Enterprise Tax Burden and R&D Investment: Evidence from Chinese GEM Listed Companies

Yingxuan Liu[(✉)]

Shenzhen Institute of Information Technology, Shenzhen 518172, People's Republic of China
yingxuan.liu@outlook.com

Abstract. R&D investment costs a lot of funds, which is the fundamental driving force to maintain enterprise competitiveness and innovation ability. As a rigid expenditure of enterprises, tax revenue will reduce the free cash flow of enterprises to a certain extent. The relationship between the degree of enterprise tax burden and its R&D activities is worth further exploration. This paper constructs a regression model based on the data of listed GEM companies from 2010 to 2020 and examines the relationship between the enterprise's total tax burden and its R&D investment. Empirical research has shown that an increase in the total tax burden of enterprises will negatively affect innovation investment activities to a certain extent. It is also found by further testing the enterprise age that the tax burden has a greater impact on R&D innovation activities for younger companies.

Keywords: R&D investment · Tax burden · Innovation · Heterogeneity · Regression analysis

1 Introduction

Innovation, as a new engine and active force driving development, is an important guarantee for the production and operation of enterprises and an inexhaustible impetus for the sustainable development of the whole country. To encourage public innovation and entrepreneurship, the relevant national departments continue to introduce many tax-related policies for the main links and key areas of innovation, such as preferential tax for enterprises at the initial stage, preferential tax for enterprises at the growth stage, preferential tax for new high-tech enterprises and sci-tech enterprises, etc., which is used to stimulate the market innovation vitality and support the sustainable development of enterprises.

As the main body of the market innovation system, enterprises mainly target market needs for research and transform them into marketable goods and services (Yang, 2021) [1]. Business activities promote productivity and stimulate the overall market economy more extensively by bringing new products, methods, and production processes into the market (Alexander, 2014) [2]. However, innovation still brings about certain difficulties for enterprises, such as technical barriers, development investment, R&D cycle, etc.,

leading to the high risk of innovation to a certain extent (Scherer et al., 2000) [3]. In the face of many uncertainties about the future, innovation activities have different effects under different innovation strategies, and internal R&D activities have a significantly positive impact on the innovation activities of enterprises (Potters, 2009) [4].

There is no doubt that innovation requires a large amount of R&D investment for enterprises early. The greater the strength of R&D investment is, the greater the probability of successful technological innovation is (Wang et al., 2021) [5]. Larger R&D investment requires enterprises to maintain a good financial situation. Sun Songzhi et al. (2021) studied the impact of the financial situation on R&D investment by taking manufacturing-listed companies as samples and found that the enterprises which are financially sound can more promote R&D investment, especially at the mature stage[6]. Compared with other business activities, R&D activities are more likely to be constrained by financing, and the establishment of better equity financing channels is conducive to the research and development investment of enterprises (Brown et al., 2012) [7]. The decrease in capital expenditure by enterprises will hinder investment and innovation to some extent (Li et al., 2017) [8]. Tax revenue has a rigid constraint of payment time with an important impact on the investment decision of enterprises, and R&D technology investment will also be restricted to a certain extent with the increase of tax burden degree (Wu et al., 2013) [9]. Through reducing tax rates and improving tax systems, tax preference can reduce enterprises' tax cash outflow, indirectly promoting investment and R&D activities (Song et al., 2019) [10].

Therefore, the tax burden of enterprises will affect research and development activities to some extent and further innovation behaviour. This paper analyzes the relationship between enterprise tax burden and R&D investment by empirically testing the data of Chinese GEM listed companies' data and further analyzes the heterogeneity of enterprise age. It refers to the relationship between enterprise tax burden and R&D investment.

2   Theoretical Analysis and Research Hypothesis

A higher tax burden will affect R&D investment of enterprises and the launch of new products, reducing innovation vitality and willingness to take risks (Mukherjee et al., 2017) [11]. The main taxes Chinese enterprises face include income tax and circulation tax (Li et al., 2021) [12]. Enterprise income tax is mainly levied on enterprises and other organizations' production and operation income in China. Reducing the income tax burden on enterprises can help enhance the value of enterprises, especially for non-state-owned enterprises (Bao, 2018) [13]. The reduction of the income tax burden on enterprises, such as additional deduction of R&D expenses and other policies, can promote innovative R&D activities (Yang, 2020) [14] and affect enterprises' operation and investment decisions. Circulation tax is a kind of tax based on the commodity production of taxpayers, the amount or quantity of circulation, and the turnover of non-commodity transactions. As a result, the study of the enterprise tax burden should consider both income tax and circulation tax (Cao et al., 2015) [15].

The technological innovation change of enterprises is a long-term process full of uncertainties. To realize the transfer of added-value tax and other circulation taxes, it is necessary to ensure sales activities have happened. Moreover, unfinished transactions

will cause part of the circulation tax remain within the enterprise, which brings negative pressure to enterprises and affects the innovation activities of enterprises to some extent (Chen et al., 2012) [16]. Therefore, this paper includes the dual influence of income tax and circulation tax when considering the enterprise tax burden and proposes the following hypotheses:

H1: The comprehensive tax burden is negatively correlated with the R&D investment of enterprises.

Enterprises are more dependent on internal financing in R&D innovation activities, namely, enterprises' internal retained income and related cash flow (Lin, 2017) [17]. Particularly, an enterprise in a shorter established time has lower market popularity and is harder to seek external capital providers so that tax policy may have a greater impact on these younger enterprises. At the same time, newly established enterprises are usually small and face greater uncertainty in future development (Zhang, 2021) [18]. For younger enterprises, a higher tax burden may reduce their willingness to bear other risks, thus affecting their innovation activities. Therefore, this paper presents the following hypothesis:

H2: There is heterogeneity in the tax burden for enterprises with different establishment dates. The shorter the establishment time is, the more the R&D activities of enterprises are affected by the tax burden.

3 Research Design

3.1 Sample Selection and Data Source

From the distribution of enterprises listed on the Chinese GEM, most of them are high-tech enterprises, which are the backbone of the innovation and development of the national economy. Thus, we selected sample data from Chinese GEM listed companies during 2010–2020, which mainly came from the CSMAR database, excluding ST enterprises, financial industry and samples with incomplete variables. A total of 4,118 valid samples were finally obtained. The Stata15 software was used for empirical analysis.

3.2 Variable Definition

3.2.1 Explained Variable: Enterprise Innovation Investment

The innovation investment of an enterprise can reflect the degree to which it attaches importance to innovation and the process of its technological innovation. The index of R&D investment to operating income includes the operating income index, which can more clearly measure the investment strength in continuous research and technological innovation for GEM enterprises. According to the study of Fu et al. (2021), the proportion of R&D investment in operating income was selected to measure the strength of enterprise innovation investment[19].

3.2.2 Explaining Variable: Enterprise Tax Burden

A "dual-subject" tax structure has been currently adopted in China, which is mainly characterized by circulation tax and income tax (Feng et al., 2021) [20]. To make the

Table 1. Definition of research variables

Variable type	Name	Symbol	Definition
Explained variable	R&D investment	rd	The ratio of R&D investment to operating income
Explaining variable	Comprehensive Tax burden	ct	The sum of the ratio of income tax expense to total profit) and the ratio of operating taxes and surcharge to total operating income.
Control variables	Equity concentration	top1	The shareholding ratio of the largest shareholder
	Capital structure	lev	The ratio of the book value of debt to total assets
	Profitability	profr	The ratio of net profit to operating income
	Asset size	size	Logarithm from the size of total assets
	Enterprise age	age	Year of the enterprise establishment

enterprise tax burden index more comprehensive, both income tax and circulation tax should be considered in the tax burden of enterprises (Cao et al., 2015) [15]. Therefore, the sum of circulation tax burden and income tax burden can be selected to represent the overall tax burden of enterprises. The circulation tax burden is the ratio of business tax and surcharge to operating income, while the income tax burden is the ratio of income tax expenses to the total profit.

3.2.3 Control Variables

In addition to the enterprise tax burden, many other factors affect the enterprise innovation investment. Combined with the previous research literature, the equity concentration, capital structure, profitability, asset size, and enterprise age were selected as control variables of the model.

The names, symbols, and descriptions of research variables in this paper are shown in Table 1.

3.3 Model Construction

To explore the impact of enterprise tax burden on enterprise innovation investment, the above-mentioned hypotheses were verified, and the model was structured as follows:

$$rd_i t = \alpha_o + \beta_1 \times ct_{it} + \beta_2 \times control_{it} + \mu \tag{1}$$

Where control represents all the control variables, $\alpha 0$ is the constant term, βi is the coefficient of each variable, and μ is the random error term.

Table 2. Descriptive statistics of research variables

Variables	Observations	Mean	Std.Dev.	Min.	Median	Max.
rd	4118	7.243	5.986	0.070	5.260	33.910
ct	4118	13.344	12.538	-47.562	14.419	59.061
top1	4118	30.667	13.016	8.090	28.330	65.170
lev	4118	31.165	17.480	3.529	28.794	74.708
profr	4118	8.765	23.944	-136.833	11.134	48.266
size	4118	21.370	0.871	19.612	21.282	23.763
age	4118	15.187	5.172	1.000	14.920	35.750

4 Empirical Results and Analysis

4.1 Descriptive Analysis

The descriptive statistics for all variables are shown in Table 2.

From Table 2, we find: the minimum value of enterprise innovation investment strength was 0.07, and the maximum value was 33.910, indicating great differences in the strength of innovation investment between individuals in different samples. At present, the identification and management measures of new high-tech enterprises in most regions stipulate that the proportion of R&D expenses in the income is between 3% and 5%. However, the mean value and median value of enterprise innovation investment in samples were 7.243 and 5.260, respectively, indicating that sample enterprises attach more importance to improving innovation ability. The mean value and median value of enterprise tax burden were 13.344 and 14.419, respectively, indicating that sample enterprises' overall tax burden is concentrated between 13% and 15%. The overall tax burden is relatively low, probably because sample enterprises are GEM listed companies mainly characterized by high and new technology and can enjoy certain preferential tax. The minimum and maximum values of equity concentration were 8.090 and 65.170, respectively, indicating that the shareholding ratio of the largest shareholder in sample enterprises varies greatly. The variance of profitability was 23.370, indicating that there is a large gap in the profitability of sample enterprises. However, its mean value and median value were 8.765 and 11.134, respectively, indicating that most GEM enterprises are in a profitable state.

4.2 Correlation Analysis

Pearson correlation analysis was used for all the variables, as shown in Table 3. The maximum absolute value of the correlation coefficient between variables is no more than 0.449. Meanwhile, the model was further tested using VIF, and VIF values are all less than 2. Thus, there is no obvious collinearity problem.

Table 3. Correlation analysis

Variables	rd	ct	top1	lev	profr	size	age
rd	1						
ct	− 0.163***	1					
top1	− 0.145***	0.057***	1				
lev	− 0.253***	− 0.035**	− 0.065***	1			
profr	− 0.014	0.206***	0.150***	− 0.338***	1		
size	− 0.092***	− 0.001	− 0.197***	0.449***	− 0.084***	1	
age	− 0.027*	− 0.041***	− 0.086***	0.183***	− 0.136***	0.206***	1

Note: *, **, *** indicate a significant correlation at the levels of 10%, 5%, and 1%, respectively.

4.3 Regression Analysis

The overall regression results are shown in Table 4. The adjusted R2 and F values indicate that the model fits well, and the variables in the model can partly reflect changes in the explained variables.

The explaining variables passed the 1% level of significance test upon the regression results of the whole sample of enterprises (1) and (2), indicating that the current tax burden of enterprises has exerted negative effect on R&D investment. Among the control variables, the equity concentration and capital structure were also negatively related to the R&D investment of enterprises at the level of 1%. It indicates that the heavier the tax burden enterprises bear, the weaker the investment strength in technological innovation. Since tax is a rigid cost and needs to be paid in time, enterprises need to reserve sufficient cash flow for tax payment with the increase of tax burden, which will weaken the ability of enterprises to carry out technology R&D and innovation investment to a certain extent.

To further explore the difference in the impact of the tax burden on the age of different enterprises, this paper divided the overall sample into groups with a median value of 14.92 in the enterprise age. Enterprises founded less than the median are defined as growth enterprises, and enterprises founded more than the median is defined as mature enterprises. The explaining variables have passed the 1% level of significance test upon growth and mature enterprises' regression results. Moreover, the coefficient of growth enterprises is smaller than that of mature enterprises, showing that tax burden has a more significant impact on the R&D activities of growth enterprises. Enterprises in the growth period are faced with various greater uncertainties, and there are greater risks in R&D innovation activities. At the same time, compared with mature enterprises, growth enterprises have a shorter establishment time and a lower degree of market recognition, leading to a decline in financing efficiency. Therefore, innovation activities are more dependent on internal capital. As the tax burden of enterprises increases, the innovative investment decisions of growth enterprises will be more easily affected.

Table 4. Regression analysis results

Variable type	Name	Complete sample Enterprise (1)	Complete sample Enterprise (2)	Growth enterprise	Mature enterprise
		Explained variable: rd			
Explaining variable	ct	-0.073^{***}	-0.070^{***}	-0.099^{***}	-0.050^{***}
		(−7.98)	(−7.67)	(−6.47)	(−4.54)
Control variable	top1	-0.067^{***}	-0.063^{***}	-0.073^{***}	-0.051^{***}
		(−10.38)	(−9.78)	(−8.45)	(−5.32)
	lev	-0.099^{***}	-0.106^{***}	-0.114^{***}	-0.099^{***}
		(−16.16)	(−17.10)	(−11.55)	(−12.03)
	profr	-0.015^{**}	-0.011^{*}	0.006	-0.020^{***}
		(−2.55)	− 1.95)	(0.62)	(−2.71)
	size	0.030	-0.189^{*}	− 0.071	-0.277^{*}
		(0.28)	(−1.67)	(−0.43)	(−1.74)
	age	− 0.034	-1.215^{***}	-2.004^{***}	− 1.065
		(-0.13)	(−4.05)	(-3.60)	(-1.51)
Constant	_cons	12.943^{***}	18.000^{***}	17.680^{***}	19.816^{***}
		(5.67)	(7.22)	(4.55)	(5.24)
Time		Non-control	Control	Control	Control
adj. R^2		0.119	0.132	0.155	0.115
F		80.95	35.45	18.41	18.73

Note: *, **, *** indicate a significant correlation at the levels of 10%, 5%, and 1%, respectively.

4.4 Regression Analysis

In this paper, the robustness test was performed by replacing explained variables. The ratio of R&D personnel refers to the ratio of R&D personnel in the total number of employees. It considers an enterprise's investment in R&D human capital and can measure the strength of innovation investment to a certain extent. Thus, the regression analysis was conducted by replacing the ratio of R&D investment (rd) to income with the ratio of R&D personnel (rdp) as a measure of innovation investment of explained variables. The regression results show that in the regression mode, all the explaining variables have a significant negative correlation with the explained variables replaced and that the coefficient of growth enterprises is smaller than that of mature enterprises. It suggests that the research results are more reliable, as shown in Table 5.

Table 5. Robustness test results

Variable type	Name	Complete sample Enterprise (1)	Complete sample Enterprise (2)	Growth enterprise	Mature enterprise
		Explained variable: rdp			
Explaining variable	ct	– 0.151***	– 0.113***	– 0.140***	– 0.090***
		(–6.47)	(–5.61)	(4.24)	(–3.55)
Control variable	top1	– 0.147***	– 0.088***	– 0.066***	– 0.117***
		(–7.71)	(–5.63)	(–3.14)	(–4.82)
	lev	– 0.076***	– 0.140***	– 0.137***	– 0.141***
		(–4.19)	(–8.60)	(–5.84)	(–6.04)
	profr	– 0.014	0.009	0.024	0.000
		(–0.99)	(0.72)	(0.87)	(0.01)
	size	3.140***	0.145	– 0.449	0.660
		(9.05)	(0.45)	(–0.98)	(1.44)
	age	10.444***	– 1.796**	– 1.818**	0.580
		(16.02)	(–2.52)	(–2.04)	(0.28)
Constant	_cons	– 69.958***	11.205	22.300**	– 0.383
		(–9.80)	(1.63)	(2.22)	(–0.03)
Time		Non-control	Control	Control	Control
adj. R^2		0.110	0.378	0.473	0.222
F		91.32	351.94	144.5	199.3

Note: *, **, *** indicate a significant correlation at the levels of 10%, 5%, and 1%, respectively.

5   Conclusion and Suggestion

The impact of an enterprise's total tax burden on its R&D investment activities was empirically studied by establishing a relation model of enterprise tax strength and R&D investment based on the data of Chinese GEM listed companies from 2010 to 2020, concluding as follows: First, there is a significant negative correlation between an enterprise's overall tax burden and its R&D activities, that is, a higher degree of the tax burden will affect an enterprise's technological innovation activities and lead to its less R&D investment. Second, enterprise age has a heterogeneous impact on R&D investment in terms of the tax burden, which is mainly reflected by the fact that R&D investment is more affected by tax burden for growth enterprises and those in a shorter establishment time.

This study mainly gives the following suggestions: Firstly, the tax burden of enterprises should be reduced to encourage R&D innovation activities, such as an introduction of effective tax incentives and tax reduction policies, to help enterprises to enhance their core competitiveness and further improve the overall technological innovation of the

society. Secondly, it is necessary to optimize the market business environment, build a transparent and efficient government environment, and innovate means of tax supervision so that enterprises can have a clearer understanding of tax-related policies. In this way, they can pay taxes following the law, standardize tax payment, fully enjoy preferential policies, and reduce the tax burden. Finally, the financing channels of enterprise innovation activities should be expanded, especially to support growth enterprises and startups in the industry to gain more financing sources, improve their financing efficiency, and stimulate their innovation vitality, further promoting the effective transformation of innovation achievements.

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