compared with non-beneficiary firms, the beneficiary firms showed advantages in the development, sales and use of new products. Yang et al. (2010)stated that innovation policies can promote the improvement of corporate innovation efficiency by alleviating corporate resource pressure, providing more resource support, and providing conditions for the dissemination of corporate knowledge, the progress of related technologies, and the transformation of results. Wang et al. (2013) believed that innovation policies can make comprehensive use of various policy tools, which is conducive to the creation of corporate value, and thereby improves corporate innovation efficiency.

Whether it is theoretical analysis or practical exploration, experts have done lots of related research. It involves the necessity analysis of taxation policies, as well as the impact of taxation policies on innovation and so on. Related analysis and exploration have provided a lot of enlightenment for the research work of the paper, which is a reference for further research in this paper. The paper compares the effects of tax preferences for SMEs and large firms on innovation, and further explores the underlying reasons for the differences. This paper has certain theoretical and practical significance for improving tax preferences and promoting innovation research.

2.2 Theoretical basis

(1) Schumpeter's theory

In 1912, Schumpeter put forward the theory of innovation in The Theory of Economic Development. The theory clarifies that the driving force of economic growth and technological progress comes from changes in production technology and production methods. Innovation is an economic concept, which refers to the introduction of something new in the economy, which is essentially different from invention. When the invention is not practically applied, it cannot bring economic benefits to people, so it has no economic value. Schumpeter does not provide us with a precise innovation theory, but emphasizes the close relationship between entrepreneurs and enterprises for economic development. The entrepreneur is the

decisive factor in realizing the new combination, and the motivation is the pursuit of monopoly profit or excess profit. Therefore, the driving force of economic development is profit and entrepreneurship. Schumpeter puts forward an important technological innovation model-the entrepreneurial innovation model. This model is a linear model with several successive stages, containing a positive feedback loop from successful innovation, called profit from innovation fed back to entrepreneurial activity and investment in innovation. Schumpeter believes that the specific requirement of innovation is to construct a new production function, realize the recombination of production factors, and create new products or new values, so that the organization can obtain excess benefits. The specific circumstances of innovation include five aspects: first, product innovation, that is, new products or product features that were not there before; second, process innovation, that is, a new production method; third, market innovation, that is, entering a new product market; fourth, resource allocation innovation, that is, to obtain a new source of supply and to be able to control it effectively; fifth, organizational innovation, that is, to form a new industrial organization, or to obtain a certain organizational status. Schumpeter clearly pointed out that innovation originates from within the enterprise. For enterprises, the purpose of production and operation is to maximize profits. Enterprises attach great importance to investment in innovation, and only through innovation can they achieve sustainable development and improve their comprehensive strength and core competitiveness. In the face of strong market pressure, all firms are exploring technological innovation, so any innovation will quickly spread in the market. Firm innovation needs to invest a lot of cost. If the firm benefit is far lower than the social benefit, the firm innovation will lack enthusiasm and initiative. The government needs macro-control to maintain the innovation enthusiasm of enterprises.

(2) Classical Economic Theory

Neoclassical economics regards technological innovation as the basic factor of economic growth, and there are two main schools. One is represented by Abramowitz and Solow, based on traditional economics, taking technological progress as an exogenous factor of economic growth, and focusing on measuring the contribution rate of technological progress to

long-term economic growth. In his published “Technical Progress and Aggregate Growth Function”, Solow tested the impact of technological progress on the non-discriminatory effect of technological progress in the United States from 1909 to 1949. The contribution of labor productivity growth in the agricultural sector pioneered the neoclassical theory of innovation theory. However, studies represented by Solow did not explain the mechanism of technology generation. They only regarded technological progress as the residual value of economic growth that was not explained by labor and capital, and did not exactly explain the role of technological progress. In the view of neoclassical economists, science and technology play a very important role in economic growth, but they can only be used as exogenous variables of the economic system. This logical contradiction has attracted the attention of economists. Arrow and Romer put forward the famous new economic growth theory, which takes technological innovation as the basic unit to promote economic growth and is endogenous to the mainstream economic model, and proposes the endogenous growth theory. It has become another school of innovation theory in neoclassical economics. Scholars of endogenous growth theory believe that technological progress can avoid the law of diminishing marginal returns of capital and maintain sustained economic growth. There is a knowledge spillover effect in the innovation process. Knowledge and technology research and development jointly promote economic growth and are endogenous factors of economic growth. In the 1990s, Romer and Lucas further improved the endogenous growth model, took human capital as an important factor to examine economic growth, and divided social production into three parts: input, output and performance.

(3) New Schumpeter Theory

In 1942, Schumpeter further put forward the judgment of the “creative destruction” of the capitalist economy, and the judgment that big business plays a decisive role in this process. After Schumpeter's innovation theory, there is another branch of research innovation that has grown up with the neoclassical school of economics. Representative figures include American economists Rosenberg, Richard Nelson and British economists. Freeman et al. focus on the study of technological innovation processes, including the technological and economic

foundations of technological innovation, technological tracks and technological paradigms, and technological innovations. The major theoretical issues such as innovation clustering, technological innovation diffusion and long wave are proposed, and the entrepreneurial innovation model, interaction model, chain loop model and innovation cycle model are proposed. At the same time, neo-Schumpeterian scholars argue that innovation is an evolutionary situation through “destruction-shaping”. The circulation mode constantly replaces and improves the market structure in which it is located. During this period, the innovation theory basically followed the linear pattern of “basic research - applied research - technology development - new product and process application - economic growth”.

In 1966, the demand-pull theory of innovation was put forward, which was opposed to Schumpeter's theory of technological innovation promotion, and was accepted by Walsh, Townsend and Freeman of the Science Policy Institute of the University of Sussex in the United Kingdom. However, the British government at that time invested a lot of scientific and technological funds to science and technology, and it did not achieve much. Gradually, people began to realize the complexity of the technological innovation process, gradually expanding the basic linear model. Rosenberg pays attention to the relationship between technical characteristics and economic characteristics, emphasizes the importance of innovation by the chain integrated model.

In 1982, Freeman in his book “The Economics of Industrial Innovation” refined Schumpeter's thesis into a new model, namely the large-scale firm technological innovation model. In this model, large firms take the place of entrepreneurs, and exogenous R&D activities are set as endogenous R&D activities. Freeman believes that large enterprises have a leading advantage in research and development expenditure, so they naturally have an innate market advantage in technological innovation, and play a decisive role in promoting technological innovation. However, whether it is an entrepreneur model or a large firm model, it is a linear model, which is a simple input-output process. The market is only an added role, becoming the recipient of research and development results.

At the 7th International Symposium on Innovation, a Hofler model based on the effective

coupling of two cycles of research and development and economic activity was proposed. The knowledge cycle of Hofler model research and development accumulates new scientific knowledge and breeds new technological inventions. Through information transmission activities, technological innovation activities are continuously injected to form new products, new methods, and new processes, and then obtain the economy of micro-enterprises. The Hofler model is a macro model that covers almost the entire process of technological progress. The study emphasizes technological innovation through scientific research and promotes economic growth through technological innovation, revealing that the essence of technological innovation lies in the application of science and technology in economic development. However, the Hofler model ignores key links, namely innovation diffusion and changes in industrial structure. In addition, the Hofler model is too simplistic for the generalization of the development and technological innovation operation process, and does not reveal the interaction and complex connection between the various elements and stages within the innovation operation. The Leukippos model complements and improves the Hofler model, linking the information of each stage of innovation operation as a communication network connecting all stages of the whole process, emphasizing the communication network of information communication at each stage.

(4) National Innovation Theory

With the continuous improvement of innovation theory, more and more economists realize that enterprises are the main carrier of technological innovation, but not the only carrier. In the 1990s, the “National Innovation System” was gradually established and was generally accepted by members of the OECD and the international community. In 1988, Freeman first established the “National Innovation System” and began to focus on the role of government policies, corporate R&D capabilities, education and training, and industrial structure. Nelson affirmed the important role of education departments, universities, scientific research institutions, government funds and planning departments in the innovation system. Starting from the existence and evolution characteristics of technological change, he focused on the necessity of change and its adaptability to the institutional structure, emphasized the

impact of factors such as institutional and technological behavior on innovation systems. He believes that there are many uncertainties and complexities in the development of technology, and the nature and characteristics of different fields are also different. Therefore, a variety of strategic options may arise. An economy should maintain a diversified technological structure. Different industrial combinations, different technologies and institutional integrations reflect the shape of different national innovation systems. The micro school of national innovation system research emphasized the interaction between users and manufacturers, and believed that the national innovation system should actually be a social system, the central activity is learning, and there is a feedback mechanism. He defines a broad national innovation system, arguing that learning is taking place in all parts and aspects of the economic structure, and that they are linked and interact with each other. On this basis, Porter further added the dimension of time, arguing that the national system and social history and culture are also included in the national innovation system, affecting the formation and development of innovation, and proposed the famous diamond theory.

The common point about national innovation system research is to determine that enterprises, universities, research institutions and government agencies together constitute the carrier of technological innovation. As the main force of technology research and development, enterprises are an important carrier for technological progress, new product research and development, industrial upgrading, and the realization of the market value transformation of innovation results; universities and education and training institutions carry the important tasks of improving the quality of human capital, cultivating and delivering professional talents. Research institutes and universities and other research institutions undertake the responsibility of building a knowledge innovation system, and undertake the important task of improving the knowledge structure system and realizing scientific and technological invention, which is the foundation and guarantee of technological innovation of enterprises. The R&D cooperation between universities, research institutes and enterprises can give full play to the advantages of strong alliances, and realize the combination of theoretical research and actual productivity, the combination of invention patents and

achievement transformation, and the combination of technological progress and management innovation. Through the effective combination of production factors, the economic benefits can be maximized. In the national innovation system, the system is an effective means to maintain fairness and justice, while the government is the maker of the system, the maintainer of the institutional environment, and the supervisor of the market economic order. Implement a series of measures such as policy measures, formulate innovative development strategies, implement scientific and technological innovation plans, and invest support funds, rationally allocate various innovative resources for scientific optimization and combination, and achieve the goal of promoting technological innovation and development and boosting technological innovation of enterprises. In short, the national innovation system is an external structure composed of innovative main enterprises, universities, scientific research institutions, and the government, and is a social innovation system under the comprehensive effect of soft environments such as social system, legal environment, and market structure. To build a world-class scientific and technological power, it is necessary to proceed from the overall concept of the country, scientifically allocate the country's innovation resources, and at the same time optimize the combination to form a national innovation system that combines government, industry, academia and research that can give full play to the role of various innovation elements.

(6) Market Failure Theory

Real market economy society is difficult to meet the market competition conditions of perfect competition. Because of the influence of information asymmetry, externalities and public factors, the price mechanism cannot achieve its original effect, and the free allocation of resources by the market will always have its own inherent shortcomings. The characteristic of resource allocation is the phenomenon of market failure. The ultimate goal of a firm in the process of its own technological innovation is to maximize its own interests. Due to the free-rider phenomenon in the market, the R&D and innovation achievements of enterprises are easily used by other enterprises. Therefore, it is difficult to realize the efficient and rational allocation of firm resources only by relying on the invisible hand of the market hand

to correct the unreasonable phenomena existing in the spontaneous allocation of resources by the market. There are many reasons for market failure, including monopoly, external economy, public goods, and information asymmetry and so on. Although it is possible to increase market activity through competition, there is often a monopoly in the case of market failure, and it is difficult to achieve effective flow of technology, geographical location, scarce resources, etc., thus increasing transaction costs, product gaps, and affecting the effectiveness of capital. Competition restricts the effective flow of capital in the market. A monopoly market will lead to unreasonable allocation of resources, lack of motivation for technological innovation, and even rent-seeking behavior. Public goods are indispensable products in social development, with non-competitive and non-exclusive features. The purpose of producing such products is for social members to share. The use of public goods by some members of society does not affect others' use at the same time, and members of society do not have to pay for the use and enjoyment of public goods. External economic effects mainly refer to the impact of market transactions on the economic environment. The government's regulation in this regard is taxation, intervention fines, etc. Such factors can have a certain impact on manufacturers' costs and market economic activities. Even if it is a firm innovation, the firm can only obtain part of the innovation income, and the other part belongs to the social income. Therefore, technological innovation activities have typical characteristics of external effects, which affect the effective allocation of innovation resources. There is information asymmetry among the participants in economic activities. The party with information advantage can use its advantageous position to obtain more benefits, and even damage the interests of the party with weak information. Asymmetric transactions can easily lead to unbalanced education. Illegal transactions are transactions that violate market laws and lose the normal order of the market, which will directly affect the effective allocation of market resources. Complete information is impossible to achieve in practice. In reality, there is information asymmetry. Even the innovation information obtained by technical innovators is limited. Information asymmetry will affect the investment of innovation cost, and even affect innovation success. Affected by factors such as market failure, it is difficult to achieve optimal allocation of

technological innovation resources in the market, which will lead to deviations in innovation and research and development, or lead to the final failure of innovation activities. This phenomenon will seriously dampen the enthusiasm of enterprises for innovation and is not conducive to stable social and economic development.

2.3 Characteristics of innovation

Innovation has to go through a long and complex process of input and output, during which there is a risk of market failure. The resource allocation is not optimal. Therefore, government intervention is required to promote the improvement of market allocation of resource performance. Innovation has the nature of public goods, externalities and high risks.

(1) Innovation has the nature of public goods.

A public good is a commodity whose marginal cost to increase consumers is zero, and its utility can be extended and shared with anyone, and points out that non-rivalry and non-exclusivity are the main characteristics of public goods. When a social product has any one of these conditions, it is called a quasi-public good; when a social product has two properties at the same time, it is called a pure public good. Technological innovation is the process of comprehensively utilizing production technology knowledge or information to transform it into productive forces. Therefore, innovation has the nature of public goods. This feature makes the results of R&D and innovation likely to be sit back and enjoy by other firms, and the benefits of investment in innovation are far lower than the optimal level that may be expected, which greatly dampens firms to engage in innovation. The non-rivalry, non-exclusivity and non-segmentation of innovation are produced with the nature of public goods. Non-exclusivity means that once certain products are put into the consumer field, every consumer has the right to use them fairly, and no one has exclusive rights. The non-divisible nature of public products is reflected through the sharing of results by consumers, and the benefits brought to people by public facilities such as parks and libraries are inseparable. Public goods in a broad sense include material goods and various public services. The services provided by the government include government administration and

business services, such as national defense, foreign affairs, public security, and industry and commerce administration. Technological innovation activities are based on scientific knowledge. Although the results are mostly expressed in external forms such as new technologies, new processes, and new products, the direct results of technological innovation are patents, which are the results of the application and practice of scientific knowledge. Specifically, according to the different links of production activities, the technological innovation of firms can be divided into three stages, innovation input, innovation output and innovation performance stage. The innovation input stage includes physical capital, human capital and other inputs. This stage is the initial stage of technological innovation of the firm. The firm decides to invest in innovation based on the consideration of profit, market demand, technological opportunities and other factors, and raises various input elements for R&D activities. Technological innovation has rich forms in the input stage, including R&D investment and production. Basic research is the first stage of innovation investment, mainly through the increase of manpower to produce products in the form of knowledge. This process is mainly to obtain the essential mechanism behind various phenomena and observable facts, and to summarize and infer new theoretical knowledge based on the existing theoretical knowledge, mainly including pure theoretical research and guided theoretical research. Pure theoretical research is to theoretically explore the unknown basic laws of material structure, interaction and material motion in nature. The results cannot be directly applied to actual production activities, but are only conducive to promoting the development of theoretical research and are the foundation and foundation of research and development, which determines the significance and feasibility of research and development. From the practical point of view, firms pay attention to the research activities engaged in direct economic or social welfare. Orientation theory research provides a systematic knowledge theoretical basis and structural framework for existing actual problems or potential future problems in the production activities of firms, and attempts to adjust the way of thinking. Construct new knowledge structures, discover new activity phenomena, search for new natural laws, derive new scientific principles, scientific theories and scientific methods, solve

real problems and problems that may arise, and promote the progress of production technology. Applied practical research is mainly based on pure theoretical research and oriented theoretical research, and based on large-scale transformation of existing production equipment and systems. Technological innovation reflects the process of accumulation, practice, application and transformation of scientific knowledge in the process of production practice. Knowledge products are non-competitive in use. Because technological innovations created by firms can be reused for an unlimited number of times, even if technological consumption continues to increase Synchronized increase in usage cost. Technological innovation products are obviously non-exclusive. When a consumer has relevant knowledge about an innovative product, it can be used, and the producer of the innovative product cannot exclude other consumers from the free use of the innovative product. If there is incomplete intellectual property protection, then innovative products are easily used by other consumers for free, and the cost of copying or using technologically-innovative products by other consumers is basically negligible compared with the production costs paid by innovative product producers. It is precisely because of the above characteristics that in the current real economic society, a firm's technological R&D innovation often has a strong spillover effect. Used by firms conducting R&D and innovation. Other firms imitate and exploit their innovations and share the market and profits originally belonging to the innovative firms through free-rider behavior. This kind of free-rider behavior will seriously weaken the product advantages of technological innovation firms, damage their interests, but also dampen the enthusiasm of firms to continue technological innovation, thus creating an unfavorable social innovation environment, which is not conducive to firms and national innovation capabilities develop.

(2) Innovation has externalities.

Economists define externalities mainly in two ways. On the one hand, the externality is defined from the perspective of the externality's generating subject. Marshall is the most typical representative of defining externalities from the perspective of the externality generating agent. He believes that the actions and decisions of an economic agent benefit

bystanders around its activities (positive externalities) or damage (negative externalities). This is not the original intention of the economic subject, but the non-market-oriented impact of one economic force on another. Another aspect is to define an externality in terms of its receptive object. Randall is the most typical representative of defining externalities from the perspective of the receiving object of externality. He believes that an economic subject in the market is forced to accept certain benefits or costs for its economic activities inadvertently or unknowingly. The resulting positive (negative) effects are called externalities. Among them, positive externalities can improve the efficiency of corporate economic activities, while negative externalities can reduce the efficiency of corporate economic activities. The externalities of innovation activities are mainly reflected in the spillover effect of innovative technologies. Technological innovation has brought huge profits to successful innovative firms. In order to obtain the same high profits, other firms in the market will obtain innovative information through various means. The results are mostly in the form of patents, technologies, research reports and other knowledge forms. Improper protection of patents and intellectual property rights will lead to information leakage and obvious spillover effects of innovation. It will also collect and obtain technical information through various means, resulting in information spillover. R&D personnel are the carriers of technological innovation of firms. R&D personnel can take away the relevant information of innovation, resulting in a large amount of leakage of innovation information. Regarding the income generated by private investment in R&D, both the private return and the social return are quite considerable, generally in the range of 20%-40%, and the social return is higher than the private return. The externalities caused by different situations make firms that actively implement technological innovation fail to achieve the expected benefits of innovation, and gradually turn to the other side of passive waiting, which inhibits the development of innovation. At this time, the government needs to regulate and improve the intellectual property protection law, and make up for the economic losses caused by externalities through financial support. The government will make the private marginal benefit of the product consistent with the social marginal benefit to make up for its lost external marginal benefit through direct or indirect funding.

Since the innovation of a firm is generally non-exclusive and non-competitive, its competitors may obtain its technological innovation results for free without market transactions, and obtain the market share and profits that should belong to the innovative firm, but do not need to Pay the corresponding economic costs, that is to say, there is a strong positive externality in the R&D activities of firms. This situation is mainly caused by the following reasons: First, the firm has not applied for a patent or the patent application has expired. Because firms need to disclose some relevant information when applying for patents, and firms in the same field can often obtain relevant information about some patents through these published materials. On the other hand, the protection period of a patent is generally temporal, and other Businesses can use and obtain patent information free of charge. The second is the flow of R&D personnel. The personnel are very important to the firm, because they often master the core technology of a firm and are the carrier of the firm's knowledge products, and the flow of R&D personnel between firms means that the innovative technology is in the middle of each firm. The third is the linkage effect between manufacturers and customers. Firms with an advantage in technology will make these customers or manufacturers obtain their innovative technologies and production processes from the firm's products for free when they contact their suppliers or their downstream customers.

(3) Innovation has high risk.

Risk is determined by the uncertainty and high investment of innovation. Due to the long cycle of R&D innovation, the follow-up of funds at different stages, and the need to reserve room for failure, the demand for funds for corporate innovation is huge. However, the process of innovation is long and complex, and the outcome of innovation is unpredictable. In addition, the market is not everything. Simple market adjustment will inevitably lead to fluctuations in technological progress activities, but market adjustment is an after-the-fact adjustment, which will cause an extreme waste of social resources in the long adjustment process. It is also difficult for the market itself to maintain an orderly balance, and moderate competition is a necessary condition to stimulate innovation. However, excessive competition can lead to extremes, the formation of concentration and monopoly, and ultimately inhibit

competition. Therefore, the market mechanism is not omnipotent, and the inherent drawbacks of innovation make government intervention particularly important. In addition, national defense, infrastructure, education, urban environment, public health, and other public finances for collective consumption by the public are essentially fields that are not suitable for market domination, and must be organized and coordinated by the government. The uncertainty of firm innovation includes two main aspects: market uncertainty and technological uncertainty. Technological uncertainty refers to the possibility that the technological innovation carried out by the firm may not be advanced enough. Generally speaking, the higher the technological uncertainty it exists, and the greater the unpredictability of the innovation results brought by technological innovation. The market uncertainty is more from a country's policy orientation, laws and regulations, changes in market demand and the degree to which technological innovation is accepted by the market. On the other hand, the firm innovation is often affected by the management environment in which the firm is located, external funds and its own internal management and production level, and sometimes even faces technical challenges from competitors in the market. These factors will affect the firm. The activities have caused great obstacles. Whether it is the uncertainty risk in technology or the uncertainty risk in the market, the firm innovation will face greater risks, which will cause the decision makers of the firm to have doubts in the face of innovation investment, unable to output the final results of innovation.

2.4 Tax preferences in China

(1) Dual-subject tax preferential policy system.

In the tax incentive policy system to stimulate firm innovation, it mainly involves corporate income tax, value-added tax, tariff and other taxes, of which corporate income tax occupies the dominant position, followed by value-added tax. The tax objects of corporate income tax include income from the sale of main commodities, income from labor supply, income from asset transfer, income from dividends and bonuses, income from royalties, and donations. The essence of corporate income tax to stimulate innovation is to influence the size

of the net profit (tax base) of the firm by defining the object, proportion, scope and standard of the cost expense, thereby affecting the investment orientation and business strategy of the firm, adjusting the industrial direction and allocating resources. In addition, from the perspective of the specific form of income tax, the application of specific policy tools for income tax is also very flexible and extensive, almost covering direct and indirect preferential tools such as preferential tax rates, tax deductions, tax refunds and accelerated depreciation. Value-added tax is a turnover tax levied on the basis of the value added of commodities and taxable labor services in production, circulation and supply. It is conducive to increasing and stabilizing income, and can reward exports, restrict imports, and encourage Export enthusiasm of firms. From the perspective of commodity circulation, value-added tax is not affected by the number of commodity circulation links. It can not only meet the requirements for the development of production to the direction of professional cooperation, but also take into account the joint operation of firms on the basis of specialization, which is conducive to the optimal allocation of social production. Value-added tax is a neutral tax, and it is an extra-price tax, which is borne by consumers. Therefore, the adjustment effect is not as obvious as that of corporate income tax. At present, most of the tax preferences related to innovation are based on corporate income tax, and only a small amount of value-added tax is involved. Although China takes the dual-subject tax system structure as the goal of China's tax system reform, at present China is still dominated by indirect taxes such as value-added tax, and the tax revenue of income tax is still relatively low in the total tax revenue. In the process of operation and production, firms still mainly pay indirect taxes. For firms, the further expansion of R&D tax preferences to cover the indirect tax field can enable firms to obtain more preferential measures and inject more impetus into firm innovation.

(2) Direct preferential forms dominate.

At present, there are various forms of tax preferences, including tax exemptions, tax reductions, preferential tax rates, expense deductions, accelerated depreciation, investment credits, carry-over of losses, first tax refunds and immediate tax refunds. Among them, tax relief and preferential tax rate are direct preferential forms, and the policy objects and

preferential degrees are selected through specific scope and standards. China currently mainly adopts the form of direct preferential policies, accounting for 60% of the total preferential policies. Direct preferential incentives are at the end of the innovation chain, which is a reward for the initial innovation achievements of firms. The high risk and uncertainty of innovation itself lead to the need for a loose cultivation environment for innovation. Direct incentives cannot give due help to firms that have failed to innovate or need funding in the current period, which weakens the orientation of policies and greatly reduces the effect of policies. Expense deductions, accelerated depreciation, investment credits, loss carry-forwards, first-to-refund and immediate-to-refund, etc. are indirect preferential forms, emphasizing the application of different preferential policies to different links that affect the tax base. Such preferential forms can enable firms to enjoy the benefits and effects of tax preferences at the initial stage of investment, and the degree of incentives is closely related to the firm's own investment, production and business activities (investment projects, purchase objects, products sold and sales scope). Through the adjustment of the tax base, the innovation behavior of firms is guided.

(3) Focus on encouraging innovation of high-tech firms and SMEs

High-tech firms belong to the category of “High-tech Fields Supported by the State” promulgated by the state. A high-tech firm is a knowledge-intensive and technology-intensive economic entity. The identification policy of high-tech firms is actually an affirmation of the potential strength and future development of the firm, and has a certain policy orientation. Firms that are recognized as high-tech firms generally have the following characteristics: first, the firm belongs to the high-growth firm; second, the firm manager has a strong sense of scientific and technological innovation, with a certain level of firm management and market development; third, the firm has a high position in the industry and field to which it belongs, and has strong technical research and development capabilities and high-end technology development capabilities. Therefore, high-tech firms have become the focus of the state's preferential support, reflecting China's urgent requirements for innovative development and support for scientific and technological innovation. Tax preferences for high-tech firms and

related industries accounted for more than half of the total number of tax preferences. There are a large number of SMEs in China, accounting for more than 90% of the firms. In the process of innovation exploration, SMEs are often the breakthrough. The various reform achievements of SMEs provide useful experience for the reform practice of firms, and accelerate the development of China's overall economy. Premier Li put forward the slogan of “Mass Entrepreneurship, Mass Innovation”, which made the requirements for technological innovation of Chinese firms more urgent, setting off a new wave of “Mass Entrepreneurship” and “Everyone Entrepreneurship”. The state has successively introduced various tax preferences, and implemented support for SMEs through tax preferences such as tax reduction and tax reduction, and taxable income tax reduction and exemption.

(4) Policies are mainly aimed at innovation investment and R&D links.

Innovation investment is the foundation and source of firm R&D innovation. Innovation investment requires a lot of financial support. The essence of tax preferences to stimulate innovation is to use direct or indirect tax preferences to reduce the tax base and tax rate to stimulate innovation. On the one hand, through accelerated depreciation of current R&D equipment, super deduction of research and development expenses, reduction of corporate tax rate, and reduction or exemption of turnover tax for research and development instruments and equipment, etc., reduce the tax base of firms and reduce the taxes payable; On the one hand, due to the cyclical characteristics of business operations, indirect preferential methods such as first-order refunds, loss carry-forwards, and investment credits will significantly affect the firm’s capital investment in innovation in the next cycle. By solving the financial pressure of firms, guide firms to choose the correct direction of industrial development. Therefore, China's current tax preferences for technological innovation of firms are mainly aimed at innovation investment and R&D links, and there are certain requirements for technology transfer, transformation of technological achievements and product sales, but the incentive policies are limited, and they are ex-post incentives, and the effect is not obvious.

2.5 The fiscal policies to promote innovation

While creating a macro innovation environment for firms, the government will take a series of specific fiscal and taxation support measures to intervene in the technological innovation of firms according to the development needs of different industries. Among them, financial subsidies, government procurement, and government venture capital are direct investment means, and tax preferences are indirect investment means. Financial subsidy is the most common direct investment method. Financial subsidy refers to the government subsidy method adopted by the state to achieve specific political, economic and social goals according to the political and economic situation in a certain period of time. Financial subsidies are ex-ante incentives, which are the financial supply provided by the government to firms in accordance with the pre-set range of support and funding for economic development. The government's financial subsidy has a strong capital replenishment effect on firm innovation, which helps to rapidly improve the technological innovation ability of firms. Government procurement is an important part of the public finance system and an important support policy for the government to stimulate innovation. Government procurement, also known as public procurement, refers to the needs of state organs, administrative institutions and social organizations at all levels, in accordance with statutory procedures and methods, in an open, fair and just way of bidding, with low prices and high quality for the needs of daily government work. Good service is the principle of selection, and it is an act of using funds inside and outside the financial budget to purchase and lease required goods and services. Government procurement improves the utilization efficiency of financial funds by standardizing, rational and effective use of social resources. While meeting the daily procurement work of the government, it conducts macro-control and guidance on the economy, and supports and protects the development of innovative firms. New products have just entered the sales market, and there is a need for a process of acceptance. Due to the constraints of consumers' consumption habits and mindsets, it is difficult to develop new products in the early stage of market development. Government procurement gives priority to

innovative products and gives them a great deal support, and guide the trend of consumption. Not only that, some regions have market monopoly and discriminatory procurement problems to varying degrees. Government procurement has well corrected this distorted path dependence, maintained a fair market, and protected the market position of innovative products. At the same time, government procurement behavior conveys good news for firms and opens up market prospects for new product sales. In addition, innovation activities have great uncertainty. After firms make innovation decisions, they need to pay high production costs and trial-and-error costs to carry out innovation practices. The government's priority purchase has given firms great encouragement and greatly reduced the cost of innovation. The decision-making risk and market transaction risk of new product development. Government procurement not only reduces the risk of technological innovation of firms, but also increases the income of firms, solves the problem of capital turnover of firms, and is of great help to SMEs and emerging industries with limited funds and limited financing channels.

Government venture capital is an innovation promotion policy in which the government provides equity capital to innovative firms and increases the innovation capital investment of firms, thereby improving innovation achievements. At present, venture capital is a government-supported policy widely adopted in the world to promote the development of high-tech industries and SMEs. Equity investment is realized through the following three modes: First, direct investment, that is, the government establishes a venture capital fund to invest in equity. Second, indirect investment, the government first invests in venture capital firms, and then the venture capital firms invest in firms to achieve indirect investment; third, mixed investment, that is, the government absorbs a certain amount of private capital, and then combines with government funds to establish a hybrid fund. The government promotes government and social funds to enter science and technology firms in a way of supplying first and then guiding, which solves the financing constraints of firms themselves, saves the corresponding financing costs, and increases the capital supply for technological innovation of firms. In addition, firms with government venture capital are more daring to carry out innovative practices than those without government venture capital, and are more likely to

produce innovative results.

Tax preference is an important indirect means for China's fiscal and tax policies to stimulate technological innovation of firms. It refers to the adjustment and revision of the tax law in accordance with the current tax structure and pre-determined purposes. Specifically, by exempting all or part of the taxes they should pay, or giving them back a certain percentage of the taxes they paid, etc., their tax burdens will be reduced. Tax preference is a broad concept, including tax reduction or exemption, super deduction, accelerated depreciation and deferred settlement, etc. Tax reduction or exemption refers to reducing or exempting the tax burden of production and business activities with special circumstances, in combination with the universality and particularity of taxation. Tax reduction generally includes three forms: First, tax reduction includes regular reduction and irregular reduction by time. Regular reduction emphasizes the certain timeliness, and generally no longer enjoys the reduction or exemption after expiration; there is no fixed time limit for irregular reduction or exemption. Second, tax reduction is generally divided into policy reduction, difficulty reduction and general reduction by nature; policy reductions refer to relief for specific taxable objects in accordance with the spirit of relevant national policies; difficulty reductions refer to reductions and exemptions for taxpayers who have difficulty in paying taxes; general reductions refer to other general reductions and exemptions. Third, tax reduction is divided into statutory relief and non-statutory relief. Statutory reductions and exemptions refer to tax reductions and exemptions expressly stipulated in the Basic Tax Law; non-statutory reductions and exemptions refer to tax reductions and exemptions stipulated by administrative regulations other than those stipulated in the Basic Tax Law. In the process of firm innovation, tax relief is often used for income tax and turnover tax, but for value-added tax in turnover tax, the tax burden is transferred between different taxpayers. The incentive effect is more applied to the innovation output stage. Tax deduction refers to allowing firms to deduct some or all of the specified special expenses from the taxable income to reduce the tax base and reduce the tax burden, that is, when calculating taxable income, a certain amount is deducted from the income. The amount may be deducted by a certain percentage to reduce the taxpayer's taxable

income. The tax deductions for innovation incentives are mainly made for R&D expenses, which are divided into proportional deductions and fixed deductions. The proportional deduction is relatively scientific, and the deduction amount is determined by the taxable income. Tax deduction reduces the risk of technological innovation investment of firms and reduces the net cash outflow of firms to a certain extent. Additional deduction is a tax incentive measure that adds a certain percentage to the actual amount as a deduction when calculating the taxable income. In essence, the super deduction is actually a policy of magnifying effect of tax deduction, which induces firms to invest in innovation through the magnifying effect of the proportion of expenditures. Accelerated depreciation is aimed at the large-scale R&D equipment of firms. Generally, large-scale fixed assets have a long service life. Accelerated depreciation is a tax incentive method that provides more depreciation for fixed assets at the beginning of their use, and then reduces them in subsequent years, including shortening the depreciation period and increasing the depreciation rate. The preferential tax method of accelerated depreciation mainly reduces the tax burden on investors at the initial stage of purchase, accelerates the return of funds to firms, and improves the utilization rate of funds. The tax preferences have an obvious effect on encouraging independent innovation of firms.

Tax preference can reduce R&D costs. The R&D cost is a key factor that firms consider first in the innovation process. The cost of innovation will directly affect whether to conducts R&D. Excessive innovation costs will increase the risk of R&D products, which will ultimately affect the firm's ability to operate risk. The fundamental goal of tax preferences is to encourage firms to increase R&D cost, mainly by partially reducing, exempting or even exempting the taxes paid by firms for technological research and development, so as to achieve the goal of helping firms to enhance their own research and development capabilities. The essence of tax preferences is to return the tax benefits originally belonging to the government to firms through tax preferences, which means that the government partially bears the R&D for firms, reducing the burden of firms. If the economic benefits brought by the R&D results of the firm remain unchanged, the R&D benefits obtained by the firm will be

higher than before, which will drive the firm to carry out more R&D innovation and further increase new Technology research and development to obtain more economic benefits. According to the capital cost model of scholars such as Jorgensen, the capital use cost of a firm is composed of the depreciation expense of the firm's fixed assets and the cost of capital financing. After the corporate income tax is levied, the capital use cost of the firm will increase. At the same time, the government's taxation behavior will change the R&D cost of the firm. For example, the current Chinese Corporate Income Tax Law stipulates that 100% of the R&D expenses of firms can be deducted when calculating the taxable income and the scientific research equipment purchased by firms for R&D can be tax-reduced or even exempted. Accelerated depreciation can be selected. All of these tax preferences play a role in reducing R&D cost.

Tax preference can reduce the risk of R&D. Uncertainty is an inevitable part of the innovation of every firm. Unexpected factors such as financial pressure, changes in R&D personnel, and changes in relevant government policies will lead to high uncertainty risks in innovation. Once the products lag behind competitors in the process of upgrading, the firm will often face greater pressure to survive, suffer severe impact from rivals and the market, and lose its original market share. Only when a firm has a good psychological expectation for the benefits of R&D innovation, will it actively invest in innovation. The government helps firms to reduce their tax burden through tax reductions, tax rebates and additional deductions for R&D expenses, so that government departments indirectly undertake part of the R&D innovation risks that should be borne by firms. The government's tax preferences can affect the uncertain risks in the innovation. In fact, the government's tax preferences can often help firms alleviate the financial pressure of firms at critical moments, thereby helping firms get out of business difficulties, reduce business risks, and help firms. Better business development.

Tax preferences can enrich the source of funds. There are two main ways to obtain R&D funds for firms, one is the financing obtained from outside the firm, and the other is the profit obtained from the internal operation of the firm. The external financing of firms is

divided into two types, one is external funds obtained by issuing corporate bonds or stocks, and the other is financial support from government departments. From the perspective of external financing, tax preferences can be seen to support the firm R&D. The super-deduction policy for R&D expenses enjoyed by firms can ease the tax burden of firms and enrich the channels for firms to obtain funds from external sources. Tax preferences can enable firms to reduce tax payment, and the less tax payment helps firms save internal funds, so that firms have more funds to invest in product R&D.

The government can influence firm innovation in costs, risks and funds or R&D by implementing tax preferences. With the reduction of R&D costs, firms will carry out more innovation activities under the same financial conditions. With the reduction of R&D risks, firms will also have higher enthusiasm for R&D innovation, which will ultimately motivate firms to innovate.

Chapter3 Analysis of the effects of tax preferences on innovation

3.1 Introduction

Innovation is important for firms to improve the market competitiveness, and it is also a major driver of the productivity growth (Guinet and Kamata 1996). However, innovation is often below the optimal level because private returns to knowledge production are lower than social returns (Arrow 1962). The government should promote the innovation investment of firms (Fabiani and Sbragia 2014). Tax preferences can be seen to subsidize innovation, which is conducive to R&D and innovation investment (Hall 2020). Until June 2019, China has successively launched 89 tax preferences (Table 3-1). The effect of tax preferences on such a large scale is worth studying in depth. This paper does research on tax preferences and firm innovation. As the transfer of state revenue, do tax preferences encourage innovation? Do tax preferences have different effects on different firms? These practical problems need to solve urgently in the academic circle and the industry.

This paper focuses on firm innovation and verifies the effect of tax preferences. Firms are prone to respond to sustained and substantial tax preferences. The intensity and persistence of tax preferences significantly affect firm innovation. The study provides empirical support for tax preferences.

The paper contributes to the study of the impact of tax preferences on innovation. The paper is significantly different from the previous research in the following. First, the paper focuses on developing countries like China, and the previous research mainly concentrate in developed countries. Second, unlike research that uses R&D costs to measure innovation, this paper use invention patents as an innovation proxy variable to better reflect the quality and quantity of innovation.

Table3-1 Main forms of tax preferences policy

Inclusive tax preferences	R&D expenses plus deduction policy : Based on the amount incurred, a certain proportion shall deduce from the taxable income. The policy of R&D expenses plus deduction has been revised and improved for many times. In 2008, the new corporate income tax law in China stipulated the policy of R&D expense plus deduction. In 2013, the R&D achievement appraisal expense and R&D personnel "five insurances and one fund" include in the scope of R&D plus deduction. In 2017, 75% of R&D expense plus deduction proportion was stipulated for technological SMEs. In 2018, all firms can enjoy the tax preference of 75% plus deduction proportion. In 2022, the R&D expenses actually incurred in the R&D activities of small and medium-sized technology-based firms enjoy 100% super deduction.
	Tax preferences for technology transfer: Income from technology transfer of less than 5 000000 Yuan shall free from corporate income tax, and income from technology transfer of more than 5 000000 Yuan shall lessen by half.
	Accelerated depreciation of fixed assets.
	Tax exemption for small, low-profit firms: Small, low-profit firms whose annual taxable income is less than 500000 Yuan (including 500000 Yuan) should be reduced by 50% of taxable income.
Industry-specific tax preferences	High-tech firms shall enjoy corporate income tax 15%
	Advanced technology service firms shall enjoy corporate income tax 15%
	Software manufacturing firms in China will free from corporate income tax in the first and second years and reduced by half in the third to fifth years from the profit-making year.
	For key software manufacturing firms within the national planning and layout, if they do not enjoy the preferential tax exemption in the current year, the corporate income tax shall levy at 10%.
	Firms that produce IC products with line width less than 0.8 μ m (including) shall free from corporate income tax in the first and second years and reduced by half from the third to the fifth years from the profit-making year after recognized.
	Eligible animation firms will free from corporate income tax regularly.

Note: the content comes from the State Administration of taxation in China.

3.2 Literature review and research hypothesis

In recent years, more attention has been paid to tax preferences compared with direct subsidies. The reason is that tax preferences can reduce the risk of “choosing losers”, that is, choosing firms with low returns due to political relations (Dechezlepretre et al. 2016). However, the research on the impact of tax preferences on innovation has been controversial. On one hand, many scholars believe that tax preferences promote firm innovation. The reasons are as follows. First of all, the tax preferences can reduce the firm's cash expenditure and increase the internal fund. The internal fund is the main fund source of innovation (Manso 2011). Tax preferences reduce the cash outflow of firms, which is equivalent to subsidizing the innovation (Hall 2020). However, the result would be the opposite if taxes were raised. Lower after-tax profits after tax increases could increase firm debt and discourage riskier innovation (Heider and Ljungqvist 2015). On the other hand, some studies suggest that tax preferences do not work in firm innovation. The reasons are as follows. First, the effect of tax preferences affected by coverage, policy strength, and implementation difficulty. The United States tax credit is not effective, mainly because of its small size and incremental format (Tassey 2007). Second, tax preferences reduce the burden on firms, but they cannot affect the firm’s innovation investment decisions. Underinvestment in innovation cannot change by relaxing financing limits through tax preferences (Howell 2016). In conclusion, tax preferences have both promoting effects and inhibitory effects. Most of the existing studies hold the view that tax preferences encourage firms to innovate. Hall and Van Reenen (2000) study the literature before 2000 and find that tax preferences increased R&D costs. Many literatures have verified that tax credits promote innovation in the United States (Rao 2016; Chang 2018b), Canada (Czarnitzki et al. 2011), France (Bozio et al. 2014), Russia (Nechaev and Antipina 2015a), Japan (Kasahara et al. 2014), Brazil (Fabiani and Sbragia 2014), etc.

This paper studies the relationship between tax preferences and innovation based on the signal theory. The intensity of tax preferences can effectively reduce the information asymmetry that exists between firms and potential investors, and introduce external

investment to promote firms innovation. More than 80% of China's firms enjoy different kinds of tax preferences. The intensity of the tax preferences sends a signal to businesses, banks, venture capitalists and others that it is valid for them to attract outside investment. The strength of the signal is determined by the intensity of the tax preferences enjoyed by the firms. The higher tax preferences the firm enjoys, the more signals it sends out to external funding. A good relationship between government and firms is sustainable for firms, which can ensure the firm innovation. To confirm the positive effect on innovation in China, the hypothesis is proposed as follows.

Hypothesis: Tax preferences promote firm innovation.

3.3 Data source and variable definition

3.3.1 Data source

This paper selects 2008-2017 A-share listed firms as samples. The samples started in 2008 due to the new corporate income tax law of China. In 2008, the benchmark tax rate changed from 33% to 25%. The samples ended in 2017 due to the statistics of patent data ends in 2017. The data of this paper is from the CSMAR database, and 15043 samples left.

3.3.2 Variable definition

Dependent variable: innovation. R&D and patent are often used to measure firm innovation in recent research. R&D reflects firm’s R&D investment while patent reflects firm's innovation output. Since R&D investment does not necessarily produce patent output, patents show the efficiency of firm innovation. Patents measure the impact of tax preferences on innovation and productivity (Mukherjee et al. 2017). Patent is an innovation index superior to R&D (Shao and Xiao 2019). First, firms may overestimate the R&D to obtain more tax credits (Griffith 1996). Second, not all R&D produce patents (Cohen et al. 2013). Patents include invention, utility model, and appearance design. The invention is more difficult than utility model and appearance design. The invention needs to examine the practicability, novelty and non obviousness, while the utility model and appearance design only needs to go

through the formal examination (Shao and Xiao 2019). In 2018, invention accounted for 17.7% of all patents, and utility models accounted for 60.40% in China. Invention correlates with social productivity and belong to high-tech innovation. Compared with the appearance design and utility model patents, invention can better reflect the substantive technological progress of firms. Following the literature (Aghion et al. 2018; Chen and Yang 2019), this paper adopts the invention application to measure the innovation. The calculation method is as following. The standard deviation of innovation is 1.4282, which implies there are some differences in the innovation.

$$\text{Innovation} = \ln(\text{invention application} + 1)$$

Independent variable: tax preference. The corporate income tax rate includes the nominal tax rate and the effective tax rate. If only the nominal tax rate used to distinguish whether the firms enjoy the tax preferences, it equals to limiting the firms to specific industries, ignoring the R&D expenses plus deduction policy. However, all the behaviors with tax preferences will reflect on the effective tax rate. Following the literature (Li and Zheng 2016), the paper uses the effective tax rate to measure the corporate tax burden. In this paper, whether the effective tax rate is less than the benchmark tax rate 25% is the standard to judge whether the firm enjoys tax preferences (Chen and Fa 2019). The calculation method of this variable is the difference between 25% and the effective tax rate.

$$\text{tax preference} = 25\% - \text{effective tax rate}$$

The calculation formula for the effective tax rate is following.

$$\begin{aligned}\text{Effective tax rate} &= (\text{corporate income tax expense} - \text{deferred income tax liability} \\ &\quad + \text{deferred income tax asset})\end{aligned}$$

$$\text{Corporate income tax expense} = \text{pretax profit} \times \text{tax rate}$$

Following Chen and Yang (2019), this paper selects government subsidy, firm scale, firm value, leverage, established time as control variables.

Government subsidy is the free funds obtained by firms from the government, which can effectively reduce the financial pressure on innovation. Government subsidy is in direct proportion to innovation. The control variable subsidy equals the logarithm of government subsidies.

Firm scale implies the economic strength of the firm. Large firms have more cash to invest in innovation than SMEs. Firm scale is in direct proportion to innovation. The control variable size equals the logarithm of asset value.

Firm value is conventionally measured by Tobin's Q (the quotient of firm’s market value and replacement cost). If the firm value is big, it means that the firm has a good development potential. Firm value is in direct proportion to innovation.

The paper uses leverage to represent the asset-liability ratio. The asset-liability ratio shows the firm's debt level. A high debt-to-asset ratio means that the firm may face greater financial risks and inhibit corporate innovation

The firm established time is represented by age, which is calculated by the logarithm of the difference between the year and the firm established time. The firm's established time roughly indicates the firm's position in the firm's life cycle.

3.3.3 Descriptive statistics

Table 3-2 shows the descriptive statistics. The range of tax preference is – 46.19% to 50.35%, which means the range of the effective tax rate is – 25.35% to 71.19%. Due to the different tax preferences and the income tax adjustment policies, the effective tax rate deviates from the nominal tax rate of 25%. It should be noted that the maximum tax preference is 50.35%, which shows that the effective tax rate is -25.35%. According to the calculation formula for the effective tax rate, this will occur when the deferred income tax liability is greater than the sum of the income tax expense and the deferred income tax assets. Deferred income tax liabilities and deferred income tax assets are adjustment items caused by differences in the treatment of accounting and tax laws. In short, a negative effective tax rate can exist.

Table3-2 Variable definition and descriptive statistics

Variables	Symbol	Variable definition	Mean	Sd	Max	Min
Innovation	Invent	ln (invention +1)	2.1513	1.4282	9.1083	0
Tax preference	tax	25%- effective tax rate	0..0768	0.1204	0.5035	-0.4619
Subsidy	subsidy	ln (subsidy)	15.9495	2.8524	24.642	0
Firm scale	size	ln(assets)	22.0376	1.3294	28.5080	18.0077
Firm value	tobinQ	tobin's Q	2.0785	1.2104	8.3660	0.8810
Leverage	lev	liabilities /assets	0.4055	0.2063	0.9806	0.0070
Established time	age	ln(year-established time)	2.6064	0.4547	3.9120	0

Figure 3-1 shows the distribution of sample firms in different ownership and economic regions. In terms of the ownership, among the 15043 samples, there are 5476 state-owned firms, accounting for 36.40%, while 9567 private firms, accounting for 63.6%. In terms of the economic region, 10449 firms locate in the eastern region, accounting for 69.46%, and 4594 firms in other regions, accounting for 30.54%.

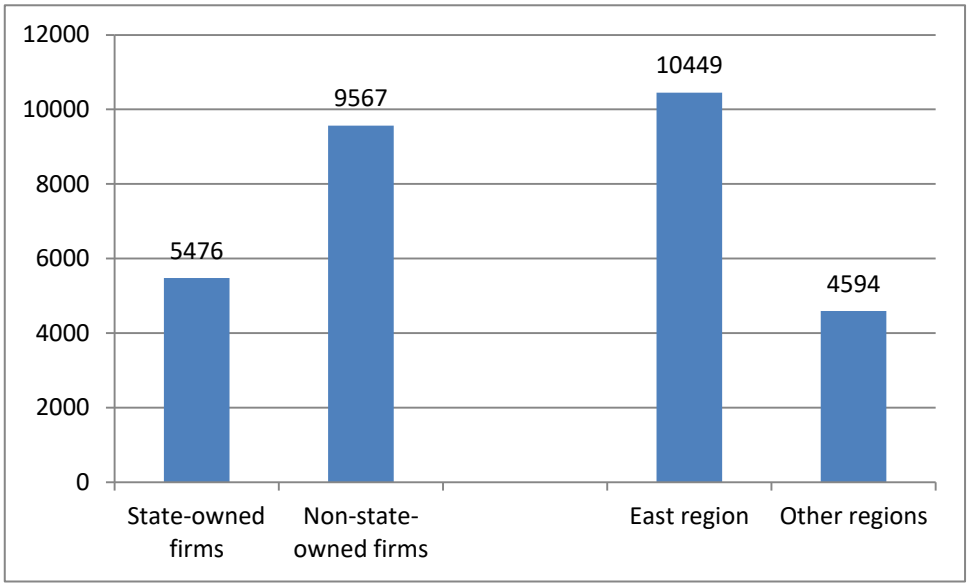


Figure 3-1 Distribution of firms

Table 3-3 shows the yearly statistics. The number of firms with tax preferences in each fiscal year is over 81% of the total sample, up to 87%. The vast majority of firms enjoy tax preferences in various forms, suggesting a wide range of tax preferences. The mean effective tax rate is 11.09% at the minimum and 14.14% at the maximum. The mean rate is less than the benchmark tax rate 25%, even lower than the preferential tax rate of high-tech firms 15%, which indicates the large intensity of tax preferences. The total number of sample firms is increasing year by year, and the firms enjoying the tax preferences account for the vast majority. The total number of innovations in each accounting year is increasing year by year. Notably, the innovation of firms with tax preferences is higher than that without tax preferences, which preliminarily shows the positive effect of tax preferences on innovation.

In order to make the chart comparison clearer, the paper divides the samples into three equal parts based on the variable tax, and compares the first group with the third group. The critical points of three equal divisions are 9.32% and 21.68%. Firms with tax preferences greater than 21.68% are classified as those with more tax preferences, while firms with tax preferences less than 9.32% are classified as those with fewer tax preferences. The trend of innovation is listed by year. As shown in Figure 3-2, the trend of innovation of firms with distinct tax preferences is the same, increasing year by year. The innovation of firms with more tax preferences is significantly greater than that with fewer tax preferences, which

preliminarily verifies that tax preferences encourage innovation.

Table 3-3 Yearly statistics

Year	Firms with tax preferences	Total number of firms	The average preferential tax rate	The innovations of firms with tax preferences	The innovations of firms without tax preferences
2008	82.21%	697	11.09%	1.66	1.31
2009	82.92%	855	13.04%	1.81	1.41
2010	87.05%	1143	13.64%	1.82	1.53
2011	85.66%	1450	14.14%	1.98	1.50
2012	81.89%	1524	14.02%	2.18	1.67
2013	81.39%	1580	13.75%	2.24	1.91
2014	82.07%	1612	13.32%	1.32	2.06
2015	81.37%	1728	13.10%	2.41	2.01
2016	81.35%	2043	13.69%	2.50	2.07
2017	84.11%	2411	13.49%	2.38	2.10

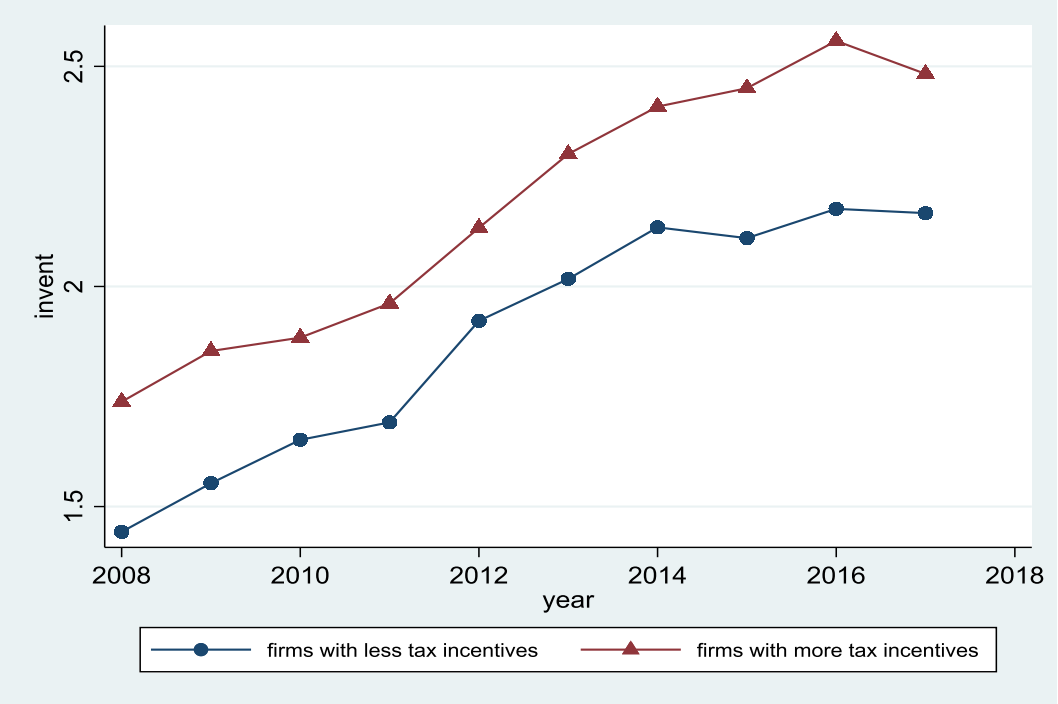


Figure 3-2 Innovation and tax preferences

3.4 Empirical tests between tax preferences and firm innovation

3.4.1 The test of tax preferences on innovation

To prove that tax preferences effectively promote innovation, the following model is used.

$$invent_{i,t} = \beta_0 + \beta_1 tax_{i,t} + \beta_2 subsidy_{i,t} + \beta_3 size_{i,t} + \beta_4 tobinQ_{i,t} + \beta_5 lev_{i,t} + \beta_6 age_{i,t} + \mu_i + \gamma_t + \varepsilon_{it}$$

Based on the Hausman test of the correlated random-effect model, the paper decides to use the fixed-effect model. The model regresses the dependent variable with the mean of the variables. The results are significant and suggest that a fixed-effect model should be used.

The results of FE and RE are reported in Table 3-4. The independent variable is tax (tax preferences), and the dependent variable is invent (firm innovation). The variable tax implies the intensity of tax preferences. The paper expects that β_1 is significantly positive, which implies tax preferences promote innovation due to reduced cash outflow. As shown below, the overall results of fixed-eff(chang 2018a)ect stepwise regression model are significant. Column 2 shows the positive relation between tax preferences and innovation without control variables. The third to seventh columns show the regression results after the control variables are increased one by one.Column3 shows the more government subsidies, the more conducive to the innovation. Column 4 shows the larger the firm-scale, the more powerful it is to carry out innovation. The regression results of the control variables added in the fifth column to the seventh column are not significant, indicating that firm value, debt and establishment time have little effect on innovation. In the results of stepwise regression, after considering the increasing control variables, β_1 of tax are all significantly positive, which verifies the incentive effect of tax preferences on innovation. The empirical results verify the hypothesis. Many literatures have verified that tax preferences have a positive impact on innovation (Rao 2016; chang 2018a; Czarnitzki et al. 2011; Nechaev and Antipina 2015b; Kasahara et al. 2014) . The conclusion is in line with the existing study.

Table 3-4 Stepwise regression

Variables	FE						RE
	invent	invent	invent	invent	invent	invent	invent
tax	0.162**	0.165**	0.192***	0.188***	0.189***	0.187***	0.322***
	(0.073)	(0.073)	(0.068)	(0.068)	(0.068)	(0.068)	(0.065)
subsidy		0.022***	0.009***	0.009***	0.009***	0.009***	0.028***
		(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
size			0.477***	0.484***	0.483***	0.480***	0.530***
			(0.034)	(0.035)	(0.037)	(0.037)	(0.013)
tobinQ				0.012	0.011	0.009	0.043***
				(0.011)	(0.011)	(0.011)	(0.007)
lev					0.016	-0.008	-0.485***
					(0.107)	(0.107)	(0.065)
age						0.128	0.448***
						(0.078)	(0.029)
_cons	1.269***	0.948***	-9.014***	-9.184***	-9.161***	-9.354***	-11.195***
	(0.038)	(0.068)	(0.730)	(0.754)	(0.785)	(0.784)	(0.245)
Observations	14512	14512	14512	14512	14512	14512	15043
Pseudo R^2	.z	.z	.z	.z	.z	.z	.z

Standard errors are in parentheses

Hausman test based on correlated random effect model

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tax	0.121	0.069	1.75	0.081	-0.015	0.256	*
subsidy	0.013	0.003	3.71	0.000	0.006	0.019	***
size	0.569	0.035	16.39	0.000	0.501	0.637	***
tobinQ	0.014	0.009	1.61	0.107	-0.003	0.031	
lev	-0.182	0.106	-1.72	0.086	-0.390	0.026	*
age	0.656	0.069	9.54	0.000	0.522	0.791	***
taxbar	2.449	0.283	8.64	0.000	1.893	3.004	***
subsidybar	0.086	0.011	7.90	0.000	0.064	0.107	***
sizebar	-0.195	0.045	-4.29	0.000	-0.284	-0.106	***
tobinQbar	0.088	0.026	3.34	0.001	0.036	0.139	***
levbar	-0.156	0.166	-0.94	0.348	-0.481	0.169	
agebar	-0.936	0.089	-10.48	0.000	-1.111	-0.761	***
Constant	-7.327	0.641	-11.43	0.000	-8.582	-6.071	***

Mean dependent var	2.151	SD dependent var	1.428
Overall r-squared	0.273	Number of obs	15043
Chi-square	1713.041	Prob > chi2	0.000
R-squared within	0.255	R-squared between	0.199

3.4.2 The test of sustained tax preference on innovation

Innovation needs a large amount of investment. Firms are prone to respond to continuous tax preferences. To verify the effect of sustained tax preferences on the innovation, the paper introduces SUS and taxprior to represent the continuity of tax policies.

SUS is set to represent the sustained tax preference as suggested by Li and Zheng (2016). If the effective tax rate is lower than 25%, it means the firm has enjoyed tax preferences. In the first year the firm receive tax preferences, SUS will record as 1, and in the second year, it will record as 2, and so on. Otherwise, if there is no tax preferences for the firm, SUS will records as 0. If a firm breaks off the tax preferences and enjoys it again, SUS starts at 1.

Taxprior is set as a proxy variable for sustained tax preference, and the calculation method is to take the average value of three periods of tax preference.

$$\text{taxprior}_{i,t} = \frac{\text{tax}_{i,t} + \text{tax}_{i,t-1} + \text{tax}_{i,t-2}}{3}$$

Sustained tax preferences are conducive to promoting firm innovation. If the firm enjoys strong and sustained tax preferences, it means that the firm continues to receive indirect funding to innovate, indicating that the industry is strongly supported by the government and has good development prospects. It is necessary for firms to increase investment in innovation for the future. Sustained tax preference should promote firm innovation.

The results are reported in Table3-5. The independent variable is the sustained tax preferences, and the dependent variable is the innovations. The paper expects that β_1 is significantly positive, because the sustained tax preferences are conducive to stably reducing the cash expenditure of firms, which is equivalent to continuingly fund firms to innovate. As shown in Table 3-5, the coefficients of SUS and taxprior are significantly positive, suggesting that the sustained tax preferences promote the firm innovation. The empirical results verify the hypothesis. The longer the firms enjoy the tax preferences, the stronger the promotion effect. The paper use the same methodology and samples from different periods to verify the conclusions of relevant studies (Li and Zheng 2016).

Table 3-5 The test of sustained tax preference on innovation

	FE invent	FE invent
SUS	0.020***	
	(0.004)	
taxprior		0.344*
		(0.177)
subsidy	0.010***	0.010**
	(0.003)	(0.005)
size	0.465***	0.485***
	(0.021)	(0.035)
tobinQ	0.006	0.008
	(0.009)	(0.011)
lev	0.000	0.017
	(0.077)	(0.123)
age	0.118**	-0.022
	(0.057)	(0.105)
2008		
2009	0.095**	
	(0.039)	
2010	0.094**	
	(0.039)	
2011	0.261***	0.238***
	(0.040)	(0.042)
2012	0.420***	0.428***
	(0.042)	(0.044)
2013	0.440***	0.475***
	(0.045)	(0.048)
2014	0.470***	0.536***
	(0.049)	(0.053)
2015	0.518***	0.587***
	(0.055)	(0.060)
2016	0.605***	0.725***
	(0.057)	(0.066)
2017	0.533***	0.613***
	(0.060)	(0.073)
_cons	-9.027***	-8.924***
	(0.453)	(0.767)
Observations	15043	7838
R-squared	0.270	0.209

Standard errors are in parentheses

3.4.3 The long-term effect of tax preferences on innovation

It takes a long time from R&D spending to the invention application. There is a certain lag between tax preferences and the innovation. To estimate the long-term effect of tax preferences on innovation, the paper uses the system GMM methodology by estimating the following ARDL model (Autoregressive distributed lag model).

$$invent_{i,t} = \alpha + \rho invent_{i,t-1} + \beta_0 tax_{i,t} + \beta_1 tax_{i,t-1} + \beta_2 tax_{i,t-2} + control + \sum year + \varepsilon_{it}$$

I newly added $invent_{i,t-1}$, $tax_{i,t-1}$and $tax_{i,t-2}$ in the model. The coefficient β_0 indicate the current effect of tax preference on innovation. The long-term effect of tax preferences on innovation is expressed using the following formula, where ρ is the coefficient of the $invent_{i,t-1}$.

$$\text{long-run effect of tax preference} = \frac{\beta_0 + \beta_1 + \beta_2}{1-\rho}$$

The paper expects that β_1 and β_2 as well as β_0 are significantly positive. Due to the lag in the effect of tax preferences, the incentive effect on innovation is long-term. The regression results are reported in Table 3-6. β_0 (0.596) is significantly positive, suggesting that 1% point increase in tax preference produce 0.596% increase in innovation. The long-term effect of tax preference on innovation is 2.66 [(0.596+0.539+0.364)/(1-0.436)], indicating that 1% point increase in tax preference has a long-term effect of 2.66% increase in innovation. Notably, the long-term effect of tax preference (2.66) is bigger than the short–term effect (0.596). The possible reason is that the intensity of tax preference is a signal to potential investors, attracting external investment to promote firm innovation and have a long-term impact on enterprise innovation. The intensity of tax preference is useful for the future innovation. The empirical results verify the hypothesis. The conclusion is in line with the relevant study (Atanassov and Liu 2019), which uses a DID methodology and find that most innovations occurs 2 years after the tax exchange.

Table 3-6 The test of tax preferences on long-term innovation

invent	Coef.	St.Err.	t-value	p-value	[95%Conf	Interval]	Sig
L.invent	0.436	0.023	18.58	0.000	0.390	0.482	***
tax	0.596	0.108	5.53	0.000	0.385	0.807	***
L.tax	0.539	0.122	4.41	0.000	0.300	0.778	***
L2.tax	0.364	0.105	3.45	0.001	0.157	0.571	***
subsidy	0.038	0.005	6.90	0.000	0.027	0.049	***
size	0.300	0.023	12.96	0.000	0.255	0.346	***
tobinQ	0.048	0.011	4.39	0.000	0.027	0.070	***
lev	-0.011	0.096	-0.12	0.904	-0.199	0.176	
age	-0.126	0.043	-2.96	0.003	-0.210	-0.043	***
2010	-5.960	0.480	-12.41	0.000	-6.902	-5.019	***
2011	-5.700	0.479	-11.90	0.000	-6.640	-4.761	***
2012	-5.640	0.478	-11.79	0.000	-6.578	-4.703	***
2013	-5.696	0.480	-11.87	0.000	-6.637	-4.756	***
2014	-5.683	0.483	-11.77	0.000	-6.629	-4.737	***
2015	-5.726	0.488	-11.72	0.000	-6.683	-4.769	***
2016	-5.592	0.490	-11.42	0.000	-6.552	-4.633	***
2017	-5.740	0.490	-11.72	0.000	-6.701	-4.780	***

Mean dependent var	2.555	SD dependent var	1.448
Number of obs	7838	Chi-square	.

The paper calculates the effect of tax preferences on innovation in each year. Results are reported in Table 3-7 and Figure 3-3. The sum of the annual coefficients is 2.6571, which is consistent with the long-term effect of 2.66 calculated above. It can be seen that the effect is maximum in the first year and then decreases year by year. This trend verifies that there is a lag in the incentive effect of tax preferences on innovation, and tax preferences promote long-term firm innovation.

Table 3-7 The coefficients of tax preferences in each period

0	1	2	3	4	5	6	7	8	9	10	sum
0.5960	0.7989	0.7123	0.3106	0.1354	0.0590	0.0257	0.0112	0.0049	0.0021	0.0009	2.6571

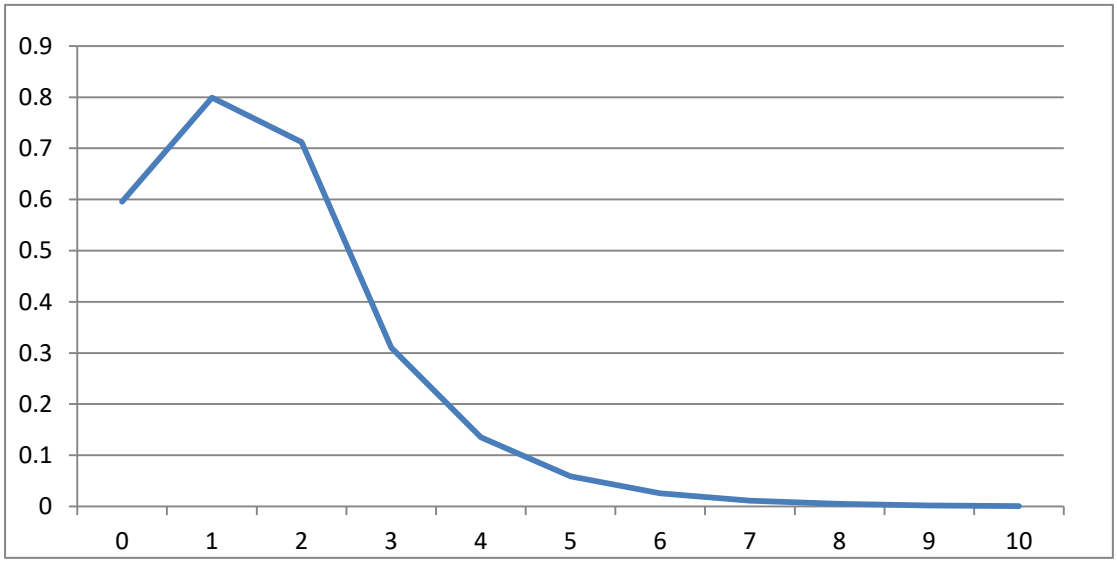


Figure3-3 The long-term effect of tax preference on innovation

3.5 The policy effect of tax preference between different firm groups

3.5.1 Firms with high and low subsidy

To estimate the effect of subsidies in tax preference and innovation, the paper sets the dummy variable highsubsidy and uses the interaction term in the fixed effects model. Divide the samples into two equal parts according to the quantile of the subsidy, the highsubsidy of the group with higher subsidy is set as 1, otherwise it is 0.The critical points of the division is 16.22. The range of the subsidy is 0-24.64. Firms with subsidy between 16.22 and 24.64 are classified as high subsidy firms (highsubsidy=1), while firms with subsidy less than 16.22 are classified as low subsidy firms (highsubsidy=0).

The results show that βof tax preferences (0.304) is significantly positive, which prove the hypothesis. The coefficient β of the interaction term (-0.229) is significantly negative, suggesting that tax preferences for low-subsidized firms are more sensitive to innovation than high-subsidized firms. Compared with the indirect impact of tax preferences on firms, government subsidies are direct funding methods, which are more conducive to firm innovation. If the firm enjoys both tax preferences and government subsidies, the effect of government subsidies is more obvious. The direct funding nature of government subsidies

makes the effect of tax preferences seem relatively weaker. This result validates relevant research (Busom et al. 2014) which finds that subsidies are more suitable for encouraging firms than tax preferences using the bivariate probit model.

Table 3-8 Firms with high and low subsidy

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tax	0.304	0.091	3.34	0.001	0.126	0.482	***
highsubsidy	0.123	0.021	5.84	0.000	0.081	0.164	***
highsubsidy*tax	-0.229	0.119	-1.92	0.055	-0.462	0.005	*
size	0.468	0.021	22.02	0.000	0.427	0.510	***
tobinQ	0.010	0.009	1.13	0.260	-0.007	0.026	
age	0.126	0.057	2.23	0.026	0.015	0.237	**
lev	-0.008	0.077	-0.11	0.913	-0.158	0.142	
2008	0.000	.	.	.	.	.	
2009	0.107	0.039	2.71	0.007	0.030	0.184	***
2010	0.108	0.039	2.78	0.005	0.032	0.185	***
2011	0.286	0.039	7.26	0.000	0.209	0.363	***
2012	0.450	0.042	10.71	0.000	0.367	0.532	***
2013	0.474	0.045	10.52	0.000	0.386	0.562	***
2014	0.508	0.049	10.42	0.000	0.413	0.604	***
2015	0.556	0.054	10.25	0.000	0.450	0.662	***
2016	0.643	0.056	11.41	0.000	0.533	0.754	***
2017	0.576	0.059	9.73	0.000	0.460	0.692	***
Constant	-9.028	0.455	-19.86	0.000	-9.919	-8.137	***

Mean dependent var	2.151	SD dependent var	1.428
R-squared	0.270	Number of obs	15043
F-test	279.061	Prob > F	0.000
Akaike crit. (AIC)	29843.477	Bayesian crit. (BIC)	29972.994

3.5.2 Firms with high and low tobinQ

To estimate the effect of tobinQ in tax preference and innovation, the paper sets the dummy variable hightobinQ and uses the interaction term in the fixed effects model. In line with subsidy, the paper divides the samples into three equal parts according to the quantile of the tobinQ, the hightobinQ of the group with highest tobinQ is set as 1, the hightobinQ of the group with lowest tobinQ is set as 0. The critical points of three equal divisions are 1.42 and 2.11. The range of the variable tobinQ is 0.88-8.36. Firms with tobinQ between 2.11 and 8.36 are classified as high-tobinQ firms (hightobinQ=1), while firms with tobinQ less than 1.42 are classified as low-tobinQ firms (hightobinQ=0). TobinQ equals the quotient of the firm's market value and replacement cost, which represents the firm's investment value.

As shown in Table 3-9, β of the interaction term is 0.090, indicating the positive effect of market value on innovation in tax incentives. The total effect of hightobinQ of 0.097 (0.090+0.007) is positive, indicating that firm value promotes the incentive effect of tax preferences on innovation. In order to have better development potential, high-tobinQ firms will pay more attention to firm innovation than low-tobinQ firms. The possible reason is that hign tobinQ represents high firm value, which is a higher market value relative to book value, indicating better prospects for the company. Innovation is an investment in the future of the firm. Firms that focus on market value will pay more attention to firm innovation and are more sensitive to tax preferences.

Table 3-9 Firms with high and low tobinQ

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tax	0.200	0.066	3.04	0.002	0.071	0.329	***
tobinQ	0.007	0.009	0.79	0.428	-0.010	0.024	
tobinQ*tax	0.090	0.066	1.36	0.175	-0.040	0.220	
subsidy	0.009	0.003	3.01	0.003	0.003	0.015	***
size	0.480	0.021	22.67	0.000	0.439	0.522	***
lev	-0.012	0.077	-0.16	0.876	-0.162	0.138	
age	0.126	0.057	2.23	0.026	0.015	0.238	**
2008	0.000	.	.	.	.	.	
2009	0.100	0.040	2.52	0.012	0.022	0.178	**
2010	0.104	0.039	2.64	0.008	0.027	0.181	***
2011	0.286	0.039	7.25	0.000	0.209	0.363	***
2012	0.453	0.042	10.78	0.000	0.371	0.536	***
2013	0.476	0.045	10.53	0.000	0.387	0.565	***
2014	0.509	0.049	10.39	0.000	0.413	0.604	***
2015	0.555	0.054	10.21	0.000	0.449	0.662	***
2016	0.647	0.057	11.45	0.000	0.536	0.758	***
2017	0.583	0.059	9.84	0.000	0.467	0.699	***
Constant	-9.378	0.449	-20.90	0.000	-10.257	-8.498	***

Mean dependent var	2.151	SD dependent var	1.428
R-squared	0.269	Number of obs	15043
F-test	277.014	Prob > F	0.000
Akaike crit. (AIC)	29873.339	Bayesian crit. (BIC)	30002.856

3.5.3 Firms with high and low leverage

To estimate the effect of leverage in tax preference and innovation, the paper sets the dummy variable highlev and uses the interaction term in the fixed effects model. In line with subsidy, the paper divides the samples into three equal parts according to the quantile of the lev, the highlev of the group with highest lev is set as 1, and the highlev of the group with lowest lev is set as 0. The critical points of three equal divisions are 0.29 and 0.49. The range of the variable lev is 0.01-0.98. Firms with lev between 0.49 and 0.98 are classified as high-lev firms (highlev=1), while firms with lev less than 0.29 are classified as low-lev firms

(highlev=0). Compared with low-lev firms, high-lev firms have more debt and greater financial pressure.

As shown in Table 3-10, β of the interaction term is -0.18, indicating that debt inhibits the incentive effect of tax preferences on innovation. The total effect of highlev is -0.144 (0.036-0.180), verifying the inhibitory effect of debt on innovation. The possible reason is that compared with the indirect fund of tax preferences to firms, high lev firms bear more debts and higher financial risks, and it is difficult to meet the resource support of firm innovation. High debt greatly inhibits the firm's ability to innovate.

Table 3-10 Firms with high and low leverage

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tax	0.256	0.072	3.57	0.000	0.115	0.396	***
highlev	0.036	0.017	2.07	0.039	0.002	0.070	**
highlev*tax	-0.180	0.082	-2.18	0.029	-0.341	-0.018	**
subsidy	0.009	0.003	3.01	0.003	0.003	0.015	***
size	0.472	0.021	22.63	0.000	0.431	0.513	***
tobinQ	0.009	0.009	1.05	0.293	-0.008	0.026	
age	0.123	0.056	2.18	0.030	0.012	0.233	**
2008	0.000	.	.	.	.	.	
2009	0.106	0.039	2.69	0.007	0.029	0.184	***
2010	0.113	0.039	2.89	0.004	0.036	0.189	***
2011	0.293	0.039	7.47	0.000	0.216	0.370	***
2012	0.460	0.042	10.99	0.000	0.378	0.543	***
2013	0.486	0.045	10.82	0.000	0.398	0.574	***
2014	0.521	0.049	10.72	0.000	0.425	0.616	***
2015	0.571	0.054	10.60	0.000	0.465	0.676	***
2016	0.664	0.056	11.87	0.000	0.554	0.774	***
2017	0.599	0.059	10.20	0.000	0.484	0.715	***
Constant	-9.204	0.448	-20.55	0.000	-10.082	-8.326	***

Mean dependent var	2.151	SD dependent var	1.428
R-squared	0.269	Number of obs	15043
F-test	277.404	Prob > F	0.000
Akaike crit. (AIC)	29867.655	Bayesian crit. (BIC)	29997.173

3.5.4 Firms with different ownership

By ownership, the samples divided into state-owned firms and non-state-owned firms. In order to estimate the effect of ownership in tax preference and innovation, the paper sets the dummy variable ownership and uses the interaction term in the model. The ownership of state-owned firms is set to 1, otherwise 0. As shown in Table 3-11, β of the interaction term is -0.205, which is negative, implying the negative effect of ownership in tax preference to encourage innovation. The total effect of ownership is -0.071 (0.134-0.205), indicating the effect of tax preferences of state-owned firms is weaker than non-state-owned firms. It may be due to the "public property" nature, they have a weak enthusiasm for R&D innovations. Since the innovation returns of non-state-owned firms belong to shareholders, the non-state-owned firms are more sensitive to tax preferences.

Table 3-11 Firms with different ownership

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tax	0.297	0.095	3.15	0.002	0.112	0.483	***
ownership	0.134	0.072	1.87	0.062	-0.007	0.275	*
ownership*tax	-0.205	0.129	-1.59	0.111	-0.458	0.047	
subsidy	0.009	0.003	3.00	0.003	0.003	0.015	***
size	0.478	0.021	22.55	0.000	0.436	0.519	***
tobinQ	0.010	0.009	1.15	0.249	-0.007	0.027	
lev	-0.009	0.077	-0.12	0.906	-0.159	0.141	
age	0.128	0.057	2.26	0.024	0.017	0.239	**
2008	0.000	.	.	.	.	.	
2009	0.106	0.040	2.67	0.008	0.028	0.183	***
2010	0.109	0.039	2.79	0.005	0.033	0.186	***
2011	0.290	0.039	7.36	0.000	0.213	0.367	***
2012	0.458	0.042	10.89	0.000	0.375	0.540	***
2013	0.483	0.045	10.70	0.000	0.395	0.571	***
2014	0.517	0.049	10.59	0.000	0.422	0.613	***
2015	0.564	0.054	10.38	0.000	0.457	0.670	***
2016	0.657	0.056	11.64	0.000	0.546	0.767	***
2017	0.592	0.059	9.99	0.000	0.476	0.709	***
Constant	-9.390	0.449	-20.92	0.000	-10.270	-8.510	***
Mean dependent var		2.151	SD dependent var			1.428	
R-squared		0.269	Number of obs			15043	
F-test		260.972	Prob > F			0.000	
Akaike crit. (AIC)		29871.076	Bayesian crit. (BIC)			30008.212	

3.5.5 Firms in different regions

As most firms locate in the east, the samples divided into firms in the east and other regions. In order to estimate the effect of region in tax preference and innovation, the paper sets the dummy variable region and uses the interaction term in the fixed effects model. The region of eastern firms is set to 1, otherwise 0. As shown in Table 3-12, β of the interaction term is 0.301, which is significantly positive, implying the positive effect of region in tax preference to encourage innovation. The total effect of region is 0.62 (0.319+0.301), indicating the effect of tax preferences of eastern firms is stronger than other firms. The possible reason is that eastern firms are more developed and have better financing capabilities to support innovation, innovation can be more easily converted into profits, and the innovation of eastern companies is more sensitive to tax preferences. Notably, the coefficient for tax (0.008) is not significant. In order to verify whether there is an incentive effect in the tax preferences of eastern firms, the paper regresses with the eastern firms. The result of eastern firms is significantly positive, and the tax preferences of eastern companies can promote corporate innovation.

Table 3-12 Firms in different regions

	All firms with area dummy	Only with eastern firms
	invent	invent
tax	0.008	0.288***
	(0.101)	(0.084)
area	0.319***	
	(0.119)	
area*tax	0.301**	
	(0.131)	
subsidy	0.009***	0.013***
	(0.003)	(0.004)
size	0.483***	0.498***
	(0.021)	(0.026)
tobinQ	0.009	0.016
	(0.009)	(0.010)
lev	-0.016	-0.047
	(0.077)	(0.092)
age	0.130**	0.188***
	(0.057)	(0.061)
2008		
2009	0.102***	0.011
	(0.039)	(0.048)
2010	0.107***	0.014
	(0.039)	(0.047)
2011	0.285***	0.154***
	(0.039)	(0.047)
2012	0.453***	0.316***
	(0.042)	(0.050)
2013	0.476***	0.335***
	(0.045)	(0.053)
2014	0.510***	0.358***
	(0.049)	(0.058)
2015	0.555***	0.394***
	(0.054)	(0.064)
2016	0.646***	0.476***
	(0.056)	(0.067)
2017	0.581***	0.414***
	(0.059)	(0.070)
_cons	-9.660***	-9.783***
	(0.460)	(0.546)
Observations	15043	10449
R-squared	0.270	0.264

Standard errors are in parentheses

3.6 Robustness test

In the previous analysis, $tax_{i,t}$ is used as the independent variable. In the section, the paper uses the amount tax preference (Tax) as a proxy variable for tax preference, and uses the FE model for regression to estimate the impact of tax preference on innovation.

$$\text{Tax} = \ln(\text{pretax profit} \times (25\% - \text{effective tax rate}))$$

Compared with tax, Tax is a proxy variable for the amount tax preferences. The regression results are reported in Table 3-13. In the FE model, the coefficient of Tax (0.025) is in line with the previous results and significantly positive, which verifies the hypothesis that tax preferences promote firm innovation. The results of the robustness test using Tax are in line with the previous ones, verifying the effect of tax preferences on innovation.

Table 3-13 The positive effect of Tax on innovation

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Tax	0.025	0.009	2.79	0.005	0.008	0.043	***
subsidy	0.007	0.004	1.84	0.066	-0.000	0.014	*
size	0.464	0.026	17.65	0.000	0.412	0.515	***
tobinQ	0.012	0.009	1.32	0.186	-0.006	0.031	
lev	0.036	0.088	0.41	0.680	-0.136	0.209	
age	0.060	0.061	0.99	0.322	-0.059	0.180	
2008	0.000	.	.	.	.	.	
2009	0.099	0.044	2.27	0.024	0.013	0.185	**
2010	0.122	0.043	2.81	0.005	0.037	0.207	***
2011	0.350	0.044	7.93	0.000	0.263	0.436	***
2012	0.519	0.047	10.92	0.000	0.425	0.612	***
2013	0.548	0.051	10.72	0.000	0.448	0.649	***
2014	0.596	0.055	10.77	0.000	0.488	0.705	***
2015	0.648	0.062	10.45	0.000	0.526	0.769	***
2016	0.749	0.064	11.68	0.000	0.624	0.875	***
2017	0.667	0.067	9.91	0.000	0.535	0.799	***
Constant	-9.184	0.514	-17.87	0.000	-10.191	-8.177	***

Mean dependent var	2.212	SD dependent var	1.417
R-squared	0.282	Number of obs	12472
F-test	252.215	Prob > F	0.000
Akaike crit. (AIC)	24195.211	Bayesian crit. (BIC)	24314.111

3.7 Summary

Recently, China has issued many tax preferential policies to encourage firm innovation. This paper finds that tax preferences promote innovation. Not all firms are eligible for tax preferences. The government's support of tax-advantaged firms sends a positive signal to potential investors, which can ensure firm innovation. Innovation needs a large amount of investment. Firms are prone to respond to sustained and substantial tax preferences. The longer the firms enjoy tax preferences, the stronger the promotion effect of tax preferences. The intensity and persistence of tax preferences significantly affect the innovation of firms. This paper analyzes the diversity from the ownership and region. The effect of the tax preferences is more significant in eastern firms and non-state-owned firms. Finally, the robustness test is carried out by changing the proxy variable (Tax), and the results are in line with the text.

Chapter4 Analysis of the effects of tax preferences on innovation in SMEs and large firms

4.1 Introduction

According to the scale, firms can be divided into SMEs and large firms. In China, the standard of SMEs in different industries is different. The division of SMEs and large firms generally use indicators such as operating income, employees, and total assets. See Table 4-1 for the definition of SMEs.

SMEs are important in the national economy. The number of SMEs accounts for 99% of the total firms. SMEs provide approximately 75% of urban employment opportunities. The total industrial output value of SMEs accounts for 60% of the total. The sales revenue of SMEs accounts for 57% of the total revenue. SME taxation accounts for 50% of total firm taxation.

Notably, the core competitiveness of China's SMEs is relatively weak. There are about 5,000 SMEs in Zhongguancun (Beijing, China), of which 430 have a life span of more than five years, accounting for only 8.6%. The overall life cycle of SMEs is relatively short in China. This paper uses listed firms as a sample. Half of the listed SMEs have a life cycle of less than five years, and the life cycle of a large number of unlisted SMEs will only be shorter.

Although the size of a single SME is small and the strength is weak, its large number makes the overall impact of SMEs on the economy impossible to ignore. As SMEs have received more and more attention recently, the effect of tax preferences on SMEs' innovation has become a topic worthy of further discussion.

Table 4-1 Definition of SMEs

Industry	Large firms	SMEs	unit
Agriculture, forestry, animal husbandry and fishery	Operating income≥200	Operating income<200	million Yuan
Industry	Employees≥1000	Employees<1000	person
	Operating income≥400	Operating income<400	million Yuan
Building industry	Operating income≥800	Operating income<800	million Yuan
	Total assets≥800	Total assets<800	million Yuan
Wholesale industry	Employees≥200	Employees<200	person
	Operating income≥400	Operating income<400	million Yuan
Retail	Employees≥300	Employees<300	person
	Operating income≥200	Operating income<200	million Yuan
Transportation industry	Employees≥1000	Employees<1000	person
	Operating income≥300	Operating income<300	million Yuan
Warehousing industry	Employees≥200	Employees<200	person
	Operating income≥300	Operating income<300	million Yuan
Postal industry	Employees≥1000	Employees<1000	person
	Operating income≥300	Operating income<300	million Yuan
Accommodation Industry	Employees≥300	Employees<300	person
	Operating income≥100	Operating income<100	million Yuan
Catering	Employees≥300	Employees<300	person
	Operating income≥100	Operating income<100	million Yuan
Information Transmission Industry	Employees≥2000	Employees<2000	person
	Operating income≥1000	Operating income<1000	million Yuan
Software and Information Technology Service Industry	Employees≥300	Employees<300	person
	Operating income≥100	Operating income<100	million Yuan
Real estate	Operating	Operating income<2000	million Yuan

development and management	income≥2000		
	Total assets≥100	Total assets<100	million Yuan
Property management	Employees≥1000	Employees<1000	person
	Operating income≥50	Operating income<50	million Yuan
Leasing and business services	Employees≥300	Employees<300	person
	Total assets≥1200	Total assets<1200	million Yuan
Other unspecified industries	Employees≥300	Employees<300	person

Data source: Classification criteria for large, medium, small and micro firms. https://baike.so.com/doc/7009122-7232004.html

4.2 Literature review and research hypothesis

As mentioned above, tax preferences can promote firm innovation. If a detailed analysis is carried out, whether there is a difference in the effect of tax preferences for innovation between SMEs and large firms is worthy of in-depth study.

Large firms can afford to spend a lot more on a large amount of R&D spending; relatively complete internal systems and diversified production and operation methods enable large firms to bear relatively higher risks; these are objective in favor of large firms' innovation conditions(Schumpeter 2013). The relative advantages of large firms are mainly material advantages; while the relative advantages of SMEs are mostly behavioral (Rothwell 1987). This means that SMEs are prone to face material resources and capacity constraints when they are innovating, while large firms are prone to experience behavior constraints. SMEs especially face financing constraints when they innovate (Czarnitzki 2006; Lee et al. 2015; Czarnitzki et al. 2011).

SMEs differ from large firms in terms of financing. Large firms may choose debt financing to ensure that the control of firm ownership isn't weakened (Hamilton and Fox 1998). It is difficult for SMEs to obtain external financing (Freel 2007; Hutton and Lee 2012; Manso 2011; Mason and Brown 2013). Only 10% of SMEs can obtain bank loans (Kanamori et al. 2007). Venture capital may be important for SMEs, but even venture capital is prone to

invest in large firms (Landstrom 1990). Internal financing is important for R&D spending (Himmelberg and Petersen 1994; Gomes et al. 2006; Garc á-Quevedo et al. 2018). The reason lies that the operating risk and external financing capital cost are too high, and it is difficult to find external investors. On the one hand, innovation is riskier than physical investment, and investors need to pay higher external capital costs for innovation. On the other hand, innovators are unwilling to share their innovation information with external investors. It is expensive to provide convincing signals about the quality of innovation projects (Bhattacharya and Ritter 1983). The information asymmetry is not conducive to external financing of innovation (Berger and Udell 1995; Saito and Villanueva 1981). In short, firms prefer internal financing rather than external financing because of differences between the capital costs.

Financing constraints inhibited the innovation motivation of SMEs. For the innovation activities that have already started, the lack of funds will directly reduce the success rate of SME innovation. With the expansion of innovation, financial constraints will become an important constraint for large firms.

There are differences in the sensitivity of SMEs and large firms to tax preferences. Innovation requires a large amount of resources to support. Large firms have a relatively large tax base and can obtain more tax preferences, and the reduced capital outflow can play a more positive role in stimulating innovation investment. SMEs are deeply troubled by financing constraints, and the total amount of tax preferences obtained is smaller than that of large firms, which may not be enough to support firm innovation investment, and the incentive effect on innovation may not be as effective as large firms. The following hypothesis is proposed.

Hypothesis: The incentive effect of SMEs' tax preferences on innovation is weaker than that of large firms.

4.3 Data source and variable definition

4.3.1 Data source

This paper selects 2008-2017 A-share listed firms as samples. The samples started in 2008 due to the new corporate income tax law of China. In 2008, the benchmark tax rate of corporate income tax changed from 33% to 25%. The samples ended in 2017 due to the statistics of patent data ends in 2017. The data of this paper is from the CSMAR database, and 15043 samples left.

Table 4-2 The distribution of SMEs and large firms

	Large firms	Proportion	SMEs	Proportion
Non-state-owned firms	8114	60.64%	1453	87.37%
State-owned firms	5266	39.36%	210	12.63%
Eastern region	9284	69.39%	1165	70.05%
Central region	1940	14.50%	213	12.81%
Western region	1643	12.28%	219	13.17%
Northeastern region	513	3.83%	66	3.97%

4.3.2 Variable definition

Dependent variable: innovation. Following the literature (Aghion et al. 2018; Chen and Yang 2019), this paper adopts the invention application to measure the innovation. The calculation method is the logarithm of the invention application plus 1.

$$\text{Innovation} = \ln(\text{invention application} + 1)$$

Independent variable: tax preference. Following the literature (Li and Zheng 2016), the paper uses the effective tax rate to measure the corporate tax burden.

$$\text{tax preference} = 25\% - \text{effective tax rate}$$

As used in Chapter3, this paper selects government subsidy, firm scale, firm value, leverage, established time as control variables.

4.3.3 Descriptive statistics

The paper makes descriptive statistics for large firms and SMEs. The mean value of invent for large firms is 2.241, far exceeding the 1.43 for SMEs. The tax for large firms is 0.074, which is less than 0.101 for SMEs. SMEs enjoy more tax preference, but innovation is less than large firms, which preliminarily proves that the positive effect of tax preferences for SMEs on innovation is weaker than that of large firms.

Table 4-3 Descriptive statistics of large firms

Variable	Obs	Mean	Std. Dev.	Min	Max
invent	13380	2.241	1.450	0	9.108
tax	13380	0.074	0.121	-0.462	0.504
subsidy	13380	16.104	2.811	0	24.642
size	13380	22.222	1.280	19.156	28.509
tobinQ	13380	2.017	1.150	0.881	8.366
lev	13380	0.428	0.198	0.007	1.616
age	13380	2.626	0.442	0	3.912

Table 4-4 Descriptive statistics of SMEs

Variable	Obs	Mean	Std. Dev.	Min	Max
invent	1663	1.430	0.980	0	5.268
tax	1663	0.101	0.109	-0.462	0.504
subsidy	1663	14.706	2.882	0	20.224
size	1663	20.556	0.585	18.008	23.83
tobinQ	1663	2.571	1.531	0.965	8.366
lev	1663	0.223	0.175	0.011	1.806
age	1663	2.448	0.519	0	3.584

In the Table 4-5, the distribution of the life cycle of large firms and SMEs is very different. The life cycle of large firms is very evenly distributed. The life cycle of SMEs is concentrated in less than ten years. In the sample, 48.49% of SMEs have been established for less than five years, accounting for about half of the proportion; 74.17% (48.49%+25.68%) of SMEs have been established for less than ten years. This paper uses listed firms as samples. The listed SMEs are China's most powerful SMEs. The life cycle of a large number of

unlisted SMEs will only be shorter.

Table 4-5 The distribution of life cycle of large firms and SMEs

Life cycle	Large firms	Propotion	SMEs	Propotion
Less than 5years	2182	16.40%	810	48.49%
6-10 years	2567	19.29%	425	25.68%
11-15 years	2812	21.13%	181	10.69%
16-20 years	2888	21.70%	104	6.28%
More than 21 years	2857	21.47%	135	8.16%
Total	13306	100%	1655	100.00%

The paper has carried out sample descriptive statistics in terms of firm distribution, average tax rate and innovation. As shown in Table 4-6, from 2008 to 2017, the number of large firms account for the majority of firms. The largest proportion of large firms enjoying tax preferences is 85.42%, and the smallest is 80.28%. The largest proportion of SMEs enjoying tax preferences is 93.61%, and the smallest is 86.18%. This shows that the proportion of SMEs enjoying tax preferences is greater than large firms.

Table 4-6 Tax preference and distribution of firms

	Large firms with tax preferences	Total number of large firms	SMEs with tax preferences	Total number of SMEs	Firms with tax preferences	Total number of firms
2008	81.17%	616	90.12%	81	82.21%	697
2009	82.01%	745	89.09%	110	82.92%	855
2010	85.42%	967	96.02%	176	87.05%	1143
2011	84.24%	1231	93.61%	219	85.66%	1450
2012	80.28%	1303	91.40%	221	81.89%	1524
2013	80.30%	1411	90.53%	169	81.39%	1580
2014	81.15%	1464	91.22%	148	82.07%	1612
2015	80.90%	1576	86.18%	152	81.37%	1728
2016	80.61%	1857	88.71%	186	81.35%	2043
2017	83.67%	2210	89.05%	201	84.11%	2411

As shown below, the average tax preferences for large firms with tax preferences each year is slightly lower than that of SMEs. In order to compare the substantial difference in tax rates between firms with tax preferences and firms without tax preferences, Table 4-7 reports the tax rates for comparison. From 2008 to 2017, the average tax rate of large firms with tax preferences ranged from 11.19% to 14.28%, and the average tax rate of large firms without

tax preferences ranged from 32.86% to 36.91%. From 2008 to 2017, the average tax rate for SMEs with tax preferences ranges from 10.41% to 13.53%, and the average tax rate for SMEs without tax preferences ranges from 33.21% to 42.53%. The average tax rate of SMEs with tax preferences is relatively lower than large firms. The intensity of tax preferences for SMEs is relatively greater.

As shown in Table 4-8, tax preferences promote firm innovation. From 2008 to 2017, the innovation of large firms with tax preferences ranged from 1.74 to 2.60, and the innovation of large firms without tax preferences ranged from 1.34 to 2.14. From 2008 to 2017, the SMEs' innovation with tax preferences ranged from 1.09 to 1.62, and the SMEs' innovation without tax preferences ranged from 0.61 to 1.56. Among SMEs and large firms, the innovation of firms with tax preferences is much higher than that of firms without tax preferences.

Table 4-7 The average tax preferences and tax rate of SMEs and large firms

	The average tax preferences of large firms with tax preferences	The average tax rate of large firms with tax preferences	The average tax rate of large firms without tax preferences	The average tax preferences of SMEs with tax preferences	The average tax rate of SMEs with tax preferences	The average tax rate of SMEs without tax preferences
2008	13.81%	11.19%	36.08%	14.59%	10.41%	42.53%
2009	12.04%	12.96%	34.25%	11.47%	13.53%	39.49%
2010	11.14%	13.86%	32.86%	12.45%	12.55%	33.21%
2011	10.72%	14.28%	34.57%	11.52%	13.48%	34.89%
2012	10.82%	14.18%	36.08%	11.81%	13.19%	38.91%
2013	10.92%	14.08%	37.62%	13.70%	11.30%	39.11%
2014	11.56%	13.44%	35.09%	12.66%	12.34%	36.92%
2015	11.70%	13.30%	36.00%	13.85%	11.15%	39.00%
2016	11.18%	13.82%	36.91%	12.47%	12.53%	37.68%
2017	11.41%	13.59%	35.32%	12.53%	12.47%	43.01%

Table 4-8 Tax preferences and the innovations of SMEs and large firms

	The innovations of large firms without tax preferences	The innovations of large firms with tax preferences	The innovations of SMEs without tax preferences	The innovations of SMEs with tax preferences
2008	1.34	1.74	0.92	1.14
2009	1.48	1.93	0.61	1.09
2010	1.55	1.94	1.27	1.21
2011	1.56	2.09	0.69	1.41
2012	1.72	2.31	1.05	1.52
2013	1.95	2.33	1.24	1.62
2014	2.09	2.43	1.33	1.54
2015	2.03	2.49	1.35	1.59
2016	2.1	2.6	1.56	1.6
2017	2.14	2.47	1.43	1.47

4.4 Empirical tests between tax preferences and innovation in SMEs and large firms

4.4.1 The test of tax preferences on innovation in SMEs and large firms

To prove that tax preferences effectively promote innovation, the following FE model is used.

$$invent_{i,t} = \beta_0 + \beta_1 tax_{i,t} + \beta_2 subsidy_{i,t} + \beta_3 size_{i,t} + \beta_4 tobinQ_{i,t} + \beta_5 lev_{i,t} + \beta_6 age_{i,t} + \mu_i + \gamma_t + \varepsilon_{it}$$

For comparison, the paper performs regression analysis on large firms, SMEs and all firms separately. The variable tax represents the intensity of tax preferences and the variable invent represents firm innovation. As shown in Table 4-9, β_1 of large firms (0.169) and all firms (0.187) are both significantly positive, which implies that tax preferences promote firm innovation. Notably, β_1 of SMEs (0.354) is not significant; the possible reason is the effect of tax preferences on innovation is inhibited by the financial constraints. The results of FE models show that tax preferences are more effective on innovation in large firms than SMEs. The conclusion is in line with the existing study(Chen and Yang 2019), which uses the PSM-DID model and finds that the R&D tax credit only significantly promotes innovation in manufacturing companies and large firms.

Table 4-9 Empirical results of firms with different sizes

	Large firms	SMEs	All firms
	invent	invent	invent
tax	0.169**	0.354	0.187***
	(0.072)	(0.286)	(0.068)
subsidy	0.008**	0.020*	0.009***
	(0.004)	(0.011)	(0.003)
size	0.507***	0.555***	0.480***
	(0.042)	(0.168)	(0.037)
tobinQ	0.007	0.064**	0.009
	(0.012)	(0.025)	(0.011)
lev	-0.006	-0.602	-0.008
	(0.119)	(0.399)	(0.107)
age	0.103	0.279	0.128
	(0.083)	(0.296)	(0.078)
2008			
2009	0.136***	-0.125	0.104***
	(0.041)	(0.151)	(0.039)
2010	0.112**	-0.044	0.109**
	(0.048)	(0.174)	(0.045)
2011	0.303***	0.099	0.288***
	(0.052)	(0.196)	(0.050)
2012	0.481***	0.188	0.455***
	(0.057)	(0.213)	(0.054)
2013	0.498***	0.233	0.480***
	(0.064)	(0.235)	(0.061)
2014	0.544***	0.124	0.514***
	(0.071)	(0.269)	(0.068)
2015	0.586***	0.094	0.561***
	(0.080)	(0.290)	(0.077)
2016	0.683***	0.082	0.652***
	(0.083)	(0.307)	(0.079)
2017	0.605***	0.040	0.587***
	(0.089)	(0.320)	(0.084)
_cons	-9.887***	-11.094***	-9.354***
	(0.896)	(3.283)	(0.784)
Observations	12852	1367	14512
R-squared	0.794	0.649	0.784

Standard errors are in parentheses

4.4.2 The test of sustained tax preferences on innovation in SMEs and large firms

The 3.4.2 in Chapter 3 analyzes the incentive effect of sustained tax preferences on innovation. In this section, SUS is used to represent sustained tax preference, and the effect of sustained tax preferences on innovation of large firms and SMEs is analyzed.

SUS is set to represent the sustained tax preference as suggested by Li and Zheng (2016). If the effective tax rate is lower than 25%, it means the firm has enjoyed tax preferences. In the first year the firm receive tax preferences, SUS will record as 1, and in the second year, it will record as 2, and so on. Otherwise, if there is no tax preferences for the firm, SUS will record as 0. If a firm breaks off the tax preferences and enjoys it again, SUS starts at 1.

As shown in Table 4-10, SUS=0 means that the firm has not received tax preferences. The paper should focus on the distribution of SUS>0. As shown in Table 4-8, the distribution of SUS is uneven. Firms mainly focus on SUS $\leq$3. The proportion of firms with tax preferences for three consecutive years is 51.15% (23.50%+15.93%+11.73%). The proportion of large firms with tax preferences for three consecutive years is 48.21% (21.70%+15.00%+11.50%). The proportion of SMEs with tax preferences for three consecutive years is 74.86% (37.94%+23.39%+13.53%). This implies that compared with large firms, SMEs lack continuous tax preferences. Nearly 75% of SMEs enjoy tax preferences for less than or equal to three years, and the same proportion of large firms enjoy tax preferences for less than seven years(21.70%+15.00%+11.50%+9.19%+7.17%+5.77%+4.58%≈75%). This implies that compared with large firms, SMEs enjoy tax preferences for a shorter duration.

Table 4-10 Distribution of SUS in SMEs and large firms

SUS	Large firms	Percent	SMEs	Percent	Total	Percent
0	2418	18.07%	153	9.20%	2571	17.09%
1	2904	21.70%	631	37.94%	3535	23.50%
2	2007	15.00%	389	23.39%	2396	15.93%
3	1539	11.50%	225	13.53%	1764	11.73%
4	1229	9.19%	118	7.10%	1347	8.95%
5	960	7.17%	74	4.45%	1034	6.87%
6	772	5.77%	44	2.65%	816	5.42%
7	613	4.58%	16	0.96%	629	4.18%
8	450	3.36%	9	0.54%	459	3.05%
9	285	2.13%	3	0.18%	288	1.91%
10	203	1.52%	1	0.06%	204	1.36%
	13380	100.00%	1663	100.00%	15043	100.00%

Note: SUS=10 means the firm gets a tax preference for 10 consecutive years. The data field selected in this paper is from 2008 to 2017. SUS=10 is the maximum consecutive tax preference available for this paper.

For large firms and SMEs, sustained tax preferences are conducive to promoting firm innovation. If the firm enjoys strong and sustained tax incentives, it means that the firm continues to receive indirect funding to innovate, indicating that the industry is strongly supported by the government and has good development prospects. It is necessary for firms to increase investment in innovation. Sustained tax preferences promote firm innovation. The results of large firms, SMEs and all firms list in Table 4-11. The coefficient β of sustained tax preference on innovation for large firms are significantly positive. Notably, the coefficient of sustained tax preferences for SMEs is not significant. The possible reason is that SMEs have short life span and lack continuous tax preferences. According to relevant statistics, the life cycle of SMEs in China is about 3 years. The sample of this paper is listed SMEs, and their financial status is better than most unlisted SMEs. However, the SUS of 75% of the sample SMEs listed in Table 4-10 is still less than 3. The incentive impact of tax preferences for large firms on innovation is much stronger than that for SMEs. The empirical results verify the hypothesis. This conclusion is in line with Li and Zheng (2016) , which calculates SUS using

effective and nominal tax rates respectively, and estimates the impact of SUS on firm innovation

Table 4-11 The impact of sustained tax preferences on innovation in SMEs and large firms

	Large firms invent	SMEs invent
SUS	0.020***	0.013
	(0.006)	(0.021)
subsidy	0.008**	0.021*
	(0.004)	(0.011)
size	0.490***	0.558***
	(0.043)	(0.166)
tobinQ	0.003	0.062**
	(0.012)	(0.025)
lev	0.010	-0.658
	(0.118)	(0.401)
age	0.094	0.267
	(0.081)	(0.293)
2008		
2009	0.128***	-0.138
	(0.041)	(0.150)
2010	0.097**	-0.056
	(0.048)	(0.173)
2011	0.277***	0.075
	(0.052)	(0.191)
2012	0.448***	0.158
	(0.057)	(0.208)
2013	0.459***	0.201
	(0.064)	(0.231)
2014	0.503***	0.084
	(0.071)	(0.263)
2015	0.545***	0.060
	(0.080)	(0.283)
2016	0.638***	0.039
	(0.083)	(0.299)
2017	0.554***	-0.015
	(0.089)	(0.310)
_cons	-9.500***	-11.084***
	(0.897)	(3.262)
Observations	12852	1367
R-squared	0.794	0.648

Standard errors are in parentheses

4.5 The policy effect of tax preference between different firm groups

4.5.1 Firms with different ownership and sizes

By ownership, the samples divided into state-owned firms and non-state-owned firms. The distribution of SMEs and large firms is the same, and most of them are non-state-owned firms. The proportion of state-owned SMEs is small, only 12.63% (210/1663). The proportion of state-owned firms in large firms accounted for 39.36% (5266/13380).

Table 4-12 The firm distribution according to ownership

	Large firms	SMEs	Total
Non-state-owned firms	8114	1453	9576
State-owned firms	5266	210	5476
Total	13380	1663	15043

To estimate the effect of ownership in tax preference and innovation of large firms and SMEs, the paper sets the dummy variable ownership and SME, and uses the interaction terms in the fixed effects model. The ownership of state-owned firms is set to 1, otherwise 0. SME is set to 1 if the sample is an SME, otherwise 0.

As shown in Table 4-13, β of the interaction term ownership*SME is -0.26, implying the negative effect of ownership in tax preference to encourage innovation. The effect of tax preferences of state-owned firms is weaker than non-state-owned firms. It may be due to the "public property" nature, they have a weak enthusiasm for R&D innovations. Since the innovation returns of non-state-owned firms belong to shareholders, the non-state-owned firms are more sensitive to tax preferences. B of the interaction term ownership*SME*tax is 1.136, which is significantly positive. It shows that the tax preferences for state-owned SMEs can effectively promote firm innovation.

Table 4-13 Firms with different ownership and sizes (interaction term)

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tax	0.324	0.102	3.19	0.001	0.125	0.523	***
ownership	0.146	0.072	2.02	0.043	0.004	0.289	**
SME	0.079	0.045	1.77	0.077	-0.009	0.166	*
tax *ownership	-0.260	0.135	-1.92	0.055	-0.525	0.005	*
tax*SME	-0.179	0.252	-0.71	0.477	-0.673	0.315	
ownership*SME	-0.137	0.104	-1.31	0.189	-0.342	0.068	
tax*ownership*SME	1.136	0.535	2.12	0.034	0.087	2.184	**
subsidy	0.009	0.003	3.01	0.003	0.003	0.015	***
size	0.485	0.022	22.49	0.000	0.443	0.527	***
tobinQ	0.011	0.009	1.33	0.185	-0.005	0.028	
lev	0.001	0.077	0.01	0.993	-0.150	0.152	
age	0.133	0.057	2.35	0.019	0.022	0.244	**
2008	0.000	.	.	.	.	.	
2009	0.103	0.040	2.59	0.009	0.025	0.180	***
2010	0.104	0.039	2.66	0.008	0.027	0.181	***
2011	0.286	0.040	7.24	0.000	0.209	0.364	***
2012	0.454	0.042	10.76	0.000	0.371	0.536	***
2013	0.479	0.045	10.59	0.000	0.390	0.568	***
2014	0.513	0.049	10.47	0.000	0.417	0.609	***
2015	0.557	0.054	10.22	0.000	0.450	0.664	***
2016	0.650	0.057	11.49	0.000	0.539	0.761	***
2017	0.586	0.059	9.86	0.000	0.469	0.702	***
Constant	-9.569	0.460	-20.80	0.000	-10.471	-8.667	***

Mean dependent var	2.151	SD dependent var	1.428
R-squared	0.270	Number of obs	15043
F-test	211.679	Prob > F	0.000
Akaike crit. (AIC)	29869.762	Bayesian crit. (BIC)	30037.373

The paper further analyzes the impact of tax preferences on innovation for firms of different ownerships and sizes. There are four tax-related items in Table 4-14, including tax, tax*ownership, tax*SME, and tax*ownership*SME. The ownership of state-owned firms is 1, the ownership of non-state-owned firms is 0, the SME of SMEs is 1, and the SME of large firms is 0. Table 4-14 can be obtained by substituting the relevant values in. By comparing the

coefficients of tax preferences for firms with different ownership and sizes, it can be seen that the positive effect of tax preferences on innovation is strongest for state-owned SMEs, followed by non-state-owned large firms, third is state-owned large firms, and finally non-state-owned SMEs.

Table 4-14 Results of firms with different ownership and sizes

	State-owned firms	Non state-owned firms
SMEs	0.324-0.26-0.179+1.136=1.021	0.324-0.179=0.145
large firms	0.324-0.26=0.064	0.324

According to the above analysis, the tax preferences of non-state-owned firms are more sensitive to innovation than state-owned firms, and the tax preferences of large firms are more sensitive to innovation than SMEs. Large non-state-owned firms > large state-owned firms > non-state-owned SMEs, this order is reasonable. The key is that the tax preferences enjoyed by state-owned SMEs have the strongest incentive effect on innovation. The paper further verifies this conclusion by grouping regression in Table 4-15. The coefficient of tax preference for state-owned SMEs is 1.393, followed by non-state-owned large firms (0.322), both of which are significantly positive. The coefficients of large state-owned firms and non-state-owned SMEs are not significant. The excellent performance of state-owned SMEs may be due to the fact that SMEs have greater development capabilities and pay more attention to firm innovation, and state-owned SMEs have relatively strong financing capabilities. Innovation power and financial support have achieved breakthroughs in state-owned SMEs. The effectiveness of tax preferences for state-owned SMEs needs to be verified by more research in the future.

Table 4-15 Firms with different ownership and sizes

	State-owned firms		Non-state-owned firms	
	Large firms invent	SMEs invent	Large firms invent	SMEs invent
tax	0.071	1.393**	0.322***	0.084
	(0.093)	(0.656)	(0.116)	(0.297)
subsidy	0.006	0.006	0.010*	0.028**
	(0.005)	(0.018)	(0.006)	(0.013)
size	0.530***	1.323**	0.502***	0.443***
	(0.078)	(0.610)	(0.051)	(0.146)
tobinQ	-0.012	0.093**	0.025	0.064**
	(0.022)	(0.046)	(0.015)	(0.029)
lev	-0.237	-1.840*	0.075	-0.366
	(0.227)	(1.025)	(0.135)	(0.377)
age	0.125	0.390	0.148	0.231
	(0.102)	(1.936)	(0.129)	(0.301)
2008				
2009	0.190***	-0.135	0.060	-0.136
	(0.053)	(0.299)	(0.067)	(0.168)
2010	0.211***	-0.097	-0.059	-0.045
	(0.065)	(0.432)	(0.075)	(0.183)
2011	0.374***	-0.172	0.158*	0.129
	(0.071)	(0.560)	(0.081)	(0.207)
2012	0.520***	0.004	0.350***	0.224
	(0.078)	(0.650)	(0.087)	(0.233)
2013	0.603***	0.000	0.308***	0.282
	(0.090)	(0.808)	(0.097)	(0.258)
2014	0.627***	-0.249	0.363***	0.197
	(0.101)	(0.892)	(0.106)	(0.302)
2015	0.642***	-0.412	0.392***	0.181
	(0.114)	(1.024)	(0.120)	(0.326)
2016	0.751***	-0.781	0.483***	0.216
	(0.113)	(1.168)	(0.128)	(0.346)
2017	0.716***	-0.512	0.379***	0.145
	(0.124)	(1.264)	(0.136)	(0.359)
_cons	-10.486***	-26.653**	-9.763***	-8.858***
	(1.704)	(11.965)	(1.069)	(2.864)
Observations	5150	168	7670	1195
R-squared	0.836	0.768	0.756	0.637

Standard errors are in parentheses

4.5.2 Firms with different regions and sizes

China divides the country into the eastern, central, western and northeastern regions. As shown in Table 4-16, the regional distribution of SMEs and large firms is uniform. The vast majority of firms are located in the east, with the fewest in the northeast.

Table 4-16 The firm distribution according to region

	Large firms	SMEs	Total
Eastern region	9284	1165	10449
Central region	1940	213	2153
Western region	1643	219	1862
Northeastern region	513	66	579
Total	13380	1663	15043

As shown in Table 4-17, firms are further classified by size and region. In general, tax preferences for firms in the east are more conducive to innovation, in line with the existing results (Liu et al. 2019; Shao and Xiao 2019). The possible reason is the eastern economy more developed. For innovation is easier to turn into the profitability, firms have stronger desire for R&D. Among the eastern region, the results of large firms and the full sample are significantly positive, which verifies the incentive effect of tax preferences on innovation. Notably, even in the eastern region, the coefficient of tax incentives for SMEs is not significant, preliminary indicating that the region has little impact on SMEs.

Table 4-17 Firms with different regions and sizes

	East region			Other regions		
	Large firms	SMEs	All firms	Large firms	SMEs	All firms
	invent	invent	invent	invent	invent	invent
tax	0.261***	0.345	0.288***	0.084	0.524	0.086
	(0.096)	(0.334)	(0.090)	(0.109)	(0.503)	(0.105)
subsidy	0.011**	0.026*	0.013***	-0.000	0.011	0.001
	(0.005)	(0.013)	(0.004)	(0.007)	(0.018)	(0.006)
size	0.497***	0.770***	0.498***	0.544***	0.154	0.489***
	(0.053)	(0.211)	(0.047)	(0.073)	(0.260)	(0.064)
tobinQ	0.017	0.064**	0.016	-0.008	0.071	-0.002
	(0.014)	(0.031)	(0.012)	(0.023)	(0.045)	(0.020)
lev	-0.013	-0.597	-0.047	-0.025	-0.258	-0.027
	(0.145)	(0.479)	(0.132)	(0.215)	(0.749)	(0.188)
age	0.167*	0.352	0.188**	-0.064	0.123	-0.041
	(0.091)	(0.352)	(0.088)	(0.215)	(0.405)	(0.172)
_cons	-9.381***	-15.607***	-9.469***	-9.822***	-2.470	-8.691***
	(1.148)	(4.184)	(1.025)	(1.663)	(5.593)	(1.399)
Observations	8892	955	10043	3948	411	4453
R-squared	0.811	0.645	0.800	0.752	0.665	0.745

Standard errors are in parentheses

4.6 Further research

Tax preference is more effective on innovation of large firms than SMEs. For SMEs, due to severe financing constraints, the effect of tax preferences is inferior to government subsidies. The paper further analyzes the positive effect of subsidies on SMEs' innovation from three aspects. First, the paper conducts the analysis of the positive effects of patent subsidies, other subsidies and government subsidies on firm innovation. Three kinds of subsidies can significantly stimulate firm innovation. Second, the paper analyzes the effect of the subsidy on the tax preferences and innovation. Third, the paper further compares the impact of subsidies between SMEs and large firms on innovation.

4.6.1 The results of different subsidies in SMEs and large firms

Government subsidies can be further subdivided into R&D subsidies and other subsidies. The paper conducts regression analysis on government subsidies (subsidy), R&D subsidies (RDsubsidy) and other subsidies (othersubsidy). As shown in Table 4-18, the coefficients of tax preferences for large firms are all significantly positive, while the coefficients for SMEs are not significant. Tax preferences for large firms are more sensitive to innovation than SMEs. Compared with tax preferences, subsidies for SMEs can promote firm innovation. The coefficients of subsidy and othersubsidy are both significant. The possible reason is that no matter what kind of subsidy, it can alleviate the financial pressure of firms. R&D subsidies directly alleviate the financial pressure on firms for patent research; the investment of other subsidies reduces the overall financial pressure on firms, thus indirectly reducing the burden on firms for innovation research.

Table 4-18 The results of different subsidies in SMEs and large firms

	Large firms			SMEs		
	invent	invent	invent	invent	invent	invent
tax	0.169**	0.173**	0.169**	0.354	0.347	0.352
	(0.072)	(0.072)	(0.072)	(0.286)	(0.290)	(0.288)
subsidy	0.008**			0.020*		
	(0.004)			(0.011)		
RDsubsidy		0.004**			0.009	
		(0.002)			(0.006)	
othersubsidy			0.003			0.010**
			(0.002)			(0.005)
size	0.507***	0.511***	0.511***	0.555***	0.564***	0.557***
	(0.042)	(0.042)	(0.042)	(0.168)	(0.163)	(0.167)
tobinQ	0.007	0.006	0.007	0.064**	0.061**	0.062**
	(0.012)	(0.012)	(0.012)	(0.025)	(0.025)	(0.025)
lev	-0.006	-0.006	-0.006	-0.602	-0.567	-0.557
	(0.119)	(0.119)	(0.119)	(0.399)	(0.393)	(0.399)
age	0.103	0.109	0.109	0.279	0.235	0.264
	(0.083)	(0.083)	(0.083)	(0.296)	(0.296)	(0.296)
_cons	-9.425***	-9.452***	-9.449***	-11.006***	-10.894***	-10.831***
	(0.929)	(0.927)	(0.927)	(3.334)	(3.269)	(3.347)
Observations	12852	12852	12852	1367	1367	1367
R-squared	0.794	0.794	0.794	0.649	0.649	0.649

Standard errors are in parentheses

4.6.2 The effect of subsidies on sustained tax preferences

In the previous section, SUS was set as a proxy variable for sustained tax preferences. This section sets the dummy variable sus and use the interaction term in the FE model to further analyze the effect of subsidies on tax preferences. When SUS> 2, which implies firms have received tax preferences for more than two consecutive years, sus is set to 1, otherwise sus is set to 0. The results are reported in Table 4-19. B of interaction terms is significantly positive, suggesting that subsidy has a significant effect on sustained tax preferences and innovation. Government subsidies boost the incentive effect of persistent tax preferences on innovation.

Table 4-19 The effect of subsidies on sustained tax preferences

invent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
sus	0.040	0.020	2.04	0.041	0.002	0.079	**
subsidy	0.002	0.004	0.50	0.614	-0.006	0.011	
sus*subsidy	0.018	0.006	2.96	0.003	0.006	0.029	***
size	0.472	0.037	12.62	0.000	0.399	0.546	***
tobinQ	0.008	0.011	0.75	0.454	-0.013	0.029	
lev	-0.017	0.107	-0.16	0.874	-0.226	0.193	
age	0.116	0.077	1.50	0.134	-0.036	0.267	
2008	0.000	.	.	.	.	.	
2009	0.110	0.039	2.80	0.005	0.033	0.186	***
2010	0.100	0.046	2.18	0.029	0.010	0.189	**
2011	0.275	0.050	5.51	0.000	0.177	0.373	***
2012	0.440	0.055	8.05	0.000	0.333	0.548	***
2013	0.465	0.061	7.61	0.000	0.345	0.585	***
2014	0.502	0.068	7.43	0.000	0.369	0.634	***
2015	0.553	0.076	7.24	0.000	0.403	0.702	***
2016	0.645	0.079	8.17	0.000	0.490	0.799	***
2017	0.581	0.084	6.90	0.000	0.416	0.746	***
Constant	-9.055	0.784	-11.55	0.000	-10.592	-7.518	***

Mean dependent var	2.151	SD dependent var	1.428
R-squared	0.269	Number of obs	15043
F-test	103.865	Prob > F	0.000
Akaike crit. (AIC)	29861.979	Bayesian crit. (BIC)	29983.878

4.6.3 The effect of subsidies on tax preferences in SMEs and large firms

Based on the previous section, this section makes a further analysis of the effect of subsidy between SMEs and large firms. This paper expects that β of the interaction terms is positive significantly, which implies the effect of subsidy on tax preference and innovation. As shown in Table 4-20, the effect of large firms is significant, implying that subsidies received by large firms are conducive to the incentive effect of sustained tax incentives on innovation. Notably, β of the interaction term for SMEs is not significant, which verifies that subsidies for SMEs have little impact on tax preferences and innovation. There is a clear difference in the effect of tax preferences for SMEs and large firms.

Table 4-20 The effect of subsidies on sustained tax preferences in SMEs and large firms

	Large firms invent	SMEs invent	All firms invent
sus	0.049**	0.025	0.040**
	(0.021)	(0.068)	(0.020)
subsidy	0.001	0.017	0.002
	(0.005)	(0.013)	(0.004)
sus*subsidy	0.016**	0.011	0.018***
	(0.006)	(0.017)	(0.006)
size	0.496***	0.560***	0.472***
	(0.042)	(0.167)	(0.037)
tobinQ	0.004	0.064**	0.008
	(0.012)	(0.025)	(0.011)
lev	-0.007	-0.662*	-0.017
	(0.118)	(0.400)	(0.107)
age	0.088	0.282	0.116
	(0.082)	(0.295)	(0.077)
_cons	-9.056***	-11.012***	-8.610***
	(0.929)	(3.331)	(0.815)
Observations	12852	1367	14512
R-squared	0.794	0.648	0.784

Standard errors are in parentheses

4.7 Robustness test

Patents include invention, appearance design, and utility model. The invention is more difficult than utility model and appearance design. The invention needs to examine the practicability, novelty and non obviousness, while the utility model and design only needs to go through the formal examination (Shao and Xiao 2019). As a result, the number of utility models and appearance designs far exceeds inventions. In 2018, invention accounted for 17.7% of all patents, and utility models accounted for 60.40% in China. Invention correlates with social productivity and belong to high-tech innovation. Compared with the design and utility model, invention can better reflect the substantive technological progress of firms. The paper adopts invention as a proxy variable of firm innovation. For comparison, this section uses patents, inventions, utility models, and appearance designs as proxy variables for innovation to regress. The results of patent, invent, and utility of large firms are all significantly positive, which verifies the incentive effect of tax preferences on innovation. Only patent is significant for SMEs. The results of large firms and SMEs once again verify that the tax incentives of large firms are more sensitive to innovation. The results are in line with the previous, indicating that even if the proxy variables are replaced, the results are still robust.

4.8 Summary

This part analyzes the difference between SMEs and large firms in the effectiveness of tax preference on innovation. The impact of tax preferences on firm innovation and the impact of sustained tax preferences indicate that tax preferences are more effective for innovation in large firms than in SMEs. The paper further analyzes the effects of tax preferences on innovation for SMEs and large firms of different ownership and regions, and the results verify the above conclusions.

Table4-21 The effect of tax preference on four kinds of innovation

	Large firms				SMEs			
	patent	invent	utility	design	patent	invent	utility	design
tax	0.157**	0.169**	0.151*	0.099	0.560**	0.354	0.380	0.097
	(0.072)	(0.072)	(0.081)	(0.068)	(0.235)	(0.286)	(0.256)	(0.209)
subsidy	0.008**	0.008**	0.007*	0.003	-0.005	0.020*	-0.013	-0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.011)	(0.010)	(0.009)
size	0.465***	0.507***	0.435***	0.229***	0.470***	0.555***	0.318***	0.197*
	(0.040)	(0.042)	(0.040)	(0.038)	(0.144)	(0.168)	(0.123)	(0.114)
tobinQ	0.001	0.007	-0.011	-0.002	0.022	0.064**	0.014	0.000
	(0.011)	(0.012)	(0.012)	(0.011)	(0.025)	(0.025)	(0.027)	(0.025)
lev	0.016	-0.006	0.005	0.076	0.205	-0.602	0.676*	0.364
	(0.117)	(0.119)	(0.127)	(0.108)	(0.350)	(0.399)	(0.374)	(0.279)
age	0.016	0.103	0.032	-0.023	0.385	0.279	0.218	-0.037
	(0.077)	(0.083)	(0.088)	(0.082)	(0.271)	(0.296)	(0.277)	(0.134)
_cons	-7.348***	-9.425***	-7.589***	-4.265***	-8.337***	-11.006***	-5.564**	-3.510
	(0.880)	(0.929)	(0.894)	(0.862)	(2.846)	(3.334)	(2.501)	(2.356)
Observations	12852	12852	12852	12852	1367	1367	1367	1367
R-squared	0.806	0.794	0.804	0.747	0.690	0.649	0.748	0.706

Standard errors are in parentheses

Chapter5 Financial constraints, tax preferences and firm innovation

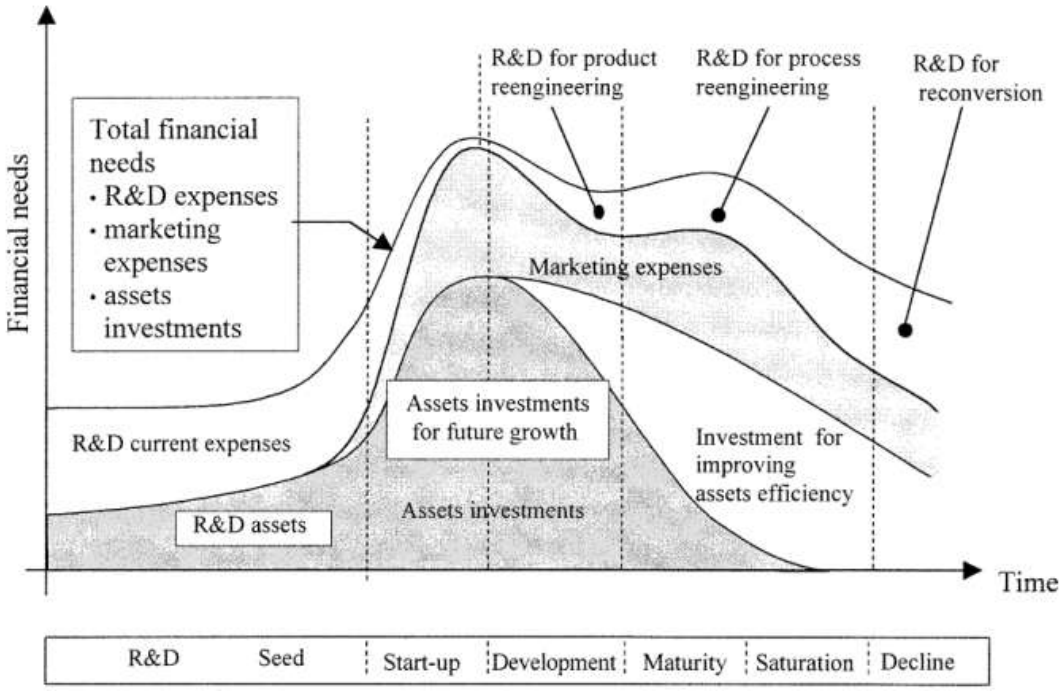
5.1 Introduction

The previous analysis results reflect that tax preferences are more effective for innovation in large firms than in SMEs. This part further analyzes the impact of financial constraints on the tax preference and innovation.

As shown in Figure 5-1, firm innovation is prone to financial constraints in the firm life cycle (Hölzl and Janger 2014). Among them, the capital demand of product innovation stage is the biggest, and it is most likely to face financing constraints. (Amara et al. 2016; D'Este et al. 2012; Mancusi and Vezzulli 2014). At this stage, the uncertainty of profit is high, and the required financing is at the maximum level. Therefore, external financing is usually necessary.

Financing has an important impact on the growth of firms. Large firms may have more access to stable external financing. At the same time, SMEs often encounter difficulties in external financing. The difference in financing ability determines the level of firm innovation ability. Large firms may carry out multiple innovation projects simultaneously to diversify investment risks, while SMEs need to concentrate funds to carry out a single project and bear greater innovation risks.

Based on financial constraints, this paper analyzes the financial constraints of SMEs and large firms, and explains the difference in the effectiveness of tax preferences on innovation for SMEs and large firms.



Source: European commission (1994)

Figure 5-1 Financial needs in the lifecycle of an innovative product.

5.2 Literature review and research hypothesis

The tax preferences can reduce the firm's cash expenditure and increase the internal fund. The internal fund is the main fund source of innovation (Manso 2011). Tax preferences reduce the cash outflow of firms, which is equivalent to subsidizing the innovation (Hall 2020). However, the result would be the opposite if taxes were raised. Lower after-tax profits after tax increases could increase firm debt and discourage riskier innovation (Heider and Ljungqvist 2015). The tax preference policy reduces the tax expenditure of firms so that firms have more profits and cash flow to increase investment in firm innovation.

Firm innovation is vulnerable to financial constraints. Schumpeter's theory points out that due to high barriers to entry, innovative activities require considerable economic strength, so innovative behaviors are prone to occur in large firms. SMEs, especially those in high-tech industries, are more susceptible to liquidity restrictions than large firms, which is not conducive to firm innovation(Acs and Audretsch 1990). Firms with insufficient capital are prone to be subject to financial constraints when conducting innovative activities than firms with greater liquidity(Hottenrott and Peters 2012).

Because of the high risk of innovation investment, information asymmetry, and the difficulty of transferring some innovations, it is difficult for firms to carry out innovation investment with external financing. Internal financing is an important determinant of innovation investment (Himmelberg and Petersen 1994; Gomes et al. 2006; Garc á-Quevedo et al. 2018). The internal financing of SMEs is limited, and financing constraints are extremely prone to occur.

On one hand, due to the uncertain return on investment in innovation, the investment risk of innovation is quite high (Hall and Van Reenen 2000; Coad and Rao 2008; Mazzucato 2013). The process of transforming R&D cost into patents and patents into new products has a high failure rate. New products may also fail in the market. Only a few firms can achieve significant growth after innovation investment (Coad and Rao 2008). Innovation risks are particularly serious for SMEs because they are unable to invest in multiple projects due to lack of funds and therefore risk of "all-for-all" (Freel 2006). Large firms can launch multiple innovative projects to diversify investment risks. Even if the failure rate of innovation is extremely high, the investment risks of large firms are still controllable.

On the other hand, innovators are unwilling to share their innovation information with external investors. It is difficult for banks to evaluate innovation investments (Bhattacharya and Ritter 1983). Compared with venture capital or other external investors, the high risk of innovation investment makes it less likely for banks to finance innovation. The reason is that a key criterion for bank loan evaluation is the ability to repay the principal and interest with investment returns(Mina et al. 2013). Although venture capital can bear higher risks, compared with SMEs, venture capital tends to invest in large firms with strong management ability (Landstrom 1990). This has led to financial constraints inhibiting the SMEs' innovation. By the way, if part of the innovation may only be used by the firm, the patent may not be a valid collateral (Mina et al. 2013). This may make it more difficult for SMEs to obtain innovative financing (Hutton and Lee 2012).

SMEs tend to suffer the most from capital constraints (Beck and Demirguc-Kunt 2006; Czarnitzki 2006; Czarnitzki and Hottenrott 2011; Mancusi

and Vezzulli 2010). Most SMEs cannot meet the listing conditions for equity financing and have few collateralized assets and low borrowing capacity. In innovation activities, SMEs rely more on internal financing for innovation, and internal funding constraints may lead to the termination of innovative projects. Compared with large firms, SMEs face more severe external financial constraints.

From what has been discussed above, the hypothesis is proposed as follows.

Hypothesis: Tax preferences for SMEs are less sensitive to innovation than large firms because of financing constraints.

5.3 Data source and variable definition

5.3.1 Sample selection

This paper selects 2008-2017 A-share listed firms as samples. The samples started in 2008 due to the new corporate income tax law of China. In 2008, the benchmark tax rate of corporate income tax changed from 33% to 25%. The samples ended in 2017 due to the statistics of patent data ends in 2017. The data of this paper is from the CSMAR database, and 15043 samples left.

5.3.2 Financial constraints

KZ index(Kaplan and Zingales 1997) is commonly used to represent firm financial constraints. The KZ index is positively correlated with financing constraints. This paper uses the KZ index as the proxy variable. The KZ index is obtained by comprehensively weighting multiple financial indicators.

$$KZ_{it} = -1.002CF_{it}/TA_{i,t-1} - 39.368DIV_{it}/TA_{i,t-1} - 1.315Cash_{it}/TA_{i,t-1} + 3.139LEV_{it} + 0.283Tobin's\ Q_{it}$$

The KZ index represents the degree of financing constraint. The variables in the formula are explained as follows.

$CF_{i,t}/TA_{i,t-1}$ represents the cash flow of operating activities in the current period divided

by assets at the beginning of the current period. Sufficient cash flow means that the firm has fewer financial constraints, and simultaneously the KZ index is smaller. The KZ index and financial constraints change in the same direction.

$Div_{it}/ TA_{i,t-1}$ represents the current cash dividends divided by assets. The distribution of dividends indicates that the firm has sufficient funds and less financial constraints. The variable sign is negative, indicating that the KZ index becomes smaller when dividends are paid. The KZ index and financial constraints change in the same direction.

$Cash_{it}/ TA_{i,t-1}$ represents the current cash divided by total assets. According to the formula, an increase in cash will lower the KZ index. Sufficient cash means that the firm lacks financial constraints. The KZ index and financial constraints change in the same direction.

LEV_{it} represents the current liabilities divided by assets. A larger debt-to-asset ratio indicates that the firm has more debt, greater capital pressure and greater financial constraints.

Tobin's Q indicates an investment opportunity for the firm. A larger Tobin's Q implies more investment expenditures and greater financial constraints.

According to Table 5-1, most SMEs list in the low-lev level, implying that most SMEs have less than 29% debt. The result shows that SMEs lack external financing capabilities and can only rely on internal financing.

Table 5-1 The firm distribution according to the quantiles of lev

Quantiles of lev	Large firms	SMEs	Total
1 low-lev	3763	1251	5014
2medium-lev	4712	303	5015
3 high-lev	4905	109	5014
Total	13380	1663	15043

As shown in Table 5-2, this paper divides the KZ index of large firms, SMEs and the full sample into five equal parts. The distribution of large firms in each part is relatively balanced. The majority of SMEs are concentrated in the highest quantile range (80%-100%), indicating that SMEs have a relatively high degree of financial constraints.

Table 5-2 The firm distribution according to the KZ index

Quantiles	Large firms	SMEs	Total
0-20%	1745	2	1747
20%-40%	1742	6	1748
40%-60%	1731	17	1748
60%-80%	1640	108	1748
80%-100%	1321	427	1748
Total	8179	560	8739

5.3.3 Other variables

(1) Innovation. Following the literature (Aghion et al. 2018; Chen and Yang 2019), this paper adopts the invention application to measure the innovation. The standard deviation of innovation is 1.4282, which implies there are some differences in the innovation.

$$\text{Innovation} = \ln(\text{invention application} + 1)$$

(2) Tax preference. Following the literature (Li and Zheng 2016), the paper uses the effective tax rate to measure the corporate tax burden.

$$\text{tax preference} = 25\% - \text{effective tax rate}$$

Following Chen and Yang (2019), this paper selects government subsidy, firm scale, firm value, lev, established time as control variables. See Table 5-3 for specific variable definitions.

Table 5-3 Variable definitions

Variables	Symbol	Variable definition	Mean	Sd	Max	Min
Innovation	Invent	ln (invention +1)	2.1513	1.4282	9.1083	0
Tax preference	tax	25%- effective tax rate	0. .0768	0.1204	0.5035	-0.4619
Subsidy	subsidy	ln (subsidy)	15.9495	2.8524	24.642	0
Firm scale	size	ln(assets)	22.0376	1.3294	28.5080	18.0077
Firm value	tobinQ	tobin’s Q	2.0785	1.2104	8.3660	0.8810
Lev	lev	liabilities /assets	0.4055	0.2063	0.9806	0.0070
Established time	age	ln(year-established time)	2.6064	0.4547	3.9120	0

5.4 Regression analysis

5.4.1 Financial constraints and the policy effect of tax preference

The paper adopts KZ index to represent financial constraints. In order to estimate the effect of financing constraints on tax preferences and innovation, this paper sets the interaction term KZ*tax in the regression model. The coefficient of tax is significantly positive, validating the hypothesis. B of the interaction term is significantly negative, indicating that financing constraints inhibit the incentive effect of tax preferences on innovation. Financing constraints are not conducive to firm innovation.

Table 5-4 Financial constraints and the policy effect of tax preference

invent	Coef.	St.Err.	t-value	p-value	[95%Conf	Interval]	Sig
tax	0.408	0.143	2.85	0.004	0.127	0.688	***
KZ	0.007	0.009	0.75	0.450	-0.011	0.024	
KZ*tax	-0.134	0.071	-1.88	0.060	-0.274	0.005	*
subsidy	0.011	0.004	2.63	0.009	0.003	0.019	***
size	0.484	0.044	10.90	0.000	0.397	0.571	***
tobinQ	0.014	0.012	1.19	0.235	-0.009	0.037	
lev	0.007	0.125	0.06	0.952	-0.237	0.252	
age	0.015	0.094	0.16	0.871	-0.169	0.199	
2009b	0.000	.	.	.	.	.	
2010	-0.012	0.036	-0.34	0.731	-0.082	0.058	
2011	0.177	0.043	4.10	0.000	0.092	0.262	***
2012	0.350	0.049	7.15	0.000	0.254	0.446	***
2013	0.398	0.056	7.07	0.000	0.288	0.509	***
2014	0.440	0.063	7.00	0.000	0.317	0.563	***
2015	0.492	0.073	6.78	0.000	0.350	0.635	***
2016	0.617	0.077	7.97	0.000	0.465	0.769	***
2017	0.541	0.084	6.45	0.000	0.376	0.705	***
Constant	-9.140	0.944	-9.68	0.000	-10.991	-7.290	***
Mean dependent var		2.258	SD dependent var			1.453	
R-squared		0.241	Number of obs			11717	
F-test		71.615	Prob > F			0.000	
Akaike crit. (AIC)		22274.302	Bayesian crit. (BIC)			22392.203	

5.4.2 Financial constraints, tax preferences and innovation

To further analyze the effect of financing constraints on tax incentives and innovation, this section conducts regressions on large firms, SMEs, and the full sample. The coefficients of tax preferences for large firms, SMEs and the full sample are all significantly positive, which verifies that tax preferences promote firm innovation.

B of the interaction term tax*KZ of large firms is not significant, indicating that financing constraints have little effect on the incentive effect of tax preferences for large firms. The possible reason is that the financing capacity of large firms is relatively strong, and the financing constraints of large firms are not serious, which has little impact on firm innovation.

B of the interaction term KZ*tax of SMEs is -0.426, reflecting the negative effect of financing constraints on the tax preferences and innovation of SMEs. Financing constraints of SMEs inhibit the incentive effect of tax preferences on innovation. There is a significant difference in the incentive effect of tax preference on innovation for large firms and SMEs. The possible reason is that the financial constraints of SMEs are generally relatively large, in the range of 80%-100% of the financial constraints. The innovation investment of SMEs is seriously inhibited by financing constraints.

5.5 Summary

This section analyzes the significant differences in the impact of tax preferences on innovation between SMEs and large firms. As discussed above, tax preferences are more effective for innovation in large firms than in SMEs. The reason for the difference between SMEs and large firms in the effects of tax preferences is that the financing constraints of SMEs are too severe. The innovation investment of SMEs is seriously inhibited by financing constraints.

Table 5-5 Financial constraints, tax preferences and innovation

	Large firms invent	SMEs invent	All firms invent
tax	0.397**	0.781**	0.408***
	(0.164)	(0.396)	(0.143)
KZ	0.005	0.071**	0.007
	(0.010)	(0.034)	(0.009)
KZ*tax	-0.135	-0.426**	-0.134*
	(0.085)	(0.216)	(0.071)
subsidy	0.009**	0.014	0.011***
	(0.004)	(0.011)	(0.004)
size	0.523***	0.463***	0.484***
	(0.049)	(0.164)	(0.044)
tobinQ	0.012	0.068**	0.014
	(0.013)	(0.034)	(0.012)
lev	0.029	-0.517	0.007
	(0.135)	(0.481)	(0.125)
age	-0.002	0.063	0.015
	(0.099)	(0.458)	(0.094)
2009bn.year			
2010.year	-0.021	0.035	-0.012
	(0.038)	(0.124)	(0.036)
2011.year	0.175***	0.216	0.177***
	(0.046)	(0.173)	(0.043)
2012.year	0.339***	0.386*	0.350***
	(0.052)	(0.213)	(0.049)
2013.year	0.382***	0.393*	0.398***
	(0.060)	(0.235)	(0.056)
2014.year	0.436***	0.286	0.440***
	(0.066)	(0.279)	(0.063)
2015.year	0.483***	0.196	0.492***
	(0.076)	(0.320)	(0.073)
2016.year	0.613***	0.229	0.617***
	(0.082)	(0.344)	(0.077)
2017.year	0.517***	0.257	0.541***
	(0.089)	(0.368)	(0.084)
_cons	-9.930***	-8.831***	-9.140***
	(1.043)	(3.254)	(0.944)
Observations	10701	1016	11717
R-squared	0.244	0.100	0.241

Standard errors are in parentheses

Chapter6 Conclusions

Innovation is conducive to improving the market competitiveness of firms and promoting economic growth. Because of the market failures of innovation, firm innovation is generally lower than expected. As a result, the government needs to adopt tax preferences to encourage firm innovation. The number of SMEs accounts for 99% of Chinese firms, which implies the importance of SMEs in the Chinese economy. This study of the incentive effect of tax preferences on innovation in firms, especially in the in-depth analysis of SMEs, has important theoretical and practical significance. The research conclusions are as follows.

(1) Tax preferences promote firm innovation. Innovation requires a large amount of investment. Firms are prone to respond to ongoing, substantial tax preferences. The intensity and durability of tax preferences significantly affect firm innovation.

(2) Tax preferences are more effective for innovation of large firms than SMEs. The results of tax preferences on firm innovation and the impact of sustained tax preferences indicate that tax preferences are more effective for innovation in large firms than in SMEs. The paper further analyzes the effectiveness of tax preferences for SMEs and large firms of different ownership and regions, and the results verify the above conclusions. From the empirical results, it is known that compared with tax preferences, subsidies have a better effect on innovation in SMEs. The paper further analyzes the effect of subsidies on tax preferences and innovation.

(3) There are differences in the effect of tax preferences for large firms and SMEs on innovation. Financing constraints are the reason for the differences in the effectiveness of tax preferences between SMEs and large firms. As China's SMEs have severe financing constraints, the effects of tax preferences for large firms on innovation are significantly stronger than those for SMEs.

The limitation of the paper is that the data of SMEs is limited to the listed firms that can be collected. However, 99% of Chinese firms are SMEs, and most do not meet the listing conditions. The empirical results may have certain deviations. In the future, we can use

questionnaires to collect data on unlisted SMEs for research and compare the effects of tax preferences for listed SMEs and unlisted SMEs on innovation to use more comprehensive data to verify the effects of tax preferences.

References

Acs, Z. J., and D. B. Audretsch. 1990. *Innovation and small firms*: Mit Press.

Acs, Z. J., D. B. Audretsch, and M. P. Feldman. 1994. R & D spillovers and recipient firm size. *The review of Economics and Statistics*:336-340.

Aghion, P., U. Akcigit, A. Hyytinen, and O. Toivanen. 2018. On the Returns to Invention within Firms: Evidence from Finland. *AEA Papers and Proceedings* 108:208-212.

Amara, N., P. D'Este, R. Landry, and D. Doloreux. 2016. Impacts of obstacles on innovation patterns in KIBS firms. *Journal of Business Research* 69 (10):4065-4073.

Arrow, K. 1962. The economic consequences of learning by doing. *Review of Economic Studies* 29 (3):155-173.

Batjargal, B., M. A. Hitt, A. S. Tsui, J.-L. Arregle, J. W. Webb, and T. L. Miller. 2013. Institutional polycentrism, entrepreneurs' social networks, and new venture growth. *Academy of Management Journal* 56 (4):1024-1049.

Beck, T., and A. Demirguc-Kunt. 2006. Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of banking & finance* 30 (11):2931-2943.

Berger, A. N., and G. F. Udell. 1995. Relationship lending and lines of credit in small firm finance. *Journal of Business*:351-381.

Bernstein, J. I. 1986. The effect of direct and indirect tax incentives on Canadian industrial R&D expenditures. *Canadian Public Policy/Analyse de Politiques*:438-448.

Bessant, J. R. 1982. Influential factors in manufacturing innovation. *Research Policy* 11 (2):117-132.

Bhattacharya, S., and J. R. Ritter. 1983. Innovation and communication: Signalling with partial disclosure. *The Review of Economic Studies* 50 (2):331-346.

Bozio, A., D. Irac, and L. Py. 2014. Impact of research tax credit on R&D and innovation: evidence from the 2008 French reform.

Busom, I. 2000. An empirical evaluation of the effects of R&D subsidies. *Economics of Innovation and New Technology* 9 (2):111-148.

Busom, I., B. Corchuelo, and E. Mart ńez-Ros. 2014. Tax incentives… or subsidies for business R&D? *Small Business Economics* 43 (3):571-596.

Carboni, O. A. 2011. R&D subsidies and private R&D expenditures: evidence from Italian manufacturing data. *International Review of Applied Economics* 25 (4):419-439.

chang, A. C. 2018a. tax policy endogeneity-evidence from R&D tax credits.

———. 2018b. Tax policy endogeneity: evidence from R&D tax credits. *Economics of Innovation and New Technology* 27 (8):809-833.

Chen, d., and c. Fa. 2019. Study on the incentive effects of government Subsidies and Tax preferences on enterprise Innovation. *East China Economic Management* 8 (2):5-15.

Chen, L., and W. Yang. 2019. R&D tax credits and firm innovation: Evidence from China. *Technological Forecasting and Social Change* 146:233-241.

Coad, A., and R. Rao. 2008. Innovation and firm growth in high-tech sectors: A quantile regression approach. *Research Policy* 37 (4):633-648.

Cohen, L., K. Diether, and C. Malloy. 2013. Misvaluing innovation. *The Review of Financial Studies* 26 (3):635-666.

Czarnitzki, D. 2006. Research and development in small and medium? sized enterprises: The

role of financial constraints and public funding. *Scottish Journal of Political Economy* 53 (3):335-357.

Czarnitzki, D., P. Hanel, and J. M. Rosa. 2011. Evaluating the impact of R&D tax credits on innovation: A microeconometric study on Canadian firms. *Research Policy* 40 (2):217-229.

Czarnitzki, D., and H. Hottenrott. 2011. R&D investment and financing constraints of small and medium-sized firms. *Small Business Economics* 36 (1):65-83.

D'Este, P., S. Iammarino, M. Savona, and N. von Tunzelmann. 2012. What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy* 41 (2):482-488.

Dechezlepretre, A., E. Einio, R. Martin, K.-T. Nguyen, and J. Van Reenen. 2016. Do tax incentives for research increase firm innovation? An RD design for R&D. *National Bureau of Economic Research*.

Eickelpasch, A., and M. Fritsch. 2005. Contests for cooperation? A new approach in German innovation policy. *Research Policy* 34 (8):1269-1282.

Estache, A., and V. Gaspar. 1995. Why tax Incentives do not Promote Investment in Brazil. In A. Shah (Ed.), Fiscal Incentives for Investment and Innovation. Baltimore: Oxford University Press.

Fabiani, S., and R. Sbragia. 2014. Tax incentives for technological business innovation in Brazil: the use of the Good Law-Lei do Bem (Law No. 11196/2005). *Journal of technology management & innovation* 9 (4):53-63.

Fama, E. F., and A. B. Laffer. 1971. Information and capital markets. *Journal of Business*:289-298.

Fontana, R., and L. Nesta. 2009. Product Innovation and Survival in a High-Tech Industry. *Review of Industrial Organization* 34 (4):287-306.

Freel, M. S. 2006. Are Small Innovators Credit Rationed? *Small Business Economics* 28 (1):23-35.

———. 2007. Are small innovators credit rationed? *Small Business Economics* 28 (1):23-35.

Garc á-Quevedo, J., A. Segarra-Blasco, and M. Teruel. 2018. Financial constraints and the failure of innovation projects. *Technological Forecasting and Social Change* 127:127-140.

Gomes, J. F., A. Yaron, and L. Zhang. 2006. Asset pricing implications of firms' financing constraints. *The Review of Financial Studies* 19 (4):1321-1356.

Gonz ález, X., and C. Paz ó. 2008. Do public subsidies stimulate private R&D spending? *Research Policy* 37 (3):371-389.

Griffith, R. 1996. Tax competition: Is there any empirical evidence. *Insitute of Financial Studies, mimeo*.

Griliches, Z. 1991. The search for R&D spillovers: National Bureau of Economic Research.

Guinet, J., and H. Kamata. 1996. Do tax-incentives promote innovation? *OECD Observer* (202):22-26.

Hall, B., and J. Van Reenen. 2000. How effective are fiscal incentives for R&D? A review of the evidence. *Research Policy* 29 (4-5):449-469.

Hall, B. H. 2020. Tax policy for innovation. In *Innovation and Public Policy*: University of Chicago Press.

Hall, B. H., and J. Van Reenen. 1999. How effective are fiscal incentives for R&D? A new

review of the evidence. *National Bureau of Economic Research Working Paper Series* (w7098).

Hamilton, R. T., and M. A. Fox. 1998. The financing preferences of small firm owners. *International Journal of Entrepreneurial Behavior & Research*.

Heider, F., and A. Ljungqvist. 2015. As certain as debt and taxes: Estimating the tax sensitivity of leverage from state tax changes. *Journal of Financial Economics* 118 (3):684-712.

Himmelberg, C. P., and B. C. Petersen. 1994. R & D and internal finance: A panel study of small firms in high-tech industries. *The review of Economics and Statistics*:38-51.

Hölzl, W., and J. Janger. 2014. Distance to the frontier and the perception of innovation barriers across European countries. *Research Policy* 43 (4):707-725.

Hottenrott, H., and B. Peters. 2012. Innovative capability and financing constraints for innovation: more money, more innovation? *Review of Economics and Statistics* 94 (4):1126-1142.

Howell, A. 2016. Firm R&D, innovation and easing financial constraints in China: Does corporate tax reform matter? *Research Policy* 45 (10):1996-2007.

Hussinger, K. 2008. R&D and subsidies at the firm level: An application of parametric and semiparametric two? step selection models. *Journal of Applied Econometrics* 23 (6):729-747.

Hutton, W., and N. Lee. 2012. The City and the cities: ownership, finance and the geography of recovery. *Cambridge Journal of Regions, Economy and Society* 5 (3):325-337.

Jones, N. 2003. Competing after radical technological change: the significance of product line management strategy. *Strategic Management Journal* 24 (13):1265-1287.

Kanamori, T., J. J. Lim, and T. Yang. 2007. China's SME development strategies in the context of a national innovation system. *Asian Development Bank Institute (ADBI) Discussion Paper* 55.

Kaplan, and Zingales. 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? *The quarterly journal of economics* 112 (1):169-215.

Kasahara, H., K. Shimotsu, and M. Suzuki. 2014. Does an R&D tax credit affect R&D expenditure? The Japanese R&D tax credit reform in 2003. *Journal of the Japanese and International Economies* 31:72-97.

Kleer, R. 2010. Government R&D subsidies as a signal for private investors. *Research Policy* 39 (10):1361-1374.

Landstrom, H. 1990. Co-operation between venture capital companies and small firms. *Entrepreneurship & Regional Development* 2 (4):345-362.

Lee, N., H. Sameen, and M. Cowling. 2015. Access to finance for innovative SMEs since the financial crisis. *Research Policy* 44 (2):370-380.

Li, W., and M. Zheng. 2016. Substantive innovation or strategic innovation? -The impact of macro industrial policies on micro enterprise innovation. *Economic research* (4):60-74.

Liu, L., C. Kang, Z. Yin, and Z. Liu. 2019. The effects of fiscal and taxation polices on the innovation efficiency of manufacturing enterprises:a comparative study from the perspective of economic regions. *Transformations in Business & Economics* 18 (3).

Lucas Jr, R. E. 1988. On the mechanics of economic development. *Journal of Monetary Economics* 22 (1):3-42.

Mancusi, M. L., and A. Vezzulli. 2010. R&D, innovation and liquidity constraints, 2010.

———. 2014. R&D AND CREDIT RATIONING IN SMEs. *Economic Inquiry* 52 (3):1153-1172.
Mani, S. 2004. Government, innovation and technology policy: an international comparative analysis. *International Journal of Technology and Globalisation* 1 (1).
Manso, G. 2011. Motivating innovation. *The Journal of Finance* 66 (5):1823-1860.
Mason, C., and R. Brown. 2013. Creating good public policy to support high-growth firms. *Small Business Economics* 40 (2):211-225.
Mazzucato, M. 2013. Financing innovation: creative destruction vs. destructive creation. *Industrial and Corporate Change* 22 (4):851-867.
Mina, A., H. Lahr, and A. Hughes. 2013. The demand and supply of external finance for innovative firms. *Industrial and Corporate Change* 22 (4):869-901.
Mukherjee, A., M. Singh, and A. Žaldokas. 2017. Do corporate taxes hinder innovation? *Journal of Financial Economics* 124 (1):195-221.
Nechaev, A., and O. Antipina. 2015a. Tax stimulation of innovation activities enterprises. *Mediterranean Journal of Social Sciences* 6 (1 S2):42.
———. 2015b. Tax Stimulation of Innovation Activities Enterprises. *Mediterranean Journal of Social Sciences*.
Nelson, R. R. 1959. The simple economics of basic scientific research. *Journal of Political Economy* 67 (3):297-306.
Rao, N. 2016. Do tax credits stimulate R&D spending? The effect of the R&D tax credit in its first decade. *Journal of Public Economics* 140:1-12.
Roberts, P. W., and R. Amit. 2003. The dynamics of innovative activity and competitive advantage: The case of Australian retail banking, 1981 to 1995. *Organization science* 14 (2):107-122.
Romer, P. M. 1986. Increasing returns and long-run growth. *Journal of Political Economy* 94 (5):1002-1037.
Rothwell, R. 1987. Intracorporate entrepreneurs. *Management Decision* 25 (2):12-19.
Saito, K. A., and D. P. Villanueva. 1981. Transaction costs of credit to the small-scale sector in the Philippines. *Economic Development and Cultural Change* 29 (3):631-640.
Samuelson, P. A. 1954. The pure theory of public expenditure. *The review of Economics and Statistics* 36 (4):387-389.
Scherer, F. M. 1983. R & D and declining productivity growth. *The American Economic Review* 73 (2):215-218.
Schumpeter, J. A. 1934. The theory of economic development. *Harvard University Press*.
Schumpeter, J. A. 2013. *Capitalism, socialism and democracy*: routledge.
Shao, Y., and C. Xiao. 2019. Corporate tax policy and heterogeneous firm innovation: Evidence from a developing country. *Journal of Comparative Economics* 47 (2):470-486.
Solow, R. M. 1956. A contribution to the theory of economic growth. *The quarterly journal of economics* 70 (1):65-94.
Su, Y., and T. Su. 2017. Performance aspiration, industrial search and R&D investment among chinese firms. *Chinese Management Studies*.
Tassey, G. 2007. Tax incentives for innovation: time to restructure the R&E tax credit. *The Journal of Technology Transfer* 32 (6):605-615.
Wagner, S., and I. Cockburn. 2010. Patents and the survival of Internet-related IPOs. *Research*

Policy 39 (2):214-228.

Wang, C.-H., Y.-H. Lu, C.-W. Huang, and J.-Y. Lee. 2013. R&D, productivity, and market value: An empirical study from high-technology firms. *Omega* 41 (1):143-155.

Yang, H., C. Phelps, and H. K. Steensma. 2010. Learning from what others have learned from you: The effects of knowledge spillovers on originating firms. *Academy of Management Journal* 53 (2):371-389.

Zachariadis, M. 2003. R&D, innovation, and technological progress: a test of the Schumpeterian framework without scale effects. *Canadian Journal of Economics/Revue canadienne d'茅conomique* 36 (3):566-586.