An empirical study on the impact of dual technology innovation on the performance of agricultural and sideline food processing enterprises: a case study of 36 listed companies in China

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Abstract

Technological innovation has a significant impact on the performance of enterprises, but current research on technological innovation investment tends to focus on high-end industries, lacking empirical research in the field of agricultural and sideline food processing. There are significant differences in the internal production models of agricultural and sideline food processing enterprises. This article conducts a classified study of the agricultural and sideline food processing industry based on production models, using panel models to explore the impact of exploratory technological innovation and exploitative technological innovation on the economic added value, solvency, profitability, and development capabilities of enterprises. The following research conclusions are drawn: overall, exploratory technological innovation in agricultural and sideline food processing enterprises negatively affects the solvency of enterprises, positively affects the profitability and development capabilities of enterprises, and negatively affects the economic added value of enterprises. However, in the subcategories of agricultural and sideline food processing industries, the performance of feed, breeding, slaughtering, and meat processing enterprises is consistent with the overall performance of the agricultural and sideline food processing industry; there is no exploitative innovation investment in the prefabricated food and snack food enterprises, and exploratory technological innovation negatively affects the performance of enterprises; in the grain and oil and grain processing enterprises, exploratory technological innovation negatively affects the performance of enterprises, and exploitative technological innovation has a negative impact on the economic added value of enterprises; in the sugar and biological additive enterprises, exploratory technological innovation has a positive impact on the economic added value of enterprises. This study enriches the research on dual innovation while providing some reference for adjusting innovation directions in the subcategories of the agricultural and sideline food processing industry and for scientific allocation of innovation investment amounts by agricultural and sideline food processing enterprises.

Keywords: Dual innovation. Enterprise performance. Agricultural and sideline food processing industry.

1. Introduction

The company continues to improve its innovation ability, maintain its innovation vitality, and try to gain a foothold and maintain its advantages in the fierce business competition. As a new form of innovation, dual technological innovation has attracted widespread attention. This theory divides the technological innovation investment of enterprises into exploratory technological innovation and exploitative technological innovation, and provides a more flexible innovation path for enterprises. Exploratory technological innovation refers to the development of new technologies or products in unknown or uncertain fields, while exploitative technological innovation refers to the creation of new products and services by using existing resources and knowledge on the basis of existing technologies. In the process of investment in technological innovation, funds continue to flow to all directions of the enterprise, affecting the competitive advantage of the enterprise, and finally reflected in the enterprise performance.

Agricultural and sideline food processing enterprises are an indispensable industrial link from farm to table. They extend the industrial chain of the development of grain agriculture, expand the downstream demand of grain production, and alleviate the problem of agricultural safety to a certain extent. Agricultural and sideline food processing industry not only has the unique nature of agriculture, but also has some commonalities of manufacturing industry. Its uniqueness and importance are self-evident. However, the current research on science and technology is mostly limited to high-tech enterprises and large industrial enterprises. Little attention has been paid to traditional sub sectors such as agricultural and sideline food processing industry. The technological innovation status of agricultural and sideline food processing enterprises is not clear, and the research on dual technological innovation of agricultural and sideline food processing industry is slightly scarce. As a large agricultural country, China is actively promoting the reform and upgrading of the grain and agricultural system, paying particular attention to agricultural and non-staple food processing enterprises,

Taking China as an example, this paper discusses the impact of exploratory technological innovation and exploitative technological innovation on the performance of agricultural and sideline food processing enterprises from the subdivision of agricultural and sideline food processing industry, and discusses the performance of solvency, profitability, development ability and economic added value from multiple dimensions, providing a new theoretical perspective and framework for the study of dual innovation theory and enterprise performance.

2. Literature Review and Hypotheses Development

2.1 Literature review

Schumpeter (1912) first defined the concept of innovation. He believed that innovation was "to establish a new production function" and to integrate brand-new production factors and conditions into the production system. Duncan first introduced the theory of "ambidextrous organization" in 1976. He stressed that to carry out dual action, a dual institutional structure must be set up. From the perspective of organizational learning, March divided innovation into exploratory innovation and exploitative innovation in 1991. Exploratory innovation aims to launch new products, enter new markets, and rely on new knowledge to meet the needs of emerging markets and customers; While the exploitative innovation focuses on improving the existing products and markets, building on the existing knowledge to meet the existing market and customer needs. Exploratory innovation has higher uncertainty and risk, while exploitative innovation is easier to control, with higher certainty, faster output speed and clearer feedback.

Enterprise performance refers to the operating efficiency and operator performance during a certain period of operation. It is mainly expressed through the profitability, solvency and subsequent development ability of the enterprise, as well as the achievements and contributions of the operators in the process of managing the enterprise. When evaluating performance, we should consider the following aspects: first, we must consider the long-term nature, because social investors pursue the long-term return in the future; Second, risk, performance may be accompanied by different degrees of risk; Third, growth. Investors expect the company to continue to grow steadily in the future and achieve long-term returns higher than the cost of capital; Fourth, authenticity. The study of enterprise performance needs to truly and effectively describe the consequences of enterprise behavior, rather than simply analyze the financial statements. At present, the research on enterprise performance is rich in content and covers a wide range. Scholars at home and abroad have different views on its definition. The mainstream view includes financial performance and non-financial performance. Financial performance reflects whether the investment of an enterprise contributes to the final operating performance, including cost control, asset operation management, capital allocation and return on shareholders' equity. Generally, financial indicators such as return on total assets, return on net assets, Tobin Q value and economic added value are used to measure the comprehensive ability of an enterprise. For example, Shen Yi (2016) classified enterprise performance into expansion type and income type, measured by sales growth rate and net profit margin respectively. Zhou Jian (2014) and others measured enterprise performance from profitability, shareholder profitability and development ability, and discussed enterprise performance through indicators such as ROA, roe, EPS, net profit growth rate and net profit rate.

Non financial performance is a measurement index in addition to financial indicators, which pays more attention to the development direction and the realization of strategic objectives. Common indicators include management effectiveness, innovation efficiency, market share, customer satisfaction, etc. Non financial performance can not only be evaluated from the perspective of the overall development of the enterprise, emphasizing the overall interests, but also be subject to process tracking evaluation, timely adjusting the deficiencies in management, paying attention to future trends, facilitating trend analysis and discovering the expected development. It is closely related to the development strategy of the enterprise, and easy to distinguish responsibilities and discover management problems in operation. Non financial performance is equivalent to financial performance, which has considerable advantages and can more comprehensively show the company's financial performance. However, non-financial performance evaluation also has some inherent shortcomings. For example, the relationship between non-financial measurement indicators is not strictly differentiated, and the classification standard is not unique, which may even lead to conflicts between non-financial measurement indicators in non-financial performance evaluation. The improvement of some indicators may be based on the sacrifice and concession of other indicators, which easily makes the whole system difficult to coordinate.

2.2. Hypotheses development

2.2.1. Technological innovation investment level and performance of agricultural and sideline food processing enterprises

The main production raw materials of agricultural and sideline food processing enterprises come from the agricultural field, which are greatly affected by seasonal and climatic factors, and such enterprises usually involve multiple production links, so it is necessary to coordinate and manage all links to ensure product quality and production efficiency. Under this industry characteristic, the impact of the level of technological innovation investment of agricultural and sideline food processing enterprises on enterprise performance is multifaceted.

In terms of economic added value, exploratory technological innovation usually brings new products, new processes or new services, which often brings the uniqueness and innovation of products or processes, which helps enterprises gain competitive advantages in the market, find new ways to save costs and improve efficiency, improve market share, increase sales revenue, and thus enhance the economic added value of enterprises. The minor improvement of existing products or processes by using technological innovation, based on the existing technology, may lead to serious product homogeneity, difficult to distinguish from competitors, and may even fall into cost inertia, resulting in the decline of market share and the impact on the economic added value of enterprises.

In terms of solvency, the higher the level of exploratory technological innovation, the higher the product quality and production efficiency, which will increase the profitability of enterprises and help improve the solvency.

In terms of profitability, high-level exploratory technological innovation may bring product innovation and cost optimization, so as to improve the added value and market competitiveness of products, increase sales revenue and profit level, and then improve the profitability of enterprises. On the other hand, the enhancement of profitability can provide more cash flow for debt repayment and reduce debt repayment risk.

In terms of development ability, exploratory technological innovation encourages enterprises to continuously explore new markets and develop new products or services. High level exploratory technological innovation can help enterprises better adapt to changes in market demand, maintain competitive advantages, and promote sustainable development of enterprises. However, exploitative technological innovation may lead to enterprises' lack of innovation awareness and competitive advantages, and it is difficult to keep up with market changes by relying on existing technologies for minor improvements, thus affecting the development ability of enterprises. Therefore, this paper puts forward the following assumptions:

H1a: the higher the level of exploratory technological innovation, the better the performance of agricultural and sideline food processing enterprises

H1b: the higher the level of applied technological innovation, the worse the economic added value performance of agricultural and sideline food processing enterprises

H1c: the higher the level of applied technological innovation, the poorer the development ability of agricultural and sideline food processing enterprises

2.2.2. Technological innovation investment level and performance of feed, breeding, slaughtering and meat processing enterprises

The business forms of agricultural and sideline food processing enterprises are quite different internally, and their production processes and input-output levels are quite different. Therefore, in order to carefully explore the correlation between the input level of technological innovation and performance output under each category, the author classifies the agricultural and sideline food processing industry according to the industry classification of China Securities Regulatory Commission (2012 Edition), and considers the upstream and downstream environment of the agricultural and sideline food processing industry, and divides the research objects into four categories according to the production processes, namely, feed, breeding and slaughtering and meat processing enterprises; Prefabricated vegetables and snack food enterprises; Grain and oil and grain processing enterprises; The data of sugar and biological additive enterprises are discussed respectively.

Feed, livestock breeding, slaughtering and meat processing enterprises mostly adopt large-scale production and adhere to vertical integration. In order to better control the production process and product quality, such enterprises are usually responsible by the same enterprise from feed production, livestock breeding, slaughtering and processing to meat sales. In addition, such enterprises widely adopt mechanization and automation technologies, including automatic feeding system, automatic slaughtering line, automatic packaging line, etc., and the investment in technological innovation can have a positive impact on the above aspects. In the feed, breeding, slaughtering and meat processing enterprises, exploring new feed ingredients and formulas, developing new meat products and processing technologies, introducing big data analysis, artificial intelligence and Internet of things technologies, and realizing real-time monitoring and data analysis of the breeding process are obvious exploratory technological innovation investment directions, which will improve the performance of feed, breeding, slaughtering and meat processing enterprises. Making use of the knowledge of feed science and nutrition, accurately adjusting feed composition and formula, improving traditional processing technology, improving product processing efficiency and quality control and other exploitative innovation activities will not necessarily bring about the improvement of economic added value and long-term development ability, and will have a negative impact on the performance of such enterprises. Therefore, the following assumptions are put forward:

H2a: the higher the level of exploratory technological innovation, the better the performance of feed, breeding, slaughtering and meat processing enterprises

H2b: the higher the level of applied technological innovation, the worse the performance of economic added value of feed, breeding, slaughtering and meat processing enterprises

H2c: the higher the level of applied technological innovation, the poorer the development ability of feed, breeding, slaughtering and meat processing enterprises

2.2.3. The level of technological innovation investment and the performance of prefabricated dishes and snack food enterprises

Prefabricated dishes and snack food enterprises are mainly engaged in the production of prefabricated dishes and snack food. Among these enterprises, exploratory technological innovation includes the research and development of food ingredients with innovative characteristics, the exploration of new processing technology and mechanical equipment, and the research and development of new prefabricated dishes and snack food products. The exploitative technological innovation behavior includes the use of food science and nutrition knowledge to accurately adjust the ingredients and formulas of food and realize the optimization and improvement of products. The production process of prefabricated dishes and snack food enterprises is relatively simple, mainly focusing on food processing and packaging. However, the requirements for raw materials are high, the freshness and taste of food need to be guaranteed, and the market demand is relatively flexible, so it is necessary to continuously introduce new varieties and tastes to meet the needs of consumers. However, once the new dish ratio is formed, enterprises will no longer invest in it. Therefore, exploratory innovation has a great impact on prefabricated dishes and snack food enterprises, while exploitative innovation has little impact on the performance of such enterprises. Therefore, the following assumptions are proposed:

H3: the higher the level of exploratory technological innovation, the worse the performance of prefabricated dishes and snack food enterprises

2.2.4. Investment level of technological innovation and performance of grain, oil and grain processing enterprises

Grain, oil and grain processing enterprises mainly use grains (such as wheat, rice, corn, etc.) as raw materials for processing and production. They need to process and refine fixed raw materials, and the production process is relatively stable. The products of enterprises under this classification, including edible oil, flour, rice, etc., are highly standardized products. Because the products are highly standardized and the production process is relatively stable, the use of technological innovation is often difficult to bring significant production cost savings or product quality improvement, which is not conducive to the improvement of the economic added value of enterprises. In addition, the competition of similar products in the market is fierce, and the space for new product development is limited. The use of technological innovation may only bring local product improvement, and it is difficult to obtain a significant advantage in the market. Therefore, the following assumptions are proposed:

H4: the higher the level of applied technological innovation, the worse the performance of grain and oil and grain processing enterprises

2.2.5. Technological innovation investment level and performance of sugar and biological additives enterprises

Sugar and biological additive enterprises need to master advanced production technology and process. The production process is relatively complex, and the mastery of technology and innovation ability are crucial to the competitiveness of enterprises. The continuous refining and refining process and the accurate control of temperature, pressure and flow through the automatic control system can improve the production efficiency and product quality stability of sugar and biological additive enterprises. Highly technical sugar and biological additive enterprises have higher requirements for technological innovation, and the corresponding investment has a positive impact on the performance of sugar and biological additive enterprises. Therefore, the following assumptions are put forward:

H5: the higher the level of exploratory technological innovation, the better the performance of sugar and biological additives Enterprises

3. Methodology

3.1. Data

According to the industry classification of the 2012 edition of the CSRC, this study selected the agricultural and sideline food processing enterprises listed in Shanghai and

Shenzhen stock exchanges from 2018 to 2022 as the research sample, screened out the data of domestic listed companies that have suffered losses for two consecutive years and received special treatment, and selected the remaining 36 companies as the research object. Eliminate the missing samples of observation value, and finally get 180 effective statistical samples. The statistical software Stata was used for panel data regression analysis to verify the corresponding hypothesis.

Limited by the similarities and differences of business scale, cost affordability and management level of some agricultural and sideline food processing enterprises, the application of advanced equipment and production technology has not been widely promoted, and is only limited to the leading enterprises in some industries. Leading enterprises in the industry gradually increase technology research and development, carry out technological transformation and optimization of manual operation, formulate standardized operation procedures, improve the mechanization and automation level of production lines, and ensure the unity of product quality and quality, which is also one of the reasons why this paper selects 36 listed enterprises as the research object. However, due to the significant differences in the production and processing processes of different enterprises, although some enterprises belong to the agricultural and sideline food processing industry, their production mode is significantly different from the upstream and downstream interactive environment, and their technological innovation investment and enterprise performance mode are significantly different. Therefore, a total of 36 business entities to be studied in this paper are classified according to similar production modes, including 18 feed, breeding, slaughtering and meat processing enterprises, 7 prefabricated vegetables and snack food enterprises, 7 grain and oil and grain processing enterprises, and 4 sugar and biological additives enterprises.

3.2. Variables

3.2.1. Explained variable

Economic value added (EVA): the calculation method of economic value added is the after tax operating profit after deducting the cost of debt and equity, which is the real residual value generated by operating activities. Wangxigang et al. (2003) confirmed that the ability to explain the market value of listed companies is stronger than accounting indicators. The economic value-added data required in this paper is from the annual reports of listed companies. When the economic added value is positive, it means that the company has created value, otherwise it will reduce value.

Asset liability ratio (DAR): the asset liability ratio is the ratio between the total debt and total assets of an enterprise, which is used to evaluate the debt level and asset financing ratio of an enterprise. Specifically, it is the ratio of total liabilities to total assets. The total liabilities here refer to the sum of all debts (including long-term and short-term debts) of the enterprise at a specific time point, while the total assets refer to the sum of all assets (including fixed assets, current assets, etc.) of the enterprise at the same time point. In this paper, the asset liability ratio is used as an important standard to evaluate the solvency of enterprises.

Return on assets (ROA): return on assets is a financial indicator to evaluate the ability of an enterprise to realize net profit by using its total assets. The ROA calculation formula is net profit divided by total assets. ROA is an important financial indicator, because it can show the ability of enterprises to effectively use their assets to achieve profitability. Higher ROA means that enterprises are more effective in using their assets, thus creating more value for shareholders. Compared with other enterprises, enterprises with higher ROA may be more competitive because they can create more profits based on the same assets. This paper uses the net profit rate of total assets as an important measure of the profitability of enterprises

Sustainable growth rate (SGR): the sustainable growth rate of an enterprise refers to the speed at which an enterprise can continue to grow without increasing debt or shareholders' equity. It reflects the rate at which an enterprise can achieve growth through internal profitability and capital reinvestment on the basis of maintaining the existing capital structure and financial policies. The sustainable growth rate is calculated as follows:

Sgr=roe* (1-dividend payout ratio)/asset liability ratio

$$SGR = ROE * \frac{1 - dividend\ payout\ ratio}{asset\ liability\ ratio}$$

Where, "roe" is the return on equity, which means the percentage of net profit created by each unit of shareholders' equity of the enterprise; "Dividend payout ratio" refers to the ratio of dividends paid by an enterprise to net profits; "Asset liability ratio" is the ratio of assets to liabilities of an enterprise, reflecting the degree of financial leverage of an enterprise. Higher SGR means that enterprises can achieve growth at a faster speed without increasing debt or diluting shareholders' equity. This paper uses the sustainable growth rate as a symbol to evaluate the development ability of enterprises.

3.2.2. Explanatory variables

Exploratory technological innovation investment (R) and exploitative technological innovation investment (d): China's accounting standards for business enterprises stipulates that R&D expenditures should be distinguished between research expenditures and development expenditures. The research stage refers to the planned and original investigation to acquire new scientific or technical knowledge, mainly involving the activities of acquiring relevant knowledge. Due to the exploratory uncertainty in the research stage, it is difficult for enterprises to prove the existence of their intangible assets. Therefore, for the internal R&D projects of the enterprise, all relevant expenditures in the research stage should be expensed when they occur and included in the current profit and loss (management expenses). The development stage refers to the application of research results or other knowledge to a plan or design before commercial production or use to produce new or substantially improved materials, devices, products, etc. This stage includes the design, construction, testing of prototypes and models, as well as small-scale tests, medium-scale tests and pilot production activities. Since the R&D projects entering the development stage are usually more likely to produce results, if the enterprise can prove that the development expenditure meets the definition of intangible assets and relevant recognition conditions, it can be recognized as intangible assets. For R&D projects within the enterprise, the expenditures in the development stage must meet certain conditions at the same time before they can be capitalized and then recognized as intangible assets. Therefore, according to the accounting standards for business enterprises (2006), this paper uses the expensed expenditure in the financial statements of listed companies to represent the investment of enterprises in the research stage, that is, the investment in exploratory technological innovation; The capitalized expenditure in the financial statements of listed companies is used to show the investment of enterprises in the development stage, that is, the use of innovation investment. The data of exploratory innovation investment and exploitative innovation investment are both from the annual financial statements of listed companies.

3.2.3. Control variables

In the empirical study, the possible confounding effect is controlled by adding relevant control variables. This paper uses the current ratio, total assets and the shareholding ratio of the top ten shareholders as control variables.

Tab 3-1: Variable Definition tadle

Variable	variable meaning	variable description
EVAi,t	the economic added value of the enterprise i in year t and the presentation of the economic added value of the enterprise	Net operating profit after tax - (weighted average cost of capital * total investment capital)
DARi,t	The asset liability ratio of the enterprise i in year t and the demonstration of the solvency of the enterprise	Total liabilities/total assets at the end of T year
ROAi,t	The total net asset profit rate of the enterprise i in year t and the display of the profitability of the enterprise	Net profit/total asset balance
SGRi,t	The sustainable growth rate of the enterprise i in year t and the demonstration of the enterprise development ability	ROE* (1- dividend payout ratio) / asset liability ratio
Di,t	The level of utilizing technological innovation of enterprise i in year t	Capitalized expenditure
Ri,t	The level of exploratory Technological innovation of I enterprise i in year t	Expensed expenditure
CURi,t	Current ratio of enterprise i in year t	Current assets/current liabilities
ASi,t	Total capital of enterprise i in year t	Total enterprise capital
TSHi,t	Shareholding ratio of top ten shareholders of enterprise i in t year	Proportion of equity held by top ten shareholders held by the enterprise at the end of year T to the total share capital of the company

4. Results

4.1. Descriptive statistics

There are 36 sample companies in the panel data in this paper. The observation period of the sample is a five-year time span from 2018 to 2022, and the individuals in the sample in each period are unchanged. They are all 36 listed companies, that is, the panel is a "balanced panel"; The sample time is 5 years, and the number of enterprises is 36, that is, the panel is "short panel".

There are 36 listed companies of agricultural and sideline food processing enterprises, with an overall average economic value-added of 311000000, ranging from -13600000000 to 28400000000, indicating that the economic value-added of listed companies of agricultural and sideline food processing enterprises is good, and the average value is positive even if there is a negative value. In addition, in terms of enterprise value performance, the solvency measurement index, i.e. the average asset liability ratio, is 0.478, and the overall range is between 0.117 and 0.994, indicating that there are large internal differences in the solvency of listed companies of agricultural and sideline food processing enterprises; The index to measure profitability, that is, the average net profit margin of total assets, is 0.035, and the overall range is -0.369 to 0.346, indicating that the profitability of listed companies of agricultural and sideline food processing enterprises is not strong; The average sustainable growth rate is 0.037, and the overall range is -0.976 to 0.579, indicating that the development ability of Listed Companies in China's agricultural and sideline food processing enterprises is not optimistic. In terms of the core explained variables, the average value of the investment index of exploratory technological innovation is 1490000000, the minimum value is 298970.8, the maximum value is 4400000000, the standard deviation is 394000000, and the average value of the investment index of exploitative technological innovation is 2597806, the minimum value is 0, the maximum value is 104000000, and the standard deviation is 13400000, indicating that the listed companies of agricultural and sideline food processing enterprises prefer to invest in exploratory technological innovation, and the internal difference of the investment of exploratory technological innovation is greater than that of exploitative technological innovation.

Tab 4-1: Descriptive Statistics of Main Variables in Agricultural and Food Processing Enterprises

Variable	Number of samples	mean value	standard deviation	Minimum	Maximum
EVA	180	311,000,000	2,630,000,000	-13,600,000,000	28,400,000,000
DAR	180	0.478	0.175	0.117	0.994
ROA	180	0.035	0.078	-0.369	0.346
SGR	180	0.037	0.169	-0.976	0.579
R	180	149,000,000	394,000,000	298,970.8	4,400,000,000
D	180	2,597,806	13,400,000	0	104,000,000
CUR	180	1.643	1.080	0.421	7.149
AS	180	12,600,000,000	21,800,000,000	679,000,000	145,000,000,000

TSH	180	58.826	13.428	22.810	84.150

In the overall sample, there are large internal differences in the investment of exploratory and exploitative technological innovation of listed companies of feed, breeding, slaughtering and meat processing enterprises. Therefore, the overall sample will be classified and discussed next.

Group 1 includes 18 feed, breeding, slaughtering and meat processing enterprises, group 2 includes 7 prefabricated vegetables and snack food enterprises, group 3 includes 7 grain and oil and grain processing enterprises, and group 4 includes 4 sugar and biological additives enterprises. See table 4-2 to table 4-5 for specific data.

The average value of EVA in group 1 is 610000000, and the overall range is -13600000000 to 28400000000. Compared with the overall sample, the minimum and maximum values are the same, but the average value becomes larger, indicating that the economic added value performance of feed, breeding, slaughtering and meat processing enterprises is better than the overall sample. The average EVA of group 2 is 1190000000, and the overall range is -598000000 to 632000000, which is smaller than the average of the overall sample, indicating that the economic value-added performance of prefabricated vegetables and snack food enterprises is weak. The average economic value-added of group 3 is -39.3 million, with an overall range of -123.0 million to 186.0 million. The average economic value-added of group 4 is -89.6 million, with an overall range of -150.0 million to 150.0 million, indicating that the average economic value-added of the two groups of listed companies from 2018 to 2022 is negative and performs poorly.

The average asset liability ratio of group 1 is 0.503, the overall range is between 0.171 and 0.872, and the standard deviation is 0.160, indicating that the solvency of this group of enterprises is weaker than the overall sample, with a large internal span, but the internal difference is smaller than the overall sample; The average asset liability ratio of group 2 is 0.386, the overall range is between 0.157 and 0.684, and the standard deviation is 0.149, indicating that the solvency of this group of enterprises is stronger than the overall sample, and the internal span is smaller than the overall sample; The average asset liability ratio of group 3 is 0.441, and the overall range is between 0.117 and 0.670, which is lower than the overall sample asset liability ratio and stronger debt paying ability; The average asset liability ratio of group 4 is 0.591, and the overall range is between 0.333 and 0.994, which is higher than the average of the overall sample, indicating that the solvency of this group of companies is weak.

As an indicator of profitability, the average net profit margin of total assets of group 1 is 0.039, with an overall range of -0.369 to 0.227; the average net profit margin of total assets of group 2 is 0.047, with an overall range of -0.096 to 0.165; the average net profit margin of total assets of group 3 is 0.026, which is lower than the average of the overall sample, with a range of -0.118 to 0.346; the average net profit margin of total assets of group 4 is 0.014, with an overall range of -0.238 to 0.067, indicating that the profitability of the four groups of companies is not strong;

The average sustainable growth rate of group 1 is 0.052, and the overall range is -0.570 to 0.579, indicating that the development ability of listed companies of feed, breeding, slaughtering and meat processing enterprises is not optimistic, but better than the overall sample. The average sustainable growth rate of group 2 is 0.036, and the overall range is -0.196 to 0.144, indicating that the development ability of listed companies of prefabricated vegetables and snack food enterprises is not optimistic, but the internal difference is significantly smaller than the overall sample. The average sustainable growth rate of group 3 is 0.030, and the overall range is -0.190 to 0.424, indicating that the development ability of listed companies of grain and oil and grain processing enterprises is not optimistic. The average sustainable growth rate of group 4 is -0.015, and the overall range is -0.976 to 0.385. The development ability of this group of companies is the least optimistic among the four groups.

In terms of core explained variables, in group 1, the average value of exploratory technological innovation investment index is 2470000000, which is higher than the average level of the overall sample, the minimum value is 2225505, the maximum value is 4400000000, and the standard deviation is 394000000. The average value of exploitative technological innovation investment index is 4988662, which is higher than the average level of the overall sample, the minimum value is 0, the maximum value is 104000000, and the standard deviation is 18600000, indicating that listed companies of feed, breeding, slaughtering and meat processing enterprises prefer to invest in exploratory technological innovation, and the internal difference of exploratory technological innovation investment is greater than that of exploitative technological innovation investment, and higher than the overall average. In group 2, the average value of the exploratory technological innovation investment index is 630000000, which is lower than the average level of the overall sample. The minimum value is 10100000, and the maximum value is 180000000. The more special, the exploitative technological innovation investment index is 0, indicating that the prefabricated dishes and leisure food enterprises attach importance to exploratory innovation investment, and there is no exploitative technological innovation investment. In group 3, the average value of the exploratory technology innovation investment index is 30500000, the minimum value is 298971, the maximum value is 105000000, the standard deviation is 32500000, the average value of the exploitative technology innovation investment index is 334224.2, the minimum value is 0, the maximum value is 8505980, the standard deviation is 1467530, and in group 4, the average value of the exploratory technology innovation investment index is 68200000, the minimum value is 1113183, the maximum value is 221000000, the standard deviation is 62800000, and the average value of the exploitative technology innovation investment index is 346383.30, the minimum value is 0, the maximum value is 3023472, and the standard deviation is 864311.70, indicating that the difference between group 3 and group 4 is companies prefer to invest in exploratory technology innovation, and the internal difference of exploratory technology innovation investment is greater than that of exploitative technology innovation investment.

Tab 4-2: Descriptive Statistics of Main Variables in Feed, Livestock Slaughtering, and Meat Processing Enterprises

Variable	Number of samples	mean value	standard deviation	Minimum	Maximum
EVA	90	610,000,000	3,680,000,000	-13,600,000,000	28,400,000,000
DAR	90	0.503	0.160	0.171	0.872
ROA	90	0.039	0.085	-0.369	0.227
SGR	90	0.052	0.173	-0.570	0.579
R	90	247,000,000	539,000,000	2,225,505	4,400,000,000
D	90	4,988,662	18,600,000	0	104,000,000
CUR	90	1.351	0.797	0.421	5.798
AS	90	19,300,000,000	29,100,000,000	679,000,000	145,000,000,000
TSH	90	61.108	13.183	29.84	84.15

Tab 4-3: Descriptive Statistics of Main Variables in Prefabricated Vegetables and Snack Food Enterprises

Variable	Number of samples	mean value	standard deviation	Minimum	Maximum
EVA	35	119,000,000	301,000,000	-598,000,000	632,000,000
DAR	35	0.386	0.149	0.157	0.684

ROA	35	0.047	0.066	-0.096	0.165
SGR	35	0.036	0.090	-0.196	0.144
R	35	63,000,000	49,900,000	10,100,000	180,000,000
D	35	0	0	0	0
CUR	35	2.183	1.173	0.707	5.178
AS	35	4,630,000,000	3,180,000,000	1,150,000,000	16,200,000,000
TSH	35	61.436	10.906	32.160	76.240

Tab 4-4: Descriptive Statistics of Main Variables in Grain and Oil Processing Enterprises

Variable	Number of samples	mean value	standard deviation	Minimum	Maximum
EVA	35	-39,300,000	470,000,000	-1,230,000,000	1,860,000,000
DAR	35	0.441	0.152	0.117	0.670
ROA	35	0.026	0.075	-0.118	0.346
SGR	35	0.030	0.105	-0.190	0.424
R	35	30,500,000	32,500,000	298,971	105,000,000
D	35	334,224.2	1,467,530	0	8,505,980
CUR	35	2.099	1.462	0.854	7.149
AS	35	6,010,000,000	2,950,000,000	1,920,000,000	14,600,000,000
TSH	35	55.757	15.494	22.810	75.840

Tab 4-5: Descriptive Statistics of Main Variables in Sugar and Biotechnology Additives Enterprises

Variable	Number of samples	mean value	standard deviation	Minimum	Maximum
EVA	20	-89,600,000	367,000,000	-1,500,000,000	150,000,000
DAR	20	0.591	0.229	0.333	0.994
ROA	20	0.014	0.068	-0.238	0.067
SGR	20	-0.015	0.300	-0.976	0.385
R	20	68,200,000	62,800,000	1,113,183	221,000,000
D	20	346,383.3	864,311.7	-	3,023,472
CUR	20	1.216	0.452	0.536	2.042
AS	20	7,830,000,000	6,000,000,000	2,520,000,000	19,900,000,000
TSH	20	49.365	9.666	33.930	63.580

4.2. Correlation analysis

The correlation analysis of agricultural and sideline food processing enterprises is shown in tables 4-6 and 4-7. The Pearson correlation coefficients among variables are listed in the table, including the correlation coefficients between the overall variables and the correlation coefficients under each grouping. In addition, this paper uses Vif to test the collinearity between variables. The maximum Vif in the agricultural and sideline food processing enterprise model is 1.91, and the average value is 1.48, the grouped data is lower than 10[21]. Therefore, there is no serious multicollinearity problem, so it can be used as the basis for the analysis of the panel data model.

Tab 4-6: Correlation Matrix of Variables in Agricultural and Food Processing Enterprises

	(1) EVA	(2) DAR	(3) ROA	(4) SGR	(5)R	(6)D	(7)CUR	(8)AS	(9)TSH
(1) EVA	1.0000								
(2) DAR	-0.1144	1.0000							
(3) ROA	0.4444***	-0.4773***	1.0000						
(4) SGR	0.3369***	-0.3381***	0.8225***	1.0000					
(5) R	0.7873***	0.0384	0.2570**	0.1749	1.0000				
(6) D	-0.0255	0.0036	-0.0183	-0.0188	0.1661	1.0000			
(7) CUR	0.0673	-0.6700***	0.3741***	0.2187	-0.0672	-0.0964	1.0000		
(8)AS	0.3033***	0.1378	0.1505	0.1018	0.6821***	0.1413	-0.1538	1.0000	
(9)TSH	0.0869	-0.1478	0.3237***	0.2287*	0.0093	-0.1339	0.1050	0.1196	1.0000

Note: ***,** and * represent that the variables are significant at 1%, 5% and 10% levels respectively

Tab 4-7: Variance Inflation Factor (VIF) values of independent variables under different explanatory variables in agricultural and food processing enterprises

	EVA	DAR	ROA	SGR
R	1.91	1.90	1.90	1.90
D	1.06	1.05	1.05	1.05
AS	1.98	1.92	1.92	1.92
TSH	1.06	1.05	1.05	1.05
CUR	1.05	/	/	/
均值	1.41	1.48	1.48	1.48

4.3. Regression analysis

4.3.1. Solvency

The panel data regression of agricultural and sideline food processing enterprises first needs to choose among mixed regression model, fixed effect model and random effect model. The comparison result of mixed regression model and fixed effect model is prob>F=0.000, which is far less than 0.01. Therefore, the p value corresponding to F test is less than 0.05, so the original hypothesis is rejected and the fixed effect model is selected; The comparison result of mixed regression model and random effect model was prob>chibar2=0.000, so the random effect model was selected. The Hausman test was used to determine whether to choose the fixed effect model or the random effect model. The results showed that prob>chi2=0.3749, and the p value corresponding to F test was far greater than 0.1, so the original hypothesis could not be rejected and the random effect model was selected. Table 4-16 is the integrated report of model operation results.

Specifically, the first column shows the overall regression results of the sample of Listed Companies in the agricultural and sideline food processing industry. The results show that the coefficient of exploratory technological innovation level is significantly positive (P=0.008<0.1), indicating that the exploratory technological innovation level is conducive to the improvement of the solvency of agricultural and sideline food processing enterprises, while the coefficient of the exploitative technological innovation level is negative, but it does not pass the significance test. The second column is the regression results of feed, breeding, slaughtering and meat processing enterprises. The results show that the coefficient of exploratory technological innovation level is significantly positive at the 10% level (P=0.075<0.1), indicating that exploratory technological innovation level is conducive to the improvement of debt paying ability of feed, breeding, slaughtering and meat processing enterprises, while the coefficient of exploitative technological innovation level is negative, but it does not pass the significance test. The third column shows the regression results of prefabricated dishes and snack food enterprises. The results show that the coefficient of exploratory technological innovation level is significantly positive at the 10% level (P=0.074<0.1), indicating that the exploratory technological innovation level is conducive to the improvement of the debt paying ability of prefabricated dishes and snack food enterprises in this sample. At the same time, the exploitative innovation level under this grouping is zero, indicating that there is no exploitative innovation investment in this sample group, and prefabricated dishes and snack food enterprises are not optimistic about the exploitative innovation investment. The fourth column shows the regression results of grain, oil and grain processing enterprises. The coefficient of exploratory innovation level is significantly positive at the 1% confidence level (P=0.001<0.01), indicating that the investment level of exploratory technological innovation is conducive to the improvement of debt paying ability of grain, oil and grain processing enterprises.

Column 5 shows the regression results of sugar making and biological additive enterprises, and the results show that both the exploratory technological innovation level and the exploitative technological innovation level fail to pass the significance test on the solvency.

Tab 4-8: Panel data regression analysis results on debt-paying ability

DAR	(1) Whole sample	(2) group 1	(3) group 2	(4) group 3	(5) group 4
	Agricultural and sideline food processing enterprises	Feed, breeding, slaughtering and meat processing	Prepared dishes and snack foods	Grain, oil and grain processing	Sugar making and biological additives
R	1.24e-10***	9.31e-11*	2.87e-09*	7.08e-09***	8.18e-10
	(0.008)	(0.075)	(0.074)	(0.001)	(0.169)
D	-8.54e-10	-1.00e-09	/	8.25e-09	-1.61e-08
	(0.633)	(0.595)		(0.609)	(0.479)
CUR	-0.609***	-0.538***	-0.577***	-0.736***	-0.323 **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.016)
TSH	-0.004**	-0.006**	0.005	-0.001	-0.0006
	(0.032)	(0.018)	(0.133)	(0.785)	(0.818)
_cons	-0.406***	-0.305*	-1.121***	-0.639***	-0.569***
	(0.000)	(0.062)	(0.000)	(0.007)	(0.002)
obs	180	90	35	35	20
R2	0.6252	0.5192	0.6752	0.7067	0.4375

Note: ***,** and * represent that the variables are significant at 1%, 5% and 10% levels respectively

4.3.2. Profitability

Similar to solvency, the panel data regression of the profitability of agricultural and sideline food processing enterprises first needs to be selected from the mixed regression model, fixed effect model and random effect model. The comparison between the mixed regression model and the fixed effect model: prob>F=0.000, far less than 0.01. Therefore, the P value corresponding to the F test is less than 0.05, so the original hypothesis is rejected and the fixed effect model is selected. The comparison between the mixed regression model and the random effect model: prob>chibar2=0.001, P value is 0.001, and the random effect model is selected. The Hausman test was used to determine whether to choose the fixed effect model or the random effect model. The results showed that prob>chi2=0.4956, and the p value corresponding to F test was far greater than 0.1, so the original hypothesis could not be rejected and the random effect model was selected. Table 4-17 is the integrated report of model operation results.

Specifically, the first column shows the overall regression results of agricultural and sideline food processing enterprises. The coefficient of exploratory technological innovation level is significantly positive (P=0.003<0.1), indicating that exploratory technological innovation level is conducive to the improvement of the profitability of agricultural and sideline food processing enterprises, while the coefficient of exploitative technological innovation level is negative, but it fails to pass the significance test. The second column shows the regression results of feed, breeding, slaughtering and meat processing enterprises. The coefficient of exploratory technological innovation level is significantly positive (P=0.006<0.01), indicating that exploratory technological innovation level is conducive to the improvement of the profitability of feed, breeding, slaughtering and meat processing enterprises, while the coefficient of exploitative technological innovation level is negative, but it does not pass the significance test. The third column shows the regression results of prefabricated dishes and snack food enterprises. The results show that the coefficient of exploratory technological innovation level is significantly negative at the 10% confidence level (P=0.080<0.1), indicating that exploratory technological innovation level is not conducive to the improvement of profitability in prefabricated dishes and snack food enterprises. At the same time, the exploitative innovation level under this grouping is zero, indicating that prefabricated dishes and snack food enterprises have no exploitative innovation investment.

The fourth column shows the regression results of grain, oil and grain processing enterprises, and the fifth column shows the regression results of sugar and biological additive enterprises. The results show that the coefficients of exploratory technological innovation and exploitative innovation level have not passed the significance test.

Tab 4-9: Panel data regression analysis results on profitability

DAR	(1) Whole sample	(2) group 1	(3) group 2	(4) group 3	(5) group 4
	Agricultural and sideline food processing enterprises	Feed, breeding, slaughtering and meat processing	Prepared dishes and snack foods	Grain, oil and grain processing	Sugar making and biological additives
R	9.00e-11*** (0.003)	9.27e-11*** (0.006)	-1.86e-09* (0.080)	-3.96e-10 (0.884)	2.19e-10 (0.716)
D	-7.86e-10	-6.43e-10	/	-1.30e-08	-7.85e-10

	(0.392)	(0.519)		(0.196)	(0.974)
AS	-1.60e-12 **	-1.61e-12*	4.87e-12	7.66e-14	8.78e-12
	(0.042)	(0.063)	(0.429)	(0.996)	(0.536)
TSH	0.001	0.002	0.001	0.002	0.001
	(0.106)	(0.132)	(0.445)	(0.582)	(0.628)
_cons	-0.039	0.066	0.075	-0.053	-0.143
	(0.467)	(0.415)	(0.443)	(0.786)	(0.544)
obs	180	90	35	35	20
R2	0.1086	0.2676	0.3679	0.1863	0.0434

Note: ***,** and * represent that the variables are significant at 1%, 5% and 10% levels respectively

4.3.3. Development capability

The comparison results of mixed regression model and fixed effect model showed that prob>F=0.008, less than 0.01. Therefore, the p value corresponding to F test was less than 0.05, so the original hypothesis was rejected and fixed effect model was selected. The comparison results of mixed regression model and random effect model showed that prob>chibar2=0.075, P value was 0.075, and random effect model was selected. Then the Hausman test was used for comparison, prob>chi2=0.4879, P value is far greater than 0.1, so the random effect model was selected. Table 4-18 is the integrated report of model operation results.

Specifically, the first column shows the overall regression results of the sample of agricultural and sideline food processing enterprises. The coefficient of exploratory technological innovation level is significantly positive (P=0.002<0.1), indicating that exploratory technological innovation level is conducive to the improvement of the development ability of agricultural and sideline food processing enterprises, while the coefficient of exploitative technological innovation level is significantly negative (P=0.032<0.05), indicating that exploitative technological innovation level is not conducive to the improvement of the development ability of agricultural and sideline food processing enterprises. The second column shows the regression results of feed, breeding, slaughtering and meat processing enterprises. The results show that the coefficient of exploratory technology innovation level is significantly positive (P=0.008<0.01), indicating that the exploratory technology innovation level is conducive to the improvement of the development ability of feed, breeding, slaughtering and meat processing enterprises, while the coefficient of exploitative technology innovation level is significantly negative (P=0.068<0.1), indicating that the exploitative technology innovation level is not conducive to the improvement of the development ability of feed, breeding, slaughtering and meat processing enterprises. The third column shows the regression results of prefabricated dishes and snack food enterprises. The results show that the coefficient of exploratory technological innovation level is significantly negative (P=0.043<0.05), indicating that the exploratory technological innovation level in this sample is not conducive to the improvement of the development ability of prefabricated dishes and snack food enterprises. At the same time, the exploitative innovation level under this grouping is zero, indicating that the prefabricated dishes and snack food enterprises have no exploitative innovation investment. The fourth column shows the regression results of grain, oil and grain processing enterprises. The results show that the coefficient of exploratory technological innovation level is significantly negative (P=0.099<0.1), indicating that exploratory technological innovation level is not conducive to the improvement of the development ability of grain, oil and grain processing enterprises in this sample. At the same time, the coefficient of exploitative technological innovation level is negative, but it does not pass the significance test. Column 5 shows the regression results of sugar making and biological additive enterprises. The results show that the coefficient of exploratory technological innovation is positive, and the coefficient of exploitative innovation level is not negative, but none of them has passed the significance test.

Tab 4-10: Panel data regression analysis results on development capability

DAR	(1) Whole sample	(2) group 1	(3) group 2	(4) group 3	(5) group 4
	Agricultural and sideline food processing enterprises	Feed, breeding, slaughtering and meat processing	Prepared dishes and snack foods	Grain, oil and grain processing	Sugar making and biological additives
R	1.43e-10*** (0.002)	1.42e-10*** (0.008)	-3.45e-09** (0.043)	-7.49e-10 * (0.099)	-7.60e-10 (0.195)
D	-2.94e-09** (0.032)	-2.94e-09* (0.068)	/	-9.10e-09 (0.751)	1.20e-08 (0.677)
AS	-2.80e-12** (0.023)	-2.73e-12* (0.066)	9.61e-12 (0.329)	7.57e-12 (0.209)	-2.47e-12 (0.650)

TSH	0.0003	0.0007	0.002	0.0001	-0.002
	(0.803)	(0.735)	(0.367)	(0.929)	(0.708)
_cons	0.082	0.083	0.082	0.020 (0.774)	0.267
	(0.354)	(0.563)	(0.595)		(0.236)
obs	180	90	35	35	20
R2	0.2274	0.5192	0.2240	0.6374	0.7798

Note: ***,** and * represent that the variables are significant at 1%, 5% and 10% levels respectively

4.3.4. Economic added value

In the selection of mixed regression model and fixed effect model, the p value is less than 0.05, and the fixed effect model is selected. In the comparison of mixed regression model and random effect model, the p value is 0.000, and the random effect model is selected. In Hausman test, prob>chi2=0.3749, the p value corresponding to F test is far greater than 0.1, so the random effect model is selected. Next, we did the same processing for the data under each group and reached the same conclusion. Therefore, the operation results of the random effect model are reported in table 4-19.

Specifically, the first column shows the overall regression results of the sample of agricultural and sideline food processing enterprises. The results show that the coefficient of exploratory technological innovation level is significantly positive (P=0.00<0.1), indicating that the exploratory technological innovation level is conducive to the improvement of economic added value of agricultural and sideline food processing enterprises, while the coefficient of exploitative technological innovation level is significantly negative (P=0.001<0.01), indicating that the exploitative technological innovation level is not conducive to the improvement of economic added value of agricultural and sideline food processing enterprises. The second column shows the regression results of feed, breeding, slaughtering and meat processing enterprises. The results show that the coefficient of exploratory technological innovation level is significantly positive (P=0.00<0.01), indicating that exploratory technological innovation level is conducive to the improvement of economic added value of feed, breeding, slaughtering and meat processing enterprises, while the coefficient of exploitative technological innovation level is significantly negative (P=0.03<0.05), indicating that exploitative technological innovation level is not conducive to the improvement of economic added value of feed, breeding, slaughtering and meat processing enterprises. The third column shows the regression results of prefabricated dishes and snack food enterprises. The results show that the coefficient of exploratory technological innovation level is significantly negative (P=0.000<0.01), indicating that exploratory technological innovation level is not conducive to the improvement of economic added value of prefabricated dishes and snack food enterprises in this sample. At the same time, the exploitative innovation level under this grouping is zero, indicating that prefabricated dishes and snack food enterprises have no exploitative innovation investment. The fourth column shows the regression results of grain, oil and grain processing enterprises. The results show that the coefficient of the exploitative innovation level is significantly negative at the 10% confidence level (P=0.074<0.1), indicating that the exploitative type technological innovation investment level is not conducive to the improvement of the economic added value of grain, oil and grain processing enterprises. At the same time, the coefficient of the exploratory type technological innovation level is negative, but it fails to pass the significance test. Column 5 shows the regression results of sugar making and biological additive enterprises. The results show that the coefficient of exploratory technological innovation level is significantly positive at the 10% confidence level (P=0.081<0.1), indicating that exploratory technological innovation level is conducive to the improvement of economic added value of sugar making and biological additive enterprises. At the same time, the coefficient of exploitative technological innovation level is negative, but it fails to pass the significance test.

Tab 4-11: Panel data regression analysis results on economic value added

DAR	(1) Whole sample	(2) group 1	(3) group 2	(4) group 3	(5) group 4
	Agricultural and sideline food processing enterprises	Feed, breeding, slaughtering and meat processing	Prepared dishes and snack foods	Grain, oil and grain processing	Sugar making and biological additives
R	7.450*** (0.000)	7.674476*** (0.000)	-3.490*** (0.000)	-4.020 (0.210)	3.475269* (0.081)
D	-25.920*** (0.001)	-22.46264** (0.031)	/	-97.201* (0.074)	-3.018715 (0.979)
AS	-0.055*** (0.000)	-.0584438*** (0.000)	0.065*** (0.000)	0.073* (0.067)	0.0147 (0.426)
TSH	2.21e+07 *** (0.003)	3.80e+07*** (0.010)	4457977 (0.142)	-3555520 (0.574)	6107610 (0.683)

_cons	-1.35e+09 *** (0.003)	-2.36e+09** (0.011)	-2.35e+08 (0.265)	-1.28e+08 (0.654)	-7.42e+08 (0.327)
obs	180	90	35	35	20
R2	0.9045	0.9478	0.9738	0.7426	0.7501

Note: ***,** and * represent that the variables are significant at 1%, 5% and 10% levels respectively

4.4. Robustness test

In the study of the impact of China's main incentive policies for technological innovation on the quality and quantity of enterprise technological innovation, Chen Qiangyuan [22] conducted a 1% quantile bilateral tailing treatment on the return on assets and debt ratio of agricultural and non-staple food processing enterprises. Referring to his practice, this paper conducted a regression test on this panel data by conducting a 1% quantile bilateral tailing treatment on the Solvency Index, profitability index, development ability index and economic added value of agricultural and non-staple food processing enterprises. The results showed that the conclusions were consistent with the previous article. The robustness of this paper was supported, which proved the reliability of this empirical study. See table 4-20 for the regression analysis results after tailing treatment.

Tab 4-12: Regression analysis results after panel data trimming

	DAR	ROA	SGR	EVA
R	1.19e-10*** (0.010)	9.00e-11*** (0.001)	1.42e-10 *** (0.002)	3.662*** (0.000)
D	-8.26e-10 (0.642)	-7.91e-10 (0.332)	-97.201* (0.074)	-20.808* (0.077)
AS	/	-1.58e-12 ** (0.023)	0.073* (0.067)	-0.085*** (0.000)
TSH	-0.004** (0.025)	0.002* (0.052)	-3555520 (0.574)	-3,817,972 (0.729)
_cons	-0.401 *** (0.011)	-0.045 (0.346)	- 1.28e+08 (0.654)	1,030,000,000** (0.130)
CUR	-0.591*** (0.000)	/	/	/
obs	180	180	180	180

R2	0.6484	0.1245	0.2287	0.4327

Note: ***,** and * represent that the variables are significant at 1%, 5% and 10% levels respectively

5. Conclusions

This paper analyzes the data of dual technological innovation and enterprise performance of agricultural and sideline food processing enterprises and their sub categories from 2018 to 2022, and draws the following conclusions:

On the whole, the exploratory technological innovation of agricultural and non-staple food processing enterprises negatively affects the solvency of enterprises, positively affects the profitability, development ability and economic added value of enterprises, and the exploitative technological innovation negatively affects the development ability and economic added value of enterprises. However, in the sub category of agricultural and sideline food processing industry, the impact of exploratory technological innovation and exploitative technological innovation on the performance of enterprises in different sub categories is different. First, the performance of feed, breeding, slaughtering and meat processing enterprises is consistent with the overall performance of the agricultural and sideline food processing industry, that is, exploratory technological innovation negatively affects the solvency of enterprises, positively affects the profitability, development ability and economic added value of enterprises, and exploitative technological innovation negatively affects the development ability and economic added value of enterprises. Second, prefabricated dishes and snack food enterprises have no use of innovation investment, and exploratory technological innovation negatively affects enterprise performance, including solvency, profitability, development ability and economic added value. Third, among grain, oil and grain processing enterprises, exploratory technological innovation has a negative impact on enterprise performance, including solvency, profitability and development ability, and exploitative technological innovation has a negative impact on enterprise economic added value. Fourth, the exploratory technological innovation of sugar and biological additive enterprises has a positive impact on the economic added value of enterprises.

In terms of solvency, the overall performance is consistent with that of sub categories, that is, exploratory technological innovation has a negative impact on solvency, which may be related to the high investment of exploratory innovation. The index to measure solvency is the asset liability ratio, which means that the proportion of corporate assets is debt. The higher the proportion of debt to assets, the less funds the enterprise will use to repay debt, that is, the poorer the corresponding solvency. Exploratory technological innovation may lead enterprises to increase investment in R&D and production equipment updating, which will increase the liabilities of enterprises and increase the asset liability ratio. When the asset liability ratio of enterprises increases, it means that enterprises rely more on debt to support their business activities and investment projects. Although exploratory technological innovation may bring new sources of income and profit opportunities, if these new income can not cover the cost of debt in time, or the innovation investment can not get effective returns, it will increase the pressure on enterprises to repay debts and reduce their solvency. In addition, the investment in exploratory technological innovation is usually accompanied by high uncertainty and risks, and enterprises may face risks such as poor market acceptance, technological failure and intensified competition when carrying out innovation, which will affect the solvency. The exploratory technological innovation of feed, breeding, slaughtering and meat processing enterprises, prefabricated vegetables and snack food enterprises, and grain and oil and grain processing enterprises all have a negative impact on the solvency of enterprises, but the impact of innovation behavior of sugar and biological additives enterprises on performance has not passed the significance test.

In terms of profitability, the overall performance of the sample is inconsistent with that of the sub categories. This paper uses ROA as the profitability measurement index. On the whole, the exploratory technological innovation of agricultural and non-staple food processing enterprises has a positive impact on the profitability of enterprises. In the grouping, feed, breeding and slaughtering and meat processing enterprises are consistent with the overall performance. Exploratory technological innovation has a positive impact on the profitability of enterprises, but in the prefabricated vegetables and leisure food enterprises, exploratory innovation has a negative impact on the profitability. For feed, breeding, slaughtering and meat processing enterprises, exploratory technological innovation may bring new breeding, slaughtering and processing technologies and improve the added value of products. This can directly promote the improvement of profitability by improving product quality and launching high value-added products. For prefabricated dishes and snack food enterprises, the industry market competition is fierce and the product life cycle is relatively short. Exploratory technological innovation may lead to higher R&D and promotion costs, but due to market saturation and rapid product upgrading, new products may soon lose competitiveness, making investment unable to get full return, thus affecting profitability. In addition, feed, breeding, slaughtering and meat processing enterprises may be more likely to enhance the added value of products through innovation, while prefabricated vegetables and snack food enterprises may face greater market competition and short life cycle due to market characteristics, resulting in relatively weak return on innovation. Therefore, factors such as business model, market characteristics and product life cycle may lead to different effects of exploratory technological innovation in different sub industries. Therefore, the two sub industries are different in the impact of exploratory technological innovation on profitability.

In terms of development ability, the overall performance of the sample is inconsistent with that of the sub category. This paper uses the sustainable growth rate as the measurement index of development ability. On the whole, the exploratory technological innovation of agricultural and non-staple food processing enterprises has a positive impact on the development ability of enterprises. The group I feed, breeding and slaughtering and meat processing enterprises are consistent with the overall performance. Exploratory technological innovation has a positive impact on the development ability of enterprises. However, among the group II prefabricated food and snack food enterprises and the group III grain and oil and grain processing enterprises, the exploratory technological innovation has a negative impact on the development ability of enterprises. This may be due to the relatively stable market of feed, breeding and slaughtering and meat processing enterprises and the relatively sustainable demand for products. The products produced by grain, oil and grain processing enterprises usually have a high degree of standardization and fierce market competition, but the degree of product differentiation is low. Therefore, the high investment in exploratory technological innovation makes the input-output relatively low. On the other hand, the overall agricultural and sideline food processing enterprises' exploitative technological innovation has a negative impact on their development ability, and feed, breeding and slaughtering and meat processing enterprises are consistent with the overall situation. This may be due to the fierce competition in the agricultural and sideline food processing industry, and the use of technological innovation often can only bring small product improvements, which is difficult to obtain obvious advantages in the market. In such a competitive environment, even if the enterprise has made a certain degree of technological improvement, it is difficult to achieve significant market share growth and income improvement in a short time, thus affecting the development ability of the enterprise. In addition, agricultural and sideline food processing products tend to have a relatively high degree of standardization, and the homogenization of products between different enterprises is more obvious. Utilizing technological innovation is difficult to bring product differentiation, and it is difficult for enterprises to stand out in the market, so its impact on development ability is limited. Therefore, the negative impact of agricultural and non-staple food processing enterprises' overall exploitative technological innovation on their development ability may be due to the high pressure of market competition and the high degree of product homogeneity. These factors lead to the fact that technological innovation is difficult to bring substantive development advantages to enterprises, which limits the development ability of enterprises.

In terms of economic value-added, the overall performance of the sample is inconsistent with that of the sub categories. This paper uses economic value-added as a measurement index. On the whole, the exploratory technological innovation of agricultural and non-staple food processing enterprises has a positive impact on the economic value-added of enterprises. Group I feed, breeding and slaughtering and meat processing enterprises are consistent with the overall performance, which shows that feed, breeding and slaughtering and meat processing enterprises can improve the growth speed, health status and meat quality of livestock and poultry, and positively affect the added value of enterprises through the research and adoption of new feed ingredients, additives and formulas. Blindly using the local improvement of existing technology can not further improve the economic value-added of feed, breeding and slaughtering and meat processing enterprises. However, the prefabricated food and snack food enterprises in group 2 showed the opposite conclusion, that is, the prefabricated food and snack food enterprises did not use innovation investment, and exploratory innovation investment had a negative impact on enterprise performance. The reasons why the enterprises of prefabricated dishes and snack foods may prefer exploratory technological innovation investment rather than technological innovation investment may be as follows: first, market demand and consumption trend: the prefabricated dishes and snack food industry is usually greatly affected by consumer preferences and trends. These enterprises may be more inclined to explore technological innovation to adapt to changes in market demand and consumer demand for new products, rather than just pursuing the innovation extension of existing products. Secondly, product differentiation and brand building: in the highly competitive market environment, prefabricated dishes and snack food enterprises may pay more attention to product differentiation and brand building. Exploratory technological innovation can help them develop new product categories, improve product formulas or launch special products, so as to enhance brand competitiveness. In addition, the optimization of production process and production technology of prefabricated dishes and snack food enterprises cannot achieve significant results in the fierce competition. This exploratory technological innovation focuses more on practicability and operability than technological breakthroughs and innovations. Finally, the prefabricated dishes and snack food industry usually needs to respond quickly to market changes and consumer demand.

Exploratory technological innovation is more flexible and fast than technological innovation, so this kind of enterprises tend to explore technological innovation. However, at the same time, exploratory technological innovation has large investment, long response cycle, and the output efficiency has not strong repercussions on such enterprises. The positive impact on such enterprises is limited, which leads to the negative impact of exploratory technological innovation on the performance of prefabricated dishes and snack food enterprises. In addition, the exploitative technology innovation of grain, oil and grain processing enterprises has a negative impact on enterprise performance. This may be because, on the one hand, exploitative technological innovation pays more attention to technology replication and improving production efficiency than exploratory technological innovation. Grain, oil and grain processing enterprises are usually faced with problems such as small market size, low industry concentration, high raw material costs and fierce market competition. However, exploitative technological innovation that pays too much attention to production efficiency may lead to enterprises' lack of product differentiation competitiveness, thus falling into the mire of low-cost competition, which has a negative impact on the added value of products and market competitiveness of enterprises and negatively affects enterprise performance. On the other hand, exploitative technological innovation may lead to the stagnation of enterprises at the technical level, and the long-term inability to meet the new needs of the market and customers, thus losing market share and competitive advantage. Finally, the exploratory technological innovation of sugar and biological additive enterprises has a positive impact on the economic added value of enterprises. Sugar making and biological additive enterprises are obviously different from the other three sub categories. They mainly extract raw materials from biological sources (such as plants, microorganisms, etc.) for biological processing and transformation. The main task of sugar making enterprises is to extract sugar from sucrose or beet, and refine and process it to produce various sugar products. Biological additive enterprises focus on extracting beneficial biological molecules from biological sources such as microorganisms, such as enzymes, yeast, etc., for food, medicine and industrial applications. Its biological processing characteristics, dependence on natural raw materials, sustainability tendency and wide application in the field of food and medicine make it significantly different from other categories. Exploratory technological innovation helps sugar and biological additive enterprises to develop new sweeteners and sugar substitutes, functional additives and nutrition fortified products, effectively strengthen the research and development of bioactive ingredients extraction and biological food additives, and has a significant effect on improving enterprise performance.

Agricultural and sideline food processing enterprises in different sub industries are affected by factors such as market characteristics, product life cycle and changes in market demand, resulting in differences in the impact of exploratory technological innovation on enterprise performance. In a relatively stable market environment, technological innovation may not bring higher added value and profitability to enterprises, while in the case of fierce competition or rapid changes in market demand, technological innovation may bring sustained profit growth and affect the performance of enterprises.

6. References

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