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A Decision Support System to Estimate Green Sustainability from Environmental Protection and Debt Financing Indicators

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Abstract: In the social context of advocating a low-carbon economy, achieving sustainable growth in line with current social development requirements is an issue that agribusiness must face. In order to explore the mechanisms influencing the sustainable growth of Chinese agriculture and to optimize the quality of agribusiness decisions, this paper examines the relationship between environmental management, debt financing indicators, and financial sustainable growth of the company in Chinese agriculture. Specifically, a decision support system based on the least square dummy variable (LSDV) model, mediating effects model and threshold effects model was constructed by using annual financial reports and questionnaire data of the listed agricultural enterprises. After empirical analysis, the following results were obtained: first, both environmental management and debt financing management help Chinese agricultural firms achieve financially sustainable growth. Second, debt financing can transmit the effect of environmental management on financially sustainable growth. Third, there are significant differences in the effects of debt financing on financially sustainable growth under different environmental management conditions. Finally, in order to promote the development of Chinese agriculture, this paper suggests that agricultural enterprises should actively implement environmental management and that relevant Chinese authorities should lower the financing threshold of the agricultural industry, while ensuring risk regulation.

Keywords: low carbon economy; financial sustainable growth; the least square dummy variable (LSDV); mediating effects; threshold effects

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1. Introduction

In the last decade, environmental issues have gradually become a regular concern in society [1]. Since the World Climate Conference in Paris in 2015, the world has agreed to combat climate change by achieving a green transition [2]. People's environmental awareness and motivation are increasing [3], and various fields, including business, have begun to carry out research related to climate change [4]. Agriculture is an industry that is relatively dependent on environmental resources; therefore, environmental green policies may have an overall negative impact on agriculture [5]. Environmental management (*EM*) is currently one of the most important ways of transitioning the agricultural sector to a green economy [6]. In the context of advocating green and sustainable development, how to achieve sustainable development of the agricultural industry has become an urgent issue. Due to economic and technological development, green agriculture has become one of the fastest growing industries in China. In recent years, agricultural studies have mainly focused on business performance [7] and return on investment assessment [8], although they have increasingly addressed diversified investment strategies [5], internal governance mechanisms [9], and business crisis prediction [10]. Previous studies have shown that engaging in environmental activities may increase a firm's competitive advantage, and thus its financial position [11,12]. Furthermore, for the agricultural sector, rationalizing production structures may increase production based on a reduction in green emissions in the sector [1].

Few scholars have focused on debt financing (*DF*) in the agricultural industry. In fact, due to macroeconomic and institutional pressures, the agricultural sector often faces financing problems, which seriously hinder its survival and sustainable development [13]. The agricultural industry relies on environmental endowments, and as labor costs rise, the benefits of agricultural investments become more limited, which in turn leads to increased financing thresholds and financing costs for the agricultural industry [14]. In addition, the long-term viability of Chinese agriculture in a green economy is a concern because agribusinesses must meet both social policy needs and financial needs [15]. Therefore, the field of environmental management and financial sustainable growth (*FSG*) deserves exploratory research. In summary, this study focuses on the relationship between environmental management, debt financing indicators, and sustainable corporate financial growth in Chinese agriculture in the context of a green and low-carbon society.

The contribution of this paper is mainly to establish a corporate decision support system by studying the relationship between *EM* and *DF*, *FSG*, and to provide a basis for business decision making in the environmental protection context. Second, this paper uses a mediating model to verify the transmission mechanism of $EM \rightarrow DF \rightarrow FSG$. The nonlinear threshold relationship between *EM*, *DF* and *FSG* was examined by using the threshold effect model, which further expands the research area of *FSG*. In addition, to control for endogeneity, this paper applies different methods, including instrumental variables (IVs), two-stage least squares (2SLS) and the system GMM model to make the results more robust and reliable. Finally, specific practical recommendations for decision support systems for agribusiness are presented. At present, the decision support model established in this paper is still inadequate, and the factors considered in future decision support systems for agricultural enterprises should be more comprehensive, such as adding more social factors and enterprise financial indicators.

2. Literature Review and Proposed Hypotheses

2.1. The Impact of Environmental Management (EM) on Financial Sustainable Growth (FSG)

With the increasing demand for environmental protection, climate and environmental factors have become important factors that cannot be ignored in business operations. In order to identify and improve the business environment, Patfitzianas (2008) added climate factors to the information and decision-making system of a company [16]. Existing studies generally agree that the implementation of green policies has a positive impact on the economy. Doukas (2020) adds climate policy to the considerations of the decision-making system to support climate-related decisions [17]. Some scholars believe that the implementation of green policies has a positive impact on the economy. Environmental management can help the environment by reducing the energy use intensity of companies and reducing pollutants. Scholars have argued that pollution prevention and greening can improve a company's reputation and through reputation, companies can attract environmentally friendly consumers [18]. Li and Wu (2017) [19] found that increased environmental investment led to a decrease in both revenue and costs, but the decrease in costs was more pronounced. As a result, corporate profits increased. Zhu and Zhang (2015) [20] concluded that CSR and financial performance in China showed a significant positive relationship.

In addition, it has also been suggested that there is a negative correlation that occurs between environmental management and financial performance, and no correlation occurs between social responsibility and financial performance [21,22]. Studies have also presented other conclusions. For instance, certain aspects of social responsibility affect financial performance, whereas others are not significantly related to financial performance [23,24]. Therefore, whether environmental management can help firms achieve *FSG* is still inconclusive in the academic field. In summary, the first hypothesis is proposed in this paper as follows:

Hypothesis 1 (H1) . *EM can effectively promote corporate FSG.*

2.2. Impact of Debt Financing (DF) on Financial Sustainable Growth (FSG)

Debt financing is an important part of corporate finance and the impact of debt on a company's operations and financial performance has been a popular area of research. Simerly and Li (2000) [25] found that the association between debt ratios and financial position varies depending on the firm's environment. Furthermore, Hayam Wahba. (2013) [26] discovered that the debt maturity, not the leverage ratio, influences a firm's financial performance. El-Sayed Ebaid (2009) [27] discovered that *DF* and ROA had a negative relationship. Yazdanfar and Ohman (2015) [28] discovered that debt ratios have a detrimental influence on business profitability when it comes to trade credit, short term and long term debt. As decision support systems are becoming more widely used in business, corporate management is using them to help companies become more competitive in the marketplace [29]. Akinfiev et al. (2021) [30] designed a financial decision system based on agricultural business processes to enhance the development of sustainability of agricultural companies and reduce financing risks. Liu et al. (2022) [31] proposed a decision support system to evaluate the relationship between financing constraints and innovation in agricultural firms.

Compared to the world's agricultural powerhouses, financing is one of the main problems faced by Chinese agricultural enterprises. On the one hand, Chinese agriculture companies are small in scale, poor in financial status, and weak in financing capabilities [32]; on the other hand, financial institutions are not knowledgeable about agriculture management, development planning, project development, or financing needs, and cannot make accurate judgements about project prospects, expected returns, or risk levels. Therefore, further efforts are needed to establish bank credit that meets the needs of China's agricultural development [33].

Overall, *DF* has not reached a consensus on the financial performance-financial performance link. The reason for controversy is because, in addition to differences in empirical methodology, the economic and social conditions of the many nations represented in the literature may also influence the results; as one example, when regional economic policy instability is high, it can raise the cost of debt financing, and thus affect financial performance [34]. As a result, this paper's research is defined by a study of the agriculture business in a Chinese social environment and the second hypothesis is proposed as follows:

Hypothesis 2 (H2) . *DF can promote corporate FSG.*

2.3. The Role of Debt Financing (DF) between Environmental Management (EM) and Financially Sustainable Growth (FSG)

In the course of business management, one may be faced with the dilemma of choosing between current profits or long-term development. As a general rule, companies should neither be obsessed with current profits, nor should they focus on long-term development to the exclusion of immediate financial difficulties. According to Picas et al. (2021) [35], there has been a lot of scholarly interest in long-term financial growth. Srebro (2021) [36] indicated that a strong financial position is a need for long-term productivity. Sustainable growth indicators have been used to assess the sustainable production capacity of enterprises and to build sustainable supply chains in later research based on quantitative models [37,38]. Financial mechanisms are often important for sustainable corporate financial growth [39] and FGS is, therefore, generally measured using indicators from the following three different categories: economic, social, and environmental [40,41]. In studying the relationship between debt financing, corporate governance and market value for all listed companies in the Shenzhen Stock Exchange and Shanghai Stock Exchange, Li (2016) [42,43] found that debt financing, in general, has the effect of strengthening corporate governance, while corporate governance, as a signal, can also reflect firm performance. Thus, this paper proposes the third hypothesis as follows:

Hypothesis 3 (H3) . *EM promotion can be transmitted to FSG through DF.*

3. Materials and Methods

3.1. Model Framework

To explore the relationship between environmental management, debt financing and sustainable financial growth, the model of *EM*, *DF* and *FSG* is established as follows:

$$FSG_{it} = a_0 + a_1 Em_{it} + a_2 DF_{it} + a_3 Em_{it} * DF_{it} + \beta X_{it} + \varepsilon_{it} \tag{1}$$

where the letters "*i*" and "*t*" stand for the firm and the year, respectively; SGR_{it} represents financial sustainability growth; Em_{it} represents environmental management; and DF_{it} represents debt financing. $Em_{it} \times DF_{it}$ represents the *EM* and *DF* interaction term; the control variables are represented by βX_{it}; and random errors are represented by ε_{it}.

3.2. Variable Selection

For financial sustainable growth (*FSG*), there are two main types of models to research FGS, which are accounting-based and cash flow-based [44]. In this paper, the cash flow-based sustainable growth model is chosen because it examines the growth of the business from the *DF* perspective. In turn, the cash flow-based models can be divided into the Roppaport model and the Colley model, which are both based on different original assumptions [45]. The Roppaport model assumes that a firm must generate positive net cash flows in its operations, while in reality, a firm may generate negative net cash flows, which leads to significant differences between the model's conclusions and reality. Therefore, we chose the Colley model because it usually produces stable and efficient results that are more in line with the current situation of Chinese agricultural enterprises.

The following are the hypotheses of the Colley model: first, the firm's debt to operating ratio and dividend share in net income remain constant; second, the firm's assets and current liabilities grow in proportion to sales; and third, asset depreciation expense is available for reinvestment in fixed assets. The calculation formula is as follows:

$$SGR = \frac{(EBIT - 1)(1 - t)(1 + DER)(1 - DPO)}{NA_0 - (EBIT - 1)(1 - t)(1 + DER)(1 - DPO)} \tag{2}$$

where *SGR* denotes the financial sustainable growth indicator for agriculture companies, *EBIT* denotes earnings before interest and taxes, *I* denotes debt interest expense, *t* denotes tax rate, *DER* denotes debt-to-equity ratio, *DPO* denotes dividend payout ratio and NA_0 denotes net assets at the beginning of the period.

For environmental management (*EM*), this research is based on Gil's (2001) [46] quantitative analysis table of agriculture company environmental management time, and it aims to investigate the following seven areas of company environmental management: environmental cost savings, environmental training programs, green purchasing policies, environmental protection as a selling point in advertising and marketing, asking customers to participate in environmental protection projects, requiring energy and water conservation, and collection of recyclable materials generated during operations, which are all examples of environmental cost savings. These seven indicators provide a comprehensive assessment of the environmental management of a business in terms of its staff, measures and operations. Managers of agriculture businesses were asked to rate the above seven things on a scale of 0–10, with the scores indicating how far their organization went to initiate and implement each of the steps.

Table 1 shows how the seven factors were transformed into a factorial indication. The Cronbach alpha value (0.83) is higher than Nunnally's (1978) [47] 0.70 threshold value for ensuring internal consistency. Furthermore, the use of a supplementary assessment has confirmed the convergent validity of this component. Drawing on the approach of studies on exhibition (Jin and Weber, 2013) [48] and hotel companies (Buffa, et al., 2018 and Filimonau, 2018) [49,50], this work relied on studies that used the creation of an environmental strategy as a surrogate for *EM*.

Table 1. Factor analysis results for *EM* item subjective scales.

Scale and Item	Factor Loading		
	1	**2**	**3**
The company quantifies in its budget its environmental savings and costs	0.20	0.68	0.17
The company gives the employees training on environmental issues	0.34	0.64	0.11
The company gives priority to purchasing ecological products (biodegradable, reusable, recyclable, etc.)	0.14	0.70	0.25
The company uses ecological arguments in its marketing campaigns	0.09	0.75	0.31
The company facilitates customer collaboration in environmental protection (voluntary changing of towels, etc.)	0.10	0.64	0.35
The company applies energy and water saving practices	0.11	0.64	0.34
The company makes a selective collection of paper, oil, glass, etc.	0.15	0.68	0.15
Eigenvalue	/	3.68	/
Percentage of variance explained	/	17.47	/
Alpha	/	0.83	/

Note: This scale is referenced from Alvarez Gil et al. (2001) [46].

For debt financing (*DF*), this paper draws on the approach proposed by Cole and Sokolyk (2018) [51], where the ratio of long-term debt to total assets represents leverage; this approach avoids the situation where the relationships between financial indicators obtained in the empirical evidence do not correspond to the reality. In addition, in order to have a representative sample for the article, enterprises in very poor financial condition close to bankruptcy are excluded from the sample in this paper.

For control variables, three control variables are set in this paper. Firm size and denoted by "Size", growth rate of total agricultural output denoted by GTOV, and net assets per share denoted by "Ass". Among them, the firm size indicator is expressed as the logarithm of the firm's total assets, and the net asset per share is expressed as the ratio of shareholders' equity to total stock.

Table 2 lists the names, symbols and definitions of all the variables. To reduce the influence of outliers on the estimate findings, the data were treated with a 2% tailing treatment on all the continuous variables.

Table 2. The definition of variables.

Variable	Symbols	Definition
Debt financing	*DF*	Long-term debt to total assets
Size	*Size*	Ln (total assets)
Growth rate of the total output value of industry	*GTOV*	$(TOV_2\text{-}TOV_1)/TOV_1$
Net assets value per share	*Ass*	The ratio of stockholders' equity to total stock
Environmental management	*Em*	Calculated by factor analysis
Sustainable growth rate	*SGR*	Equation (2)

3.3. Sample Selection and Data Sources

Annual financial reports of the listed Chinese A-share agriculture businesses from 2008 to 2017 were chosen as a sample of financial performance in this research, with data gathered from the China Stock Market and Accounting Research Database (CSMAR) and RESSET Financial Research Database (RESSET). Meanwhile, this paper used a questionnaire survey to collect environmental management indicators from 50 agriculture firms. The results of the descriptive statistics for the variables are presented in Table 3.

Table 3. The description analysis.

Variable	Mean	St. Dev.	Max.	Min.
SGR	0.65	0.43	1.56	0.01
EM	5.28	2.16	7.19	4.01
DF	0.22	0.18	0.29	0.01
Size	20.42	1.37	23.14	19.13
GTOV	0.102	0.814	0.22	0.03
Ass	2.49	1.53	6.27	−0.52

4. Results and Discussion

4.1. Baseline Regression Analysis

For samples with a large number of individuals but short time periods, Peric (2019) [52] discovered that the least square dummy variable (LSDV) estimate approach outperforms both the instrumental variable (IV) and GMM estimation methods. The generalized method of moment (GMM) is a method of constructing estimates based on the assumption that the random variables follow specific moments rather than assumptions about the entire distribution, which are referred to as moment conditions. This makes the GMM model relatively robust, but it also leads to a reduction in the validity of the estimator. In short, the GMM model is more suitable for data with a longer sample time span, while the LSDV model, which is suitable for data with a short time span and large number of individuals, better fits the data characteristics of this paper. Therefore, this paper mainly uses the LSDV model for fitting and the GMM model for robustness testing. The results of the fitting are presented in Table 4. According to Table 4, the F-values in the fitted results are large and pass the 1% significance level test, indicating that the overall coefficients of the model are significant, and the conclusions are valid. Both model 1 and model 2 were fitted based on Equation (2), the difference being that model 1 incorporates an interaction term, while model 2 has no interaction term as a control group. Based on the results of the fit, it appears that *EM* has a positive correlation with *FSG* at the 5% level of significance. Thus, hypothesis 1 was confirmed. Hypothesis 2 was confirmed based on the results of the *DF* fit, which showed a positive correlation with *FSG* at the 1% significance level.

Model 3 was fitted based on Equation (2), which considers whether *EM* affects the extent of the effect of *DF* on *FSG* when the interaction term is included. Based on the results of the fit, on the one hand, *DF* continues to act significantly on *FSG* and is positively correlated with *FSG*, which once again confirms hypothesis 2. On the other hand, the coefficients fitted to the interaction term indicate that *EM* has a significant effect on the relationship between *DF* and *FSG*, a result that verifies the validity of hypothesis 3.

In the fitted results for the relevant control variables, the coefficient representing firm size is 1.12, indicating that larger tourism firms are more capable of ensuring financially sustainable growth at the 5% level of significance. The fitted coefficient for GTOV is 1.55, indicating that growth in gross agriculture industry output is positively associated with financial sustainability at the 10% level of significance. The Ass coefficient is 3.12, indicating that at the 10% significant level, the company's profitability is positively correlated with financial sustainability growth.

By fitting Equation (2) to obtain the coefficient results, we have preliminarily tested the previously proposed hypothesis. However, a series of tests are still required to obtain robust and valid results.

Table 4. The results of baseline regression.

Input Variable	Output Coefficient		
	Model 1	**Model 2**	**Model 3**
Cons.	8.76 (6.74)	12.37 (9.45)	6.81 * (4.33)
EM	1.94 ** (3.17)	1.79 ** (2.35)	
DF	2.54 *** (5.13)	2.91 *** (7.44)	2.673 *** (7.01)
*EM*DF*			3.41 *** (5.89)
Size		0.87 ** (1.64)	1.14 ** (2.35)
GTOV		1.91 * (3.88)	1.52 * (2.19)
Ass		2.77 * (5.72)	3.01 * (6.14)
Adjust R^2	0.502	0.534	0.551
F value	22.97 ***	21.81 ***	20.33 ***

Note: ***, **, * significant at 1%, 5%, and 10% levels, respectively; () represents Z value.

4.2. Endogeneity Test

The explanatory variables in this paper are likely to be correlated with the nuisance terms. Furthermore, while LSDV estimates might mitigate the endogeneity problem produced by missing variables, the endogeneity problem induced by the bilateral causal link between variables is difficult to avoid. As a result, this research employs the IV approach to address the endogeneity issue. To overcome the endogeneity problem, this article used the dispersion transformation on the fixed effect model first, and then used the two-stage least squares method to estimate the converted model (2SLS). The endogenous explanatory variables for the 2SLS estimate must be given in advance and described by suitable IVs. This paper assumes that the explanatory variables *EM* and *DF* are endogenous, and their lagged variables are selected to proxy for the IV method, and the estimation results are shown in Table 5.

Model 1 corresponds to the IV estimate result of Equation (2) without the interaction term, whereas model 2 corresponds to the IV estimate result of Equation (2) with the interaction term. As indicated in Table 5, the Anderson canon corr. LM statistic, which is employed in all models for “unrecognizable tests,” rejects the null hypothesis at the 1% level, indicating that the IVs set is identifiable. Simultaneously, the Cragg–Donald Wald F statistic used in the “weak instrumental variable test” in all models is significantly larger than the critical value (8.15) at the 10% bias level, rejecting the null hypothesis. In conclusion, the IVs sets can be considered to be effective and reasonable. Furthermore, there is no over-identification problem because the number of IVs chosen for this paper was comparable to the number of endogenous variables in order to avoid the appearance of over identification. According to the results, the fitted coefficients are similar to those obtained previously within Table 4, indicating that the previous fit using the LSDV model is valid. In addition, the fitted coefficients for the group of control variables are also the same as in the previous paper.

Table 5. The results of 2SLS estimation.

Input Variable	Output Coefficient	
	Model 1	**Model 2**
Cons.	10.31 (8.17)	11.03 ** (8.91)
EM	1.91 ** (3.75)	
DF	1.08 *** (5.27)	3.071 *** (9.14)
*EM*DF*		2.49 *** (4.77)
Size	1.35 * (3.12)	1.35 ** (3.19)
GTOV	1.23 ** (3.04)	2.33 ** (4.07)
Ass	2.14 ** 10.59	1.35 ** (4.07)
Uncentered R^2	0.334	0.327
Anderson canon. corr. LM value	98.35 ***	97.46 ***
Cragg–Donald Wald F value	82.47	80.06

Note: ***, **, * significant at 1%, 5%, and 10% levels, respectively; () represents Z value.

4.3. Robustness Test

In practical terms, financially sustainable growth should be a continuous time series indicator, and the position in the previous period may have an impact on both current and future values. However, this effect was not considered in the previous model in this paper, so the results may not be robust. Therefore, this paper adds consideration of the lagged term of *FSG* to the model and performs a robustness test using the systematic GMM. The test results show that the P-values for the residuals of the model differences are all much greater than zero, indicating that the models display no second-order correlation. According to the test results, the P-value is close to 1, the model is not over identified and the IV method is valid. In addition, the fitted variable coefficients were generally consistent with those from the baseline regression analysis. In summary, the robustness test proved the validity of the three hypotheses of this paper.

4.4. Retesting Interaction Effects through a Mediating Effects Model

In the previous model, an 'interaction term' was used to examine the impact of *EM* on *FSG* through *DF*. According to the results, the coefficient of the interaction term is significantly positive, but this result may be due to the fact that there is a correlation between the environmental management behavior of Chinese smart agriculture companies and the capital allocation behavior of the capital market, and that this correlation has a link to sustainable corporate financial growth. However, the significance of the 'interaction term' does not fully justify the impact of *EM* on *FSG* through *DF*. As a result, this research employs Baron and Kenny's (1986) [53] mediating effects model to create the recursive model below, which properly identifies the transmission mechanism of $EM \rightarrow DF \rightarrow FSG$.

$$SGR_{it} = \beta_0 + \beta_1 EM_{it} + \eta X_{it} + \varepsilon_{it} \quad (3)$$

$$DF_{it} = \lambda_0 + \lambda_1 EM_{it} + \theta X_{it} + \varepsilon_{it} \quad (4)$$

$$SGR_{it} = \alpha_0 + \alpha_1 EM_{it} + \alpha_2 DF_{it} + \varphi X_{it} + \varepsilon_{it} \quad (5)$$

The first step is to run Equation (3) through regression and check if the *EM* coefficient is significant. If it is considerable, it suggests that tourist firms' *EM* actions have an influence on *FSG*. The second step is to examine the influence of *EM* on *DF* by regressing Equation (4) (mediator). If the regression coefficient is substantial, then *EM* will have an impact on *DF*. The next step is to run Equation via regression (5). If the *EM* and *DF* coefficients are significant, and the coefficient falls when compared to the absolute value of the coefficient, there is a partial mediating impact. If the coefficient is substantial but the coefficient is not, it is possible that *DF* is acting as a full intermediary.

The assessment result of the mediating effect test is shown in Table 6. According to the results, the fitted coefficient of the *EM* term in model 1 is significantly positive at the 1% level of significance. The fit results for model 2 are also positive at the 1% level of significance, while the over-fit results in model 3 show that the fitted coefficient of the *EM* term is evidenced at the 5% level of significance and the coefficient of the *DF* term is evidenced at the 1% level of significance. In summary, the fitted coefficient of the *EM* term in model 3 is much lower than that of model 1, which reflects the involvement of the *DF* term in mediating the impact, indicating that the EM of tourism enterprises influences *FSG* through *DF*, revealing the impact transmission path of "*EM* → *DF* → *FSG*".

Table 6. The results of mediating effect model.

Input Variable	Output Coefficient		
	Model 1 (For *SGR*)	**Model 2 (For *DF*)**	**Model 3 (For *SGR*)**
EM	3.01 *** (4.24)	1.17 *** (2.42)	1.18 ** (3.07)
DF			2.35 *** (4.71)
Adjust R^2	0.513	0.492	0.547
F value	20.17 ***	16.07 ***	23.43 ***

Note: ***, **, * significant at 1%, 5%, and 10% levels, respectively; () represents Z value.

4.5. Retesting Interaction Effects through Threshold Effect Models

The "interaction term test" results suggest that *EM* promotes *FSG* via *DF*. However, another limitation of the "interaction term test" is that it assumes that "the impact of *EM* is a linear correlation of monotonous decreasing or increasing," whereas existing studies show that the influence of *EM* on *FSG* is a non-linear correlation [54,55], which raises the question of whether there is a non-linear relationship between *EM*, *DF*, and *FSG*. In fact, this suggests that the influence of *EM* may have a threshold effect, meaning that the impact of *DF* on *FSG* varies significantly across *EM* thresholds. To assess the non-linear connection between *EM*, *DF*, and *FSG*, this work enhances the "interaction term test" by using the threshold effect model established by Hansen (1999) [56]. In other words, depending on *EM*, one must check if the influence of *DF* on *FSG* has a threshold effect. We created the panel threshold model presented in Equation (6) based on Equation (2).

$$\begin{aligned} SGR_{it} &= a_0 + a_1 DF_{it}(Em_{it} \le \gamma_1) + a_2 DF_{it} I(\gamma_1 < Em_{it} \le \gamma 2) + \ldots \\ &+ a_n DF_{it} I(\gamma_{n-1} < EM_{it} \le \gamma_n) + a_{n+1} DF_{it}(Em_{it} > \gamma_n) + \beta X_{it} + \varepsilon_{it} \end{aligned} \tag{6}$$

where Em_{it} represents the threshold variable for the environmental management term. γ is the threshold value of the environmental management term to be tested. a_n series terms represent the coefficients of the effect of *DF* on *FSG* for different ranges of values of Em_{it}. A threshold setting is valid if there is a significant difference between the fitted values of a_n; $I(x)$ is a dummy variable with $I = 1$ when certain conditions are met, otherwise $I = 0$. ε_{it} is the error term. The remaining terms have the same sign as in Equation (2) above.

The results of the threshold model fitting are shown in Table 7. Based on the results, it can be found that there are significant differences in the series indices, representing the effect of *DF* on *FSG*. Specifically, there should be two thresholds for the *EM* term, and the impact effect coefficient is roughly divided into three stages. When the value of the *EM* term is below 0.55, the impact effect coefficient is 2.05; when the *EM* term coefficient is above this threshold, the impact effect coefficient is 2.33, which is significantly higher than the impact effect coefficient in the previous stage. Furthermore, when the coefficient of the *EM* term is above 0.58, the impact effect coefficient is 2.76, which is again significantly higher than the impact effect coefficient of the second stage. This not only allowed the threshold values of 0.55 and 0.58 for the *EM* term, respectively, but also allowed the positive correlation between the effect of *EM* on *DF* and *FSG* to be established once again.

Table 7. The results of threshold effect model.

Input Threshold Variable: *EM*	**Output Coefficient**	
	Coefficient	**Z Value**
$DF_{it}I(Em_{it} \leq 0.553)$	2.07 ***	6.16
$DF_{it}I(0.533 < Em_{it} \leq 0.584)$	2.35 ***	6.98
$DF_{it}(Em_{it} > 0.584)$	2.87 ***	7.51
Adjust R^2	0.571	
F value	7.53 **	

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

5. Conclusions

In this paper, the least square dummy variable (LSDV) model, mediating effects model and threshold effects model are used to build a decision support system around environmental management (*EM*), debt financing (*DF*) and financial sustainable growth (*FSG*) factors of Chinese agricultural companies. The decision support system is able to provide a reference basis for agricultural business decisions. Secondly, this paper combines the decision support system and sample data to verify the transmission mechanism of *EM* → *DF* → *FSG* from a qualitative perspective with a mediation model; from a quantitative perspective with a threshold effect model to test the nonlinear threshold relationship among *EM*, *DF* and *FSG*, further expanding the research field of *FSG*. According to the results of the study, the cost of debt financing is reduced by a company's involvement in environmental management, but environmental expenditures can partially offset the benefits of environmental management investments on the cost of debt financing. Company owners are concerned not only with reducing the cost of debt financing, but also with the long-term viability of the company. Therefore, this paper further investigates the impact of *EM* on a firm's financially sustainable growth. The results show that a company's sustainable expansion ability is impaired by the lack of debt financing ability, but investing in *EM* can reduce debt financing costs and improve debt financing ability, thus helping the company to achieve sustainable growth. Investing in *EM* increases a company's operating expenses and reduces financing costs. In the long run, investing in *EM* can be helpful to the long-term financial success of the company. Finally, this paper makes specific recommendations for agribusiness and the related sectors based on the results of the decision support system.

For agribusiness, environmental stewardship investments can help companies achieve long-term financial success by reducing the cost of debt financing. Therefore, agricultural industries should utilize various debt financing options to expand their main business. They can expand the size of their companies, develop agricultural groups through capital operations, and achieve green growth, while ensuring that overall financing costs are minimized. Currently, bank loans and commercial credit are the main sources of debt financing for China's agricultural industry. It is also critical that banks and companies appropriately ease restrictions on refinancing agribusinesses to make debt financing more readily available to these companies. Banks and related financial institutions may ease credit criteria for profitable companies with low balance sheet ratios. On the other hand, banks and related regulators must improve the tracking and management of loan financing for firms with low profitability and poor operating performance.

There are a number of strategies that the relevant government departments can use to encourage agricultural businesses to invest in environmental management. First, this can be achieved through the design of effective environmental testing procedures and the appropriate use of laws and regulations that improve the environment. Second, agricultural enterprises that contribute to energy conservation and environmental protection should be encouraged to participate in environmental management by providing appropriate incentives. Third, the government should support environmental management by creating a green environment and imposing restrictions on agricultural business stakeholders. For example, standards for environmental protection must be emphasized among the government, community monitors, customers, investors, and employees. Fourth, to support the transformation and upgrading of tourism enterprises, governments and industry organizations can encourage agricultural enterprises to use energy-efficient and environmentally friendly technologies by providing regulatory support or establishing platforms. For example, industry organizations can provide uniform training for agribusinesses or provide technical assistance in using new technologies. Agricultural enterprises should be encouraged to work with energy-efficient technology companies to provide them with customized environmental management technology services, thereby improving the efficacy of technology products. Fifth, demand-driven efforts should be made to enhance society's concept of green agriculture and to motivate consumers to change their consumption habits, so that agricultural enterprises can develop green projects.

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References

1. Xu, X.L.; Yang, X.N.; Zhan, L.; Liu, C.K.; Zhou, N.D.; Hu, M. Examining the relationship between intellectual capital and performance of listed environmental protection companies. *Environ. Prog. Sustain. Energy* **2017**, *36*, 1056–1066. [CrossRef]
2. Viñuales, J.E.; Depledge, J.; Reiner, D.M.; Lees, E. Climate policy after the Paris 2015 climate conference. *Clim. Policy* **2017**, *17*, 1–8. [CrossRef]
3. Calculli, C.; D'Uggento, A.M.; Labarile, A.; Ribecco, N. Evaluating people's awareness about climate changes and environmental issues: A case study. *J. Clean. Prod.* **2021**, *324*, 129244. [CrossRef]
4. Zemigala, M. Business and climate change-research tendencies. *Environ. Dev.* **2022**, *42*, 100696. [CrossRef]
5. Ishchenko, S.; Skrypniuk, K.; Pyrogov, D.; Tkach, T. Agricultural enterprises development strategy investment support in the field of animal husbandry in Ukraine. In Proceedings of the Innovative Economic Symposium 2019—Potential of Eurasian Economic Union (IES2019), Ceske Budejovice, Czech Republic, 7 November 2019.
6. Luo, Y.B. Research on the development of economic transformation green agriculture based on sustainable environment green technology. *Int. J. Environ. Technol. Manag.* **2020**, *23*, 91–100. [CrossRef]
7. Chen, Q.; Zhang, X.M. The Positive Analysis of The Impact on Operation Performance of Non-agricultural Business for Agricultural Listed Companies. In Proceedings of the Advanced Research On Industry, Information System and Material Engineering, Changsha, China, 16–17 March 2013; pp. 137–140.
8. Grogan, D.; Gilliland, T.J. A review of perennial ryegrass variety evaluation in Ireland. *Ir. J. Agric. Food Res.* **2011**, *50*, 65–81.
9. Sheng, L. Explaining urban economic governance: The City of Macao. *Cities* **2017**, *61*, 96–108. [CrossRef]
10. Wei, C.; Dan, L. Market fluctuation and agricultural insurance forecasting model based on machine learning algorithm of parameter optimization. *J. Intell. Fuzzy Syst.* **2019**, *37*, 6217–6228. [CrossRef]

11. Melnyk, S.A.; Sroufe, R.P.; Calantone, R. Assessing the impact of environmental management systems on corporate and environmental performance. *J. Oper. Manag.* **2003**, *21*, 329–351. [CrossRef]
12. Pagell, M.; Gobeli, D. How plant managers' experiences and attitudes toward sustainability relate to operational performance. *Prod. Oper. Manag.* **2009**, *18*, 278–299. [CrossRef]
13. Barjaktarovic, D.; Barjaktarovic, L. Possibilities of financial support to small and medium hotel companies in Serbie. *UTMS J. Econ.* **2010**, *1*, 1–11.
14. Lu, Y.; Chen, Y. Is China's agricultural enterprise growing steadily? Evidence from listed agricultural companies. *Chin. J. Popul. Resour. Environ.* **2021**, *19*, 203–212. [CrossRef]
15. Gázquez-Abad, J.C.; Huertas-García, R.; Vázquez-Gómez, M.D.; Casas Romeo, A. Drivers of sustainability strategies in Spain's wine tourism industry. *Cornell Hosp. Q.* **2015**, *56*, 106–117. [CrossRef]
16. Patfitzianas, K.D.; Pappa, A.; Psarras, J. An information decision support system towards the formulation of a modern energy companies' environment. *Renew. Sustain. Energy Rev.* **2008**, *12*, 790–806. [CrossRef]
17. Doukas, H.; Nikas, A. Decision support models in climate policy. *Eur. J. Oper. Res.* **2020**, *280*, 1–24. [CrossRef]
18. Dangelico, R.M. Improving firm environmental performance and reputation: The role of employee green teams. *Bus. Strategy Environ.* **2015**, *24*, 735–749. [CrossRef]
19. Li, B.; Wu, K. Environmental management system adoption and the operational performance of firm in the textile and apparel industry of China. *Sustainability* **2017**, *9*, 992. [CrossRef]
20. Zhu, Q.; Zhang, Q. Evaluating practices and drivers of corporate social responsibility: The Chinese context. *J. Clean. Prod.* **2015**, *100*, 315–324. [CrossRef]
21. Muhammad, N.; Scrimgeour, F.; Reddy, K.; Abidin, S. The relationship between environmental performance and financial performance in periods of growth and contraction: Evidence from Australian publicly listed companies. *J. Clean. Prod.* **2015**, *102*, 324–332. [CrossRef]
22. Hirunyawipada, T.; Xiong, G. Corporate environmental commitment and financial performance: Moderating effects of marketing and operations capabilities. *J. Bus. Res.* **2018**, *86*, 22–31. [CrossRef]
23. Lins, K.V.; Servaes, H.; Tamayo, A. Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. *J. Financ.* **2017**, *72*, 1785–1824. [CrossRef]
24. Flammer, C. Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. *Manag. Sci.* **2015**, *61*, 2549–2568. [CrossRef]
25. Simerly, R.L.; Li, M. Environmental dynamism, capital structure and performance: A theoretical integration and an empirical test. *Strateg. Manag. J.* **2000**, *21*, 31–49. [CrossRef]
26. Cao, G.; Wang, Z. Product flexibility of competitive manufactures: The effect of debt financing. *Ann. Oper. Res.* **2021**, *307*, 53–74. [CrossRef]
27. Ebaid, I.E.S. The impact of capital-structure choice on firm performance: Empirical evidence from Egypt. *J. Risk Financ.* **2009**, *10*, 477–487. [CrossRef]
28. Yazdanfar, D.; Öhman, P. Debt financing and firm performance: An empirical study based on Swedish data. *J. Risk Financ.* **2015**, *16*, 102–118. [CrossRef]
29. Blackwell, P.; Shehab, E.M.; Kay, J.M. An effective decision-support framework for implementing enterprise information systems within SMEs. *Int. J. Prod. Res.* **2006**, *44*, 3533–3552. [CrossRef]
30. Akinfiev, V.; Tsvirkun, A. Decision Support Systems for Stable Development of Agricultural SMEs. In *IFAC Papersonline*; Elsevier: Amsterdam, The Netherlands, 2021; pp. 289–292.
31. Liu, X.; Li, H.; Li, H. Analyzing Relationship between Financing Constraints, Entrepreneurship, and Agricultural Company Using AI-Based Decision Support System. *Sci. Program.* **2022**, *2022*, 1634677. [CrossRef]
32. Lee, M.J.; Huh, C.; Lee, J.Y. Business cycle and long-term debt: Effects on hotel operating lease. *J. Hosp. Financ. Manag.* **2015**, *23*, 138–146. [CrossRef]
33. Lin, C.Y.; He, L.R. Targeted monetary policy and agriculture business loans. *N. Am. J. Econ. Financ.* **2020**, *54*, 101290. [CrossRef]
34. Tran, Q.T. Economic policy uncertainty and cost of debt financing: International evidence. *N. Am. J. Econ. Financ.* **2021**, *57*, 101419. [CrossRef]
35. Picas, S.; Reis, P.; Pinto, A.; Abrantes, J.L. Does Tax, Financial, and Government Incentives Impact Long-Term Portuguese SMEs' Sustainable Company Performance? *Sustainability* **2021**, *13*, 11866. [CrossRef]
36. Srebro, B.; Mavrenski, B.; Arsic, V.B.; Knezevic, S.; Milasinovic, M.; Travica, J. Bankruptcy Risk Prediction in Ensuring the Sustainable Operation of Agriculture Companies. *Sustainability* **2021**, *13*, 7712. [CrossRef]
37. Herron, C.; Braiden, P.M. A methodology for developing sustainable quantifiable productivity improvement in manufacturing companies. *Int. J. Prod. Econ.* **2006**, *104*, 143–153. [CrossRef]
38. Chaabane, A.; Ramudhin, A.; Paquet, M. Design of sustainable supply chains under the emission trading scheme. *Int. J. Prod. Econ.* **2012**, *135*, 37–49. [CrossRef]
39. Zhang, D.; Lucey, B.M. Sustainable behaviors and firm performance: The role of financial constraints' alleviation. *Econ. Anal. Policy* **2022**, *74*, 220–233. [CrossRef]
40. Zhang, K.Q.; Chen, H.H. Environmental performance and financing decisions impact on sustainable financial development of Chinese environmental protection enterprises. *Sustainability* **2017**, *9*, 2260. [CrossRef]

41. Feng, Y.; Chen, H.H.; Tang, J. The impacts of social responsibility and ownership structure on sustainable financial development of China's energy industry. *Sustainability* **2018**, *10*, 301. [CrossRef]
42. Li, L.; Dong, F.Y.; Liu, Y.F.; Huang, H.J.; Wang, S.Y. The Effect of Corporate Governance on Debt Financing Cost of Listed Companies. *J. Syst. Sci. Complex.* **2016**, *29*, 772–788. [CrossRef]
43. Cristea, M.; Noja, G.G.; Thalassinos, E.; Cîrciumaru, D.; Ponea, C.Ș.; Durău, C.C. Environmental, Social and Governance Credentials of Agricultural Companies—The Interplay with Company Size. *Resources* **2022**, *11*, 30. [CrossRef]
44. Xu, X.L.; Chen, H.H.; Zhang, R.R. The Impact of Intellectual Capital Efficiency on Corporate Sustainable Growth-Evidence from Smart Agriculture in China. *Agriculture* **2020**, *10*, 199. [CrossRef]
45. Xu, X.L.; Sun, C.; Li, Y.; Zhou, N. The effects of environmental management and debt financing on sustainable financial growth in the tourism industry. *SAGE Open* **2020**, *10*, 2158244020948530. [CrossRef]
46. Gil, M.J.A.; Jiménez, J.B.; Lorente, J.J.C. An analysis of environmental management, organizational context and performance of Spanish hotels. *Omega* **2001**, *29*, 457–471.
47. Nunnally, J.C. Psychometric theory—25 years ago and now. *Educ. Res.* **1975**, *4*, 7–21.
48. Jin, X.; Weber, K. Developing and testing a model of exhibition brand preference: The exhibitors' perspective. *Tour. Manag.* **2013**, *38*, 94–104. [CrossRef]
49. Buffa, F.; Franch, M.; Rizio, D. Environmental management practices for sustainable business models in small and medium sized hotel enterprises. *J. Clean. Prod.* **2018**, *194*, 656–664. [CrossRef]
50. Sourvinou, A.; Filimonau, V. Planning for an environmental management programme in a luxury hotel and its perceived impact on staff: An exploratory case study. *J. Sustain. Tour.* **2018**, *26*, 649–667. [CrossRef]
51. Cole, R.A.; Sokolyk, T. Debt financing, survival, and growth of start-up firms. *J. Corp. Financ.* **2018**, *50*, 609–625. [CrossRef]
52. Liu, Y.D.; Sharma, P.; Jain, V.; Shukla, A.; Shabbir, M.S.; Tabash, M.I.; Chawla, C. The relationship among oil prices volatility, inflation rate, and sustainable economic growth: Evidence from top oil importer and exporter countries. *Resour. Policy* **2022**, *77*, 102674. [CrossRef]
53. Baron, R.M.; Kenny, D.A. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *J. Personal. Soc. Psychol.* **1986**, *51*, 1173. [CrossRef]
54. Jefferson, G.H.; Huamao, B.; Xiaojing, G.; Xiaoyun, Y. R&D performance in Chinese industry. *Econ. Innov. New Technol.* **2006**, *15*, 345–366.
55. Wang, W.; Yu, B.; Yan, X.; Yao, X.; Liu, Y. Estimation of innovation's green performance: A range-adjusted measure approach to assess the unified efficiency of China's manufacturing industry. *J. Clean. Prod.* **2017**, *149*, 919–924. [CrossRef]
56. Hansen, B.E. Threshold effects in non-dynamic panels: Estimation, testing, and inference. *J. Econom.* **1999**, *93*, 345–368. [CrossRef]