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The Moderating Effect of Economic Uncertainty on Fiscal Subsidies Incentivize Innovation Investment in High-Tech Manufacturing Enterprises

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Abstract

The role of fiscal subsidies in enterprise innovation has long been a crucial subject of study. Nevertheless, scholars hold diverse views regarding the government's intervention and guidance of enterprises through subsidy measures. In recent years, the global economic landscape has been marred by uncertainties, with events such as financial crises, political unrest, trade frictions, the COVID-19 pandemic and military conflicts occurring intermittently. These factors have introduced significant volatility into the economic operating environment. In the present context, where innovation has emerged as the primary driver of China's economic development, but the domestic and international economic development environments are highly unstable. Moreover, China is during an economic structural transformation. The effectiveness of policy-making, often hampered by its inherent lag, and the impact of the external economic environment on policy effectiveness, whether it leads to an increase or decrease, are issues worthy of in-depth exploration. To address these questions, an empirical study was conducted using data from high-tech manufacturing enterprises listed on the stock market from 2018 to 2023. Initially, the fundamental concepts and perspectives of government intervention theory were summarized, and relevant research on government fiscal policies and corporate innovation activities was reviewed. Against this backdrop, macro-economic instability was introduced as the research context, and research hypotheses were formulated. Subsequently, based on these hypotheses, a model was constructed, and regression analysis was performed. This analysis aimed to examine the relationship between fiscal subsidies and corporate innovation output, as well as the moderating effect of economic shocks on the impact of fiscal subsidies on corporate innovation investment.

Keywords: Economic Uncertainty, Fiscal Subsides, Innovation Performance, Moderator

Introduction

China's economy has entered a new phase, where innovative development is not only a central policy objective but also a fundamental driver of sustainable economic growth (Shi, 2021). Rooted in Schumpeterian growth theory, which emphasizes the role of technological progress and entrepreneurial innovation in driving economic expansion, this shift underscores the strategic importance of fostering an innovation-driven economy. Enterprises, as the primary agents of innovation, play a critical role in this transformation, with their research and development (R&D) investments serving as a key indicator of innovative capacity and long-term competitiveness. From the perspective of endogenous growth theory, which highlights the role of innovation and knowledge accumulation in sustained economic advancement, increasing firms' innovation inputs is essential for maintaining China's growth momentum. Consequently, the core challenge in implementing the innovation-driven development strategy lies in formulating effective policy mechanisms to incentivize enterprises to enhance their R&D expenditures, thereby reinforcing their role as engines of technological progress (An, 2009).

To foster independent innovation among enterprises, the government has rolled out an array of policies. These initiatives aim to stimulate enterprise innovation and drive a continuous increase in R&D investment intensity (Wu, 2016). For high-tech enterprises in particular, the government offers special matching funds, innovation vouchers, patent rewards, and more. For instance, in China's Guangdong Province, eligible high-tech firms receive direct subsidies of up to 5 million RMB for critical R&D projects, while cities like Shenzhen grant 50,000 RMB per approved invention patent to incentivize intellectual property creation. Additionally, in key technological sectors such as semiconductors, artificial intelligence, and biotechnology, the government has established dedicated industrial funds, such as the China Integrated Circuit Industry Investment Fund ("Big Fund"), which has allocated over 300 billion RMB to support innovation and industrial upgrading. Beyond the conventional direct fiscal subsidy approach, the government has introduced indirect subsidy mechanisms such as tax incentives and loan interest subsidies. A prominent example is China's "Two Exemptions and Three Halvings" policy for integrated circuit enterprises, which exempts corporate income tax for the first five profitable years and cuts rates by half for the subsequent five years. Similarly, the U.S. offers a 20% R&D tax credit for qualifying expenses, benefiting companies like Tesla and Intel in their innovation-driven expansions.

The global political landscape is experiencing rapid and profound transformations, with anti-globalization trends gaining momentum and reshaping the international economic order. As a result, China's ambition to achieve innovation-driven development faces mounting external challenges, including supply chain disruptions, trade restrictions, and technological decoupling. These uncertainties, coupled with escalating macroeconomic volatility, significantly complicate the predictability and stability of policy impacts (Chen, 2018). Given these dynamics, the government must frequently adjust its policy framework in response to shifting economic conditions, creating challenges for enterprises attempting to formulate long-term innovation strategies. Policy uncertainty, particularly concerning fiscal subsidies and tax incentives, makes it difficult for firms to anticipate future policy directions, leading to hesitancy in committing to high-risk, long-term R&D investments. For example, fiscal subsidy programs may undergo changes in funding allocation, eligibility criteria, or subsidy intensity due to economic fluctuations (Huang, 2018). The Made in China 2025 initiative, initially

intended to bolster high-tech industries, has faced modifications in response to geopolitical pressures, affecting enterprises' expectations of long-term policy stability.

Previous research has predominantly centered on exploring policy effectiveness issues stemming from enterprise heterogeneity, industry distinctions, and regional economic disparities. However, relatively little attention has been given to how shifts in the macroeconomic environment—such as global economic downturns, geopolitical tensions, and financial crises—can cause deviations from the original intent of policy design. To bridge this gap, this study examines the dynamic interactions between fiscal policy instruments and enterprise innovation under conditions of macroeconomic instability. By incorporating real-world case studies and empirical data, this research aims to provide a comprehensive understanding of how macro-environmental changes can either amplify or diminish the intended effects of policy measures. Through addressing these gaps, this study contributes to the literature by offering empirical insights into the stability and adaptability of fiscal policies in turbulent macroeconomic conditions, thereby providing practical recommendations for policymakers seeking to optimize innovation-driven growth strategies.

Theoretical Analysis and Research Hypotheses

Beginning with the market intervention theory, it is essential for the government to intervene in economic activities to some extent. This is because market failures can occur, which require corrective action to enhance resource allocation efficiency and foster economic stability and growth. During the enterprise innovation process, market failures are particularly prevalent. This is mainly due to the high-risk nature, externalities, and information asymmetry inherent in innovation activities. These risk-laden characteristics cause enterprises to be extremely cautious when making innovation - related decisions. In some cases, the high risks may even lead them to abandon innovation altogether. Consequently, the government can directly support enterprise innovation via financial subsidies. Such subsidies serve a dual purpose: they not only reduce the marginal cost of research and development (R&D), but also decrease the sunk cost associated with R&D (He Yanlin,2017). This enables enterprises to re-allocate and make use of their surplus funds more effectively. As a result, government subsidies can significantly promote enterprise technological innovation initiatives. Therefore, hypothesis 1 of this study is proposed that fiscal subsidies can promote innovation investment in high-tech manufacturing enterprises.

The eruption of trade frictions between China and the United States stands as a prominent and concentrated manifestation of anti-globalization. In this context, the large-scale imposition of tariffs by the US on Chinese goods has far reaching implications, leading to a significant decline in demand, which directly translates into a notable reduction in income. Moreover, with the erosion of market share and the added cost burden, the profit margins of these enterprises are severely squeezed, causing a serious shrinkage of profits. For enterprises, maintaining a stable and continuous cash flow is crucial for their research and development (R&D) investment. However, the adverse effects of trade frictions and other external economic shocks, which directly hampers their innovation activities, as insufficient funds may force them to cut back on R&D projects, delay the introduction of new technologies, or even abandon innovative initiatives altogether. Based on this, the following hypothesis 2 is put forward, economic uncertainty can negatively moderate the promotion of fiscal subsides on innovation investment of high-tech manufacturing enterprises

Literature Review

Enterprise innovation is a long-term and complex process fraught with high uncertainty and a significant risk of failure. Moreover, innovation outcomes often generate positive externalities, benefiting not only the innovating firm but also the broader economy. However, due to the substantial costs and risks associated with research and development (R&D), enterprises frequently encounter financial and strategic hurdles that may hinder their ability to sustain innovation efforts. In this context, government intervention through fiscal policies can play a pivotal role in alleviating financial constraints and incentivizing firms to increase their investment in scientific research and technological development (Zhang, 2016). Empirical studies provide divergent perspectives on the impact of fiscal subsidies on enterprise innovation. Iao (2014), in a study focusing on emerging strategic enterprises, found that fiscal subsidies exert a positive influence on innovation investment, effectively encouraging firms to engage in R&D activities. However, the objective of fiscal subsidies extends beyond merely stimulating innovation—they may also be leveraged for non-innovation purposes, such as enhancing firms' financial statements or improving short-term profitability. In such cases, a portion of subsidy funds may be diverted away from actual R&D activities, diminishing their intended effect on innovation. Conversely, Li et al. (2017) analysed A-share listed companies in non-financial industries, explicitly excluding fiscal subsidies unrelated to innovation. Their findings suggested that, under certain circumstances, fiscal subsidies could exert a crowding-out effect, discouraging firms from allocating their own resources to internal R&D investment. This implies that while fiscal support mechanisms are designed to bolster innovation capacity, they may, in some cases, reduce firms' incentives to engage in self-funded innovation, highlighting the complex and sometimes contradictory effects of government intervention on enterprise innovation dynamics.

The influence of economic policy uncertainty (EPU) on micro-level business activities has garnered growing attention from scholars in recent years. However, despite its theoretical and practical significance, there remains a paucity of literature systematically exploring the relationship between EPU and enterprise innovation. Furthermore, the existing body of research presents divergent perspectives on this relationship, leading to a lack of consensus in the field. On one hand, scholars such as Bhattacharya et al. (2014) argue that heightened economic policy uncertainty creates an uncertain business environment, which can deter managers from pursuing risky innovation investments. Their research suggests that when faced with increased EPU, firms tend to adopt a more conservative strategy, prioritizing short-term stability over long-term innovation. This perspective aligns with the traditional view that uncertainty reduces risk-taking behaviours, as managers may perceive innovation as a high-risk endeavour with uncertain returns. On the other hand, Gu et al. (2018) offer a contrasting viewpoint, positing that economic policy uncertainty, particularly during periods of economic decline, can paradoxically stimulate innovation investment among Chinese enterprises. According to their findings, the pressure to adapt to changing market conditions and regulatory frameworks may incentivize firms to invest in innovation as a means of gaining competitive advantage. This perspective highlights the potential for uncertainty to act as a "double-edged sword," depending on the specific context and institutional environment. However, both perspectives share a critical limitation: they primarily focus on the direct effects of EPU on innovation without adequately considering the mediating role of policy design and implementation.

Previous research has largely overlooked the impact of macroeconomic deterioration, focusing primarily on firm-level heterogeneity as the key determinant of fiscal subsidy effectiveness. While enterprise-specific factors, such as ownership structure, financial constraints, and industry characteristics, undeniably influence how different firms respond to the same policy, the broader macroeconomic environment serves as the foundational mechanism shaping these policy effects. For example, during periods of economic downturns, such as the 2008 global financial crisis, fiscal subsidies may have a more pronounced effect on stimulating innovation investment as firms seek to diversify their revenue streams and enhance competitiveness in uncertain markets. Conversely, in stable economic environments, the same subsidies may have a weaker impact due to reduced perceived necessity for innovation. Similarly, geopolitical tensions, such as trade wars or sanctions, can create an uncertain business environment, prompting firms to redirect their innovation efforts toward developing alternative technologies or markets. These examples illustrate how the external economic environment serves as a critical determinant of the effectiveness of fiscal subsidies in fostering innovation.

Moreover, existing studies often overlook the role of macroeconomic dynamics in shaping the underlying mechanisms through which fiscal subsidies influence innovation investment. For instance, during times of high inflation or currency volatility, the real value of subsidies may erode, diminishing their intended incentive effect on firms. Additionally, financial crises can disrupt access to capital, limiting firms' ability to utilize subsidies effectively for innovation purposes. These factors highlight the importance of considering macroeconomic fluctuations when evaluating the impact of fiscal subsidies on innovation.

In conclusion, while previous studies have made valuable contributions to understanding the relationship between fiscal subsidies and innovation investment, there is a pressing need to expand the scope of analysis to include the broader external economic environment. By doing so, researchers can provide more nuanced insights into the conditions under which fiscal subsidies are most effective, ultimately informing the development of policies that better support enterprise innovation in an increasingly uncertain world.

Research Design

Data Source. The data is based on Chinese A-share listed companies from 2013 to 2023, which is sourced from Guotai An. The sample is screened as follows: financial industry and ST listed companies are excluded.

Target Companies. According to the Chinese Industry Classification Standard (GB/T4754-2017), this study categorizes the 30 types of manufacturing industries, and High-tech manufacturing refers to industries with high technological content and high added value, including five categories, pharmaceutical manufacturing, specialized equipment manufacturing, railway, shipbuilding, aerospace and other transportation equipment manufacturing, computer, communication and other electronic equipment manufacturing and instrument manufacturing. By matching all listed A-share enterprises exported from the WIND database with the CSMAR database, accurate samples of high-tech manufacturing enterprises can be reasonably screened.

Variable Definition. The dependent variable of this study is innovation investment, which is measured by R&D expenditures from the annual financial reports of listed target companies. Independent variable is fiscal subsidies received, which is the government subsidies amount in the non-recurring profit and loss items of listed companies' annual reports. Controls variables are enterprise size, age, asset liability ratio. Moderator variable is economic uncertainty index, which is China Economic Policy Uncertainty Index compiled by scholars Baker, Bloom and Davis based on the method of text retrieval and text filtering for large newspapers.

Table 1
Variable Definition and Explanation

Dependent Variable	R&D Expenditures	Rin	Logarithm of R&D Expenditures
Independent Variable	Fiscal Subsidies	SUB	Logarithm of Total Amount of Subsides Received Listed on Financial Statements
Control Variables	Scale of Enterprise	SCALE	Logarithm of Total Asset of Enterprise
	AGE of Enterprise	AGE	The Difference Between the Establishment of the Company and the Year of Observation
	Asset Liability Ratio	ALR	Measured by the asset liability ratio, Total Liabilities/Total Assets
Moderator Variable	Economic Uncertainty Index	EUi	Use China Economic Policy Uncertainty Index, and take the arithmetic mean to convert monthly data into annual data, then divides it by 100

Model Formation, which is model 1, to test the hypothesis 1,

$$Rin_{it} = \alpha_0 + \alpha_1 Sub_{it} + \alpha_2 SIZE_{it} + \alpha_3 AGE_{it} + \alpha_4 ALR_{it} + \varepsilon_{it}$$

Model 2 to test the hypothesis 2,

$$Rin_{it} = \alpha_0 + \alpha_1 Sub_{it} + \alpha_2 EUi_{it} + \alpha_3 EUi_{it} * \alpha_1 Sub_{it} + \alpha_4 SIZE_{it} + \alpha_5 AGE_{it} + \alpha_6 ALR_{it} + \varepsilon_{it}$$

Tabel 2
Descriptive Statistics

	Rin	Sub	Scale	Age	Alr	EUi
Mean	424,000,000	67,611,332	12,200,000,000	21.4	0.4	71.79667
Median	135,000,000	20,255,047	4,190,000,000	21	0.392	73.55
Maximum	14,800,000,000	5,460,000,000	472,000,000,000	65	1.216	95.02
Minimum	1,148,885	11,200	205,000,000	6	0.03	43.66
Skewness	7.091393	11.34138	8.69	1.12	0.395	19.34224
Kurtosis	67.10583	194.2936	98.24	6.97	2.969	-0.15774

To better present the data characteristics of variables, this article selects the original variables of the above variables for descriptive statistical analysis. The average annual scale of R&D expenditure capital stock is about 424 million yuan, but there is also a large gap between high-end manufacturing enterprises. The largest R&D expenditure capital stock reached 1.48 billion yuan, while the smallest was only 11 million yuan. in terms of corporate characteristics, high-tech manufacturing enterprises have an average listing age of 21 years and an average size of 4.19 billion yuan. The average asset liability ratio can represent the liquidity level of the enterprise is 0.4 and median asset liability ratio is 0.392. The minimum value of the

Economic Policy Uncertainty Index is 43.66 and the maximum value is 95.02, indicating that there were frequent changes in economic policies during the observation period, and the uncertainty index fluctuated greatly.

Table 3
Correlation Analysis

Probability	AGE	ALR	RIN	SCALE	SUB	EUI
AGE	1					
ALR	0.048601 0.0047**	1				
RIN	0.172165 0***	0.296181 0***	1			
SCALE	0.240966 0***	0.358333 0***	0.883521 0***	1		
SUB	0.166788 0***	0.328629 0***	0.78096 0***	0.811361 0***	1	
EUI	0.157336 0***	0.036613 0.0333	0.095737 0***	0.082691 0***	0.064569 0.0002***	1

Notes: Significance levels: ***, **, and * represent significant levels at 1%, 5%, and 10%, respectively.

The above figure shows the correlation analysis of variables, illustrating the correlation between variables. The independent variables SUB and EUI show a significant positive correlation with the dependent variable Rin, which is consistent with the hypothesis of this study that enterprise innovation is positively correlated with fiscal subsidies and uncertainty index.

Through multicollinearity testing, this study found that the variance inflation factor (VIF) of enterprise size is the largest, which is 2.24, far less than 10, so it can be considered that there is no problem of multicollinearity.

Results and Analysis

Firstly, based on the model 1, explore the relationship between fiscal subsidies and corporate R&D expenditures.

$$Rin_{it} = \alpha_0 + \alpha_1 SUB_{it} + \alpha_2 SIZE_{it} + \alpha_3 AGE_{it} + \alpha_4 ALR_{it} + \varepsilon_{it}$$

Variable	Coefficient	Std. Error	t - Statistic	Prob	Significance
C	1.701974	0.601030	2.831763	0.0047	**
SUB	0.037421	0.007740	4.834713	0.0000	***
SCALE	0.797775	0.018172	43.90150	0.0000	***
AGE	- 0.412253	0.170025	- 2.424665	0.0154	*
ALR	- 0.096245	0.053682	- 1.792868	0.0731	*

Notes: Significance levels: ***, **, and * represent significant levels at 1%, 5%, and 10%, respectively.

From the regression results of figure above, it can be inferred that there exists a positive correlation between SUB and innovation investments (RIN), whose coefficient is 0.0037 with a 1% significant level.

In addition, observing the positive and negative values and significance of regression coefficients for other control variables, the larger the scale of an enterprise, the more research and development investment it has, and the more active its innovation. In terms of the resources and experience required for innovation, large-scale enterprises have a greater advantage in innovation capability than small-scale enterprises. The younger the enterprise, the more research and development investment it has, and the more active its innovation. New enterprises may not have as much innovation experience as mature enterprises, but they are more motivated to carry out innovation activities because innovating in the market is an important survival principle for new enterprises. The asset liability ratio is negatively correlated with innovation investment. Due to the financial situation of the enterprise, it faces significant financing constraints, making it difficult to invest in innovative activities. Therefore, the higher the asset liability ratio, the less R&D investment a company has.

According to Model 2, the next step is to explore whether economic policy uncertainty has a moderating effect on the relationship between fiscal subsidies and corporate innovation,

$$Rin_{it} = \alpha_0 + \alpha_1 Sub_{it} + \alpha_2 PUi_{it} + \alpha_3 PUi_{it} * Sub_{it} + \alpha_4 SIZE_{it} + \alpha_5 AGE_{it} + \alpha_6 ALR_{it} + \varepsilon_{it}$$

Variable	Coefficient	Std. Error	t - Statistic	Prob.	Significance
C	10.50802	0.334918	31.37491	0.0000	***
SUB	0.087747	0.017389	5.046157	0.0000	***
UPI	- 0.012178	0.003449	- 3.531301	0.0004	***
UPI*SUB	0.000717	0.000202	3.543918	0.0004	***
SCALE	0.282576	0.018807	41.61013	0.0000	***
AGE	2.243925	0.071422	31.41774	0.0000	***
ALR	0.147516	0.070463	2.093517	0.0364	**

Notes: Significance levels: ***, **, and * represent significant levels at 1%, 5%, and 10%, respectively.

From the regression results of model 2, it is clearly that UPI has negative relationship with the enterprise innovation investments, which confirmed the hypothesis 2 of this study. It means under the macro deteriorating economics, the willingness of investments of high-tech enterprises on innovation tend to be depressed.

From the cross coefficient of EUI and fiscal subsidies, which is 0.0007 with a significant level, which reflects the moderating effect of macroeconomic instability factors on the relationship between fiscal subsidies and innovation expenditures, and it is a positive adjustment. Specifically, in situations of high macroeconomic instability, the promoting effect of fiscal subsidies on innovation expenditure will be enhanced. This means that although macroeconomic instability factors themselves suppress innovation expenditures of enterprises, fiscal subsidies can to some extent alleviate this inhibitory effect and even further incentivize enterprises to increase innovation expenditures.

Meanwhile, one thing should be noticed is after adding EUI, the correlation coefficient between enterprise age and innovation investment becomes positive, indicating that macro instability factors have changed the relationship between enterprise age and innovation expenditures. When the external economy continues to be sluggish, mature enterprises have stronger capabilities and resources to invest in innovation due to their richer resource reserves, including funds, technological accumulation, market channels, stable supply chains, and customer relationships, to cope with crises and seek new development opportunities. In

contrast, young enterprises may have a higher willingness to innovate, but due to limited resources and weaker risk resistance, they are more likely to reduce innovation expenditures in a macro unstable environment due to survival pressures. Overall, macroeconomic instability factors not only affect the relationship between fiscal subsidies and innovation expenditures, but also significantly alter the correlation between enterprise age and innovation expenditures. This provides important reference for policy makers and business managers. Policy making should consider the characteristics of different enterprises under macro instability factors, and enterprises also need to adjust their innovation strategies reasonably according to changes in the macro environment and their own development stage.

In addition, the asset liability ratio is positively correlated with innovation investments. Before incorporating macro instability factors, there is a negative correlation between asset liability ratio and innovation expenditure, indicating that when the asset liability ratio is high, enterprises face greater debt pressure and financial risks, which will limit their innovation expenditure ability. Enterprises need to prioritize ensuring that funds are used to repay debts, making it difficult to have sufficient funds to invest in innovation. After incorporating macro instability factors, companies may take risks to increase innovation spending to overcome difficulties or seize new opportunities that may arise in an unstable environment, even if facing high asset liability ratios. They hope to bring new profit growth points and improve their financial situation through innovation. At the same time, macroeconomic instability may make companies realize that only through innovation can they enhance competitiveness, survive and develop in turbulent markets, so even if their debt is high, they will increase their investment in innovation.

Robust Test

To verify the robustness of the results, considering the long-term nature of the innovation process, referring to Li Weisheng's (2019) research, a lagged explanatory variable was used for regression to address endogeneity issues. The results of the robustness test supported and consolidated the conclusions of the study.

$$Rin_{it} = \alpha_0 + \alpha_1 Sub\_lag1_{it} + \alpha_2 SIZE_{it} + \alpha_3 AGE_{it} + \alpha_4 ALR_{it} + \varepsilon_{it}$$

Robust Test Model 1	**Coefficient**	**Std. Error**	**t - Statistic**	**Prob.**
C(Ro)	2.288000	0.745110	3.070689	0.0022**
C	1.701974	0.601030	2.831763	0.0047**
SUB_LAG1(Ro)	0.019601	0.007938	2.469258	0.0136**
SUB	0.037421	0.007740	4.834713	0.0000***
SCALE(Ro)	0.795956	0.020069	39.66025	0.0000***
SCALE	0.797775	0.018172	43.90150	0.0000***
AGE(Ro)	- 0.520303	0.213682	- 2.434933	0.0150**
AGE	- 0.412253	0.170025	- 2.424665	0.0154**
ALR(Ro)	0.213160	0.058171	3.664346	0.0003***
ALR	- 0.096245	0.053682	- 1.792868	0.0731*

Notes: Significance levels: ***, **, and * represent significant levels at 1%, 5%, and 10%, respectively.

The coefficient symbols of the above regression results are consistent with the previous text, indicating the robustness of the empirical results in this study.

Conclusions and Suggestions

By comparing and summarizing the results of regression analysis, the deterioration of the macro environment does indeed have a significant moderating effect on the incentive of corporate innovation investment through fiscal subsidies.

At the national level, economic downturn is threat but also opportunity, the threat is it indeed inhibit the investment willingness of enterprise but the opportunity is it improved the quality of innovation performance, which is precisely an important window period for innovation investment incentives for high-tech manufacturing enterprises. For instance, enterprises unable to predict future policy changes may postpone innovation decisions, leading to short-term inefficiencies in subsidy utilization. A clear example is the fluctuation in China's semiconductor industry subsidies, where inconsistent policies initially led to inefficiencies in capital allocation, slowing down the progress of key projects. Meanwhile, countercyclical innovation theory (Aghion et al., 2010) emphasizes that during economic recessions, firms' willingness to innovate declines due to heightened financial risks, making government intervention more crucial, as Schumpeter's theory of creative destruction suggests, economic downturns often serve as an opportunity for innovation-driven enterprises to restructure and upgrade.

Given the dual role of macroeconomic fluctuations, both as an opportunity and a constraint, the government should adjust fiscal subsidies dynamically to maximize their impact on innovation investment.

Ensure policy stability, transparency and foresight. Policy uncertainty has a restraining effect on corporate innovation investment. The government should improve the transparency and predictability of economic policies, enhance communication with enterprises, and release policy interpretations and economic forecasts in a timely manner. For example, policy transparency can be improved by holding policy interpretation meetings regularly and releasing economic situation analysis reports. This will help firms align their innovation strategies with government support, reducing the risk of abrupt investment halts.

Under normal circumstances, there is a positive correlation between subsidies (SUB) and innovation investment (RIN), while when macroeconomic instability intensifies, the promoting effect of fiscal subsidies on innovation expenditure will be enhanced. This means that at present, the government should maintain stable and sustainable subsidy policies, so that enterprises can form stable expectations and actively plan innovation investment, further strengthening the promotion effect of subsidies on innovation investment. With the continuous deterioration of the macro economy, the government should appropriately increase the scale of subsidies, optimize subsidy methods, improve the accuracy and timeliness of subsidies, further strengthen the promoting effect of fiscal subsidies on enterprise innovation expenditures, and help enterprises resist the negative impact of macroeconomic fluctuations. For instance, in response to COVID-19, China introduced R&D super deductions and accelerated depreciation policies to encourage firms to sustain innovation efforts.

Support Large Enterprises as Innovation Anchors. Large enterprises play a stabilizing role in industrial innovation, who has an advantage in innovation ability compared to small enterprises, especially during downturns. Encouraging enterprises to continuously expand their scale and enhance their innovation ability can be achieved by setting up special incentive funds for high-tech manufacturing enterprises above designated size to encourage them to carry out cutting-edge and fundamental innovation research, promote industry technological breakthroughs, and drive small and medium-sized enterprises to carry out innovation activities. For example, China's AI and semiconductor industries have benefited from direct government funding for major firms like Huawei and SMIC, which in turn stimulate innovation in smaller firms.

Prioritize Mature Enterprises in Innovation Subsidy Programs. Empirical findings indicate that mature enterprises exhibit stronger innovation resilience during economic downturns. When the economy declines, mature enterprises show a stronger willingness to innovate. The government should allocate more resources to these firms, encouraging them to undertake industry-wide technological research. Therefore, for policy support during the window period, emphasis should be placed on tilting towards mature enterprises, encouraging them to utilize their resource advantages, carry out major innovation projects, undertake industry common technology research and development tasks, and the government can provide key support through major science and technology projects, industrial innovation funds, and other means.

Encourage and support directly at Debt-Burdened Enterprises but with potential innovation competence to Sustain Innovation. Firms with a high asset-liability ratio often reduce R&D spending due to financial constraints. However, during economic downturns, innovation remains crucial for long-term survival. The government should increase innovation subsidies and rewards for high asset liability ratio enterprises during the economic downturn window. Establish a special innovation fund to provide additional financial support to enterprises that persist in innovation and achieve certain results under high asset liability ratios, incentivize enterprises to continue investing in innovation during difficult times, help enterprises improve their financial situation through innovation, and achieve a virtuous cycle. For instance, during the global financial crisis, China's "Industry Revitalization Plan" helped high-tech enterprises secure additional financial support, enabling them to continue R&D activities without liquidity concerns.

In conclusion, the deterioration of the macro - environment exerts a significant positive moderating effect on enterprises' innovation investment via fiscal subsidies. Nevertheless, macro - uncertainty also exerts a suppressive influence on enterprises' innovation investment. It is crucial not to overlook the restraining effects of policy uncertainty and financial constraints on corporate innovation. To maximize the efficacy of fiscal subsidies, the government should prioritize enhancing policy transparency, adjusting subsidy structures in accordance with economic cycles, and strengthening support for enterprises of diverse sizes and financial situations. By taking these steps, fiscal policy can function as a more targeted and potent instrument in maintaining long - term technological innovation and industrial competitiveness amidst macro - economic fluctuations. Specifically, the government should improve policy transparency and foresight while strengthening communication with enterprises. It should optimize fiscal subsidy policies, maintaining stability under normal circumstances and appropriately increasing the scale of subsidies when the macro - economy

deteriorates. Additionally, the government should encourage enterprises to expand their scale and enhance their innovation capabilities, and provide preferential support to mature enterprises and those with high debt levels.

Through these measures, the government can more effectively leverage the role of fiscal subsidies, promote enterprise innovation investment, assist enterprises in withstanding the negative impacts of macro - economic fluctuations, and achieve long - term sustainable development.

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