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Influence of Financing Methods on Sustainable Development of Agricultural Enterprises

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Abstract: This article studies the influence of different financing methods on the sustainable development of Chinese agricultural enterprises. A fixed effect model was used with data sourced from listed companies in the China Stock Market & Accounting Research (CSMAR) database spanning from 2013 to 2020. To understand the sustainability of agricultural enterprises in a comprehensive perspective, this study further adopts a series of environmental performance indicators, such as green innovation input and carbon emission intensity, in addition to social performance metrics, including rural employment contribution, and industrial chain driving effect. These indicators are integrated to construct a composite sustainability index to examine the influence of financing methods on multi-dimensional sustainability. Firstly, these indicators differ from one another, with government subsidies having the greatest promoting effect on agricultural enterprises' sustainable development, followed by endogenous financing and equity financing, while bond financing exhibits an inhibitory effect. It is worth noting that bank credit does not have a significant impact. Secondly, when evaluated by enterprise nature, the influence of internal financing ratio and government subsidy intensity is more pronounced on private companies than on state-owned companies. Thirdly, evaluated by region, the endogenous financing ratio plays a more significant role in fostering the sustainable development of agricultural enterprises in the western region than in eastern and central regions. In contrast, government subsidy intensity shows a greater promoting effect in the central region than in the eastern and western regions.

Keywords: Financing methods, return on total assets, agricultural enterprises.

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1. Introduction

Agriculture is a key component of a country's economic foundation, whose sustainable development is a crucial solution to issues such as food security and increasing farmers' income. However, despite the fact that agriculture is the primary sector and pivots economic growth, some Chinese agricultural enterprises encounter financial difficulties. Meanwhile, China's financial sector is plagued by insufficient service to the agricultural economy and poor integration of industry and finance, among many other problems that hamper the high-quality development of agriculture. To address these issues, this study aims to identify the best financing methods that support the sustainable development of these companies and whether there are systematic variations in financing efficiency across them with different ownership types and regional locations. It can be seen that the support of financing methods on the sustainable development of agricultural enterprises holds great significance.

Compared to existing literature, this research is novel in the following: firstly, most of the existing literature studies the financing channels and difficulties of agricultural operators, with less attention on the financing efficiency. In fact, financing efficiency and financing channels are equally important. Secondly, different financing methods have their own advantages and disadvantages, and it is difficult to tell which one outperforms the others. However, agricultural enterprises have special industry attributes. Finding out appropriate financing methods can provide for decision-making by relevant management authorities, which will foster policies to address agricultural financing challenges.

2. Research Review and Hypotheses

2.1. Research Overview

Existing literature focuses more on the financing channels and difficulties of agricultural enterprises, family farms, agricultural cooperative organizations and farmers. Kochar (1997), Mushinsk (1999), and Boucher and Guirkinger (2007) argued that due to a lack of collateral and low transaction costs of informal financing, farmers were more willing to obtain loans from informal financial institutions. Bhattacharyya and Kumbhakar (1997) argued that formal financial institutions would reject farmers' loan applications as they were deemed to have potential moral hazard and pose adverse selection issues. That's why informal financial institutions serve as a critical channel in meeting the immediate financial demand of farmers. Henry et al. (2015) and Machinski et al. (2016) studied the financing difficulties of agricultural cooperative organizations, while Veronika et al. (2015) studied the influence of financing on the development of agricultural enterprises. Ozili (2018) pointed out through theoretical analysis that digital inclusive finance, by leveraging digital technology, could significantly reduce the financing costs for enterprises. The benefit was that financial resources could be channeled to "long tail" customers, alleviating the financing constraints for enterprises. Yuan et al. (2021) sourced data from G7 countries, and pointed out that digital inclusive finance could reduce financial risks for enterprises through digital technology, enabling them to obtain bank financing.

Certain scholars focus on the factors that influence the efficiency of corporate financing. Romano et al. (2001), starting from corporate debt level, believed that debt was mainly influenced by corporate planning, family control, business scale and strategic goals, which in turn had an impact on the efficiency and decision-making of corporate financing. Klapper et al. (2003) compared the financing structure of small and medium-sized enterprises in Eastern and Central Europe with that of large enterprises, and concluded that the result of internal financing, equity financing and debt financing varied due to the order of selection. Hogan and Hutson (2005) argued that small and medium-sized science and technology firms would primarily adopt external direct financing. Biswas and Koufopoulos (2020) studied the competition among and financing efficiency of banks under asymmetric information. Using a combination of Data Envelopment Analysis (DEA) and Tobit models, Huang (2020) found that the financing efficiency of domestic logistics companies was relatively low. Minetti et al. (2021) found that a bank-oriented financial system was more conducive to the growth of export enterprises than a market-oriented one. In addition, a small amount of literature studied the efficiency of various financing methods for enterprises. Pang (2013) used the fuzzy comprehensive evaluation method to evaluate the effectiveness of the financing mechanisms for small and medium-sized companies in Ankang, and the results showed that endogenous financing was the most efficient way, while debt financing presented the lowest efficiency. Wang et al. (2013) evaluated the financial strategies employed by small and medium-sized companies in Anhui Province using the grey correlation method. The results showed that internal financing had the highest financing efficiency, followed by private financing, bank loans, private equity and stock issuance.

There is a paucity of studies that investigate the effects of diverse financing mechanisms on the sustainable development of agricultural enterprises. Financing channels and financing methods are equally important. Agricultural enterprises are different from industrial companies in production and operation. Therefore, this paper focuses on studying the financing methods to expand the financing theory of agricultural enterprises. Notably, recent studies have highlighted that rural population aging, exacerbated by labor migration, has reshaped agricultural enterprises' financing strategies. Liu et al. (2025) found that labor transfer accelerated aging in rural areas, pushing enterprises to rely more on endogenous financing for sustainable investments (e.g., labor-saving technologies), which aligned with the practical need to achieve financing efficiency in the agricultural sectors.

To strengthen the theoretical foundation, this study further integrates the Resource-Based View (RBV) and Institutional Theory. The RBV explains how endogenous financing enhances enterprises' control over key resources. By reducing transaction costs and avoiding external financing constraints, endogenous financing enables agricultural enterprises to allocate more resources to long-term sustainable investments, such as technological upgrading and eco-friendly practices. Institutional Theory, on the other hand, highlights the role of government subsidies as formal institutional support. It argues that government subsidies can alleviate market failure in the agricultural sector characterized by high externalities and risks, thereby encouraging enterprises to engage in activities with long-term social benefits, such as ensuring food security. Additionally, this section supplements recent literature (2020–2025) on sustainable financing under an agricultural context, including studies on the impact of digital inclusive finance on balancing profitability and environmental goals, as well as theoretical analysis of regional disparities in agricultural financial policies.

2.2. Research Hypotheses

To make production and conduct businesses, capital is an essential requirement for companies and matters to their survival and growth. In the process of financing, growth, refinancing and further-development, a company expands itself on a continuous basis. The primary sources of financing include internal and external ones. Internal financing is mainly composed of retained earnings and depreciation. External financing includes bank credit, equity financing, bond financing, etc. Varying financing strategies pose a direct influence on a company's operational activities. Companies should design financing channels, modes and financing terms scientifically based on their own conditions. This aims at ensuring the maturity match between funding sources and their uses and reducing financial expenses to fulfill the requirements of projects, operations and corporate growth. The purpose of corporate financing is to fund operational investments that ultimately maximize shareholder value and corporate value. According to capital structure decision-making theory, the objective of corporate financing is to maximize profits, and a diversified funding strategy can enhance a company's enduring progress.

To further support the hypotheses, this study integrates complementary theoretical perspectives. The Resource-Based View emphasizes that companies can maintain competitive advantages through internal resources as they are imitable and have low transaction costs. This is especially true for agricultural enterprises that need long-term investments in sustainability. Institutional Theory highlights how formal institutional support (e.g., government subsidies) can mitigate market failure in high-externality sectors such as agriculture, by incentivizing socially beneficial activities. Signaling Theory, meanwhile, suggests that financing choices reveal information about a company's quality: equity financing may signal confidence in long-term viability, while bond financing, with its strict repayment obligations, may constrain flexibility for sustainable investments.

Therefore, this study proposes the following hypotheses:

HI: Endogenous financing promotes the development of agricultural Enterprises.

This aligns with the Resource-Based View, as endogenous financing—derived from retained earnings and depreciation—avoids external financing costs and constraints, which allows enterprises to prioritize long-term sustainable investments in eco-friendly technologies or rural employment expansion.

H2: Bank credit facilitates the growth of agricultural enterprises.

Bank credit, as a formal external financing channel, can provide capital for companies to expand production and reach scale economy. However, its effectiveness may be limited in agricultural enterprises due to information asymmetry. This has been highlighted by existing literature on rural credit markets.

H3: Equity financing encourages the growth of agricultural enterprises.

Consistent with the Signaling Theory, equity financing indicates the quality of a company to investors. Through equity financing, agricultural enterprises may face less pressure on short-term returns and allocate funds to long-term sustainable development, such as improving operational efficiency or supporting rural industrial chains.

H4: Bond financing encourages the growth of agricultural enterprises.

Contrary to initial expectations, bond financing may drag the sustainability of agricultural enterprises. The Signaling Theory explains that bondholders demand strict repayment schedules, which can force enterprises to prioritize short-term liquidity over long-term investments in environmental or social performance--two factors that are critical for agricultural sustainability.

H5: Government subsidies support the growth of agricultural enterprises.

Guided by the Institutional Theory, government subsidies can reduce risks associated with sustainability-oriented activities (e.g., food security initiatives or green innovation), thus alleviating market failure in the agricultural sector. And agricultural enterprises are able to make investments to achieve long-term social and environmental goals.

3. Data Sources, Variable Selection, and Model Construction

3.1. Data Sources

The data used for this study are sourced from Guotai An database, focusing on publicly listed companies in the agricultural, forestry, animal husbandry and fishing sectors. As of December 30, 2021, there were 4683 listed companies in China. Based on the 2012 amendments to the Industry Classification Guidelines for Listed Companies by the China Securities Regulatory Commission, there are 100 publicly traded entities that belong to agricultural, forestry, animal husbandry and fishing sectors. This study utilizes financial statement data pertinent to these companies from 2013 to 2020 and establishes a panel data model for empirical research. Firstly, 15 samples with missing "total assets" were excluded; Next, missing values of other financial indicators were replaced with 0. Finally, a total of 785 valid samples were left.

3.2. Selection and Explanation of Variables

3.2.1. Dependent variable

The dependent variable of this study is the return on total assets. Domestic and foreign scholars usually take Return On total Assets (ROA), Return On Equity (ROE), and Tobin's Q value as effective indicators to evaluate corporate performance. In this paper, the model architecture of Yang and Ning (2018) and the ROA) were selected to evaluate the development status of high-tech companies. The ROA primarily evaluates a company's proficiency in generating profits using its own assets. The greater the value of this indicator, the more profit the company can make (Wiseman et al., 2022; Chisha and Togo, 2023). To comprehensively evaluate sustainable development, this paper selects a wide range of indicators encompassing economic, environmental and social dimensions. Indicators for environmental performance include green innovation and carbon emission intensity. The former is measured by the proportion of R&D expenditure allocated to eco-friendly technologies, and the latter is calculated as total energy consumption divided by operating income. This aligns with the sustainability assessment framework proposed by Wiseman et al. (2022). Indicators for social performance include rural employment contribution and industrial chain driving effect. The former is defined as the ratio of employees with rural household registration to total employees, and the latter is quantified as the number of cooperative farmers relative to total staff. These social impact indicators draw on the framework outlined by Chisha and Togo (2023). All indicators—ROA, environmental performance and social performance—are integrated via principal component analysis to construct a composite sustainability index, which serves as an auxiliary dependent variable to capture multi-dimensional sustainability.

3.2.2. Explanatory variables

Five variables are used in this paper as explanatory variables, including endogenous financing ratio, bank credit ratio, equity financing ratio, bond financing ratio and government subsidy intensity, as shown in Table 1.

The internal financing ratio represents a company's internal support and refers to retained profits within the company. Referring to the research of Li and Sun (2013), the internal financing ratio is measured by (surplus reserve + undistributed profits + depreciation of fixed assets)/total assets.

The bank credit ratio represents the funding support that high-tech industries receive from the bank, including short-term and long-term debts. It analyzes what role bank loans play in promoting a company's development. According to Jiang's (2017) research, the bank credit ratio is measured by (short-term debts + long-term debts)/total assets.

The equity financing ratio signifies the availability of equity capital for high-tech companies. This indicator is used to analyze to what extent equity funding supports business growth and reflects the overall supply of capital in the stock market. Li and Sun (2013) pointed out that the equity financing ratio was measured by (share capital + capital reserve)/total assets.

The bond financing ratio represents the bond support for high-tech industries, mainly referring to the payable bonds of enterprises. This indicator is used to analyze to what extent bond financing propels business growth. Referring to Jiang's (2017) research, bonds payable/total assets are used as a measure of bond financing ratio.

Government subsidy intensity represents government support for high-tech industries, mainly in the form of fiscal appropriations. Compared to fiscal interest subsidies and tax refunds, fiscal appropriations are more bonding and are generally limited to specified use. Referring to Chen's (2019) research, government subsidies/total assets are used as a measure of government subsidy intensity.

3.2.3. Control variables

After reviewing relevant literature and referring to the research of Xu et al. (2017) and others, the study selects the long-term debt ratio, total asset turnover ratio, current ratio and company size as control variables to ensure that the evaluation is accurate. The long-term debt ratio is calculated as dividing the total long-term liabilities by the sum of total assets, which is used to measure the long-term solvency of the enterprise; The total asset turnover rate is measured as operating income/total assets, which represents the operational efficiency of a company's assets; The current ratio serves as a measure of a company's short-term liquidity. Generally, the current ratio is employed to assess a company's short-term solvency; Company size refers to the total assets of a listed company. This study employs data from the consolidated financial statements. There is a correlation between the size of a listed company and its level of development. Generally, the bigger the company is, the more advanced its level of development.

Table 1. Variable definition

Variable category	Variable symbols	Independent variable	Variable definition
Dependent variable	roa	Return on total assets	Net profit/average total assets
Explanatory variable	nyr	Internal financing ratio	(Surplus reserves+undistributed profits+depreciation of fixed assets)/Total assets
	yhr	Bank credit ratio	(Short term loans+long-term loans)/Total assets
	gqr	Equity financing ratio	(Paid-up capital+capital reserve)/Total assets
	zqr	Bond financing ratio	Payable bonds/total assets
	zfr	Government subsidy intensity	Government subsidies/total assets
Control variable	czr	Long term debt ratio	Long term liabilities/total assets
	zzcr	Total asset turnover rate	Operating income/total assets
	ldr	Current ratio	Current assets/current liabilities
	as	Company size	Total assets in consolidated financial statements

3.3. Model Setting and Approach

This study selects publicly listed companies in the agriculture, forestry, animal husbandry, and fishing industries from the Shenzhen Stock Exchange and Shanghai Stock Exchange covering the period from 2013 to 2020. A panel data model is constructed for empirical analysis. Initially, Microsoft Excel was utilized to collate and organize the collected data; Subsequently, STATA13 was employed to perform regression analysis and robustness tests. To empirically investigate the impact of financing channels on the development of agricultural enterprises, the following econometric model is established:

The model integrates variables grounded in established theoretical frameworks to ensure empirical robustness. The total asset turnover ratio (zzcr) serves as a proxy for resource utilization efficiency, a key tenet of the RBV, as it quantifies the firm's capacity to transform assets into operational outputs, a critical determinant of sustainable development. Government subsidy intensity (zfr) is incorporated to capture formal institutional support, aligning with Institutional Theory, which

highlights the significance of policy interventions in addressing market failures prevalent in agricultural sectors.

The selection of a fixed-effects model is theoretically justified by the necessity to account for unobserved heterogeneity across agricultural enterprises, including factors such as regional institutional variations and firm-specific resource endowments. These time-invariant characteristics could potentially bias the estimates of financing methods' influence on sustainability outcomes if left unaddressed. The fixed-effects estimator isolates the within-unit, time-varying effects of financing variables, thereby aligning with the dynamic and sustainable development processes.

$$\begin{aligned} \mathrm{roa}_{i,t} &= \beta_1 \mathrm{nyr}_{i,t} + \beta_2 \mathrm{yhr}_{i,t} + \beta_3 \mathrm{gqr}_{i,t} + \beta_4 \mathrm{zqr}_{i,t} + \beta_5 \mathrm{zfr}_{i,t} + \beta_6 \mathrm{czr}_{i,t} + \beta_7 \mathrm{zzcr}_{i,t} \\ &\quad + \beta_8 \mathrm{ldr}_{i,t} + \beta_9 \mathrm{as}_{i,t} + B_{i,t} + U_t + V_i + \varepsilon_{i,t} \end{aligned} \tag{1}$$

In Eq. (1), it denotes agricultural and related enterprises (encompassing forestry, animal husbandry, and fishery), represents the time period, and roa signifies Return On total Assets. The explanatory variables nyr, yhr, gqr, zqr, and zfr correspond to endogenous financing ratio, bank credit ratio, equity financing ratio, bond financing ratio, and government subsidy intensity, respectively. The control variables include czr (long-term debt ratio), zzcr (total asset turnover ratio), ldr (current ratio), and as (firm size). The coefficient estimates are denoted by β, B represents the constant term, U captures time-fixed effects, V accounts for firm-fixed effects, and ε is the random disturbance term.

3.4. Descriptive Statistics of Variables

As presented in Table 2, the descriptive statistics indicate that the ROA has a minimum value of -183.981% and a maximum value of 67.602%, with a mean value of 6.252%. The positive mean suggests that the majority of the listed agricultural enterprises remained profitable during the period from 2013 to 2020. Among the various financing channels, equity financing demonstrates the highest average ratio at 45.3%, implying that it serves as a primary source of funding for agricultural firms. This is followed by bank credit financing, with an average ratio of 18%, indicating that bank loans are also commonly utilized by enterprises to expand operations and improve performance. In contrast, the bond financing ratio averages merely 0.9%, representing the smallest proportion across financing methods. This relatively low usage can be attributed to the stringent requirements for bond issuance, including high asset quality and the associated difficulties in accessing bond markets.

Table 2. Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
roa	785	6.252	11.866	-183.981	67.602
nyr	785	0.135	0.368	-4.306	0.777
yhr	785	0.180	0.148	0.000	0.819
gqr	785	0.453	0.359	0.039	5.123
zqr	785	0.009	0.031	0.000	0.245
zfr	785	0.012	0.018	0.000	0.177
czr	785	0.069	0.085	0.000	0.606
zzcr	785	0.782	0.592	0.012	4.515
ldr	785	2.303	2.972	0.093	36.796
as	785	5953.328	15428.380	20.325	179177.300

3.5. Correlation Analysis of Variables

To mitigate potential model estimation bias resulting from multicollinearity among explanatory variables, a correlation analysis was conducted prior to parameter estimation. This study employs the Pearson correlation coefficient method to assess the direction of the relationship between each pair of variables. As illustrated in Table 3, the correlation coefficients among most variables related to agricultural enterprises are relatively low, suggesting the absence of absolute collinearity. Thus, it can be concluded that no significant collinearity exists among the explanatory variables within the model evaluating the development effects of agricultural enterprises' financing methods.

4. Empirical Results and Analysis

In the construction of panel data models, three primary specifications are considered: the mixed effects model, the fixed effects model, and the random effects model. The model selection procedure commenced with an F-test to determine the suitability of a mixed effects model versus a model incorporating individual effects. Subsequently, a Hausman test was conducted to discriminate between a fixed effects and a random effects specification. Based on the results of the Hausman test (see appendix for details), this study employs a fixed effects model to empirically analyze the effects of various financing methods on agricultural development progress.

Table 3. Correlation analysis of variables

	roa	nyr	yhr	gqr	zqr	zfr	czr	zzcr	ldr	x4
roa	1									
nyr	0.490***	1								
yhr	-0.231***	-0.160***	1							
gqr	-0.352***	-0.832***	-0.226***	1						
zqr	-0.047	0.037	0.035	-0.123***	1					
zfr	0.043	0.035	0.044	-0.028	-0.064*	1				
czr	-0.050	-0.083**	0.375***	-0.136***	0.374***	0.063*	1			
zzcr	0.219***	0.196***	-0.007	-0.270***	-0.026	-0.007	-0.133***	1		
ldr	0.065*	0.096***	-0.390***	0.175***	-0.029	-0.043	-0.095***	-0.181***	1	
as	0.054	0.088**	0.147***	-0.164***	0.090**	-0.118***	0.026	0.108***	-0.098***	1

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

4.1. Overall Effect Analysis

As presented in Table 4, Model (1) employs a fixed effects model with standard error robust to heteroscedasticity sequence correlation.

The coefficient for the endogenous financing rate is 39.902, which is statistically significant at the 5% level. The result indicates that the endogenous financing rate exerts a significant positive effect on the development level of agricultural enterprises. Specifically, a higher endogenous financing rate corresponds to greater profit margins for these firms. In general, internal financing is often the preferred financing method for enterprises owing to its lower cost and high degree of controllability. However, excessive reliance on internal financing may compel firms to prioritize short-term gains, potentially at the expense of long-term sustainable growth.

The coefficient for the bank credit rate is -8.348; however, its lack of statistical significance suggests that the bank credit does not exert a substantial influence on the development level of agricultural enterprises. The extended agricultural production and operational cycle inherent to agriculture, coupled with high associated risks, often constrains access to bank financing, thereby limiting its potential impact on enterprise development.

Conversely, the coefficient for the equity financing ratio is 17.447 and is statistically significant at the 10% level. This indicates a positive promotional effect of equity financing on the development level of agricultural enterprises. This form of financing, which requires no repayment and features low liquidity pressure, provides firms with the stability necessary for long-term research, development, and investment. Consequently, it enables agricultural enterprises to enhance their business management practice and, ultimately, their overall development level.

The coefficient for the bond financing ratio is -28.545 and is statistically significant at the 5% level. This indicates that bond financing exerts a significant inhibitory effect on the development level of agricultural enterprises, suggesting that a higher reliance on bond financing is detrimental to their development. Bond financing constitutes a relatively low proportion of the financing structure for these enterprises, reflecting its insufficient overall support within the sector. This is primarily attributable to the stringent asset quality requirements imposed for bond issuance, the limited number of bond trading markets in China, and generally low liquidity. These characteristics collectively constrain the ability of bond financing to meet the substantial funding needs of agricultural enterprises. The results demonstrate that the potential advantages of bond financing channels in promoting the development of China's agricultural enterprises have not been fully realized. Furthermore, as a form of debt financing, bond financing is characterized by high associated costs, which can elevate financial burdens and subsequently impede enterprise progress.

The coefficient for government subsidy intensity is 44.414 and is statistically significant at the 5% level. As a specific instrument of industrial policy, government subsidies carry a strong policy orientation and reflect government preferences. The receipt of subsidies enhances the self-sufficiency of agricultural enterprises, alleviates their short-term financing constraints, and consequently leads to improved operational performance. This result underscores the positive role and significance of government subsidies in supporting the development of agricultural enterprises.

The inhibitory effect of bond financing is attributable to structural constraints within China's agricultural financing system. Agricultural enterprises are subject to stricter bond issuance requirements, including elevated asset quality thresholds and more rigorous credit assessments, which collectively increase financing costs. As noted in the 2023 China Agricultural Finance Development Report, agricultural firms typically incur bond interest rates that are 1.5 to 2 percentage points higher, than those for industrial enterprises. These elevated costs reduce the capital available for long-term sustainable investments, such as the adoption of green technology. Furthermore, a significant maturity mismatch exacerbates these challenges. Bond tenors, which often extend to five years or longer, rarely align with agricultural production cycles (typically 1–3 years). This misalignment intensifies repayment pressures and further constrains resources that could otherwise be allocated to sustainability-oriented projects.

The statistically insignificant impact of bank credit reflects deep-seated information asymmetry within rural financial markets. Agricultural production is characterized by inherent volatility due to exposure to climatic and biological risks, which complicates banks' ability to accurately assess creditworthiness. Consequently, financial institutions predominantly offer short-term loans (constituting over 80% of agricultural credit, coupled with stringent collateral requirements. Such loans are ill-suited to meet the long-term capital requirements essential for sustainable development initiatives, including multi-year projects like soil improvement or the construction of eco-friendly infrastructure. The fundamental difference between the short-term nature of prevailing credit terms and the long-term horizon of sustainability investments limits the efficacy of bank credit in fostering sustainable growth among agricultural enterprises.

It can be seen that among the various financing channels, government subsidies exert the most substantial positive effect on the development of agricultural enterprises. This is followed by endogenous financing and equity financing, both of which also demonstrate significant promotional effects. In contrast, bond financing exerts a significant inhibitory effect on development, and bank credit is found to have no statistically significant impact.

Table 4. Overall effect results and robustness test

	(1)	(2)	(3)
	roa	roa	roe
nyr	39.902**	39.902**	74.226**
	(15.899)	(15.018)	(26.506)
yhr	-8.348	-8.348	-17.751
	(8.445)	(7.396)	(15.325)
gqr	17.447*	17.447	40.169**
	(8.919)	(11.118)	(16.91)
zqr	-28.545**	-28.545**	-84.741***
	(12.068)	(9.152)	(22.288)
zfr	44.414**	44.414*	137.981***
	(19.374)	(19.777)	(33.544)
czr	14.308*	14.308**	17.881
	(8.265)	(4.964)	(16.64)
zzcr	5.059**	5.059**	13.719***
	(2.078)	(1.747)	(2.382)
ldr	-.281*	-.281*	-.751**
	(.163)	(.129)	(.277)
as	0***	0***	0***
	(0)	(0)	(0)
_cons	-11.015	-11.015	-32.371**
	(7.935)	(9.256)	(13.686)
Observations	785	785	785
Pseudo R2	.z	.z	.z

Note: Standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

4.2. Robustness Testing

One is to conduct testing with a lag of two periods. In Table 4, Model (2) is a fixed effects model with a lag order of 2. Comparing model (1), after a lag of 2 periods, except for the different significance levels of the equity financing ratio coefficient, the coefficients and significance levels of other indicators are the same, indicating that the model is robust and will not change over time.

The second is to replace the main variables. In Table 4, Model (3) is a fixed effects model that uses the return on equity to replace the return on total assets for testing. Both return on equity and return on total assets are metrics that can be used to gauge a company's profitability. The former reflects the profitability of shareholders, while the latter reflects the profitability of existing assets. Comparing Model (1) and Model (3), although the coefficient size and significance level are slightly different, the direction and significance of all indicators are the same, indicating that the model is robust and does not change with changes in variables.

4.3. Heterogeneity Analysis

4.3.1. Heterogeneity analysis of enterprise nature

According to the announcement of listed companies on the nature of enterprises, this article divides agricultural enterprises into private, state-owned, collective, and Sino-foreign joint ventures. Table 5 shows the grouped regression results of models (4), (5), (6), and (7) for the above four types of enterprises. In Model (4), endogenous financing ratio, equity financing ratio, and government subsidy intensity all have a significant promoting effect on the development of private enterprises, with government subsidy intensity having the greatest promoting effect. Bond financing ratio has a significant inhibitory effect on the development of private enterprises, while bank credit ratio has no significant impact on the development of private enterprises, which is consistent with the overall effect of agricultural enterprises. In Model (5), endogenous financing ratio and government subsidy intensity significantly promote the development of state-owned enterprises—with government subsidy intensity having the strongest effect—while equity financing ratio, bond financing ratio, and bank credit ratio show no significant impact. Comparing models (4) and (5), the impact of endogenous financing ratio and government subsidy intensity on the development of private enterprises is superior to that of state-owned enterprises. This can be attributed to the 'local urbanization' pattern of rural population in private enterprises' operating areas (Liu, 2023). Private enterprises, deeply embedded in local communities, tend to reinvest retained earnings in rural employment and industrial chain cooperation, making endogenous financing more effective for their sustainable development.

Table 5. Empirical results of enterprise nature

	(4)	(5)	(6)	(7)
	roa	roa	roa	roa
nyr	69.807***	16.03*	-56.698	-35.843
	(23.346)	(9.428)	(138.761)	(12.543)
yhr	-6.879	-9.244	-55.189	-15.296
	(11.456)	(8.393)	(14.124)	(24.191)
gqr	16.138*	7.021	55.431	-22.964
	(8.998)	(8.241)	(247.947)	(29.689)
zqr	-34.241**	-21.539	-202.473	
	(13.397)	(16.916)	(908.848)	
zfr	123.764**	25.345*	547.256	91.447
	(47.13)	(14.273)	(487.077)	(22.465)
czr	15.5**	5.241	-27.69	-85.654***
	(7.227)	(10.154)	(92.099)	(.717)
zzcr	4.794**	2.432*	4.855	19.982
	(2.391)	(1.403)	(15.148)	(7.099)
ldr	-.428**	.132	45.67	.768*
	(.189)	(.182)	(51.973)	(.116)
as	0***	0	.004	0
	(0)	(0)	(.005)	(0)
_cons	-17.797*	-2.251	-76.56	6.209
	(10.416)	(6.041)	(38.045)	(20.452)
Observations	502	256	16	11
R-squared	.48	.203	.808	.952

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

4.3.2. Regional heterogeneity analysis

According to geographical location, agricultural enterprises in this article are divided into three regions: eastern, central, and western. Grouped regression analysis on enterprises in these three regions is shown in Models (8), (9), and (10) of Table 6. Specifically, the eastern region covers an area of 1.294 million square kilometers, accounting for 13.5% of the overall land area, which includes Beijing and Tianjin Cities, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan Provinces together with Guangxi Autonomous Region. The central region refers to Inner Mongolia Autonomous Region, along with Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan Provinces, which totally occupy 2.818 million square kilometers, or 29.3% of the total land area. Finally, the western region consists of Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai Provinces, along with Xizang, Ningxia and Xinjiang

Uygur Autonomous Regions, spanning 5.414 million square kilometers, or 56.4% of the total land area.

In the eastern region, agricultural enterprises are strongly promoted by the internal financing ratio and government subsidy intensity, especially government support, contrary to a significant inhibitory effect of bank credit ratio, equity financing ratio, and bond financing ratio.

In the central region, only the intensity of government subsidies has a significant promoting effect on agricultural enterprises' development, while the other four ratios have no obvious impact.

For agricultural enterprises in the western region, their development is positively affected by the internal financing ratio and equity financing ratio, especially the former one as the greatest promoter, while the other three ratios have little promotional effect.

According to models (8), (9), and (10), the endogenous financing ratio has a stronger effect on the agricultural enterprises' growth in the western region than that in the eastern and central regions. The intensity of government subsidies strongly affects the development of agricultural enterprises in the central region than that in the eastern and western regions. The equity financing ratio plays a crucial role in fostering agricultural enterprises in the western region, but hinders the progress of agricultural enterprises in the eastern region.

When selecting financial strategies to develop agricultural enterprises, the nation naturally must adopt a comprehensive approach that takes regional variations into consideration.

Table 6. Empirical results for eastern, central, and western regions

	(8)	(9)	(10)
	roa	roa	roa
nyr	23.158**	2.309	71.748***
	(9.736)	(9.508)	(19.698)
yhr	-28.974**	-15.547	-4.564
	(11.002)	(10.116)	(15.225)
gqr	-13.902**	-6.452	36.215***
	(6.454)	(8.536)	(3.903)
zqr	-52.863**	-16.535	-18.248
	(24.548)	(18.845)	(13.445)
zfr	31.024**	107.726*	32.467
	(15.224)	(53.946)	(86.398)
czr	12.697	3.648	9.731
	(14.052)	(13.22)	(10.759)
zzcr	2.368	4.646***	7.063
	(2.256)	(1.653)	(7.284)
ldr	-.027	.043	.431
	(.207)	(.307)	(.527)
as	0	0***	0*
	(0)	(0)	(0)
_cons	10.173*	5.398	-21.186***
	(5.279)	(5.552)	(5.249)
Observations	447	210	128
R-squared	.284	.244	.495

Note: Robust standard errors are in parentheses. *** $p<.01$, ** $p<.05$, * $p<.1$.

The strength of endogenous financing in western regions comes from an underdeveloped formal financial infrastructure, which is further reinforced by an aging population and young worker loss due to labor migration in western rural areas (Liu et al., 2025). Moreover, according to 2022 data from the People's Bank of China, agricultural loan coverage in western provinces is only 60 percent of that in eastern regions. With less external labor inputs and limited access to external financing channels such as bank credit or equity markets, enterprises then turn to internal investment in mechanization and sustainable technologies instead of employment expansion, amplifying the impact of endogenous financing.

As the central regions are major grain producers which contribute 60 percent of the nation's total grain output, government subsidies demonstrate greater effectiveness there, which is consistent with Li et al. (2023)'s emphasis that

favorable natural conditions enhance policy effectiveness. In addition, Government subsidies in these regions are strategically aligned with national food security policies, which prioritize investments in high-standard farmland and green agriculture. Thus, apart from natural advantages, subsidies are efficiently allocated to high-standard farmland and climate-adaptive practices, further realizing higher efficiency and sustainability.

However, the local mature financial markets in eastern regions lead to the inhibitory effect of equity financing, as investors often prioritize short-term profitability over long-term sustainability. As noted by Liu (2023), eastern regions face intensive "off-site urbanization". That is, lots of rural labor migrates to cities, which explains investors' preference of short-term investment and the constraint of agricultural sustainability by equity financing. Therefore, agricultural enterprises in eastern areas are challenged to deliver immediate returns and turning equity funds from environmental or social projects, such as carbon emission reduction technologies, to short-term operational expansions.

4.4. Robustness Test Based on Composite Sustainability Index

To validate reasonable findings from a multi-dimensional sustainability perspective, this section replaces ROA with the composite sustainability index (integrating economic, environmental, and social indicators via principal component analysis) as the dependent variable to re-conduct the fixed-effects model regression.

Results show that government subsidies rank first in driving sustainable development, with a coefficient of 52.31 ($p<0.01$). This effect is particularly highlighted in environmental performance: government subsidies correlate strongly with higher green innovation input and less carbon emission intensity, demonstrating their incentive role in eco-friendly investments.

Endogenous financing positively affects the composite index (coefficient 41.27, $p<0.05$), mainly social performance. Higher endogenous financing ratios can mean greater rural employment contribution and stronger industrial chain driving effect, indicating that internal funds are more preferably allocated to social welfare-oriented projects.

Equity financing exhibits a weaker but still positive effect on the composite index (coefficient 12.89, $p<0.1$), primarily influencing economic and social dimensions rather than environmental performance. This suggests equity funds tend to prioritize short-term profitability and employment expansion over long-term environmental investments.

Bond financing continues to show an inhibitory effect (coefficient -30.15, $p<0.05$), with intensified negative impacts on environmental performance. High repayment pressures from bond financing appear to crowd out resources for applying green technologies, thus exacerbating carbon emission intensity.

Bank credit remains statistically insignificant in explaining the composite index, which is consistent with prior findings. It reinforces that current bank credit mechanisms fail to effectively support multi-dimensional sustainable development in agricultural enterprises.

Overall, impacts from different financing methods generate consistent results with that using ROA, verifying the robustness of our conclusions. The composite index analysis further reveals that financing methods exert heterogeneous effects on sustainability, highlighting the importance of targeted policy designs.

5. Conclusion

5.1. Research Conclusion

The aforementioned empirical findings can infer the following conclusions: firstly, different financing methods have various effects on developing agricultural enterprises. Government subsidies have the greatest promoting effect, followed by endogenous financing and equity financing. Bond financing has an inhibitory effect on their development, while bank credit has no significant impact. Secondly, in terms of enterprise nature, the internal financing ratio and the intensity of government subsidies have a stronger influence on private enterprises than that of state-owned ones. Thirdly, from a regional perspective, the endogenous financing ratio has a greater promoting effect on agricultural enterprises' development in the western region than in the eastern and central regions. However, the intensity of government subsidies strongly promotes the development of agricultural enterprises in the central region than that in the eastern and western regions. In addition, the equity financing proportion plays an excellent role in fostering agricultural enterprises in the western region, whereas it considerably restrains the agricultural enterprises' growth in the eastern region.

From the perspective of multi-dimensional sustainable development measured by the composite index integrating economic, environmental, and social indicators, the findings further reveal heterogeneous sustainable impacts of financing methods. Despite its prevailing strong influence, government subsidies particularly affect environmental performance, leading to higher green innovation input and lower carbon emission intensity. Beyond its positive influence on overall development, endogenous financing can greatly enhance social performance, which is manifested in more contributions to rural employment and a stronger driving effect on the industrial chain. Equity financing, though positively associated with the composite index, tends to prioritize economic and social outcomes over environmental investments. Bond financing remains inhibitory, especially worst in the environmental dimension by crowding out resources for eco-friendly technologies.

These supplementary findings reinforce the robustness of core conclusions in this paper. Another highlight is that financing methods affect not only profitability, but also the environmental and social pillars of sustainable development, underscoring the need for targeted strategies that align financing mechanisms with specific sustainability goals.

5.2. Policy Implications

Based on the empirical findings, corresponding policy measures are proposed to facilitate financing methods in growing agricultural enterprises sustainably.

For governments, optimized subsidy allocation should prioritize private enterprises and western regions, where endogenous financing plays a more critical role. According to Li et al. (2023), subsidies in central regions should also leverage local natural endowments, for example, funding water-saving irrigation in areas with scarce rainfall or supporting specialty crop cultivation in regions with suitable temperature conditions, so as to maximize sustainability impacts. 30% of government subsidies should be earmarked for green innovation, such as utilizing eco-friendly technologies and reducing carbon emissions, thus enhancing subsidies' influence on environmental performance. Additionally, policymakers should loosen restrictions for agricultural enterprises to issue bonds by a special guarantee mechanism for agricultural sustainable development bonds, adjusting maturity terms to match agricultural production cycles (3–5 years) to reduce repayment pressure.

For financial institutions, banks should develop long-term credit products tailored to agricultural characteristics, with less tight collateral requirements for projects related to rural employment and soil improvement. These products should extend loan tenors to 3–5 years, thus well matching short-term credit and long-term sustainability needs. Meanwhile, equity markets should be guided to value long-term sustainable performance by incentivizing investors to support agricultural enterprises' social and environmental projects, thereby mitigating the short-term profit pressure faced by eastern region enterprises.

For agricultural enterprises themselves, more efforts should be made to strengthen endogenous financing capacity. They should allocate at least half of their reserved earnings to sustainable investments, such as rural employment expansion and industrial chain cooperation, by leveraging verified effective internal funds in driving social performance. Particularly, private enterprises should upgrade profit retention mechanisms to reduce reliance on external financing with high costs or restrictive terms.

5.3. Limitations and Future Research

There are surely limitations in this study. Firstly, the sample size is relatively limited by focus on listed agricultural enterprises within the agriculture, forestry, animal husbandry, and fishery sectors, which is not general enough to cover unlisted small and medium-sized agricultural enterprises. Secondly, inadequate data constraints in-depth comparative analyses, specifically detailed comparisons among sub-sectors (agriculture, forestry, animal husbandry, and fishery) or between agricultural and non-agricultural industries.

Improvements can be made in the following two aspects. First, further explorations will be conducted in the underlying mechanisms through which financing methods affect agricultural enterprises' sustainable development, including an analysis of how financing methods interact with technological innovation or institutional factors to influence sustainability. Second, the scope of comparative studies should be expanded, including sub-sector comparisons within agriculture and cross-industry comparisons with non-agricultural sectors, so as to provide more nuanced insights into the uniqueness of agricultural financing dynamics.

Author Contributions

Peihong Huang conceptualized the study, designed the methodology, and revised the manuscript; Jing Li collected and analyzed data and drafted the original manuscript. Both authors approved the final version.

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Institutional Review Board Statement

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