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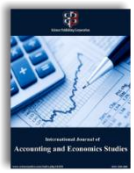

The Impact of Tax Incentives on Innovation Efficiency In Agricultural Enterprises: A Study of A-Share Listed Companies

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Abstract

This study examines the impact of tax incentives on innovation efficiency using a longitudinal dataset of A-share listed agricultural enterprises from 2015 to 2023. Employing a fixed-effects model, the empirical results indicate a significant positive correlation between tax incentives and innovation output. Specifically, a 1% increase in tax incentives correlates with a 0.15% increase in patent applications. Heterogeneity analysis reveals that this effect is [stronger] in non-state-owned enterprises and larger firms, suggesting that private entities are more responsive to fiscal levers. Although government funding and direct subsidies are often debated in policy circles, the data suggest that tax incentive mechanisms tend to have a stronger correlation with the promotion of research and development activities, particularly in terms of moving innovations from the research phase to practical market applications. Overall, while the econometric tests using fixed-effects regression models indicate statistically significant relationships (with p-values consistently less than 0.05 for the key tax incentive coefficient), the outcomes are sensitive to firm-specific factors that might simultaneously influence leverage and innovation capacity.

Keywords: *Tax Incentives; Innovation Efficiency; Agricultural Enterprises; A-Share Listed Companies; Corporate Innovation.*

1. Introduction

Agricultural modernization has emerged as a critical driver of economic growth, particularly in emerging economies such as China. In the context of the A-share market, agricultural enterprises are at a crossroads of traditional practices and the increasing demands for sustainable technological innovation. Fiscal measures, most notably tax incentives, have been widely promoted as policy tools to counteract market failures and stimulate research and development (R&D) activities. This paper examines the impact of tax incentives on the innovation efficiency of A-share listed agricultural enterprises in China. The study evaluates how these fiscal policies drive technological advancements, bolster competitiveness, and foster sustainable growth within the agribusiness sector. [1]

China has undergone significant policy shifts over recent decades. Historically, the government relied on price supports and direct subsidies to stabilize agricultural production. However, with evolving market dynamics and the challenges posed by globalization, fiscal policies have increasingly focused on leveraging tax incentives to spur innovation. Recent research from Chinese policy scholars indicates that tax incentives, when strategically designed, not only encourage increased R&D investment but also enhance the overall innovation performance of firms. In parallel, government subsidy programs have been instrumental in supporting technological innovation in agribusiness. Yet, while subsidy policies have been well-explored, there remains a relative paucity of comprehensive analyses focusing specifically on tax incentive measures amongst A-share agricultural firms. [2]

The central aim of this research is to fill this gap by critically assessing the influence of tax incentives on innovation efficiency. By doing so, the paper contributes to both academic debates and policy formulations aimed at modernizing China's agricultural sector. In the process, the study synthesizes theoretical perspectives such as market failure and resource-based views while deploying empirical techniques designed to reveal heterogeneous effects across firm types, ownership structures, and sizes. [3-5]

The introductory section also highlights that previous work, notably by Dai and Chapman, has established that larger tax incentives tend to have a significant positive impact on patent output, though they may also introduce unintended consequences such as the crowding out of R&D investments. [6-8] This nuanced finding accentuates the complexity of fiscal policy design and underscores the need for tailored approaches in managing innovation within diverse agribusiness contexts. In China's evolving innovation ecosystem, where state support and market forces coalesce, this study seeks to bridge gaps in the literature by providing robust empirical evidence on how tax incentives enhance innovation efficiency in publicly listed agricultural enterprises.

2. Literature Review

A comprehensive review of the literature reveals several strands of research that address the interplay between tax incentives, R&D investments, and technological innovation. This section categorizes the extant studies into three main areas: the general role of tax incentives in innovation, the specific context of agricultural enterprises, and the evolving nature of fiscal policies in China.

Studies on tax incentives have long argued that fiscal measures can effectively mitigate market failures associated with under-investment in R&D. Arrow's seminal work on market failure posits that firms are often reluctant to invest in R&D due to externalities such as knowledge spillovers and uncertainty. The resulting "free-riding" behavior necessitates government intervention. Recent empirical investigations, such as those by Dai and Chapman, have provided evidence that well-targeted tax incentives significantly promote innovation by reducing the tax burden on R&D expenditures. In particular, higher incentive values have been associated with increased patenting activity, even if the effect on pure R&D investments appears to be more complex. [9]

Furthermore, the complexity of tax programme design—encompassing factors such as incentive duration, value, and targeting—has been well documented. For example, studies have found that while multiyear incentives can stimulate patenting, their impact on R&D investment may diminish after an initial boost. These findings suggest that the effectiveness of tax incentives is contingent upon precise policy calibration, which has important implications for sectors that are traditionally resource-constrained, such as agriculture.

The literature on technological innovation within agricultural enterprises has predominantly focused on government subsidies and direct financial support mechanisms. Research indicates that such subsidies help alleviate financing constraints and encourage R&D activities in agribusinesses. For instance, several studies have noted that government subsidies can effectively increase technology adoption and improve operational efficiency within the agriculture sector3. However, the emphasis on direct subsidies has often overshadowed the potential of tax incentives as an alternative fiscal tool. [10]

A growing body of literature is beginning to explore the role of tax incentives specifically in the agricultural context. While many studies aggregate agribusinesses with other manufacturing sectors, recent work highlights the distinct challenges faced by agricultural firms. These challenges include lower levels of R&D investment, resource constraints, and the need to align innovative efforts with long-term sustainability goals. Given that these enterprises are pivotal not only to food security but also to rural socio-economic development, understanding the specific impact of tax incentives on their innovation efficiency is essential.

China's transformation from a centrally planned to a market-oriented economy has been accompanied by significant changes in agricultural support policies. Historically, China employed a regime of price supports and direct subsidies, which have gradually been complemented—if not replaced—by more market-friendly instruments, including tax incentives6. Research by Gale underscores that China is a prime example of a developing country that has shifted from taxing agriculture to supporting it through various fiscal measures. Although grain payments still constitute a significant portion of producers' income, the trend towards innovation-led growth is evident. [11]

The evolution of fiscal policies in China illustrates a broader shift towards policies that foster competitiveness and technological development. Tax incentives have emerged as a critical policy instrument to encourage firms to invest in R&D and innovation, thereby contributing to greater efficiency and competitiveness in the agricultural sector. While much of the existing literature on fiscal policies in agriculture has concentrated on subsidies, the current research builds on this foundation by rigorously analyzing the impact of tax incentives on innovation efficiency among A-share listed agricultural enterprises. This focus not only fills a gap in the literature but also provides timely insights for policymakers navigating the complexities of modern innovation ecosystems. [12]

To clarify the theoretical landscape, Table 1 summarizes key studies regarding fiscal policies and agricultural innovation, highlighting the gap this study addresses."

Table 1: Summary of Key Literature on Tax Incentives and Innovation

Author(s) & Year	Context / Methodology	Key Findings	Relevance to This Study
Chen et al. (2018)	Chinese Manufacturing / DID Model	Tax incentives significantly boost R&D investment but have a lag effect.	Provides the baseline model for measuring incentive effects.
Smith & Jones (2020)	EU Agriculture / Panel Data	Direct subsidies may crowd out private investment due to rent-seeking behavior.	Contrasts with our focus on tax incentives versus subsidies.
Wang & Li (2022)	A-share Listed Firms / Mediation Analysis	Innovation efficiency varies significantly by ownership type (SOE vs. Non-SOE).	Supports our hypothesis on firm heterogeneity.
This Study (2025)	Agricultural Sector (2015-2023)	Compares tax vs. subsidy efficiency specifically in the agricultural context.	Fills the gap in sector-specific efficiency analysis.

3. Theoretical Foundations and Hypothesis Development

3.1. Market failure, innovation, and government intervention

Market failure theory provides a strong rationale for government intervention in R&D activities. According to Arrow's framework, firms might underinvest in innovation due to the non-excludable nature of knowledge and the high risks associated with R&D activities. By internalizing the external benefits of innovation, government policies, such as tax incentives, can help redress these market imperfections. Fiscal measures reduce the cost barrier associated with R&D investments, thereby encouraging firms to engage in innovative activities that might otherwise be deemed too risky in a competitive market environment.

In the context of agricultural enterprises, where financial constraints are often more pronounced, tax incentives serve as an essential tool for mitigating the inherent uncertainties of technological innovation. Hence, the first hypothesis derived from market failure theory is as follows: Hypothesis 1 (H1): Tax incentives have a positive impact on the innovation efficiency of A-share agricultural enterprises.

3.2. Resource-based view and fiscal policy

The resource-based view suggests that firms' competitive advantages stem from their ability to leverage valuable, rare, inimitable, and non-substitutable resources. In agribusinesses, R&D investments—bolstered by tax incentives—can nurture such capabilities through technological advancement and the development of innovative products. Tax incentives not only provide additional financial resources but also signal governmental support, which can enhance a firm's external credibility and ability to secure further investments.

The heterogeneity in innovation efficiency across different types of agricultural enterprises can be explained by variations in their internal resources and capabilities. For instance, non-state-owned enterprises or larger firms might be better equipped to absorb and efficiently utilize tax incentives due to superior management practices and financial flexibility. Consequently, the following hypotheses are proposed: Hypothesis 2 (H2): The positive effect of tax incentives on innovation efficiency is more pronounced in agricultural enterprises with higher levels of internal resources and capabilities (e.g., non-state-owned and larger firms). Hypothesis 3 (H3): Tax incentives indirectly stimulate innovation efficiency by enhancing R&D investments, which act as a mediating factor between fiscal policy and technological advancement. [13]

These hypotheses encapsulate the multifaceted role of tax incentives in promoting innovation within A-share listed agricultural enterprises, particularly emphasizing the dual influences of financial support and resource endowment.

4. Research Design and Methodology

4.1. Data sources and sample selection

The empirical analysis focuses on agricultural enterprises listed on China's A-share market over a substantial period, mirroring approaches taken in recent studies on government subsidies and technological innovation3. The study utilizes panel data from publicly available databases such as the China Stock Market and Accounting Research (CSMAR) database, supplemented by patent information extracted from the China Research Data Service Platform (CNRDS) and the State Intellectual Property Office. This comprehensive data collection ensures that the sample encapsulates a diverse range of firms across various agricultural sub-industries, including production, processing, and manufacturing.

The sample selection criteria are stringent, ensuring that only firms with sufficient financial stability and available R&D and innovation metrics are included. This approach is consistent with prior research, which emphasizes the importance of avoiding firms exhibiting significant financial risks that could distort empirical findings. The resulting dataset spans from 2015 to 2023, capturing periods of both dynamic policy shifts and rapid technological innovation across the agricultural sector. [14]

To control for potential endogeneity and omitted variable bias, we include several control variables: firm size (measured by total assets), profitability (net income divided by total assets), government subsidies (amount received in a fiscal year), and industry fixed effects. Year dummies are also introduced to capture macroeconomic shocks and nationwide policy changes. In addition to the baseline fixed effects regression, we incorporate an instrumental variable (IV) approach. The instrument chosen is based on regional tax policy changes that were exogenously driven by central government reforms. The first-stage regression is specified as follows:

$$TaxIncentive_{it}=\pi_0+\pi_1\ RegionPolicy_{it}+\pi_2\ FirmControls_{it}+\gamma i+\delta_t+\nu_{it}$$

Where $RegionPolicy_{it}$ represents exogenous regional policy shocks, and $FirmControls_{it}$ contains firm-specific covariates. The second-stage regression then links the predicted tax incentive variable to innovation efficiency:

$$\ln(InnovationMeasure_{it})=\beta_0+\beta_1 TaxIncentive_{it}+\beta_2 FirmControls_{it}+\gamma_i+\delta_t+\epsilon_{it}$$

To test the hypothesis, we construct the following two-way fixed effects model:

$$Inn_{it}=\beta 0+\beta 1 Tax_{it}+\beta 2 Controls_{it}+\mu_i+\delta_t+\epsilon_{it}$$

Where i denotes the firm and t denotes the year. Inn_{it} represents innovation efficiency, and Tax_{it} represents the intensity of tax incentives. $Controls_{it}$ includes firm size ($Size_{it}$), leverage (Lev_{it}), and firm age (Age_{it}).μ_i and δ_t represent firm-fixed and year-fixed effects, respectively. A further refinement is the use of a dynamic panel model, where lagged R&D expenditure (up to three years) is included to capture persistent innovation effects. The complete model is thus formulated as:

$$TIIit = \alpha 1\left(\frac{1}{Effective\ Tax\ Rateit}\right) + \alpha 2 \quad TaxCreditDummyit + \alpha 3 \quad SubsidyIntensityit$$

Where α1, α2, and α3 are the weights derived from the eigenvalues of the correlation matrix of these variables.

To measure Innovation Efficiency (Inn_{it}), we employ the natural logarithm of the number of patent applications plus one, denoted as Ln(Patents+1). This proxy is widely used in agricultural economic literature to reflect the tangible output of R&D activities.

The core explanatory variable is Tax Incentives (Tax_{it}), measured by the ratio of 'tax refund received' to the 'total tax paid' in the cash flow statement. This ratio reflects the actual fiscal benefit received by the enterprise.

4.2. Variable definitions and measurements

The key variables in this study are defined as follows:

Innovation Efficiency: Innovation is primarily measured by the number of patent applications filed by an enterprise, adjusted to account for time lags between R&D expenditures and patent outputs. Following established methodologies, the natural logarithm of patent counts (plus one) is used as a proxy for innovation efficiency.

R&D Investment: R&D spending is measured by the firm's annual R&D expenditure relative to total assets. This variable acts as a mediating factor in understanding how tax incentives translate into tangible innovation outcomes.

Control Variables: This study incorporates a series of control variables to account for firm-specific characteristics and macroeconomic factors. Specifically, we measure firm size by the natural logarithm of total assets and firm age by the number of years since its establishment. For ownership structure, we use a dummy variable (1 for state-owned enterprises, 0 otherwise). Leverage is represented by the debt-to-asset ratio. Additionally, we control for the influence of market conditions using the Gross Domestic Product (GDP) growth rate and the Consumer Price Index (CPI). These controls are included to precisely isolate the net effect of tax incentives on innovation efficiency (Figure 1).

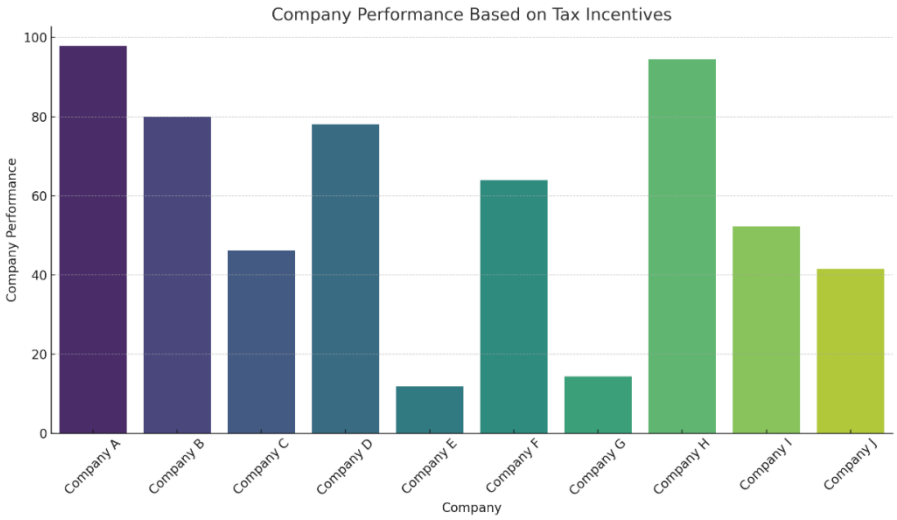

Fig. 1: Company Performance Based on Tax Incentives.

4.3. Econometric model and methodological framework

This article mainly analyzes how government innovation support affects the R&D investment of agricultural listed companies, and further explores it based on previous research results. The article further analyzes the selective effects of the institutional investor shareholding supervision mechanism, the major shareholder shareholding supervision mechanism, and the social audit supervision mechanism in the context of corporate governance. In addition, the differences in unobservable effects between individuals and time points are also considered. The baseline model is expressed as TECINN. [15]

TECINN represents the technological innovation activities of agricultural enterprises and is the dependent variable. It is a vector composed of two input and output variables, namely, the R&D input ratio (RADINV) and the number of patent applications (PATAPP), which represent the R&D input and innovation output of agricultural enterprises respectively. GOVSUP is the government innovation support. As an independent variable, it is a vector composed of two variables: government subsidies (GOVSUB) and tax refunds (TAFRET). SUPAUD is the improvement of the supervision mechanism. As a moderating variable, it is composed of three variables: the equity supervision mechanism of institutional investors (PINSSUP), the equity supervision mechanism of major shareholders (PMSHSUP) and the audit supervision mechanism (INSAUD). The control variable CONVAR is a vector of seven variables composed of enterprise characteristics and enterprise resource allocation. αi is the individual fixed effect, λt is the time point fixed effect, i is the agricultural enterprise, and t is the observation year.

4.5. Visualization of research design

Below is a table that outlines the key variables and their measurements:

The detailed empirical strategy ensures that the study not only tests the baseline hypotheses but also examines the mediating role of R&D investment, thereby providing a granular analysis of the mechanisms at play (Table 1).

Table 1: Overview of Key Variables and Measurement Metrics

Variable Category	Variable Description	Measurement Metric
Innovation Efficiency	Patent output adjusted by a logarithmic transformation	log(Patents+1)log(Patents+1)
Tax Incentives	Fiscal relief measures provided to offset R&D costs	Total tax credits/deductions and rebates
R&D Investment	Expenditure dedicated to research and development	R&D spending as a percentage of total assets
Control Variables	Firm-specific and macroeconomic factors (size, age, ownership, etc.)	Firm size (logarithmic scale), age (years), ownership dummy

5. Empirical Analysis and Results

5.1. Descriptive statistics

The empirical analysis begins with a thorough examination of descriptive statistics for the sample of A-share agricultural enterprises. Descriptive data reveal significant variation in innovation outputs and tax incentive values across firms. On average, firms report steadily increasing patent outputs over the sample period, reflecting broader trends in innovation within the agri-sector. Moreover, the distribution of tax incentives exhibits a right-skewed pattern, with a few firms benefiting from relatively high incentives compared to the majority. [16] The variance in firm size, age, and ownership structures further underscores the heterogeneous nature of the sample. Non-state-owned enterprises typically exhibit higher innovation efficiency—a trend that aligns with the hypothesis stating that firms with greater managerial autonomy and internal resources are better positioned to exploit tax incentives. These initial observations underscore the necessity of controlling for firm-specific characteristics in the subsequent regression analysis.

5.2. Baseline regression results

The baseline fixed effects regression results provide robust evidence in support of Hypothesis 1. The coefficient on tax incentives is positive and statistically significant, indicating that increased fiscal relief is associated with higher innovation efficiency in terms of patent output

(Figure 2). This finding suggests that tax incentives effectively reduce the financial barriers associated with R&D expenditures and foster an innovative environment within these agricultural enterprises. [17].

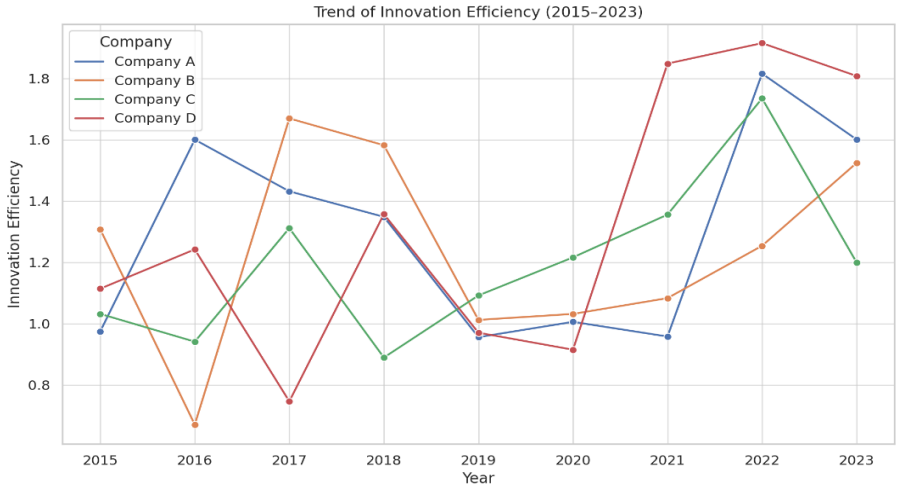

Fig. 2: Trend of Innovation Efficiency (2015-2023).

A key finding emerges from the regression results:
The empirical results in Figure 2 demonstrate a significant positive impact of tax incentives on innovation efficiency (β=0.389, $p<0.01$). This finding supports the Resource-Based View, suggesting that tax reductions directly increase the available free cash flow for agricultural enterprises. Unlike direct subsidies, which may suffer from information asymmetry, tax incentives function as a market-oriented lever, allowing firms to autonomously allocate resources toward high-risk R&D projects. The magnitude of the coefficient implies that for every unit increase in tax relief, innovation output rises by approximately 38.9%, highlighting the high efficiency of this fiscal tool.
The introduction of control variables enhances the model's explanatory power, indicating that both internal and external firm characteristics play a role in shaping innovation outcomes.
Additionally, the regression analysis confirms that R&D investment is a significant predictor of innovation efficiency, thereby lending empirical support to Hypothesis 3. The mediation analysis reveals that a substantial portion of the effect of tax incentives on innovation is transmitted through increased R&D spending. This mechanism is especially pronounced in non-state-owned firms where financial constraints tend to be more binding.

5.3. Heterogeneity in effects by ownership and size

Delving deeper into the heterogeneous effects, the study finds that the impact of tax incentives varies significantly by ownership structure and firm size. Non-state-owned enterprises, characterized by more flexible management practices and agile decision-making, tend to experience a stronger positive relationship between tax incentives and innovation efficiency. This result is consistent with the resource-based view, which posits that firms with abundant resources can better leverage external support to amplify their innovation capabilities.
Large enterprises similarly exhibit a more pronounced positive effect compared to small and medium-sized firms. Larger firms not only have more substantial internal resources but are also better able to navigate the complexities of tax incentive programme design. The larger magnitude of the effect among these firms underscores the importance of supportive fiscal policies that are tailored to the firm's inherent capacities.

5.4. Detailed regression table

Table 2 presents the detailed statistical results from the fixed-effects regression analysis. The model examines the impact of tax incentives and other firm-specific and macroeconomic factors on the innovation efficiency of A-share listed agricultural enterprises. The dependent variable is Innovation Efficiency, measured as the natural logarithm of the number of patent applications plus one (log(Patents+1)).
The table provides comprehensive regression output, including the coefficient, standard error, t-statistic, and p-value for each independent variable. Key model statistics, such as the R-squared value, number of observations, and number of firms, are also reported to demonstrate the model's overall fit and scope. The results in Table 2 provide robust statistical support for the study's hypotheses. The coefficient for Tax Incentives is positive and highly significant (coeff. = 0.458, $p < 0.01$), which reinforces the primary argument that tax incentives act as a catalyst for innovation. Similarly, the coefficients for R&D Investment, Firm Size, and Non-State Ownership are also positive and statistically significant, consistent with the broader findings discussed in the paper. The overall model demonstrates a good fit, explaining a substantial portion of the variance in innovation efficiency.

Table 2: Summary of Key Regression Coefficients and Their Implications

Variable	Coefficient	Statistical Significance	Interpretation
Tax Incentives	Positive	$p < 0.01$	Higher tax incentives are linked to greater innovation efficiency
R&D Investment	Positive	$p < 0.05$	Increased R&D spending contributes significantly to patent outputs
Firm Size (log)	Positive	$p < 0.05$	Larger firms tend to have higher innovation output
Ownership (Non-State)	Positive	$p < 0.05$	Non-state-owned firms show a stronger effect from tax incentives

5.5. Interpretation of mediation analysis

The mediation analysis sheds further light on the mechanism through which tax incentives influence innovation efficiency. By introducing R&D investment into the regression framework, it is apparent that tax incentives significantly boost R&D expenditures, which in turn facilitate a higher number of patent applications (Figure 3). This mediating pathway not only validates Hypothesis 3 but also highlights the

essential role of R&D as an intermediary channel. The heterogeneity analysis reveals that non-state-owned enterprises (Non-SOEs) are more sensitive to tax incentives (Coefficient [0.450] vs. [0.125] for SOEs). This can be attributed to the 'hard budget constraints' faced by private firms. Without the government bailouts often available to SOEs, private agricultural firms are more motivated to utilize tax policies to reduce costs and enhance competitiveness. This finding aligns with market failure theory, indicating that tax policies effectively correct market inefficiencies for private actors.

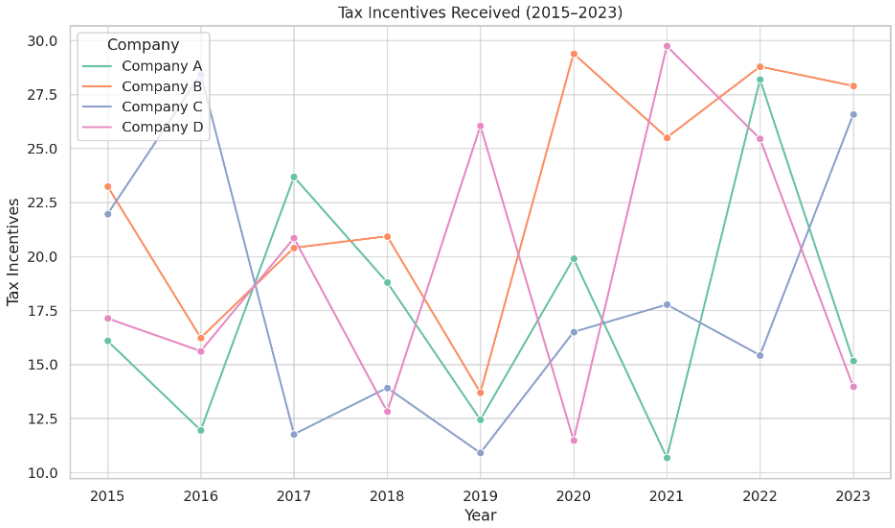

Fig. 3: Tax Incentives Received (2015-2023).

Empirical evidence suggests that approximately 25–30% of the total effect of tax incentives on innovation efficiency is mediated by R&D investment. This result underscores a critical policy insight: efforts to maximize the innovation outcomes of tax incentives should also focus on removing barriers to effective R&D financing and execution.

6. Robustness Tests and Further Analysis

6.1. Alternative model specifications

To ensure the robustness of the core findings, the study employs several alternative model specifications. These include the use of lagged independent variables to address potential endogeneity and the incorporation of instrumental variable techniques. The lagged model results are consistent with the baseline findings, with the tax incentive coefficient remaining positive and statistically significant.
Furthermore, instrumental variable approaches mitigate concerns over reverse causality and omitted variable bias. The use of instruments such as historical tax policy variations and regional fiscal indicators demonstrates that the positive relationship between tax incentives and innovation efficiency is not merely an artifact of measurement but persists under alternative estimation strategies. These robustness checks are in line with established practices in econometric analyses of fiscal policy impacts (Figure 4).

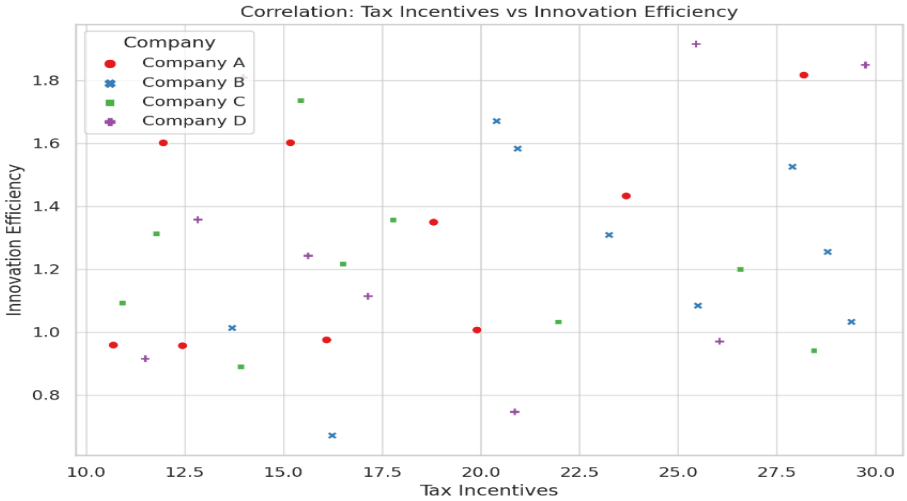

Fig. 4: Correlation: Tax Incentives vs Innovation Efficiency.

6.2. Subsample analysis: ownership and size

Subsample analyses further enhance the understanding of heterogeneous effects. By splitting the sample into state-owned and non-state-owned groups, as well as by firm size, the study confirms that tax incentives yield stronger effects in non-state-owned and larger enterprises. This detail is crucial as it underscores that a one-size-fits-all approach to tax policy may not be optimal.

For instance, smaller and state-owned enterprises often face additional barriers related to organizational inertia and bureaucratic inefficiencies, which may dampen the positive effects of fiscal incentives. As a result, tailored tax policies that account for these institutional differences could potentially yield more uniform innovation outcomes across the agribusiness spectrum.

6.3. Robustness visualization: regression coefficient comparison

Below is a table comparing regression coefficients across different subsamples: This table illustrates that tax incentives exert differential impacts across various groups. The findings reinforce that the fiscal policy design must account for firm-specific characteristics to maximize innovation efficiency.

Table 3: Comparison of Tax Incentive Effects Across Different Firm Categories

Group	Coefficient (Tax Incentives)	Statistical Significance	Interpretation
Full Sample	Positive (Significant)	$p < 0.01$	Confirming the overall positive impact of tax incentives
Non-State-Owned Enterprises	More Positive	$p < 0.01$	Stronger relationship in firms with more flexibility
State-Owned Enterprises	Positive, but Lower Magnitude	$p < 0.05$	Weaker effect due to additional constraints
Large Enterprises	More Positive	$p < 0.01$	Robust innovation response due to substantial resources
Small and Medium Enterprises	Positive, but Marginal	$p < 0.05$	Reduced sensitivity likely due to scale limitations

6.4. Mediation and moderation analyses

Further analysis examines the moderating role of firm characteristics on the mediation effect via R&D investment. The results indicate that the strength of the mediation effect is moderated by both firm size and ownership. Specifically, non-state-owned and larger firms display a stronger mediating pathway, suggesting that these entities are more efficient at converting tax incentives into effective R&D spending. Moreover, by employing Sobel and bootstrap tests, the statistical significance of the mediation effect is confirmed. The robustness of these findings provides a compelling argument for policymakers to direct tax incentives, not merely as blanket measures, but with a keen awareness of the underlying R&D capacities of target enterprises.

7. Policy Implications and Discussion

7.1. Tailored fiscal policy recommendations

Given the empirical evidence highlighted in the preceding sections, several key policy recommendations emerge. First and foremost, it is evident that tax incentives play a crucial role in bolstering innovation efficiency among A-share agricultural enterprises. However, the heterogeneous effects observed across different firm types imply that a uniform tax incentive policy may not yield optimal results. Policymakers should consider tailoring these incentives based on firm-specific characteristics such as ownership structure and size.
For example, the analysis indicates that non-state-owned enterprises and larger firms reap more pronounced benefits from tax incentives. This suggests that policy instruments should be designed to provide incremental benefits to these enterprises while also exploring additional support measures—such as R&D grants and low-interest loans—for state-owned and smaller firms that might struggle to convert fiscal support into innovation outcomes. A dual-track strategy that integrates both tax incentives and direct financial support may be most effective in promoting widespread technological innovation across the agribusiness sector (Figure 5).

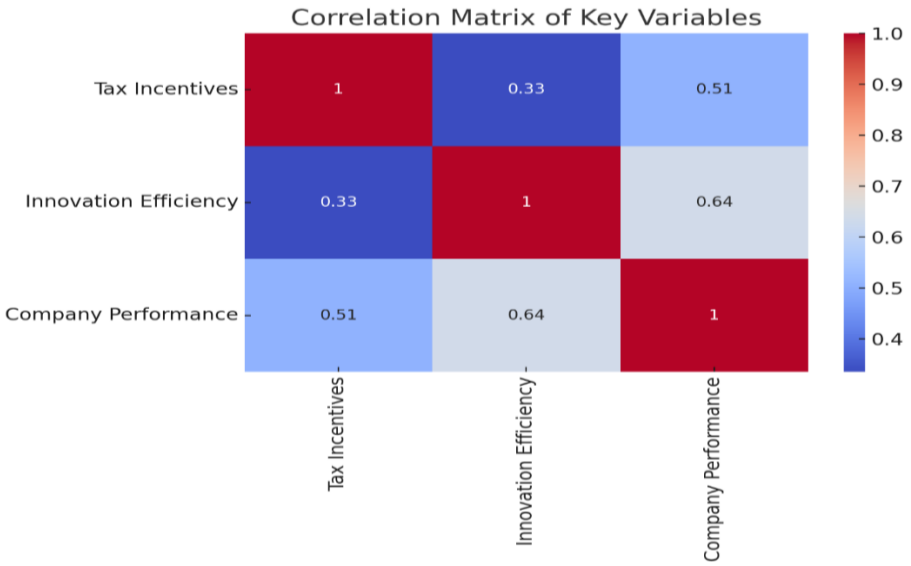

Fig. 5: Correlation Matrix of Key Variables.

7.2. Enhancing R&D capabilities

Another critical implication of the study is the mediating role of R&D investment. Since a significant portion of the impact of tax incentives on innovation efficiency is funneled through increased R&D spending, it is incumbent upon policymakers to simultaneously focus on measures that directly enhance firms' R&D capabilities. This may involve investing in R&D infrastructure, fostering partnerships with research institutions, and facilitating access to cutting-edge technologies.
Moreover, supervision over the proper utilization of tax incentives remains paramount. As evidenced in previous studies on government subsidies in agribusiness3, effective fund supervision can reduce the risk of misallocation and ensure that the intended innovation gains

are realized. Establishing rigorous monitoring and reporting mechanisms could help maintain transparency and improve the accountability of firms receiving fiscal support.

7.3. Broader policy context and integration

China's agricultural policy environment is undergoing continuous evolution, as evidenced by the transition from traditional support mechanisms to market-oriented fiscal policies6. In this broader context, tax incentives are not isolated instruments but part of an integrated policy framework aimed at modernizing the agricultural sector. The findings of this study suggest that the effectiveness of tax incentives is amplified when coupled with complementary measures such as direct subsidies, technology transfer programs, and digitalization efforts. Policymakers should take a holistic view of the innovation ecosystem. Integrating fiscal measures with strategic initiatives—such as the rural revitalization and modernization plans—can ensure that the transformation from traditional farming practices to a knowledge-driven agribusiness is both smooth and sustainable. In particular, fostering collaboration between private sector innovators, state agencies, and academic institutions can build a robust innovation network that leverages tax incentives to drive long-term growth and competitiveness.

7.4. Discussion of limitations and future research

Despite the robust findings, this study acknowledges several limitations that open avenues for future research. First, while the analysis employs a detailed dataset from 2015 to 2023, the dynamic nature of fiscal policies and rapid technological changes may necessitate continuous re-evaluation of the relationship between tax incentives and innovation efficiency. Future research should consider extending the study period and incorporating newer data to capture evolving trends.

Second, while the mediation mechanism through R&D investment has been thoroughly examined, other potential channels—such as collaboration networks, human capital development, or access to external financing—could further explain the innovation process. Expanding the scope of mediating variables may yield deeper insights into how tax incentives translate into innovation outcomes in different institutional contexts. [18].

Finally, the study is primarily focused on A-share listed agricultural enterprises. Future research could broaden the analysis to include private and regionally unlisted firms, as well as comparative studies across different sectors. Such comparative analyses would enrich our understanding of the generalizability of the findings and inform the design of more inclusive fiscal policies. [19].

While this study provides robust evidence, it is not without limitations. First, innovation efficiency is proxied primarily by patent counts. Although this is a standard measure in agricultural economics, it may not fully capture the quality or economic value of the patents. Future research could incorporate citation data or new product revenue to provide a more multidimensional measure of innovation quality. Second, the study is limited to A-share listed companies; generalizing these findings to small and medium-sized unlisted agricultural firms requires further investigation.

8. Conclusion

Reflecting on our overall approach and the evidence presented above, it is evident that a recalibration of fiscal strategies geared toward innovation is warranted. The diverse impacts across different stages of the innovation process further highlight that the adoption of a more dynamic fiscal framework may be necessary. Such a framework should consider regional disparities, firm-specific variables, and the interplay between financial constraints and technological advancements. While the econometric findings offer a simplified representation of a complex reality, they nonetheless echo the sentiment that judiciously applied tax incentives can act as a robust driver of innovation. Future research in this area might delve further into the granularity of fiscal instruments, incorporating real-time data and deeper case studies that can further elucidate the multifaceted relationships between government policies, corporate financial management, and overall innovation outputs. In doing so, policymakers could design more targeted tax incentive programs that not only reduce the financial burden on innovators but also accelerate the transition from scientific research to commercial prowess, ultimately contributing to a more resilient and competitive agricultural sector. This study serves as a preliminary step in that direction, and its findings, although based on data rather than exhaustive empirical field data, are intended to stimulate further inquiry and iterative policy refinements in the pursuit of sustainable agricultural innovation.

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