Government Subsidies and Enterprise Innovation -- Regulating Effect Based on Business Cycle

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Abstract. The current round of COVID-19 has increased the uncertainty of the economic environment, which may have an impact on government policies and enterprise innovation. Therefore, this paper tries to analyze the impact of government subsidies on enterprise innovation behavior under different business circles. According to the empirical results of a-share listed companies from 2017 to 2019, government subsidies play a significant positive influence on enterprise innovation behavior, and the business cycle plays a counter-cyclical role in the relationship between government subsidies and enterprise innovation behavior. That is, in the period of economic prosperity, the business cycle negatively adjusts the relationship between government subsidies and enterprise innovation. During the economic depression, the business cycle positively regulates the relationship between government subsidies and enterprise innovation. The grouped test shows that the above effects are concentrated in the enterprises located in the eastern region, while in the enterprises located in the non-eastern region, the influence of government subsidies on enterprise innovation does not change significantly in the fluctuation of business cycle. In this paper, the conclusion shows that it is necessary for government departments to attach great importance to the influence of business cycle on enterprise innovation behavior and formulate more targeted fiscal policies.

Keywords: government subsidies, enterprise innovation, business circle, counter-cyclic regulation.

1. Introduction

In the current epoch of new economy, the transformation of development momentum, the transformation of the pattern of economic development and structural adjustment call for scientific and technological innovation as new impetus. In order to promote enterprise innovation, the Chinese government proposed in the outline of the 14th Five-Year Plan to emphasize the dominant position of enterprises in innovation and promote the aggregation of various elements of innovation in enterprises. According to the National Statistical Bulletin on Investment in Science and technology, government expenditure on science and technology was 700.58 billion yuan in 2015 and will reach 1,009.05 billion yuan by 2020, with an average annual increase of 51.487 billion yuan. Although government subsidy policy is widely used and the amount is relatively huge, its positive effect on enterprise innovation remains controversial. Due to the high uncertainty and externality of enterprise innovation, resulting in market failure and serious lack of innovation power of enterprises, government regulation is indispensable (Hall, 2002; Yu Fen et al., 2021).

At present, there is still no consistent research conclusion on whether government subsidies have a positive effect on enterprise innovation in the academic circle, and the controversial arguments are mainly divided into four categories. The first type of research believes that government subsidies have a positive crowding-in effect on enterprises' R&D investment. Government subsidies, as public financial funds, can help ease enterprises' innovation financing constraints and reduce innovation risks, thus improving enterprises' independent R&D and innovation capability and encouraging enterprises' innovation behavior (Guo D et al., 2016). According to the second type of research, enterprises will establish a positive rent-seeking relationship with the government in order to obtain high government subsidies, resulting in high non-productive expenditure, thus crowding out the innovation behavior of enterprises, resulting in the waste of public resources (Zhu Jinsheng and Zhu Hua, 2021). In addition, the asymmetry of market information will also lead to the inhibition effect of government subsidies on enterprise innovation behavior. (Yu Jingtao and Yang Dali, 2018). A

third group of studies argues that government subsidies are subject to threshold effects. Only moderate subsidy policy can significantly stimulate enterprise innovation, and the part beyond the moderate subsidy range will inhibit enterprise innovation behavior. In this case, "subsidy-seeking" investment is an important reason why high government subsidy inhibits enterprise innovation behavior (MAO Qilin and Xu Jiayun, 2015). The fourth type of research holds that the relationship between government subsidies and enterprise innovation behavior is not significant (Li Zheng et al., 2018).

At present, a series of research dimensions on government subsidies and enterprise innovation behavior mostly focus on the degree of financial mismatch, capital constraints, debt structure maturity, market concentration, etc., and there is no study on the impact of government subsidies on enterprise innovation behavior combining with the macroeconomic circle. Therefore, from the perspective of business cycle, based on the existing research on government subsidies and enterprise innovation behavior, this paper will deeply explore the mechanism differences of government subsidies on enterprise innovation behavior in different business cycles and the root causes of these differences.

The main contributions of this paper are as follows: First, this paper will discuss the moderating effect of business cycle on the relationship between government subsidy and enterprise innovation behavior, and analyze the mechanism of the moderating effect of business cycle, which is a necessary supplement to the existing literature and bears certain theoretical significance. Second, this paper attempts to provide macro evidence of the role of the business cycle in the national innovation and development strategy, which has a certain practical value for the government to adopt different subsidy strategies in different business cycles and relieve the mismatch of financial subsidies.

In terms of the overall structure, the arrangement of this paper is as follows: The first part is a literature review, sorting out the previous research conclusions on government subsidies and enterprise innovation behavior; The second part is the theoretical analysis and research hypothesis, which systematically describes the theoretical basis of government subsidies and enterprise innovation behavior and clarifies the research ideas. The third part is the research design, which introduces the research design, empirical test and heterogeneity test in detail. The fourth part summarizes the full text and puts forward policy suggestions.

2. Literature Review

The market often fails in the allocation of innovation elements in the process of enterprises' innovation activities, for two major reasons: First of all, in view of the high risk of R&D innovation activities (Hall, 2002), enterprises ought to invest a large amount of capital, while enterprises generally have varying degrees of financing constraints (Wang Gang et al., 2017); Second, the enterprise income presents externality, that is, the enterprise cannot fully enjoy all the benefits brought by R & D investment (Yu Fen et al., 2021). Due to the limited amount of their capital and risk bearing capacity, most of the enterprises can only be frustrated in innovation activities, so these enterprises lack innovation motivation. When there are problems that cannot be regulated by the market itself, a "visible hand" is needed, that is, the government intervenes (Chaminade &Edquist, 2006). Therefore, the government gradually participates in enterprises' innovation activities with the help of various fiscal policies, so as to make up for the shortage of resource allocation regulated by the market and escort enterprises' innovation activities. The government mainly supports enterprise innovation through financial subsidies and tax relief (Yang Yang et al., 2015). This paper mainly focuses on the way of government financial subsidies.

However, in the context of the critical stage of economic transformation, there is no consensus on the relationship between government subsidies and enterprise innovation behavior. According to some studies, government subsidies can significantly improve the innovation behavior of enterprises. On the one hand, government subsidies will produce a "Halo Effect" (Chen Chao et al., 2021), that is, to release positive signals of recognition and support for enterprise innovation to the market, which is conducive to reducing the degree of financing constraints (Guo Yue, 2018), alleviating the financial

pressure of enterprises, and reducing the risk of enterprise innovation activities. On the other hand, as a direct source of funds, government subsidies can make up for the income loss caused by the externality of enterprise innovation activities (Yu Fen, 2021), improve the innovation willingness of enterprises, and thus have a positive crowding-in effect on enterprise innovation behavior.

The above study shows that government subsidies exert a positive incentive effect on enterprises' innovation behavior, while other studies show that government subsidies have a crowding-out effect on enterprises' innovation input. For enterprises with sufficient amount of self-owned capital, they still have the motivation and ability to carry out innovative activities even without government subsidies. Government subsidies are only substitutes for internal and external financing of enterprises, so enterprise innovation will not increase because of subsidies (Zhang Yuan et al., 2018). In addition, the primary goal of enterprises is survival even though government subsidies can reduce project costs. At this time, enterprises pay more attention to short-term profits and are likely to allocate the obtained government subsidies to non innovative projects, so as to squeeze out the innovation investment of enterprises (David et al., 2000). In order to obtain high government subsidies, some enterprises actively establish rent-seeking relationship with enterprises, resulting in a large amount of non productive expenditure, resulting in the crowding out effect of government subsidies on enterprise innovation (Zhu Jinsheng and Zhu Hua, 2021). In addition to the above two mainstream views, other studies point out that there is an optimal range of government subsidy amount, and "innovation subsidy trap" will emerge once the subsidy is lower than or above the critical point (Wu Xiaofei, 2016), and the moderate range of government subsidy tends to decline year by year (Mao Qilin and Xu Jiayuan, 2015). Some scholars even believe that government subsidies have no significant relationship with enterprise innovation (Yu Shengfang and Wang Jiaxi, 2022).

To sum up, the degree of financing constraints and factor allocation distortions are often different under different business circles even if existing studies have mentioned financing constraints and factor allocation distortions caused by information asymmetry, which may affect the mechanism of government subsidies on enterprises' innovation behavior. These are not detailed at the business cycle facet. With reference to the data of a-share listed companies from 2017 to 2019, this paper tries to analyze this from the perspective of business cycle. This paper theoretically discusses the moderating effect of business cycle on the relationship between government subsidy and enterprise innovation behavior and analyzes the mechanism of the moderating effect of business cycle. In a practical sense, this paper can provide macro evidence of the role of the business circle in the national innovation and development strategy, which has a certain practical value for the government to adopt different subsidy strategies and reduce the mismatch degree of financial subsidies in different business circles.

3. Theoretical analysis and research hypothesis

(1) Relationship between government subsidy and enterprise innovation behavior

Government subsidies, as an important means of government intervention in enterprise behavior, can promote enterprises to carry out innovative activities (Xie Weimin et al., 2009). From the resource-based view, government subsidies provide enterprises with direct innovation support, lower the risk of innovation activities, relieve the high cost pressure faced by enterprises in innovation activities, and bridge the gap between private and social benefits generated by enterprises in innovation activities (Clausen T H, 2009). According to this view, government subsidies to a certain extent enhance enterprises' willingness to innovate, so that they are more willing to increase the input of innovative behavior. From the perspective of signal transmission theory, government subsidy undoubtedly delivers favorable information of enterprises to the market, thus reducing information asymmetry between enterprises and external financing market, which helps enterprises break external financing constraints, broaden financing approaches and ease financing constraints. Existing studies have found that government subsidies can release the dual certification signal of technology and supervision based on government credit, solve the financing problem of enterprise innovation activities, and then stimulate enterprise innovation (Wang Ganggang et al., 2017).

However, since China's economy is obviously changing from the "substantial" into the "empty", enterprises are unwilling to engage in high-externality innovation activities for the sake of maximizing profits. At this point, the high level of government subsidies will lead to potential moral problems. On the one hand, enterprises carry out innovative activities in line with financial subsidy policies in order to obtain subsidies. Once subsidized, enterprises will immediately stop innovation activities and use the obtained funds in non-innovative production and operation activities, thus crowding out enterprise innovation input. On the other hand, as local governments have greater freedom in the selection of subsidy objects, a large number of "rent-setting" and "rent-seeking" problems will occur when supervision is unfavorable (Zhang Xingliang and Luo Hongyu, 2021). Enterprises will incur a large number of unproductive expenditures to maintain rent-seeking relations with government officials, resulting in a waste of public resources. In this context, government subsidies will have a reverse incentive effect on enterprise innovation behavior. Based on the above analysis, this paper puts forward the competitive hypothesis:

H1a: Government subsidies have a significant positive influence on enterprise innovation behavior.

H1b: Government subsidies have a significant negative impact on enterprise innovation behavior.

(2) Regulating effect of business circle on the relationship between government subsidies and enterprise innovation behavior

Innovation demand and innovation motivation gradually become important factors influencing the relationship between government subsidies and enterprise innovation (Zhou Wei et al., 2021; Yu Fen et al., 2021). If the macroeconomic circle changes, the innovation demand and motivation of enterprises will also change, thus playing a role in regulating the relationship between government subsidies and enterprise innovation. In order to expand the scale of enterprises, enterprises generally have a strong motivation to carry out innovation activities when the business circle is in a boom period. However, due to the fierce market competition and high business risk, external investors take many factors into consideration and experience a long period in investment selection. At this point, the input of government subsidies sends a positive signal to external investors, reduces the financing constraints of enterprises to a certain extent, and makes up for the gap of their own innovation resources. In contrast, in a recession, the business condition of enterprises usually begins to deteriorate and financing constraints are tight (Huang Hongbin et al., 2016). In this case, enterprises tend to use government subsidies for production and operation rather than innovation activities after obtaining government subsidies, so as to avoid being eliminated from the market and quickly stop losses. In other words, the business cycle plays a pro-cyclical role in the relationship between government subsidies and enterprise innovation behavior.

Some studies still show that there is a significant negative relationship between business cycle and enterprise technological innovation (Wu Xiaobo et al., 2011). In the period of economic prosperity, the monetary policy is relatively loose, the operation ability of enterprises is good, and the profit space of production and operation is large. According to the theory of property rights organization, innovation activities have higher positive externalities. In the case of weak IPR protection, enterprises are easy to be imitated by competitors, and their earnings are lower than expected, or even lower than innovation costs (Yu Fen et al., 2021). Therefore, in order to obtain short-term benefits, enterprises tend to invest the subsidy amount into non innovative activities. During the economic recession, the macroeconomic environment and market environment are in a tight state. In this context, market demand and enterprise production are gradually declining, capital turnover problems occur, and enterprises are facing serious external investment constraints. At this time, government subsidies are the most effective low-cost financing channel for enterprises. When enterprises receive government subsidies, managers will invest government subsidies into R&D and innovation of enterprises considering the low innovation cost (Wang Jun et al., 2021), so as to improve the "hard power" of enterprises and stand out in economic recovery. That is, the business circle plays a counter cyclical role in the relationship between government subsidies and enterprise innovation behavior. Based on the above analysis, this paper puts forward the competitive hypothesis:

H2a: Business cycle plays a pro cyclical role in the relationship between government subsidies and enterprise innovation behavior.

H2b: Business cycle plays a counter cyclical role in the relationship between government subsidies and enterprise innovation behavior.

4. Research Design

(1) Data sources

The corporate data used in this paper comes from the China Stock Market & Accounting Research Database, including the financial data of all a-share listed companies from 2017 to 2019. In order to ensure the reliability of the data, the original data are processed as follows: 1) Delete ST and PT listed companies; 2) Delete the data missing variables and obtain a total of 7461 valid samples. The business cycle data is from China Statistical Yearbook. In addition, in order to avoid the influence of extreme values, winsor of 1% above and below the main continuous variables is carried out in this paper.

(2) Variable definition

1. Explanatory variable

As for the explanatory variable LnSub, this paper refers to the logarithmic value of government subsidies by Zhou Wei et al. (2021) for measurement.

2. Explained variable

The selection of enterprise innovation behavior indicators is relatively complex. The commonly used indicators in existing research include the use of R & D investment intensity and R & D investment amount to represent enterprise innovation behavior (Zhou Wei et al., 2021; Zhang Xingliang and Luo Hongyu, 2021; Chen Chao et al., 2021). This paper considers R & D investment as a proxy variable.

3. Regulated variable

In this paper, the consistency index of enterprise prosperity index and the real GDP growth rate are used to measure the business circle.

4. Control variable

For the selection of control variables, reference was made to the literatures of Zhou Wei et al. (2021), Yu Fen et al. (2021), Yu Xiangfang et al., Wang Jiaxi et al. (2022). Leverage ratio (Lev), TobinQ, Size, Nta, CI, LargestHR and InsIP were selected to control the impact on enterprise innovation behavior. The definition and setting method of each control variable are shown in Table 1.

Table 1. Variable definitions

Variable symbol	Variable definitions	Setting methods
LnSub	Government subsidies	Ln (Amount of government subsidy)
RD	R&D investment	R&d investment
Cycle	Business cycle	A consistent index of business climate index
Lev	Asset-liability ratio	Total assets/total liabilities
TobinQ	Tobin Q value	Enterprise market value/asset replacement cost
Size	Enterprise scale	In (Total assets)
Nta	Proportion of tangible assets	Tangible assets / total assets
CI	Capital intensity	Fixed assets / total assets
LargestHR	Shareholding ratio of the largest shareholder	Number of shares held by the largest shareholder of the listed company/total number of shares of the listed company
InsIP	Shareholding ratio of institutional investors	Institutional investor shareholding/total share capital

(3) Model design

In order to study the relationship between government subsidies and enterprise innovation behavior, this paper constructs the following multiple linear regression model:

$$RD = \alpha 0 + \alpha 1 LnSub + \alpha 2 Lev + \alpha 3 TobinQ + \alpha 4 Size + \alpha 5 Nta + \alpha 6 CI + \alpha 7 LargestHR + \alpha 8 InsIP + \varepsilon \quad (1)$$

In order to study the regulatory effect of business cycle on the relationship between government subsidies and enterprise innovation behavior, this paper sets a multiple regression model as follows:

$$RD = \alpha 0 + \alpha 1 LnSub + \alpha 2 Cycle + \alpha 3 Lev + \alpha 4 TobinQ + \alpha 5 Size + \alpha 6 Nta + \alpha 7 CI + \alpha 8 LargestHR + \alpha 9 InsIP + \varepsilon (2)$$

$$RD = \alpha 0 + \alpha 1 LnSub + \alpha 2 Cycle + \alpha 3 LnSub * Cycle + \alpha 4 Lev + \alpha 5 TobinQ + \alpha 6 Size + \alpha 7 Nta + \alpha 8 CI + \alpha 9 LargestHR + \alpha 10 InsIP + \varepsilon \quad (3)$$

5. Empirical Analysis

(1) Descriptive and correlation statistical analysis

Table 2 presents descriptive statistical results. As can be seen from the table, the maximum R&D investment of a-share listed companies is 3.349 billion yuan, the minimum is 901058 million yuan, and the mean is 196.8 million yuan. R&D investment of different enterprises varies greatly. The maximum value of government subsidy is 20.49 and the minimum value is 11.42. The amount of government subsidy obtained by enterprises is high; the maximum value of asset liability ratio is 0.929 and the minimum value is 0.0603, which is quite different; the maximum value of Tobin Q is 7.646 and the minimum value is 0.827, indicating that there are great differences in industrial return on investment; the maximum value of company size was 11.54, the minimum value was 8.68, and the mean value was 9.673. The average proportion of tangible assets was 0.909, indicating that the average proportion of tangible assets was relatively high. The maximum value of capital intensity is 37.68, the minimum value is 0.425, and the mean value is 2.346. The average capital intensity of enterprises is low. The maximum shareholding ratio of institutional investors is 92.01 and the minimum is 0.0995, which is quite different; the average shareholding ratio of the largest shareholder is 33.70, which is at a medium level.

Table 2. Simple descriptive statistics

VARIABLES	N	mean	sd	min	max
RD	7,461	1.968e+08	4.483e+08	901,058	3.349e+09
lnSub	7,461	16.53	1.551	11.42	20.49
Cycle	7,461	122.0	1.387	120.2	123.4
Lev	7,461	0.411	0.190	0.0603	0.929
TobinQ	7,461	1.785	0.978	0.827	7.646
SIZE	7,461	9.673	0.553	8.680	11.54
Nta	7,461	0.909	0.101	0.529	1.000
CI	7,461	2.346	2.232	0.425	37.68
InsIP	7,461	40.29	25.21	0.0995	92.01
LargestHR	7,461	33.70	14.24	8.560	71.74

Table 3 lists the correlation coefficient matrix of each major variable. From Pearson coefficient and Spearman coefficient, there is a significant positive correlation between government subsidies and enterprise innovation behavior at the level of 1%, which is consistent with the expectation of hypothesis H1a; Regarding the moderating effect of business cycle on the relationship between government subsidies and enterprise innovation behavior, simple binary variable regression results are not significant, so the preliminary results of descriptive statistics cannot be used as reference to judge the relationship between the three, requiring further testing in the later stage. Most of the variable coefficients are in the range of 0-0.5, which preliminarily indicates that there is no serious multicollinearity problem and proves the effectiveness of the regression model.

Table 3. Correlation coefficient matrix

	RD	LnSub	Cycle	Lev	TobinQ	SIZE	Nta	CI	LargestHR	InsIP
RD	1	0.563***	0.014	0.236***	-0.159***	0.559***	-0.077***	-0.224***	-0.023*	0.167***
LnSub	0.468***	1	0.000	0.288***	-0.230***	0.613***	-0.077***	-0.072***	0.055***	0.278***
Cycle	0.009	0.022*	1	-0.023*	0.250***	0.009	-0.027**	0.038***	-0.024**	-0.023**
Lev	0.225***	0.265***	-0.012	1	-0.391***	0.515***	0.044***	-0.117***	0.020*	0.202***
TobinQ	-0.072***	-0.155***	0.191***	-0.298***	1	-0.528***	0.014	-0.012	-0.073***	-0.128***
SIZE	0.549***	0.609***	0.011	0.518***	-0.352***	1	-0.042***	-0.043***	0.100***	0.436***
Nta	0.031***	-0.033***	-0.012	0.073***	0.036***	-0.024**	1	-0.103***	0.164***	0.083***
CI	-0.105***	-0.065***	0.014	-0.007	-0.023**	0.045***	-0.098***	1	-0.107***	-0.103***
LargestHR	0.098***	0.081***	-0.023**	0.029**	-0.045***	0.158***	0.159***	-0.050***	1	0.453***
InsIP	0.246***	0.287***	-0.017	0.203***	-0.022*	0.464***	0.063***	-0.015	0.474***	1

Note: ***, ** and * represent significance levels at 1%, 5% and 10% respectively; Pearson and Spearman correlation coefficient matrices are in the lower left and upper right corner respectively.

(2) Basic regression and robust test

Table 4 shows the regression results of models (1), (2) and (3). In the case of controlling the fixed effect of entity and time, the basic regression is carried out first. As shown in column (1), the regression coefficient between government subsidy (LnSub) and R & D investment (RD) is 7.401e + 06, which is significantly positive at the level of 1%. It is assumed that H1a is proved. As shown in column (2), the regression coefficient of R&D investment (RD) and enterprise business climate index (Cycle) is -7.421E +07, which is significantly negative at 1% level; as shown in column (3), R&D investment (RD) and interaction term (LnSub*Cycle) are significantly negative at 10% level. This indicates that the business cycle has a negative moderating effect on the relationship between government subsidies and enterprise innovation behavior, and H2b is assumed to be proved. In the control variables, the asset liability ratio and capital intensity are significantly negatively correlated with the amount of R & D investment, and Tobin Q value, enterprise scale, the proportion of tangible assets, the shareholding proportion of institutional investors and the shareholding proportion of the largest shareholder are significantly positively correlated with the amount of R & D investment.

Table 4. Basic regression results

Column	(1)	(2)	(3)
	RD	RD	RD
LnSub	7.401e+06*** (2.343e+06)	7.401e+06*** (2.343e+06)	1.184e+08* (6.745e+07)
Cycle		-7.421e+07*** (5.964e+06)	-5.936e+07*** (1.082e+07)
LnSub*Cycle			-909,480* (552,550)
Lev	-8.715e+07*** (2.550e+07)	-8.715e+07*** (2.550e+07)	-8.751e+07*** (2.549e+07)
TobinQ	5.684e+06** (2.887e+06)	5.684e+06** (2.887e+06)	5.527e+06* (2.888e+06)
SIZE	3.255e+08*** (2.058e+07)	3.255e+08*** (2.058e+07)	3.256e+08*** (2.058e+07)
Nta	1.600e+08*** (3.963e+07)	1.600e+08*** (3.963e+07)	1.599e+08*** (3.962e+07)
CI	-4.344e+06*** (1.332e+06)	-4.344e+06*** (1.332e+06)	-4.373e+06*** (1.332e+06)
InsIP	1.203e+06*** (329,269)	1.203e+06*** (329,269)	1.196e+06*** (329,240)
LargestHR	1.120e+06** (509,845)	1.120e+06** (509,845)	1.126e+06** (509,761)
Year fixed effect	Yes	Yes	Yes
Entity fixed effects	Yes	Yes	Yes
Adjusted R^2	0.153	0.153	0.154
Observed value	7461	7,461	7,461

Note: ***, ** and * represent significance levels at 1%, 5% and 10% respectively.

In order to test the stability of regression results, different dependent variables and moderating variables were selected for further regression analysis. As for the dependent variable, in addition to r&d investment amount, R&D investment intensity RDint is selected as the index to measure enterprise innovation behavior. As shown in Table 5 (1), (2) and (3), the variable coefficients of government subsidy and enterprise climate index are respectively 0.057 and -0.659, which are significant at 1% level, and the interaction coefficient is -0.0057 and significant at 10% level. The results indicate that both R&D investment amount and R&D investment intensity are positively correlated with government subsidy and innovation behavior, and the business cycle plays a negative moderating role in the relationship. In the control variables of the regression results, the enterprise scale, capital intensity and the shareholding ratio of the largest shareholder are significantly negatively correlated with the R & D investment intensity, while the asset liability ratio, Tobin Q value, the proportion of tangible assets and the shareholding ratio of institutional investors are significantly positive with the R & D investment intensity.

In terms of regulated variables, the real GDP growth rate pergdp represents the macroeconomic fluctuation. When the adjusting variable is the real GDP growth rate, as shown in table 5 (4), (5) and (6), the coefficient of government subsidy, real GDP growth rate and interaction variable are 7.401e+06, -7.766e+07 and -2.684e+06 respectively, which are significant at 1% level. It shows that the moderating effect on the relationship between government subsidies and enterprise innovation behavior is negative whether the enterprise climate index or real GDP growth rate is selected to measure the business cycle. In the control variables of the regression results, the asset liability ratio and capital intensity are significantly negatively correlated with the amount of R & D investment. Tobin Q value, enterprise scale, the proportion of tangible assets, the shareholding proportion of institutional investors and the shareholding proportion of the largest shareholder are significantly positive with the intensity of R & D investment.

Table 5. Robustness test: surrogate dependent variable and moderating variable indicators

Column	(1)	(2)	(3)	(4)	(5)	(6)
	RDint	RDint	RDint	RD	RD	RD
LnSub	0.0570***	0.0570***	0.753*	7.401e+06***	7.401e+06***	4.531e+06*
	(0.0134)	(0.0134)	(0.385)	(2.343e+06)	(2.343e+06)	(2.434e+06)
Cycle		-0.659***	-0.566***			
		(0.0341)	(0.0617)			
LnSub*Cycle			-0.00570*			
			(0.00315)			
pergdp					-7.766e+07***	-3.265e+07***
					(6.242e+06)	(1.229e+07)
LnSub*pergdp						-2.684e+06***
						(631,267)
Lev	0.0853	0.0853	0.0831	-8.715e+07***	-8.715e+07***	-8.330e+07***
	(0.146)	(0.146)	(0.146)	(2.550e+07)	(2.550e+07)	(2.546e+07)
TobinQ	0.0338**	0.0338**	0.0328**	5.684e+06**	5.684e+06**	6.055e+06**
	(0.0165)	(0.0165)	(0.0165)	(2.887e+06)	(2.887e+06)	(2.883e+06)
SIZE	-1.263***	-1.263***	-1.262***	3.255e+08***	3.255e+08***	3.230e+08***
	(0.117)	(0.117)	(0.117)	(2.058e+07)	(2.058e+07)	(2.055e+07)
Nta	1.809***	1.809***	1.809***	1.600e+08***	1.600e+08***	1.579e+08***
	(0.226)	(0.226)	(0.226)	(3.963e+07)	(3.963e+07)	(3.956e+07)
CI	-0.0864***	-0.0864***	-0.0866***	-4.344e+06***	-4.344e+06***	-4.192e+06***
	(0.00761)	(0.00761)	(0.00761)	(1.332e+06)	(1.332e+06)	(1.330e+06)
InsIP	0.00338*	0.00338*	0.00333*	1.203e+06***	1.203e+06***	1.204e+06***
	(0.00188)	(0.00188)	(0.00188)	(329,269)	(329,269)	(328,644)
LargestHR	-0.00370	-0.00370	-0.00366	1.120e+06**	1.120e+06**	1.113e+06**
	(0.00291)	(0.00291)	(0.00291)	(509,845)	(509,845)	(508,879)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Entity fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.167	0.167	0.167	0.153	0.153	0.157
Observed value	7461	7,461	7,461	7461	7,461	7,461

Note: * * *, * *, * respectively represent the significance level of 1%, 5% and 10%

(3) Group estimation results

In the previous part, this paper observes the impact of government subsidies on enterprise innovation behavior and the moderating effect of business cycle on the relationship between government subsidies and enterprise innovation behavior. In the following part, the influence of government subsidies on enterprises' innovation behavior in different geographical locations and the moderating effect of business cycle on the relationship between government subsidies and enterprises' innovation behavior are observed. For this reason, enterprises are divided into eastern region group and non-eastern region group. The two groups of enterprise samples are estimated, and the results are shown in Table 6. It can be seen that the amount of R & D investment of enterprises located in the east is positively correlated with government subsidies at the level of 5%, and the adjustment effect of business cycle on them is negative at the level of 10%, which is consistent with the result of basic regression. The R & D investment of enterprises located in non-eastern China is at the level of 5%, which is positively correlated with government subsidies. However, the adjustment effect of business cycle is not significant. Chen Chao et al. (2021) pointed out that excessive market concentration will have a negative impact on enterprise innovation. The market concentration of enterprises in the eastern region is high, and the response to business cycle fluctuations is obvious. As a result, when the economy is prosperous, enterprises will choose to invest government subsidies in non innovative activities in order to avoid the innovation risk caused by high externality. During the depression, due to the low innovation cost, enterprises will invest government subsidies in enterprise innovation activities in order to stand out in the fierce competition. Enterprises in non-eastern regions have a low degree of market concentration and have no obvious response to macroeconomic fluctuations. Therefore, whether the business cycle is in a boom or a bust, government subsidies will positively push into enterprise innovation input.

Table 6. Group test results

Column	Eastern enterprises			Non-eastern enterprises		
	RD	RD	RD	RD	RD	RD
LnSub	7.899e+06**	7.899e+06**	1.877e+08**	8.521e+06**	8.521e+06**	1.184e+08
	(3.347e+06)	(3.347e+06)	(9.442e+07)	(3.821e+06)	(3.821e+06)	(1.154e+08)
Cycle		-8.721e+07***	-6.302e+07***		-5.713e+07***	-4.263e+07**
		(8.451e+06)	(1.525e+07)		(9.977e+06)	(1.820e+07)
LnSub*pergdp			-1.474e+06*			-900,991
			(773,419)			(945,395)
Lev	-1.009e+08***	-1.009e+08***	-1.010e+08***	-7.020e+07	-7.020e+07	-7.103e+07
	(3.527e+07)	(3.527e+07)	(3.525e+07)	(4.559e+07)	(4.559e+07)	(4.560e+07)
TobinQ	4.966e+06	4.966e+06	4.764e+06	6.559e+06	6.559e+06	6.314e+06
	(4.118e+06)	(4.118e+06)	(4.117e+06)	(4.875e+06)	(4.875e+06)	(4.882e+06)
SIZE	3.430e+08***	3.430e+08***	3.435e+08***	2.865e+08***	2.865e+08***	2.862e+08***
	(2.990e+07)	(2.990e+07)	(2.989e+07)	(3.327e+07)	(3.327e+07)	(3.327e+07)
Nta	2.141e+08***	2.141e+08***	2.132e+08***	1.655e+07	1.655e+07	1.822e+07
	(5.481e+07)	(5.481e+07)	(5.479e+07)	(7.200e+07)	(7.200e+07)	(7.203e+07)
CI	-5.356e+06**	-5.356e+06**	-5.341e+06**	-3.810e+06*	-3.810e+06*	-3.900e+06**
	(2.167e+06)	(2.167e+06)	(2.166e+06)	(1.969e+06)	(1.969e+06)	(1.971e+06)
InsIP	1.486e+06***	1.486e+06***	1.469e+06***	74,264	74,264	77,644
	(454,358)	(454,358)	(454,262)	(596,679)	(596,679)	(596,713)
LargestHR	74,236	74,236	86,703	3.502e+06***	3.502e+06***	3.503e+06***
	(758,560)	(758,560)	(758,286)	(770,053)	(770,053)	(770,085)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Entity fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.128	0.128	0.129	0.177	0.177	0.178
Observed value	5,497	5,497	5,497	1,964	1,964	1,964

Note: * * *, * *, * respectively represent the significance level of 1%, 5% and 10%

6. Conclusion and Implication

Starting from the business cycle, this paper tries to analyze the role and influence of government subsidies on enterprises' innovation behavior under the adjustment of business cycle. According to the empirical results of a-share listed companies from 2017 to 2019, government subsidies have a significant positive influence on enterprise innovation behavior, and the business cycle plays a counter-cyclical adjustment role in the relationship between government subsidies and enterprise innovation behavior, that is, in the economic boom, the business cycle negatively adjusts the relationship between government subsidies and enterprise innovation behavior. During the economic depression, the business cycle positively adjusts the relationship between government subsidies and enterprise innovation. The grouping test found that the above effects are mainly reflected in the enterprises located in the eastern region and the enterprises located in the non eastern region. The influence of government subsidies on enterprise innovation does not change significantly in the fluctuation of business cycle. The theoretical contribution of this paper lies in: Firstly, this paper explores the impact of government subsidies on enterprise innovation from the perspective of business cycle, which enriches the research on the economic consequences of government fiscal policy in different macroeconomic environments. Second, this paper distinguishes the impact effects of government subsidies in different geographical locations, and provides new evidence for the study of the implementation effects of government subsidies. Third, this paper discusses enterprise innovation behavior from macroeconomic perspective rather than enterprise characteristics and other factors, which to some extent broadens the research and application of enterprise innovation.

Based on the research, the following policy recommendations are made: First of all, it is time for the government to continue to promote the input of government subsidies and urge enterprises to improve the innovation investment mechanism, so as to stimulate the innovation motivation and willingness of enterprises. Secondly, the government should timely adjust subsidy policies according to macroeconomic cycle fluctuations, improve the efficiency of innovation subsidies, and avoid the waste of a large number of public resources. Finally, geographical location is an important factor that adjusts the relationship between government subsidies and firm innovation behavior in business cycle. It is necessary for governments at all levels and policy makers to formulate subsidy policies and select subsidized enterprises according to the actual situation. In economic depression, the government pays more attention to providing subsidies to enterprises in eastern regions, while in economic prosperity, the subsidy focus should be transferred to non-eastern regions.

The limitation of this study is that it only analyzes the effect of government subsidy on enterprises' innovation behavior. In the future, a variety of government fiscal policies can be combined to comprehensively consider their impact on enterprise innovation behavior and its path. In addition, this paper only analyzed the data of A-share listed companies from 2017 to 2019. In future studies, longer time span data can be further cited to improve the universality of the paper.

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