Optimizing Growth in the Agriculture Commodity Exchange Market: A Game-Theoretic Analysis of Transformation Strategies for Chinese Enterprises

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Abstract

Small and mid-sized enterprises (SMEs) have played a significant role in the growth and advancement of the Chinese agriculture sector. However, these enterprises often face challenges in navigating local distribution networks, complying with regulations, and procuring local consumer products, which can hinder the marketing environment and impede economic growth. To address these issues and promote continuous business development, Chinese agriculture enterprises require effective modeling techniques that facilitate transformation to meet evolving requirements. This study proposes a game-theoretic approach, specifically the Mixed Strategy Game-Theoretic Approach (MSGTA), as a decision-making tool for enterprises facing pre-emptive changes. By analyzing oligopoly firm behavior, the MSGTA approach identifies enterprise outcomes, cooperation patterns, and price-fixing strategies, providing decision-making options and incentives within the enterprise structure. The MSGTA approach assists SMEs in the Chinese agriculture market by systematically analyzing product development stages and ensuring the effective adoption of pre-emptive changes. The efficiency of SMEs implementing the MSGTA approach is evaluated by examining statistical relationships between enterprise growth and requirements. By integrating effective modeling techniques, Chinese agriculture SMEs can adapt to changes proactively, enhance their ability to navigate local distribution networks, comply with regulations, and procure local consumer products more effectively, thereby improving the marketing environment and fostering economic growth.

Keywords: Small and mid-sized enterprises, Game-theoretic approach, Mixed Strategy Game-Theoretic Approach (MSGTA), Agriculture sector, Pre-emptive changes, Marketing environment.

1. Introduction

In the pursuit of optimizing growth within the agriculture commodity exchange market, Chinese enterprises, particularly small and medium-sized enterprises (SMEs), encounter distinctive obstacles pertaining to the navigation of local distribution networks, adherence to regulatory mandates, and access to consumer markets.

To address these challenges and ensure continuous business development, this study proposes a game-theoretic analysis of transformation strategies, specifically focusing on the mixed-strategy game-theoretic approach (MSGTA) [1-3]. The Agriculture Commodity Exchange Market serves as a specialized platform for the trading of agricultural commodities, connecting farmers, traders, processors, and other stakeholders within the agricultural value chain. Its primary objectives include facilitating transparent price discovery through interactions between buyers and sellers, enabling fair market prices based on supply and demand dynamics. This mechanism is beneficial for farmers in determining appropriate selling prices and allows buyers to acquire commodities at competitive rates. Additionally, these markets provide risk management support by offering futures contracts, which allow farmers to hedge against price fluctuations and reduce uncertainty in agricultural production and market conditions [4-8]. This promotes fair competition and enhances market efficiency, playing a vital role in the development of the agricultural sector by driving increased participation, investment, and innovation, leading to improved productivity and income generation. However, challenges related to infrastructure, logistics, market regulations, quality standardization, and the inclusion of smallholder farmers need to be addressed through collaborative efforts among stakeholders to ensure the effective establishment and functioning of Agriculture Commodity Exchange Markets.

The MSGTA approach offers valuable guidelines for effective decision-making in the face of pre-emptive changes. By analyzing oligopoly firm behavior, the approach identifies enterprise outcomes, cooperation patterns, and price-fixing strategies. It incentivizes and provides decision-making options within the enterprise structure, enabling SMEs to make sound decisions and adapt to evolving market conditions. The importance of SMEs in the Chinese economy cannot be overstated. These enterprises make significant contributions to the national economy, employment opportunities, and various key indicators. In China, SMEs accounted for 60% of the Gross Domestic Product (GDP), 50% of tax income, 68% of exports, and 79%

of job creation in 2020 [1-6]. However, the short-term loans decreased from 41.62% to 39.09% from 2018 to 2019. In 2020, the ratio somewhat increased to 1.67%, so the government instructed the SMEs to postpone payment due to the Covid-19 crisis. After the 2020 situation, around 25.73 million SMEs get their loan from financial institutions, which is a high up to 4.61% compared to last year [6]. Henceforth, the Chinese government plans to invest in SMEs from 2021 to 2025 to improve their economy. The SMEs definition of China is a little complex compared to the remaining countries. China's government concentrates on the number of employees defined based on the SME promotion law. According to the law, SME business has been categorized into various types, such as the number of employees, assets, industries, and sales. Let the retail business have less than 100 employees and attain less than 10 million Renminbi (RMB) small company [7]. The definition of SMEs in China differs from other countries, with medium-sized enterprises having more than 100 employees and revenue above 10 million RMB, while small construction companies have less than 600 employees and 40 million RMB. The Chinese government has unique strategies and policies to support business growth, and Chinese companies proactively adapt to change by optimizing strategies and cash flow [9-11]. Pre-emptive changes require leadership, cost reduction, and time, and industries must minimize risks and challenges to improve growth. Five key factors are crucial for SME success in uncertainty. To ensure SME success in uncertainty, businesses must follow five key factors, as illustrated in Figure 1.

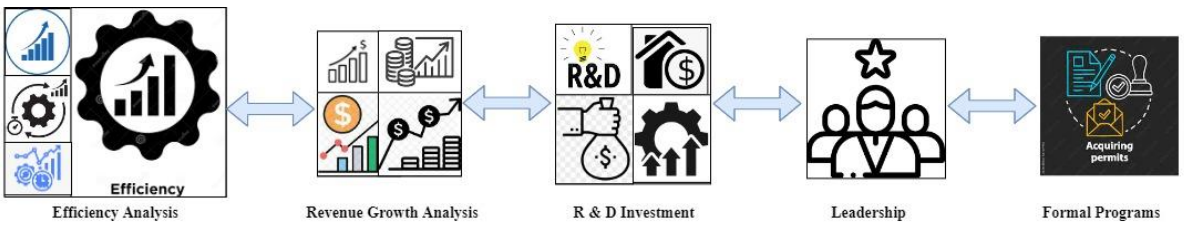

Figure 1: Factors for Successive Pre-emptive transformation of business strategy.

Figure 1 illustrates the pre-emptive transformation of five successive factors: efficiency, revenue growth, R&D investment, leadership, and formal business strategy programs [12]. By applying mixed strategy game theory, the study examines enterprise behavior and identifies effective strategies. It offers tailored guidelines for Chinese enterprises, particularly SMEs, to make informed decisions and enhance growth prospects. In this study, we emphasize the unique contribution of our proposed game-theoretic approach, the Mixed Strategy Game-Theoretic Approach (MSGTA), in guiding decision-making processes for Chinese SMEs facing pre-

emptive changes. We will clearly articulate how our study fills the existing research gap and offers a novel perspective on optimizing growth in the agriculture commodity exchange market.

1-1-Efficiency Analysis

Leadership and talent development play an important role in the success of an organization. During times of economic difficulty, leaders may consider retrenchment as a means of cutting costs, which can have a negative impact on the organization's growth [13]. Instead, leaders should prioritize the development and training of their employees to help them adapt to transformational changes, while also allocating funds to support this process. This approach can lead to the optimization of non-core areas, cost reduction, and maximization of the organization's function [14-17].

1-2-Revenue Growth Analysis

Companies frequently face difficulties sustaining revenue growth when adapting to pre-emptive changes. Temporary cost-cutting strategies and other measures often fail to achieve the desired revenue growth. Therefore, many enterprises must recalibrate their ideas and focus on their strengths to maximize revenue growth. During this process, (mergers and acquisitions) M&A activities and other business components are analysed to improve industry growth. In light of pre-emptive changes, organizations must possess a strong ability to meet their growth targets [18-21].

1-3- R & D Investment

Long-term orientation in R&D investment is a critical factor for companies, as many prefer to invest externally to manage uncertain changes. R&D investments provide new business initiatives to achieve long-term objectives and are valuable in capital expenditure. External investments can help maximize customer service and personalize client requirements in a cost-effective manner, thereby enhancing services, products, and operations through continuous data assessment.

1-5-Formal Programs

The study aimed to analyse the different strategies for managing central government planners, polluting enterprises, and local government regulators in China. The study explored the tacit collusions in the industry and enterprise incentives using stable evolutionary strategies to ensure the enterprise's robustness and quantitative results [21-22]. Kang et al. (2019) introduced the Game Theoretic approach for analyzing low-carbon tactics in supply chain enterprises. The

study aimed to resolve low-carbon market and government policy-related issues while managing the enterprise [23]. The Stackelberg Game Theoretical (SGT) approach was applied to resolve manufacturing and retailer issues, which were evaluated in the development stage and advanced carbon technology stage behaviour.

2. Materials and Methods

This study aims to analyse the pre-emptive transformation of Chinese enterprises to meet their growth requirements. Small and mid-sized industries must be prepared to face sudden changes that can increase enterprise growth. During the analysis, enterprises should focus on business agreements, policies, and development procedures to improve business growth. The study also focuses on the level of professionalization and development required to meet enterprise requirements. The study is conducted in Jiangsu province, China, which is currently receiving government funding to develop small, micro, and medium enterprises. According to a press report dated November 8th, 2022, a significant majority (over 99%) of the 4.066 million registered small, micro, and medium enterprises (SMEs) in Jiangsu province are in need of comprehensive understanding regarding the risks involved and the necessary collateral to foster their organizational growth. In order to maximize the contributions of SMEs, a national inclusive financing service platform has been introduced in Jiangsu, which establishes a structured framework for credit evaluation and enterprise risk monitoring. Consequently, Jiangsu province necessitates the implementation of additional policies and regulations to facilitate the proactive adoption of transformative changes by SMEs, as illustrated in Figure 2 (Jiangsu province).

Figure 2: East China's Jiangsu Province.

Figure 2 depicts the location of Jiangsu province, which houses several enterprises contributing to improving production. According to the analysis, 30% of the respondents are large enterprises that produce high-quality products, with 50% being exported to the market and the remaining 50% sold locally. Small and medium enterprises (SMEs) are also planning to develop in Jiangsu to improve the local economy. The Jiangsu government has established adequate infrastructure, including geographical location, information technologies, cheap labor, rich natural resources, and investment policies to improve enterprise production to global standards. This industry has horizontal convergence in the Shengze town of Jiangsu and vertical convergence with big enterprises. Therefore, 62 processes are incorporated into these textile industries that are customized to American and European enterprises. SMEs in the textile industry require low labor costs and are located in the Yangtze River Delta, operating in both international and domestic markets. Due to the high demand for textiles, the industry is incorporated with the research process to develop technology. A small sewing machine enterprise plays an important role in the production chain and is located in Hengshan Town, Jiangsu City, horizontally integrated with large domestic enterprises in Europe, South Korea, Japan, and Shanghai.

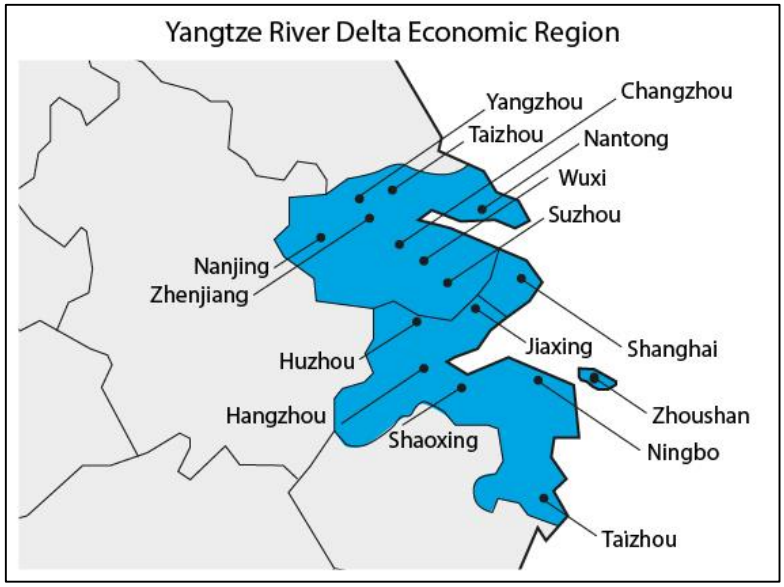

Figure 3: Economic Region of Jiangsu city.

Figure 3 demonstrates the economic region of Jiangsu city that almost covers the entire enterprise town belonging to the economic growth. However, these enterprises are highly integrated with China's economic growth; it has a few pitfalls, such as a lack of intellectual

properties, core technologies, power connection between the local and foreign enterprises, policies, limited funding, and high labour cost.

2.1 Recommendation of SMEs Policies

SMEs should have policies that guide both employees and management to meet user requirements. These policies should be designed to strengthen service quality, foster learning from experiences, and enhance competitiveness, technology satisfaction, and financial satisfaction. Figure 4 presents an overview of the policies that are advised for implementation in SMEs. The changes occurring within an enterprise can have a significant impact on the financial department of an SME. Consequently, it is necessary for the policy to concentrate on this specific unit. The policies should encompass the utilization of various financial tools available to SMEs, such as the security market, banking services, fiscal measures, private financing sources, and commercial credits. Moreover, it is vital for the formulated policies to guarantee the dependability and efficacy of credit systems.

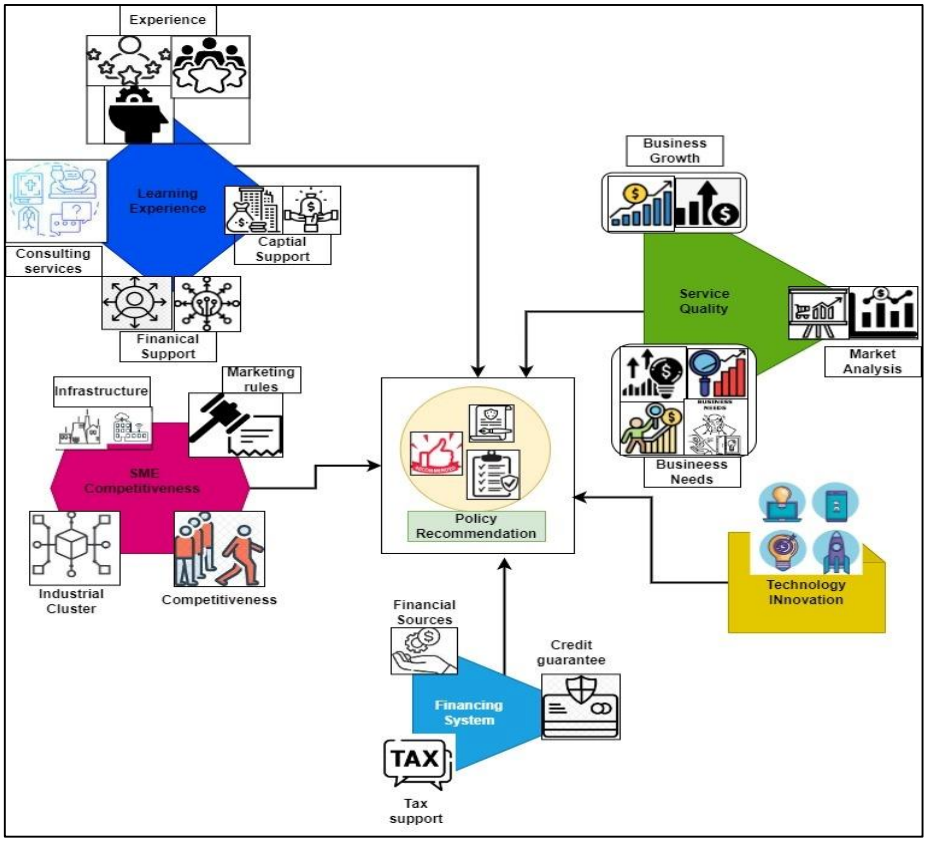

Figure 4: Recommendation of Policies to adapt change Transformation

2.2 Game Theoretic Analysis for enterprise decision making

The Game Theoretic (GT) framework is employed to handle social situations involving competing players. The GT model utilizes strategic settings to make optimal decisions in SMEs. Rational players are used in the GT model to handle interactive situations. The primary objective of this model is to improve the performance of other players with the help of their payoffs. The game involves two or more quantifiable players, and the GT approach is utilized to identify the most relevant outcomes. The following terms are used to make enterprise decisions.

The GT framework is used to manage business outcomes according to policies that maximize economic profits. The GT framework, specifically the Mixed Strategy Game-Theoretic Approach (MSGTA), can provide valuable insights and support optimal decision-making in SMEs (Small and Medium-sized Enterprises). The GT framework enables SMEs to conduct strategic analysis, considering the behavior of competitors and suppliers, to anticipate responses and make informed decisions that align with growth objectives. It offers a systematic approach to decision optimization, evaluating potential outcomes and payoffs to identify the optimal strategy for maximizing objectives like revenue growth and market share. The game G, which has several groups such as X, Y, and U, is considered, with X defined as the enterprise space in which product development faces various possible changes concerning implementation, cost, and manufacturing processes that aim to maximize production. Y is the industry's possible actions on a specific product with respective realization. U is the enterprise's utility function computed from the X and Y multiplications; $(X * Y\ pair\ of\ (x, y); here\ x \in X\ and\ y \in Y)$/Mixed strategies are applied during the business process analysis to select the business-related decision. The mixed strategy profile lists factors like structural information, requirement details, management, manufacturing, and other details. The possibilities of every factor are explored while investigating the enterprise's requirements and growth. The game theoretic process is applied to predict the decision by considering the enterprise strategies. Consider the industry manufacturing the product m which should satisfy the company's requirements and policies. Therefore, the product manufacturing-related matrix U is described as follows.

$$U = \begin{bmatrix} t_0 + t_1 - d_1 & -s_0 - s_1 + d_1 \ldots\ldots & -s_0 - s_1 + d_1 \\ -s_0 - s_2 + d_2 & t_0 + t_2 - d_2 \ldots\ldots & -s_0 - s_2 + d_2 \\ \ldots\ldots\ldots & \ldots\ldots\ldots & \ldots\ldots\ldots \\ -s_0 - s_1 + d_1 & t_0 + t_1 - d_1 \ldots\ldots & -s_0 - s_1 + d_1 \\ \ldots\ldots\ldots & \ldots\ldots\ldots & \ldots\ldots\ldots \\ -s_0 - s_n + d_n & -s_0 - s_n + d_n \ldots\ldots & t_0 + t_n - d_n \end{bmatrix} \quad (1)$$

The equation (1) also defined as $U = \|u_{ij}\| = \begin{cases} t_0 + t_j - d_i & when\ i = j \\ s_0 + s_j + d_i & when\ i \neq j \end{cases}$; here, the company income with general unit realization is defined as s_0, cost spent for product unit factors like transportation, storage, and production is defined as t_0, extra income obtained from the company is described as d_i, the number of production in the unit is defined as n, and j is the enterprise-improved production. According to the description, the matrix is formed and analyzed in terms of recommended policy rules. The enterprise, manufacturing strategies, influence of financial factors, and productions directly influence the enterprise's income and expense. Further, the GT matrix is reduced by zero diagonal, which helps make effective business decisions. The improved matrix is obtained by multiplying the equation (1) first row with K1 and the next row with K2 etc. Then the new row value is estimated using equation (2)

$$t = k_i(t_0 + t_i - d_i); i = 1\ to\ n \quad (2)$$

According to equation (2), the U matrix transformation is performed, and the new matrix is obtained as illustrated in equation (3)

$$U^* = \|U^*\| = \begin{cases} 0 & if\ i = j \\ -g_{i,} if\ i \neq j \end{cases} \quad (3)$$

In equation (3), $g_{i,}$ is estimated from the $s_0 + s_i + d_i$. Then the solution for three groups $\{X^*, Y^*, v\}$ is derived fro game G and the inequalities of the theorem results are described in equation (3a)

$$U(X, Y^*) \leq U(X^*, Y^*) \leq U(X^*, Y); \qquad x \in X, y \in Y;$$

$$kU(X, Y^*) + a \leq kU(X^*, Y^*) + a \leq kU(X^*, Y) + a; \quad x \in X, y \in Y \quad (3a)$$

During the matrix transformation, equation (1) is changed to the zero diagonal, which is done by using the below condition in equation (4).

$$g_1 > g_2 > \cdots \ldots . . g_i > \cdots \ldots g_n > 0 \quad (4)$$

After checking this condition, the game theoretic is applied to the company activities, and the growth should be analyzed. The enterprise decision depends on the growth value because every change should impact the enterprise requirement. Then the profit obtained policies of the enterprise are defined as $Y = (y_1, y_2, \ldots \ldots y_n)$. Therefore, the game theoretic matrix is defined as $U^*(n, Y^*)$ and the company process is defined with the below relation.

$$U^*(n, Y^*) = -g_n \sum_{i=1}^{n} y_i = -g_n(1 - y_n) = g_n \quad (5)$$

In equation (5), $g_n > 0$ conditions are utilized to correlate the matrix function with the company profit analysis process that is defined using equation (6)

$$U^*(i, Y^*) = -g_n(1 - y_n)\ ; 1 \leq i \leq n - 1 \quad (6)$$

Equation (6) is further defined using equation (7)

$$y \leq 1 - {}^{g_n}/_{g_i}; \;\; 1 \leq i \leq n-1 \qquad (7)$$

Mathematical computations are utilized to estimate enterprise activities based on market requirements and policies, with product manufacturing-related participants included in these strategies to maximize economic growth. The game's winning situation is analyzed after changing matrix representations to improve overall economic performance, and the optimal situation of the elements involved in the enterprise is defined as Y.

$$U^*(i,Y) = -g_i(1-y_i) = v \qquad (8)$$

In equation (8), v is defined as the game value, and the transformation result is computed for every strategy component in the enterprise that is defined using equation (9)

$$y_i = \frac{1-n(s_0+s_j+d_i)\sum_{i=I}^{n}\frac{1}{(s_0+s_j+d_i)}}{(s_0+s_j-d_i)\sum_{i=I}^{n}\frac{1}{(s_0+s_j-d_i)}} \qquad (9)$$

After computing the enterprise transformation output value, then the market mixed strategies are estimated using equation (10)

$$x_j = \frac{1}{(s_0+s_j-d_j)\sum_{i=I}^{n}\frac{1}{(s_0+s_j-d_i)}} \qquad (10)$$

Then, finally, the optimal decision about the game is taken by considering the game value that is computed using equation (11)

$$v = \frac{n-1}{\sum_{i=I}^{n}\frac{1}{(s_0+s_j-d_i)}} \qquad (11)$$

2.3 Process Transformation Winning Framework Analysis

The efficiency of small and medium-sized enterprise (SME) performance is evaluated through a three-stage winning framework. The game-theoretic (GT) framework is utilized to determine the optimal timing for industries to embrace pre-emptive changes. The analysis process encompasses rapid assessment, 100-day impacts, and total value realization. Figure 5 visually depicts the winning transformation process.

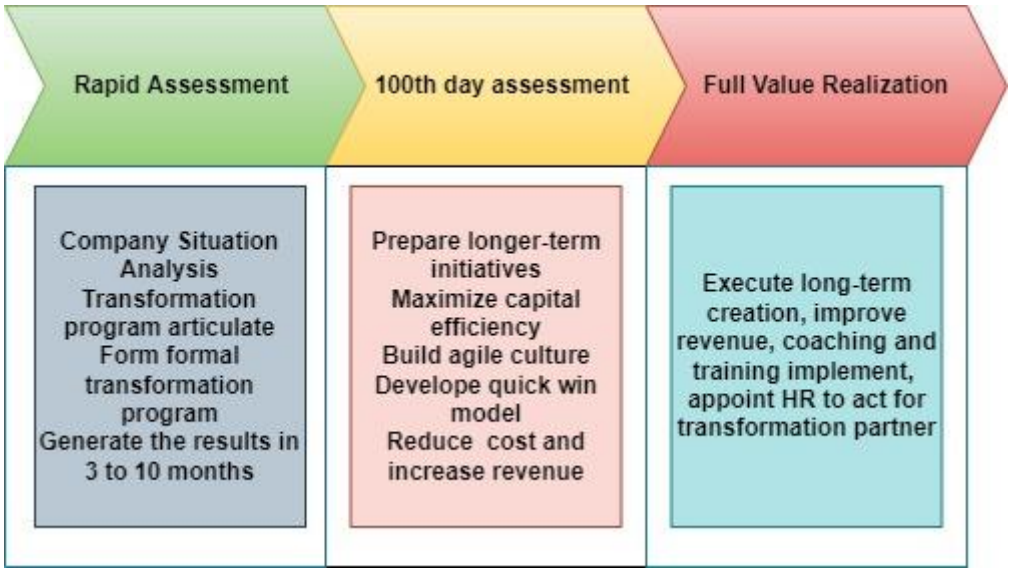

Figure 5: Graphical Representation of Winning Transformation Process

3. Result Analysis of Innovation Model Transformation to meet the requirement

SMEs require effective policies and frameworks to adopt innovation model transformations that meet enterprise requirements. Pre-emptive organizational changes can lead to enterprise growth and profit. The growth of the agriculture sector is intricately intertwined with the complex and ever-evolving marketing environment, encompassing market trends, consumer preferences, competitive dynamics, and regulatory frameworks, all of which significantly shape the industry's development, sustainability, and profitability. Market trends reflect changing consumer demands, driving agricultural growth and influencing crop choices and farming techniques. Understanding consumer preferences is crucial for effective product positioning and market connections. Competitive dynamics require differentiation and value propositions, with factors like pricing, branding, and technology playing key roles. Regulatory frameworks impact practices, market access, and competitiveness, emphasizing compliance and promoting sustainability. Adapting to the marketing environment is essential for navigating the agriculture sector successfully. The use of the Matthew Correlation Coefficient (MCC) analysis in our study is based on its suitability for evaluating the performance of classification models in imbalanced datasets. The Pearson Correlation Coefficient, while widely used, has limitations in imbalanced scenarios when assessing predictive performance. It assumes linear relationships and may not capture nonlinear associations or perform well in complex and imbalanced datasets. In such cases, it can be influenced by the dominant class, leading to biased results and inadequate evaluation of minority or rare events.

3.1 Unplanned and Planned Changes

China's continuous development and crises often lead to both planned and unplanned changes that can significantly affect business growth. The relationship between these factors is described using the Chi-Square Calculator for the 2x2 matrix. The Chi-square test is used to identify the association between categories, with the null hypothesis applied to analyze independent variables. The Chi-square test is utilized to compare the adoption of planned and unplanned changes by SMEs, which is directly dependent on enterprise policies.

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \quad (12)$$

In equation (12), the observed change frequency of enterprise is denoted as O_{ij} and change in expected frequency is represented as E_{ij}. According to the calculations, 500 small mid enterprises are taken to analyze the relationship between the policies and organizational change. Then the Chi-Square analysis of this process is illustrated in Table 1.

Table 1: Chi-Square Analysis.

Program	Adapted	Unadapted	*Marginal Row Totals*
Planned Changes	374	126	500
Unplanned Changes	305	195	500
Marginal Column Totals	679	321	1000 (Grand Total)

Table 1 illustrates the adoption of planned and unplanned changes by SMEs. The study observed 500 enterprises from the Jiangsu province, of which 374 easily adapted to planned changes and 126 faced difficulties. Industrial policies were developed for each enterprise at every stage of development to facilitate the adoption of unplanned changes. The null hypothesis was used to determine the dependent relationship between policies and changes, with a significance level of 0.05. The values were processed using equation (5), resulting in a value of 21.215 with 1 degree of freedom. The statistical analysis indicated an extremely significant association between the groups, such as planned and unplanned changes.

3.2 Financial Changes

A significant change related to finance has been identified, as continuous financial support is required to purchase new products. The policy must also meet users' requirements and maximize enterprise performance during emergencies. This process is analyzed through hypothesis testing. The following hypothesis illustrates the financial support of the public sector.

$H1$: No significant or proper relationship between the financial guidance given by the public party and SME success.

$H2$: Significant or proper relationship between the financial guidance given by the public party and SME success.

The strong relationship between the financial guidance given by the public party and their respective successive factors is explained with the correlation analysis. The correlated regression results are shown in Table 2 which is computed using equation (13)

$$correlation\ analysis = \frac{\sum[X(i)-mean(X)]\sum[Y(i)-mean(Y)]}{\sqrt{\sum[X(i)-mean(X)]^2}\sqrt{\sum[Y(i)-mean(Y)]^2}} \quad (13)$$

Table 2: H1 Correlation Analysis.

Model	Observed Value (x)	Expected value (y)	*A*	*B*	C	*D*	*A*.*B*
Grant of Raw Material	78	54	-3.4	-0.8	11.56	0.64	2.7
Grant of Infrastructure	65	51	-16.4	-3.8	268.96	14.44	62.32
Grant of Startup	87	45	5.6	-9.8	31.36	96.04	-54.88
Grant of Technology	85	54	3.6	-0.8	12.96	167.96	4-2.88
Marketing support	92	70	10.6	15.2	112.36	231.04	161.12
					437.2 (SS_x)	342.8(SS_y)	168.4(SP_{xy})

*Note: A=$X-\bar{X}$, $B=Y-\bar{Y}$, $C=(X-\bar{X})^2$, $D=(Y-\bar{Y})^2$.

According to Table 2, the probability value is equal to 0.4641, and it has been defined as (P(x≤0.8367) = 0.7679. Here, the type 1 error occurred, which is rejected in the hypothesis because of the high value (46.41%). The larger probability value indicates that the T test statistic value is equal to 0.8367 which means it strongly supports each other and has a confidentiality index value of 95%. The Pearson correlation results indicated a non-significant medium-positive relationship between X and Y (r(3) = .435, p = .464). Then the correlation analysis of H2 is illustrated in Table 3.

Table 3: H2 Correlation Analysis.

Model	Observed Value (x)	Expected value (y)	*A*	*B*	C	*D*	*A*.*B*
Grant of Raw Material	78	82	-3.4	-0.8	11.56	0.64	2.7
Grant of Infrastructure	65	73	-16.4	-9.8	268.96	96.04	160.72
Grant of Startup	87	85	5.6	2.2	31.36	4.84	12.32
Grant of Technology	85	84	3.6	1.2	12.96	1.44	4.32
Marketing support	92	90	10.6	7.2	112.36	51.84	76.32

--	--	--	--	--	437.2 (SS_x)	154.8(SS_y)	256.4 (SP_{xy})

*Note: A=$X - \bar{X}$, $B = Y - \bar{Y}$, $C = (X - \bar{X})^2$, $D = (Y - \bar{Y})^2$.

Table 3 represents the correlation analysis and relation between financial guidance and SME success. The correlation coefficient identifies the relationship between -1 and 1. This coefficient is used to predict the linear interdependence of the set, and the two compute the direction and strong relation between financial guidance and enterprise success. The computed value belonging to +1 value then both variables have a strong relationship, -1 means a negative relationship value, and the value between +1 and -1 has a linear relationship. Table 2 value is computed using the below computations.

$$\bar{x} = \frac{78+65+\cdots+85+92}{5} = 81.4$$

$$\bar{y} = \frac{82+73+\cdots+84+90}{5} = 82.8$$

$\Sigma(x - \bar{x})2 = (78-81.4)2+(65-81.4)2+\cdots+(85-81.4)2+(92-81.4)2 = 437.2$

$\Sigma(y - \bar{y})2 = (82-82.8)2+(73-82.8)2+\cdots+(84-82.8)2+(90-82.8)2 = 154.8$

$\Sigma(x - \bar{x})(y - \bar{y}) = (78-81.4)*(82-82.8)+(65-81.4)*(73-82.8)+\cdots+(85-81.4)*(84-82.8)+(92-81.4)*(90-82.8) = 256.4$

$$SXY = \frac{\Sigma(x - \bar{x})(y - \bar{y})}{n - 1}$$

$$SXY = \frac{256.4}{5 - 1} = 64.1$$

$$r = \frac{\Sigma(xi - \bar{x})(yi - \bar{y})}{\sqrt{(\Sigma(xi - \bar{x})2\Sigma(yi - \bar{y})2)}}$$

$$r = \frac{256.4}{\sqrt{(437.2*154.8)}} = 0.9856$$

Alternatively, $r = \frac{SXY}{SXSY}$

$$r = \frac{64.1}{10.4547*6.2209} = 0.9856$$

Test Calculations:

$$S = \sqrt{\left(\frac{1 - r2}{n - 2}\right)}$$

$$S = \sqrt{\left(\frac{1 - 0.98562}{5 - 2}\right)} = 0.09769$$

$$stat = \frac{r - 0}{S}$$

$$stat = \frac{0.9856 - 0}{0.09769} = 10.089$$

373 $p = p(x \leq 10.089) = 0.999$

374 p-value = 2 * Min(p, 1 - p) = 2 * Min(0.999, 0.001037) = 0.002074.

375

376 According to the above computations, the probability value is equal to 0.002074, and it has
377 been defined as P ($x \leq 10.089$)= 0.999. Here, the type 1 error occurred, which is rejected in the
378 hypothesis because of the small value (0.21%). The smaller value indicates that the T test
379 statistic value is equal to 10.089 which means it strongly supports each other and has a
380 confidentiality index value of 95% [0.792, 0.9991]. The Pearson correlation results indicated a
381 non-significant medium-positive relationship between X and Y (r(3) = .435, p = .464). From
382 the analysis, the H1 has a strong correlation (0.9856), covariance has 64.1, and five different
383 category supports are utilized in which 50 samples are utilized to evaluate the regression
384 analysis. The statistical analysis clearly states that a significant positive relationship has been
385 maintained between X and Y with respective categories defined in Table 2.

386

387 **3.3 Structural Changes**

388 For small and medium-sized enterprises (SMEs), making structural changes in terms of
389 management and organization of employee activities is of utmost importance. The success of
390 an enterprise relies heavily on its business strategies and structure, which may need to be
391 adjusted based on evolving requirements to optimize productivity and ensure sustainability. In
392 order to implement these changes and effectively address associated issues, financial support is
393 essential. To evaluate the efficiency of SMEs following multiple changes, the reliability factor
394 is employed, and the outcomes are presented in Figure 6.

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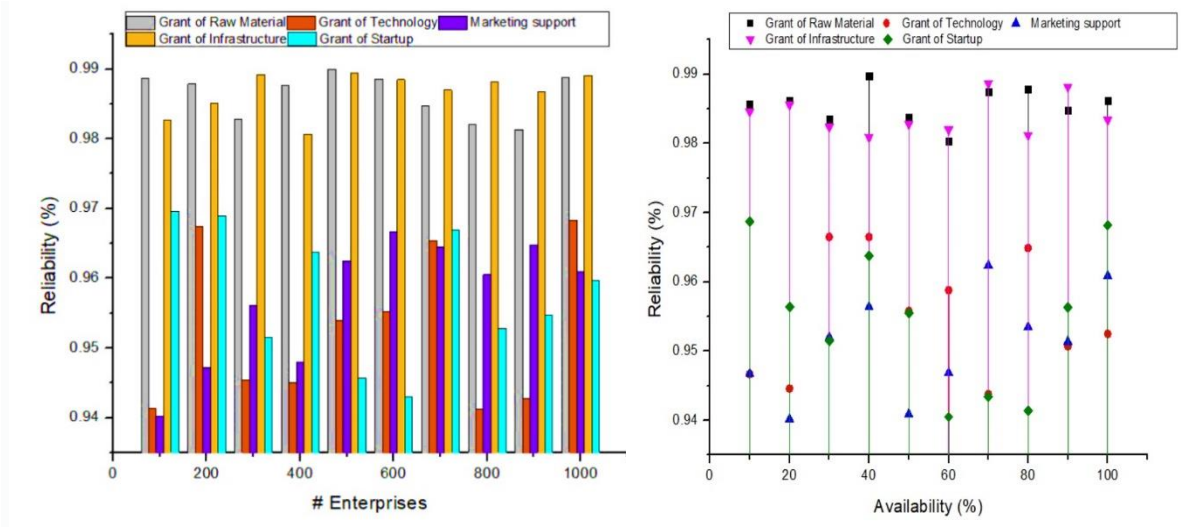


(a) (b)

Figure 6: Reliability Analysis.

Figure 6 illustrates the reliability analysis of SMEs across various enterprise factors. Industries require diverse support models and resources from different perspectives. The reliability analysis of structural changes and resource availability across various enterprises is demonstrated in Figures 6(a-b).

3.4 Managerial Capacity and Policy Incentive Changes

Managerial capacity and policy incentive changes are crucial factors for SMEs. Managerial capacity plays a vital role in observing employee processes, abilities, and contributions to increase economic growth [14-18]. This capacity also impacts employee policy incentives. Therefore, the game theoretic approach is used to recommend policies for various management techniques and minimize computation difficulties. The relationship between the adopting process of managerial capacity and policy incentive changes is evaluated using Cronbach's alpha metrics, and the results are illustrated in Table 4.

Table 4: Cronbach's Alpha (CA) Analysis.

Scale	Questions	Things	CA
Small and Medium Enterprise success	8	9	0.934
Financial Guidance	15	6	0.765
Private sector support impact on SME	10	6	0.78
Public sector support impacts SME	12	7	0.783
Policy Incentive changes	8	5	0.834
Managerial Capacity monitoring	8	7	0.789
Program based training	8	6	0.823

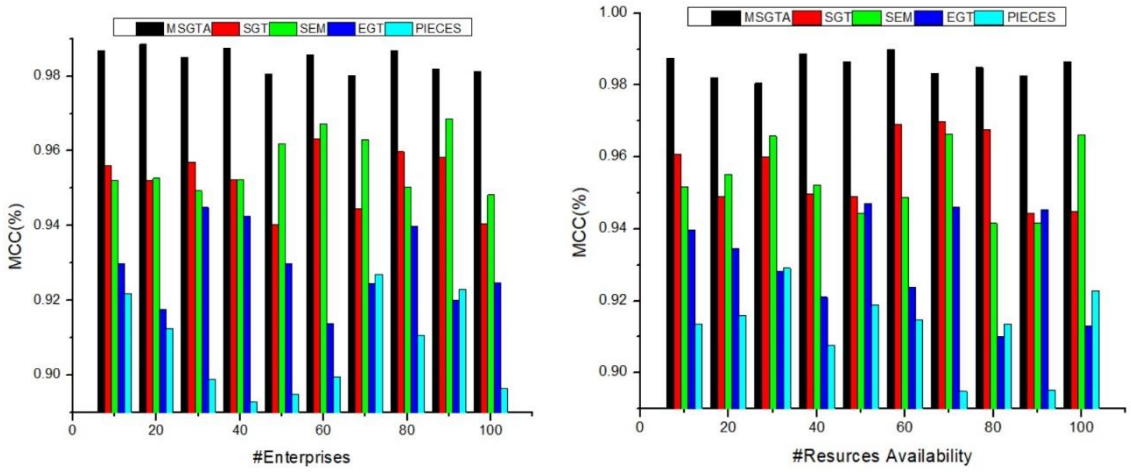
Table 4 demonstrates the internal consistency of SME employees, measured by analyzing a questionnaire. The Cronbach's Alpha value, ranging between 0 and 1, indicates the factors

related to enterprise reliability and economic growth. The system performance is determined using the Matthew Correlation Coefficient and Accuracy, computed using the equations below.

$$MCC = \frac{(TP*TN)-(FN*FP)}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}} \quad (14)$$

$$Accuracy = \frac{Number\ of\ correct\ decision\ in\ business}{Total\ Number\ of\ decision\ in\ busness} \quad (15)$$

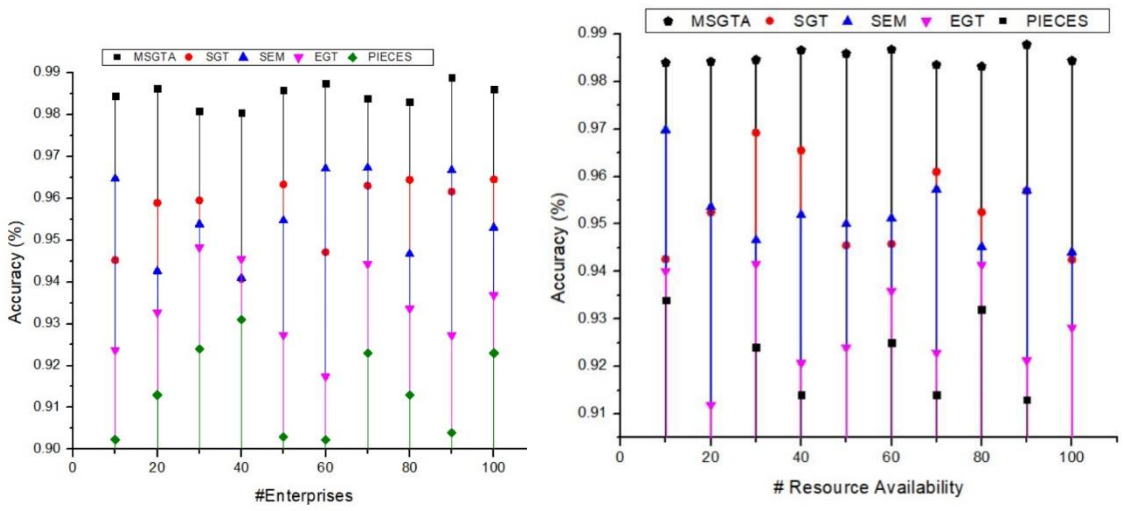
In equation (14) & (15), TP is denoted as True positive -correctly making the decision, TN-true negative- wrongly identified right decision, FN-False Negative-false identified decision, and FP-False positive -rightly identified wrong business decision. According to the computations, the obtained results are illustrated in Figure 7.



(a) **(b)**

Figure 7: Matthew Correlation Analysis (a) Enterprises and (b) Resource Availability.

Figure 7 illustrates the Matthew Correlation Analysis, computed from the true positive, false negative, true negative, and false positive computations of business decisions. The MSGTA approach recognizes every business strategy with business economy policies, investigates user requests for different enterprises, and evaluates resource availability to make accurate decisions [18-21]. Figure 7 indicates that the introduced system achieves a high MCC value compared to other modeling techniques described in the literature survey [22-25]. Figure 8 illustrates the respective Accuracy.



(a) **(b)**

Figure 8: Accuracy Analysis (a) Enterprises and (b) Resource Availability.

Figure 8 clearly illustrates that the MSGTA approach achieves excellent performance with the highest accuracy rates of 98.3% for enterprises and 98.6% for resource availability. However, the obtained accuracy is relatively lower than other methods, such as SGT (0.95%, 0.956%), EGT (0.92%, 0.93%), SEM (0.92%, 0.953%), and PIECES (0.913%, 0.916%). Small and mid-sized enterprises can benefit from utilizing the Game-theoretic approach, specifically the Mixed Strategy Game-Theoretic Approach (MSGTA), to navigate pre-emptive changes and meet their enterprise growth requirements in a dynamic marketing environment [26-36]. A study utilizes game theory to analyze the competition between container port hubs, with a specific focus on Busan and Shanghai, offering valuable insights into their strategic dynamics [37].Recent studies in China have examined the impact of the low-carbon strategy on digital transformation in manufacturing, developed stock intelligent investment strategies, explored the influence of group identity on bidding behavior, investigated innovation inequality, and analyzed the relationship between fintech, financial constraints, and outward foreign direct investment [38-42]. Additionally, researchers have assessed changes in CSR efficiency in the Chinese food industry due to the COVID-19 pandemic [43-44]. This study aims to optimize the design of a hybrid energy system using a modified-gray wolf algorithm, develop a project management strategy for urban flood disaster prevention, and propose a novel hybrid algorithm for efficient task scheduling in distributed systems [45-47].

4. Conclusion

The agriculture sector's growth is closely tied to the dynamic marketing environment, which includes market trends, consumer preferences, competition, and regulations. Market trends and

consumer demands shape agricultural growth, influencing crop selection and farming methods. Understanding consumer preferences is vital for positioning products and establishing market connections. Competition necessitates differentiation through pricing, branding, and technology. Regulatory frameworks impact practices, market access, and competitiveness, emphasizing compliance and sustainability. Adapting to the marketing environment is crucial for success in the agriculture sector. The article evaluates the impact of these strategies on growth, competitiveness, and economic development. By integrating game-theoretic analysis and market-specific insights, the study contributes new perspectives and practical recommendations for fostering growth in the agriculture commodity exchange market. Policymakers and industry stakeholders can also benefit from the insights provided to create a supportive environment for Chinese enterprises in this market. SMEs are typically established to pursue business opportunities within the economy, and they hold a unique position within both the economy and the marketplace.

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