# Financial Subsidies, Tax Incentives, and Innovation Quality: Empirical Evidence from High-Tech Enterprises in Sichuan Province, China

**Qiuhong Liu[1,2], Rani Diana Othman[3*] and Siti Nurhazwani Kamarudin[4]**

[1]*Faculty of Accountancy, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia.*

[2]*School of Economics and Management, Panzhihua University, China.*

[3]*Faculty of Accountancy, Universiti Teknologi MARA, Cawangan Melaka, Kampus Alor Gajah, Malaysia*

[4]*Faculty of Accountancy, Universiti Teknologi MARA, Cawangan Terengganu, Kampus Dungun, Malaysia*

## ABSTRACT

Innovation has become a crucial driving force for economic development now. In 2023, the Sichuan Province in China ranked 10th nationwide in innovation capability, indicating the need for further breakthroughs. Between 2016 and 2020, the Sichuan Province witnessed a total of 35 companies going public, with 26 of them being high-tech enterprises, accounting for 74.29%. Therefore, the overall improvement in innovation capability needs to be built upon the original innovation capacity of high-tech enterprises. Financial subsidies and tax incentives are often used to improve innovation quality, but their effectiveness is a subject of controversy. This study selected 34 high-tech enterprises from the Sichuan Province listed on the Shanghai and Shenzhen stock exchanges as research samples. Using relevant data from 2017 to 2022, the study empirically examined the impact of financial subsidies and tax incentives on the innovation quality of these enterprises. The research found that both individuals had a positive stimulating effect on innovation quality. However, when these two policies were implemented simultaneously, the incentive effect was weaker compared to the impact of each policy individually.

**Keywords:** Financial Subsidies, Tax Incentives, Innovation Quality, High-Tech Enterprises.

ARTICLE INFO

**Article History:**
*Received:* *19 February 2024*
*Accepted:* *23 July 2024*
*Available online:* *01 August 2024*

*Corresponding Author: Rani Diana Othman; Faculty of Accountancy, Universiti Teknologi MARA, Cawangan Melaka, Kampus Alor Gajah, Malaysia; Email: diana067@uitm.edu.my

## INTRODUCTION

Innovation plays a crucial role in the economic development of China. According to the data released by the Global Innovation Index 2023, China was ranked 12th in 2023, a decrease of one place compared to 2022. Compared with traditionally strong innovation nations, China still faces certain gaps in innovation capabilities. Innovation quality is a reflection of innovation capability. Research on the measurement of innovation quality primarily utilizes indicators such as patent citation rates, number of citations, quantity of patent applications, and granted patents (Xu et al., 2021). China was among the top 5 countries in international patent applications in 2022 after the United States, Germany, and Japan (EPO,2023). In 2021, the Chinese government further emphasized the core position of innovation in the overall modernization of China. The plan highlights the necessity to uphold innovation as the strategic support for national development and to consider technological self-reliance as a cornerstone in the country's development.

The innovation of high-tech enterprises in the Sichuan Province is crucial for the economic development of China. The definition of high-tech enterprises is based on the "Management Measures for the Recognition of High-tech Enterprises" which was revised and issued in 2016 in China. It refers to resident enterprises that, within the scope of "National Key Supported High-tech Fields" promulgated in China consistently engage in research and development and the transformation of technological achievements. Wang Siwei et al. (2023) revealed significant regional disparities in economic development, characterized by a gradient distribution of "high in the east, followed by the northeast, moderate in the central, and low in the west." Sun et al. (2021) also noted pronounced regional differences in China's high-quality development level, presenting an evident "high in the east, low in the west" pattern. As a significant western province in China, the Sichuan Province must accelerate its pace of innovative development when the Chinese government advocates the new development concepts of innovation, coordination, green, openness, and sharing. In 2021, more than 50% of the A-share listed companies in the Sichuan Province were high-tech enterprises. Therefore, the overall improvement in the innovation capability of the Sichuan Province needs to be built upon the enhancement of the innovation capabilities of high-tech enterprises.

The Sichuan Province attaches great importance to the fiscal and tax policies for high-tech enterprises. Financial subsidies, primarily include fund rewards, R&D support, significant Science and Technology Innovation Platform Construction support, Key Core Technology Breakthrough support, Industrial Base Restructuring support, Technology Achievement Transfer, and Transformation support. For example, in Dazhou City, high-tech enterprises with an annual R&D investment exceeding 2 million yuan receive support equivalent

to 3% of the R&D investment, with a maximum support limit of 500,000 yuan. The enterprises can receive a maximum subsidy of 20 million yuan for the establishment or restructuring of significant science and technology innovation platforms. Support is provided to enterprises conducting key core technology breakthrough projects with a maximum support of 10 million yuan. For key projects that demonstrate a significant driving role in industry demonstration and restructuring, the policy grants support up to 30% of the project's research and development expenses, with a maximum support of 10 million yuan. Provincially assessed outstanding new R&D institutions can receive maximum supplementary support of 5 million yuan. Tax incentives mainly include income tax exemptions and additional deductions for R&D expenses. Details are shown in Table 1:

**Table 1:Tax Incentives for High-tech Enterprises in Sichuan Province**

| | Policy type | Incentives |
|---|---|---|
| Tax Base - Based Incentives | Half Reduction Collection/ Exemption | Income from Agricultural, Forestry, Animal Husbandry, and Fisheries Projects |
| | Exemption | The portion of annual income from eligible technology transfers not exceeding 5 million yuan |
| | Half Reduction Collection | The portion of annual income from eligible technology transfers that exceed 5 million yuan |
| | Three Exemptions and Three Halves | Income derived from the investment and operation of national key supported public infrastructure projects, as well as income from eligible environmental protection, energy conservation, and water conservation projects, is exempt from tax for the first three years starting from the year of earning the first operational income. From the 4th to the 6th year, it is subject to a 50% reduction in collection |
| | Deductible Income | Income generated by enterprises through the comprehensive utilization of resources and the production of products by the national industrial policy is included in the total income at a reduced rate of 90% |
| | Accelerated Depreciation | If fixed assets need accelerated depreciation due to technological advancements or other reasons, the depreciation period can be shortened, or accelerated depreciation methods can be adopted |
| | Additional Deductions | For the years 2018-2020， if research and development expenses that have not been capitalized into intangible assets are not included in the current period's profit and loss, a pre-tax additional deduction of 175% based on the actual amount incurred is applicable |
| | Investment Offset | Start-up investment enterprises engaged in entrepreneurial investments supported and |

| | | |
|---|---|---|
| | | encouraged by the state, with a duration of at least 2 years, are eligible for a 70% deduction of the tax amount based on the invested capital |
| | | High-tech enterprises supported as a national priority and technology-advanced service enterprises duly recognized are subject to a reduced tax rate of 15% |
| Tax Rate-Based Incentives | Lower Tax Rate | From 2021 to 2030, for enterprises in encouraged industries in the western region, taxation is calculated at a reduced rate of 15% |
| | | From 2019 to 2021, third-party enterprises engaged in pollution prevention are subject to a reduced tax rate of 15% |
| Tax Amount-Based Incentives | Tax Amount Offset | 10% of the investment amount in special equipment for environmental protection, energy conservation, water conservation, and safety production, purchased and used by the enterprise, is eligible for tax offset |

***Source***：By the policy compilation of the State Administration of Taxation

Fiscal and tax policies are crucial for the innovation quality of high-tech enterprises in Sichuan Province. Schumpeter's theory emphasizes that there is a mutually supportive relationship between innovation and institutions. The institution provides incentives and order for technological innovation and economic growth, while technological innovation provides the basis and tools for institutional innovation. The government can guide the development of industrial enterprises through fiscal and tax policies. Because financial subsidies and tax incentives can directly stimulate enterprises to increase their R&D investments, they are motivated to boost their innovation efforts to gain more government support. In the short term, this will increase the enterprises' innovation output, and in the long term, it will help achieve sustainable innovation. Cheng et al. (2019) pointed out that financial support through government financial subsidies is conducive to increasing the number of patent applications and patent grants by enterprises. In summary, existing research is rich, but conclusions are controversial, mainly focusing on the level of enterprise innovation activities. This study is the first time that high-tech enterprises in the Sichuan Province are being studied, which specifically focuses on innovation quality.

## LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESES

### Theoretical Basis of Innovation Quality

Joseph Schumpeter was the pioneer in explaining economic development through innovation. In his work, "The Theory of Economic Development", Schumpeter introduced the "Innovation Theory", then further applied and developed it in his

later works, such as "Business Cycles" and "Capitalism, Socialism and Democracy," forming a unique theoretical system based on the "Innovation Theory." Schumpeter's theory of technological innovation shows that economic development involves the continuous introduction of technology-based innovations into the market. In the contemporary world, technological innovation is regarded as the engine of economic growth, becoming a decisive factor and fundamental driving force for economic development. Innovation quality has evolved from the concept of R&D quality, as proposed by Juran in 1951, who defined R&D quality as the extent to which it creates and satisfies the needs of the target customers. Keogh and Bower (1997) were among the first to emphasize the correlation and importance of innovation and quality, considering them as key factors for the success of businesses. Since then, the concept of innovation quality has gradually gained attention from scholars. Haner (2002) was the first to elucidate the concept and content of innovation quality, stating that it encompasses the overall performance of an organization in all areas related to innovation potential, innovation process, and innovation outcomes. It possesses unique dynamics, including dimensions such as quantity, performance, reliability, time, cost, customer value, and complexity of innovation. Mu et al. (2018) proposed that innovation quality is manifested in the effectiveness of a company's innovation, the number of times invention patents are cited, and the patent authorization rate.

## Financial Subsidies and Innovation Quality

In this study, financial subsidies were defined according to the Chinese "Enterprise Accounting Standard No. 16−Government Grants" (CaiKuai [2017] No. 15), referring to monetary and non-monetary assets provided by the government to enterprises without charge. Financial subsidies include subsidies for enterprise research and development expenses, equipment upgrade subsidies, technological transformation subsidies, and so on. From existing research findings, financial subsidies may positively impact a company's innovation, giving rise to specific complementary, spillover, or stimulating effects. However, they may also have negative effects on a company's R&D investment, leading to substitution, inhibition, or crowding out of R&D investment (Teng et al., 2020), thereby influencing the innovation quality of the enterprise.

Some scholars believe that financial subsidies have a positive promoting effect on enterprise innovation as indicated in Figure 1 which is constructed based on studies by Yao & Huang (2022), Busom et al. (2014) and Chen et al. (2020). Yao and Huang (2022) selected A-share-listed State-owned Enterprises from 2010 to 2019 as samples, discovering that Chinese R&D subsidies have a promoting effect on the sustainable innovation performance of strategic emerging enterprises. However, some scholars have found inconsistent empirical results, suggesting that financial subsidies have an inhibitory effect on enterprise

innovation, leading to the conclusion that financial subsidies have crowding-out effects or limited effects. In particular, when financial subsidies are improperly implemented, such as having an overly broad scope or excessive total amount, the policy effects can shift from regulating socio-economic activities to becoming a burden inhibiting economic development (Acebo et al., 2020).

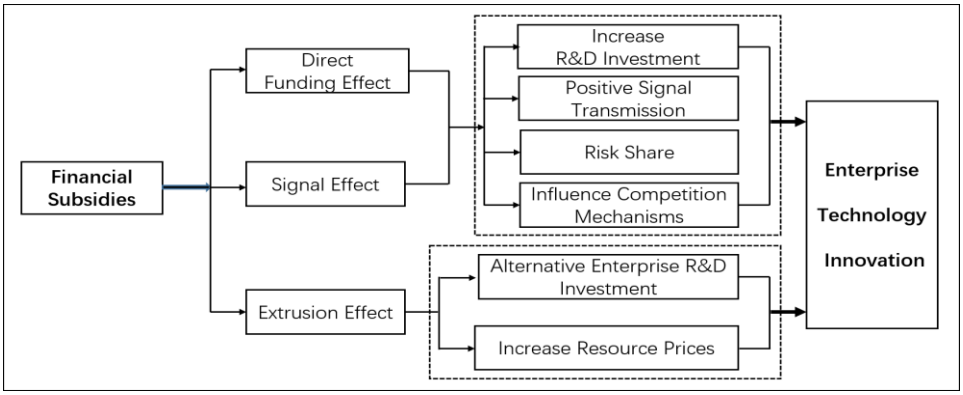


**Figure** Error! No text of specified style in document.. **The impact path of Financial Subsidies on Enterprise Technological Innovation**

Some scholars also believe that financial subsidies may have different effects on the innovation quality of different enterprises. Miotti and Sachwald (2003) found in their study that for non-high-tech sector companies, public funding increased the probability of obtaining patents but did not affect the share of innovative products in financial turnover. However, for high-tech sector companies, it did influence the share of innovative products. Research on Italian enterprises discovered that subsidies for small enterprises could increase their investment, while for large enterprises, subsidies had no additional effect (Bronzini and Iachini, 2012). In summary, there is controversy regarding the impact of financial subsidies on innovation quality (Guo et al., 2016). Therefore, based on the uncertainty in existing research regarding the influence of financial subsidies on innovation quality, we proposed Hypothesis 1.

H1: There is a significant positive relationship between financial subsidies and the innovation quality of high-tech enterprises in Sichuan Province.

## Tax Incentives and Innovation Quality

Zhu et al. (2023) suggested that tax incentives refer to the utilization of tax policies to reduce or exempt certain enterprises and taxpayers from tax burdens according to the provisions of tax laws and administrative regulations. Combining the above definition and acknowledging the summary from the Baidu

Encyclopedia (2023), this study recognized tax incentives as a measure employed by the government to support the development of specific industries, regions, or enterprises. Specific methods include tax reduction or exemption, preferential tax rates, tax offset, additional deductions, and deferred taxation. In existing research, tax incentives can reduce innovation costs for enterprises, increase operational cash flow, promote R&D investment at the enterprise level, enhance innovation investment, and lead to the successful development of new production processes and products as indicated in Figure 2, which is constructed based on studies by Zhu et al. (2023), Mardones and Ávila (2020), and Ivus et al. (2021). There is abundant evidence for both developed countries and developing countries supporting the positive impact of tax incentive policies in incentivizing R&D expenditure (Ivus et al., 2021). However, some studies analysed tax incentives from the perspective of input and output have varying conclusions (Xu and Wang, 2022).

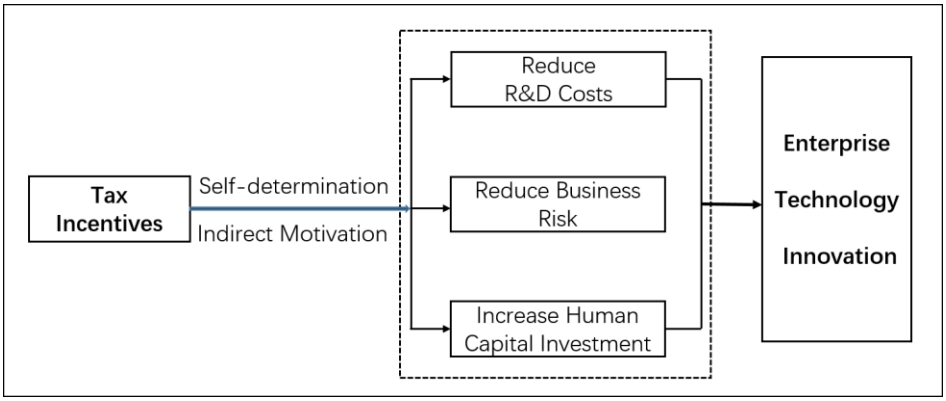


**Figure 2. The impact path of Tax Incentives on Enterprise Technological Innovation**

In summary, there is abundant evidence indicating the additional effects of this policy tool on R&D investment by enterprises (Hall, 2019), but there is controversy over its effectiveness. Recently, this research agenda has expanded to study innovation output and firm performance (Nilsen et al., 2020). Castellacci and Lie (2015) suggested, based on empirical analysis, that the effects of tax incentives are significantly higher for industrial enterprises compared to other industries, demonstrating industry differences in the impact of tax incentives. Therefore, considering high-tech enterprises, we proposed Hypothesis 2.

H2: There is a significant positive relationship between tax incentives and the innovation quality of high-tech enterprises in Sichuan Province.

### Financial Subsidies, Tax Incentives, and Innovation Quality

There is still limited research on the interaction between tax incentives and direct subsidies, and the simultaneous use of them. Researchers acknowledge that different policies may interact with each other. The reasons for the interaction between these policy tools lie in the characteristics of direct and indirect support, as well as the possibility of their simultaneous use. In terms of which type of policy has a more significant impact on innovation quality, Westmore (2013) reported in a group consisting of 19 OECD countries that subsidies have a greater effect than tax incentives. Meanwhile, Busom et al. (2014) found in their study that financially constrained small and medium-sized enterprises are more inclined towards subsidies rather than tax incentives. Mardones and Ávila (2020) suggested that tax incentives have the most significant impact on firms engaging in both internal and external R&D activities. Regarding the question of whether these two types of policies exhibit substitution effects, Busom et al. (2014) ultimately found that, from a policy perspective, tax incentives and financial subsidies are not substitutes. Later, Busom et al. (2017) conducted further analysis based on European cases, revealing that R&D tax incentives and R&D subsidies are not mutually exclusive, they must coexist to generate endless innovation. In terms of whether these two types of policies exhibit mutually reinforcing incentive effects, Bérubé and Mohnen (2009) suggested that combining tax incentives with grants is more effective for innovation output compared to using tax incentives alone. Pang et al. (2020) found that the synergistic effects of innovation policies are prominent in driving innovation in China. The authors claimed that financial subsidies play the strongest role in the innovation input and technology development stages, government procurement is crucial in the technology innovation transformation stage, and tax incentives have a more balanced impact throughout the innovation process.

Based on the aforementioned, research findings and considering the actual development situation of high-tech enterprises in Sichuan Province, the following hypothesis was proposed:

H3: There is an interactive effect between financial subsidies and tax incentives towards the innovation quality of high-tech enterprises in Sichuan Province.

## METHODOLOGY

### Sample Selection and Data Sources

Samples were A-shared listed high-tech enterprises of Sichuan Province from 2017 to 2022. A-shared, also known as RMB common stocks, are ordinary shares issued by companies registered within China. Patent outputs were obtained

through the CSMAR database, and financial subsidies, tax incentives, and other financial data were sourced from the Wind database. The original data were organized and processed as follows: (1) Excluded financial and non-profit enterprises with a history of more than 3 years; (2) Removed companies with less than five years of observations or those with interrupted or missing key data; (3) Excluded companies with an asset-liability ratio outside the range of 0-1, actual tax rate less than zero, and Earnings Before Interest and Taxes less than zero; (4) Excluded companies with financial subsidies and tax incentives less than zero; (5) Excluded companies with a substantial number of patent applications equal to zero. Ultimately, 34 enterprises were selected from the initial pool of 81 high-tech listed companies, resulting in a total of 204 observations. To reduce data volatility, and eliminate heteroscedasticity, some variable indicators underwent logarithmic transformation to enhance the stability of regression results.

## Dependent Variable

Compared to the number of authorized patents, the number of patent applications by enterprises can more accurately and timely reflect their innovation level, especially about invention patent applications, which better gauge the substantive innovation level of enterprises. Consequently, drawing from prior studies, this study utilized the number of invention patent applications by high-tech enterprises (Chen et al., 2020) as a proxy variable for innovation quality. In this study, the measurement of innovation quality was calculated by taking the natural logarithm of the current year's number of invention patent applications plus one, following the approach suggested by previous research.

$$\text{Innovation Quality} = \ln(1 + \text{Number of invention patent applications})$$

## Independent Variable

Financial Subsidies: On May 10, 2017, the Chinese Ministry of Finance issued the revised "Enterprise Accounting Standard No. 16 - Government Subsidies" (CaiKuai [2017] No. 15), which took effect on June 12, 2017. The newly promulgated standard requires that Government Subsidies related to the daily business activities of enterprises be recognized as Other Income. Government Subsidies unrelated to the daily business activities of enterprises are to be recognized as Non-operating Income. Therefore, during the period from 2017 to 2022, financial subsidies were calculated as Other Income minus Tax Return, plus the portion of Government Subsidies in Non-operating Income. To prevent heteroscedasticity in the model, this study applied a logarithmic transformation to the relevant data on financial subsidies. The measurement method for financial subsidies in high-tech enterprises in this research was as follows:

$$\text{Sub} = \ln[\text{Government Subsidies in Non-Operating Income} + (\text{Other Income} - \text{Tax Return})]$$

Tax Incentives: Turnover taxes and corporate income taxes are the main incentives in China. Tax incentives for turnover taxes are concentrated in tax refunds, as reflected in the "Received Tax Fee Refunds" section of the cash flow statement. Regarding corporate income tax incentives, this study calculated the amount of tax incentives for the current year by multiplying the difference between the nominal tax rate and the actual tax rate by the total profit. The natural logarithm of this value was then taken as the measure of the tax incentives for corporate income tax (Zhu et al., 2023). The statutory tax rate was set at 25%, as stipulated by the Chinese Corporate Income Tax Law. The actual tax rate was explicitly defined in the "Specific Analysis Indicators and Their Use in Tax Assessment for Specific Tax Categories" section of the "Tax Assessment Management Measures" published by the State Administration of Taxation of China. The actual tax burden was calculated as the taxable income divided by the total profit, where the taxable income is the income tax expense minus the deferred income tax expense. The measurement method for tax incentives in high-tech enterprises in this research was as follows:

(i) Tax incentives =Ln (Corporate income tax incentives + Corporate turnover tax incentives)
(ii) Corporate income tax incentives= (Nominal tax rate - Actual tax rate) × Total profit
(iii) Among them: actual tax rate = (Income tax expense - Deferred income tax expense) / Total profit
(iv) Corporate turnover tax incentives = Tax refund received

## Model Design

To empirically examine the implementation effects of fiscal and tax policies, the impact of financial subsidies and tax incentives on the innovation quality of high-tech enterprises in the Sichuan Province was quantified. Innovation quality was taken as the dependent variable, with financial subsidies, and tax incentives as the main explanatory variables. Simultaneously, to test the interactive effect when conducting the two policies together, variable ST was added to the model to express both multiplied terms for interaction analysis. Control variables, including enterprise size and total asset turnover rate, were included to establish the following panel data regression model:

$$\mathrm{Iq}_{it}=\beta_0+\beta_1 Sub_{it}+\beta_2 \mathrm{Tax}_{it}+\beta_3 Sub_{it}\times \mathrm{Tax}_{it}+\beta_4 \mathrm{Size}_{it}+\beta_5 \mathrm{Tat}_{it}+\varepsilon_{it}$$

Where i represented different enterprises, t represented different years, $\beta$n(n=1,2,3,4,5) represented the parameters corresponding to each explanatory variable, and $\varepsilon it$ is the disturbance term not affected by individual differences and time variations. The meanings of each core variable are shown in Table 2.

**Table 2: Variables and Their Measurements**

| Category | Variable name | Symbol | Measurement | Main reference |
|---|---|---|---|---|
| Dependent variable | Innovation quality | Iq | Ln (1+Number of invention patent applications) | (Chen et al., 2020) |
| Independent variable | Financial subsidy | Sub | ln [Government subsidies in Non-Operating Income + (Other Income-Tax return)] | (Financial Accounting [2017] No. 15) |
| | Tax incentives | Tax | Tax =Ln (Itb+Ttc)<br>Itb= (Statutory tax rate - Actual tax rate) × Total profit<br>Ttc= Tax refund received | (Zhu et al., 2023) |
| Control variable | Enterprise size | Size | Ln(total assets at the end of the year) | (Jiang, Z. et al., 2020) |
| | Total Asset Turnover Ratio | Tat | Net operating income / Average total assets | (Brigham and Houston 2021) |

## RESULTS AND DISCUSSION

### Descriptive Statistics

By analyzing the data of A-share high-tech enterprises in Sichuan Province listed on the Shanghai and Shenzhen stock markets from 2017 to 2022, a model containing 6 variables was established, and descriptive statistical analysis was conducted using Stata 17.0. The results are presented in Table 3.

**Table 3: Descriptive Statistics Results**

| Variable | Obs | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| Iq | 204 | 1.73 | 0.96 | 0 | 3.93 |
| Sub | 204 | 7.04 | 1.35 | 0 | 10.39 |
| Tax | 204 | 7.75 | 1.24 | 4.33 | 11.08 |
| ST | 204 | 54.89 | 15.91 | 0 | 103.02 |
| Size | 204 | 12.44 | 0.86 | 11.14 | 15.04 |
| Tat | 204 | 0.54 | 0.22 | 0.13 | 1.36 |

The maximum value of innovation quality for enterprises was 3.93, with a minimum value of 0, indicating a certain difference in innovation among different

high-tech enterprises in Sichuan Province. The mean value of financial subsidies was 7.04, with a minimum value of 0 and a maximum value of 10.39, indicating significant variations in subsidies provided by the government to various types of high-tech enterprises. In contrast, the minimum value for tax incentives was 4.33, and the maximum value was 11.8, with a relatively smaller gap compared to financial subsidies. As for control variables, the mean value of enterprise size for the sample high-tech enterprises was 12.44, with a minimum value of 11.14 and a maximum value of 15.04, indicating a relatively small difference in the size of the sample enterprises. The mean value of total asset turnover was 0.54, indicating good conversion ability for the outcomes of innovation, but there is still room for improvement.

## Correlation Test

The results, as in Table 4, indicated a positive correlation between financial subsidies, tax incentives, enterprise size, total asset turnover, and innovation quality. The findings align with Yao and Huang (2022), revealing that subsidies in China have a promoting effect on the sustainable innovation performance of strategic emerging enterprises. The result was also in line with Xu et al. (2021), indicating that tax incentive policies are advantageous for innovation investments by enterprises and have a positive impact on corporate innovation.

**Table 4: Correlation Test Results**

| | Iq | Sub | Tax | ST | Size | Tat |
|---|---|---|---|---|---|---|
| Iq | 1.0000 | | | | | |
| Sub | 0.1866** | 1.0000 | | | | |
| Tax | 0.1729** | 0.1796 | 1.0000 | | | |
| ST | 0.2044 | 0.8465** | 0.6641** | 1.0000 | | |
| Size | 0.3728** | 0.3466 | 0.6495 | 0.5930 | 1.0000 | |
| Tat | 0.1786 | -0.2558 | 0.2724 | -0.0533 | 0.2320* | 1.0000 |

***Note:*** *p<0.05, ** p<0.01

## Regression Results Analysis

As shown in Table 5, it can be seen that the coefficients for financial subsidies and tax incentives, as explanatory variables, were 1.061 and 0.651 respectively, indicating a positive relationship. Sichuan Province is an important province in Western China. At present, there is an obvious imbalance in regional development

in the level of innovation, and it lags far behind the eastern region. High-tech enterprises in Sichuan Province face a more prominent problem of capital shortage. Therefore, compared with preferential tax policies, direct financial subsidy policies can play a more direct promotion role. So, these data confirm the validation of Hypothesis 1 and Hypothesis 2. This implies a significant positive relationship between financial subsidies and the innovation quality of high-tech enterprises in Sichuan Province, as well as a significant positive relationship between tax incentives and the innovation quality of high-tech enterprises in Sichuan Province.

**Table 5: Regression Results**

| | (1)<br>Iq | (2)<br>Iq | (3)<br>Iq |
|---|---|---|---|
| Sub | 0.134** | | 1.061*** |
| | (0.0495) | | (0.313) |
| Tax | | 0.135* | 0.651** |
| | | (0.0540) | (0.250) |
| ST | | | -0.109** |
| | | | (0.0345) |
| Size | | | 0.396*** |
| | | | (0.101) |
| Tat | | | 0.652* |
| | | | (0.304) |
| _cons | 0.792* | 0.688 | -10.06*** |
| | (0.355) | (0.424) | (2.180) |
| N | 204 | 204 | 204 |
| adj. R-sq | 0.030 | 0.025 | 0.190 |

***Note***：*p<0.05, ** p<0.01, ***p<0.001

Moreover, due to the interaction term coefficient of -0.109 for financial subsidies and tax incentives with a p-value of 0.002, indicateds that there was an interactive effect between financial subsidies and tax incentives in influencing innovation quality, and the effect was a mutual crowding-out effect. The conclusion was different from the research findings of Ghazinoory and Hashemi (2021), who proposed that for large enterprises, there is a promoting effect between tax incentives and direct subsidies. On the one hand, this may be because the policy objectives of financial subsidies and tax incentives are inconsistent. Current financial subsidies tend to support specific innovation projects or enterprises, while tax incentives focussed more on encouraging enterprises to increase R&D investment. Pang et al. (2020) found that in the innovation process, financial subsidies have the strongest effect in the innovation investment and technology development stage. Still, the effect of tax incentives was relatively balanced. When both coexist, enterprises may face a policy goal dilemma, leading to offsetting policy effects. On the other hand, although financial subsidies and tax incentives can provide certain financial support, financial pressures, and financial issues may still constrain innovation activities. Enterprises may prioritize short-term benefits and neglect long-term innovation investment.

Additionally, market competition and external environmental uncertainty can also lead to crowding-out effects of financial subsidies and tax incentives. In intense market competition, enterprises may be more focused on short-term profits and market share competition rather than long-term innovation investment. External environmental uncertainty increases enterprises' risk perception, thereby reducing innovation investment.

## CONCLUSION

This study showed that the implementation of financial subsidies or tax incentives alone had a positive incentive effect on the innovation quality of high-tech enterprises. Currently, the effect of financial subsidies is significantly more pronounced than that of tax incentives. For the Sichuan Province, the current financial subsidies are simpler and more direct, making it easier for enterprises to obtain direct financial support and using it for specific R&D and innovation activities, reducing the financial risks faced by enterprises in the innovation process, and motivating more enterprises to invest in innovative activities. However, it is important to recognize that only a moderate intensity of financial subsidies can effectively stimulate high-tech enterprises to improve innovation. Excessive financial subsidies intensity may lead to rent-seeking behavior by high-tech enterprises. When financial subsidies are improperly implemented, such as when the subsidy scope is too broad or the total subsidy amount is excessive, the policy effects may shift from regulating socioeconomic activities to becoming a burden that inhibits economic development (Acebo et al., 2020). Currently, financial subsidies mainly focus on providing upfront support for the research and development innovation of high-tech enterprises, overlooking the effectiveness of post-subsidy fund utilization oriented towards the quality of enterprise innovation output. In the future, there should be an emphasis on post-subsidies for innovation, shifting the policy orientation of financial subsidies. The distribution of subsidies should be divided into three stages: pre-, mid-, and post-subsidy, thus implementing substantive reforms for high-tech enterprises.

When financial subsidies and tax incentives are implemented simultaneously, the incentive effect on the innovation quality of high-tech enterprises in Sichuan Province was weaker than the impact generated when the policies are implemented individually. This may be due to the upfront incentives provided by financial subsidies before conducting R&D activities, offering sufficient financial support to high-tech enterprises, thus stimulating the vitality of R&D innovation effectively and promoting innovation efficiency. On the other hand, tax incentives, which belong to post-incentives, had a broader scope of application. This allowed enterprises to autonomously adjust the investment cost of R&D innovation projects based on the tax rate, providing higher flexibility and autonomy for enterprises, and offering more funds for R&D investment. Given the current global economic downturn and the weakening effectiveness of

corporate tax incentive policies, it may be beneficial to shift towards indirect tax incentives. This approach can effectively reduce the R&D costs for enterprises, improve technological innovation and support efforts, thereby promoting the healthy development of high-tech enterprises.

Under the interactive influence of financial subsidies and tax incentives, the incentive effect on the innovation quality of high-tech enterprises in Sichuan Province tends to weaken. Therefore, it is crucial to differentially adjust the strength and mode of action of the two policies when implemented concurrently to better leverage their effects. The upfront incentives of financial subsidies and the post-incentives of tax incentives should coordinate and collaborate. By clarifying the characteristics of the incentives for innovation quality through financial subsidies and tax incentives, it is essential to fully exploit the direct advantages of financial subsidies and the indirect advantages of tax incentives. Hence, when implementing both financial subsidies and tax incentives simultaneously, it is important to maximize the differentiated advantages of each, optimizing the incentive effects on innovation quality under policy coordination.

## REFERENCES

Acebo, E., Miguel-Dávila, J. A., & Nieto, M. (2020). Do financial constraints moderate the relationship between innovation subsidies and firms' R&D investment? *European Journal of Innovation Management*, *25*(2), 347–364.

Baidu Encyclopedia (2023). Definition of tax incentives. https://baike.baidu.com/item/%E7%A8%8E%E6%94%B6%E4%BC%98%E6%83%A0/431069?fr=ge_ala

Bérubé, C., & Mohnen, P. (2009). Are firms that receive R&D subsidies more innovative? *Canadian Journal of Economics/Revue Canadienne d'économique*, *42*(1), 206–225.

Bloom, N., Griffith, R., & Van Reenen, J. (2002). Do R&D tax credits work? Evidence from a panel of countries 1979–1997. *Journal of Public Economics*, *85*(1), 1–31.

Brigham, E. F., & Houston, J. F. (2021). *Fundamentals of financial management: Concise*. Cengage Learning.

Bronzini, R., & Iachini, E. (2012). Are Incentives For R & D Effective ? Evidence From A Regression Discontinuity Approach. *American Economic Journal: Economic Policy*, *6*(4), 100–134.

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

Busom, I., Corchuelo, B., & Martı, E. (2017). Participation inertia in R & D tax incentive and subsidy programs. *Small Business Economics*, 48, 153–177.

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

Castellacci, F., & Lie, C. M. (2015). Do the effects of R&D tax credits vary across industries? A meta-regression analysis. *Research Policy*, *44*(4), 819–832.

Chen, S., Yan, X., & Yang, B. (2020). Move to success? Headquarters relocation, political favoritism, and corporate performance. *Journal of Corporate Finance*, *64*(71303059), 0–59.

Cheng, H., Fan, H., Hoshi, T., & Hu, D. (2019). Do Innovation Subsidies Make Chinese Firms More Innovative? *National Bureau of Economic Research*.

EPO. (2023). Patent Index 2022.

Ghazinoory, S., & Hashemi, Z. (2021). Do tax incentives and direct funding enhance innovation input and output in high-tech firms? *Journal of High Technology Management Research*, *32*(1), 100394.

Guo, D., Guo, Y., & Jiang, K. (2016). Government-subsidized R&D and firm innovation: Evidence from China. *Research Policy*, *45*(6), 1129–1144.

Hall, B. H. (2019). *Tax policy for innovation* (No. w25773). National Bureau of Economic Research.

Haner, U. E. (2002). Innovation quality — a conceptual framework. *International Journal of Production Economics*, *80*(1), 31–37.

Ivus, O., Jose, M., & Sharma, R. (2021). R & D tax credit and innovation : Evidence from private firms in India. *Research Policy*, 50(1), 104128.

Jiang, Z., Zhao, X., & Zhou, J. (2020). Does the supervision mechanism promote the incentive effects of government innovation support on the R&D input of agricultural enterprises? *IEEE Access*, 9, 3339–3359.

Yao, H., & Huang, W. (2022). Effect of R & D Subsidies on External Collaborative Networks and the Sustainable Innovation Performance of Strategic Emerging Enterprises : Evidence from China. *Sustainability*, 14(8), 4722.

Zhu, N., Zhou, Y., Zhang, S., & Yan, J. (2023). Tax incentives and environmental, social, and governance performance : empirical evidence from China. *Environmental Science and Pollution Research*, 30(19), 54899–54913. https://doi.org/10.1007/s11356-023-26112-3

Keogh, W., & Bower, D. J. (1997). Total quality management and innovation: a pilot study of innovative companies in the oil and gas industry. *Total Quality Management*, 8(2-3), 196-201.

Klette, T. J., Møen, J., & Griliches, Z. (2000). Do subsidies to commercial R&D reduce market failures Microeconometric evaluation studies. *Research Policy*, *29*(4–5), 471–495.

Mardones, C., & Ávila, F. (2020). Effect of R&D subsidies and tax credits on the innovative processes of Chilean firms. *Academia Revista Latinoamericana de Administracion*, *33*(3–4), 517–534.

Miotti, L., & Sachwald, F. (2003). Co-operative R & D : why and with whom ? An integrated framework of analysis. *Research Policy*, *32*(8), 1481–1499.

Montmartin, B., & Herrera, M. (2015). Internal and external effects of R&D subsidies and fiscal incentives: Empirical evidence using spatial dynamic panel models. *Research Policy*, *44*(5), 1065–1079.

Mu, Y., Bossink, B., & Vinig, T. (2018). Employee involvement in ideation and healthcare service innovation quality. *The Service Industries Journal*, *38*(1–2), 67–86.

Nilsen, Ø. A., Raknerud, A., & Iancu, D. C. (2020). Public R&D support and firm performance: A multivariate dose-response analysis. *Research Policy*, *49*(7), 104067.

Pang, S., Dou, S., & Li, H. (2020). Synergy effect of science and technology policies on innovation Evidence from China. *PloS One*, *15*(10), e0240515.

Sun, X., Fang, S., & Zhang, S. (2021). High-Quality Economic Development in Huaihe Economic Zone Level Measurement and Evaluation. *Journal of Mathematics*, *2021*, 1–16.

Teng, T., Zhang, Y., Si, Y., Chen, J., & Cao, X. (2020). Government support and firm innovation performance in Chinese science and technology parks The

perspective of firm and sub-park heterogeneity. *Growth and Change*, *51*(2), 749–770.

Wallsten, S. J. (2000). The effects of government-industry R&D programs on private R&D in the case of the Small Business Innovation Research program. *The RAND Journal of Economics*, 82–100.

Wang Siwei, C. X. (2023). Measurement, Spatial Distribution and Dynamic Evolution of the High-quality Development Level of China's Regional Economy. *Statistics and Decision*, *39*(21), 90–96.

Xu, J., & Wang, T. (2022). Impacts of the Weighted Deduction Policy for R & D Expenses on Innovation Additionality of Firms : Empirical Evidence from China. *Discrete Dynamics in Nature and Society*.

Xu, J., Wang, X., & Liu, F. (2021). Government subsidies, R&D investment, and innovation performance analysis from pharmaceutical sector in China. *Technology Analysis & Strategic Management*, *33*(5), 535–553.

Yao, H., & Huang, W. (2022). Effect of R & D Subsidies on External Collaborative Networks and the Sustainable Innovation Performance of Strategic Emerging Enterprises : Evidence from China. *Sustainability*, *14*(8), 4722.

Z., Sharma, P. N., & Cao, J. (2016). From knowledge sharing to firm performance A predictive model comparison. *Journal of Business Research*, *69*(10), 4650–4658.

Zhu, N., Zhou, Y., Zhang, S., & Yan, J. (2023). Tax incentives and environmental, social, and governance performance : empirical evidence from China. *Environmental Science and Pollution Research*, 54899–54913.