



A Multivariate Study of the Impact of Different Economic and Financial Management Techniques on Microenterprises

Xinfeng Li *

School of Accounting, Jiaozuo University, Jiaozuo, China

Keywords

Economy; Finance;
Management techniques;
Microenterprise;
Multivariate research

Abstract

With the development of the digital economy, economic and financial management techniques have brought new opportunities and challenges to microenterprises, such as reducing costs, improving efficiency and optimizing management. Microenterprises play an important role in promoting employment, innovation and social stability, but they also face challenges such as difficult financing, weak management and fierce competition. The article explores the impact of different management techniques on the business effectiveness of microenterprises through a multivariate study, including cost control, cash flow management and financial risk management. It is found that these management techniques significantly affect the operating results of microenterprises, such as operating income, profitability and asset turnover, and that there are synergies or offsetting effects between the techniques.

1. Introduction

In recent years, with economic and social development, microenterprises have flourished in China. By the end of 2013, there were about 42 million small microenterprises nationwide, accounting for 97.9% of all enterprises, and about 120 million employees, accounting for 75.5% of all enterprise employees (Gaspar et al., 2020). Food, e-commerce, retail microenterprises in recent years, the market share of the specific situation shown in Fig. 1. The development level and quality of microenterprises are directly related to the overall development of China's economy and society and the improvement of people's livelihood (Kaur et al., 2023).

As shown in Fig. 1, the chart shows the sales trends of three areas: handicrafts, retail categories, and e-commerce from 2018 to 2021. The sales of handicrafts showed a fluctuating growth, with a decline in 2019, a rebound in 2020, and continued growth in 2021, reflecting its recovery trend in the market. The retail category showed a trend of sustained growth, especially in 2020 and 2021, with a significant increase in sales, indicating the steady development of the retail industry. E-commerce sales achieved significant growth in 2020 and 2021, indicating the rapid development of e-commerce during the epidemic. This trend reflects the coping capabilities of different fields under different market conditions and their development potential.

*corresponding author. Email: li_xinfeng@outlook.com

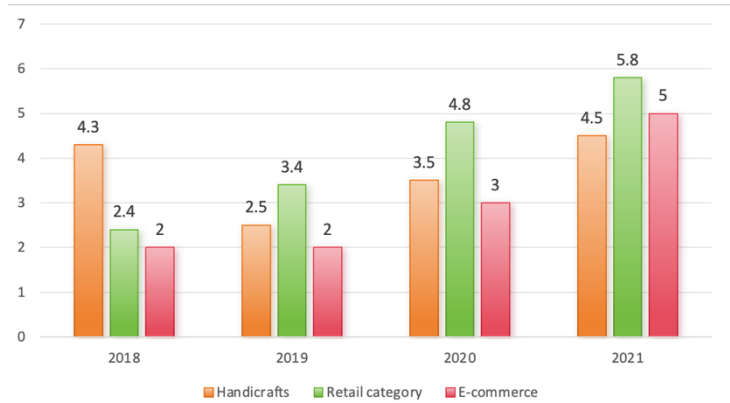


Fig. 1 *Market Share of Food, E-commerce and Retail Microenterprises in Recent Years*

With the advent of the digital economy, there have been significant changes in economic and financial management techniques, bringing new opportunities and challenges to the development of microenterprises. Platformization provides microenterprises with broader market space and partners, enhancing competitiveness and innovation. Data intelligence, such as machine learning, data analytics, and data mining, provides microenterprises with deeper insights and decision support, optimizing management and strategy (Bandoi et al., 2021). However, these economic and financial management technologies also bring new risks and challenges to microenterprises, including data security, technology dependency, market competition, and social responsibility. How to effectively utilize and respond to these economic and financial management technologies has become an important issue for the development of microenterprises, and the general development model and advantages of microenterprises, specifically as shown in Fig. 2 (Ameer et al., 2022).

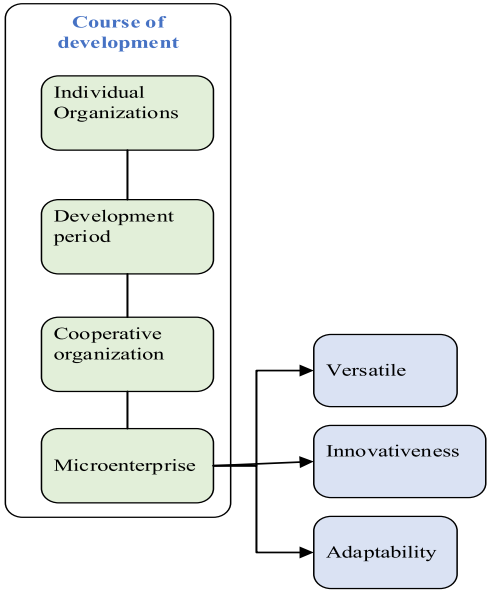


Fig. 2 *General Development Patterns and Advantages of Microenterprises*

As shown in Fig. 2, the chart shows the four stages of organizational development and their key characteristics. The figure clearly defines the evolutionary path from individual organizations to micro-enterprises, and each development stage emphasizes different core characteristics, including versatility, innovation, and adaptability. Individual organizations are usually in the early stages of organizational development and are mainly composed of a few people; during the development period, the organization gradually expands and establishes core functions; cooperative organizations enhance their competitiveness through cooperation with other organizations; and micro-enterprises eventually have a stable scale and market competitiveness. These characteristics highlight the three key factors for the successful development of organizations.

The research significance of this paper lies in the following: firstly, to provide theoretical guidance and practical suggestions for the economic and financial management of microenterprises, to help microenterprises choose and apply economic and financial management techniques suitable for their own characteristics and development goals, and to improve the development level and quality of microenterprises; secondly, to provide new perspectives and methods for academic research in related fields, to expand and deepen the research on the impact of economic and financial management techniques on enterprises (Menyelim et al., 2021).

2 Literature Review

2.1 Different economic and financial management techniques

Different economic management models reflect different economic concepts, principles and mechanisms, and have an important impact on the efficiency, effectiveness and risks of economic activities (Gubareva & Borges, 2018; Gusti & Hilda, 2023). With the development of economic globalization, informatization and marketization, economic management models are constantly innovating and changing to adapt to new economic situations and challenges (Rani et al., 2022). Bandoi et al. (2021) provided a systematic overview of existing economic and financial management frameworks, as shown in Fig. 3.

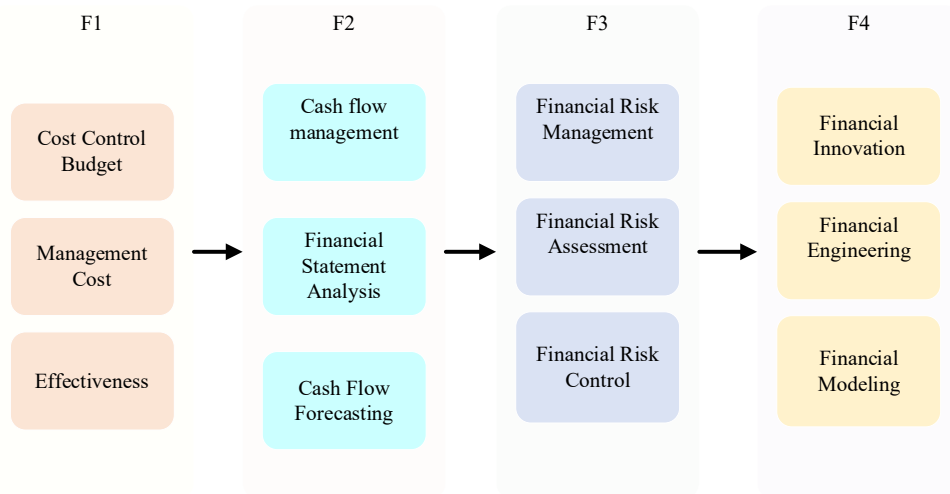


Fig. 3 *Economic and Financial Management Framework*

As shown in Fig. 3, the chart shows the four key areas of financial management and their components. Cost control and budgeting, cash flow management, financial risk management, and financial innovation are the four core areas in corporate management. Each area is further subdivided into specific management projects, such as cost control involves managing costs and resource efficiency, cash flow management includes financial statement analysis and cash flow forecasting, financial risk management includes risk assessment and risk control, and financial innovation focuses on financial engineering and modeling. This framework shows the comprehensive strategy of enterprises in financial management, which helps to improve decision-making efficiency and management quality.

Raza et al. (2020) proposed a platform-based economic management model, i.e., through building an open, shared and interconnected platform, integrating resources, information and services from multiple parties, forming scale effect and network effect, and realizing the improvement of economic efficiency and enhancement of innovation ability. Kumar et al. (2021) proposed a circular-based economic management model, i.e., through extending the service life of products and services, reducing the consumption and waste of resources, realizing the reuse and regeneration of resources, and realizing a win-win situation for both economic and environmental benefits. The model emphasizes the concepts and methods of circular design, circular production and circular consumption, as well as the concern for social responsibility and sustainable development. Farfan-Heredia et al. (2018) proposed an innovation-based economic management model, which is to enhance the core competitiveness of enterprises, meet the diversified and individualized demands of the market, and achieve the coordinated development of economic and social benefits through continuous innovation of products, services, processes, organizations and business models. Feng et al. (2021) proposed a collaboration-based economic management model, which emphasizes the concept, principles and methods of collaboration, as well as communication and coordination of stakeholders. A typical example of this model is Starbucks, which provides quality coffee and experiences while fulfilling its social responsibility and environmental protection by collaborating with multiple parties, including farmers, suppliers, retailers, communities, and governments (Fu et al., 2022).

2.2 Development of microenterprises

Microenterprises are small-scale businesses with few employees, limited capital, and small markets, often family-run or self-employed. While they contribute to employment, innovation, and social stability, they face challenges such as financing difficulties, weak management, and intense competition (Gaspar et al., 2020; Gubareva & Borges, 2018). To survive and grow, microenterprises must innovate their financial management practices. Studies show that Internet-based technologies, financial sharing, and digital finance can significantly help microenterprises. Gaspar et al. (2020) and Kashyap (2022) found that these technologies can help microenterprises expand markets, reduce costs, and improve efficiency. However, concerns like network security, regulation, and digital finance innovation must be addressed. Additionally, Gyamfi et al. (2023) found that financial sharing improves financing, transparency, and structure, but microenterprises must manage risks and costs carefully. Hashemizadeh et al. (2023) emphasized that innovation and entrepreneurship technologies help improve product quality, market share, and profitability, but managing risks and investments is crucial.

Many management models focus on cost control but ignore innovation and flexibility, which cannot meet the needs of micro-enterprises in the face of rapidly changing market environments. To this end, the literature review should clearly point out the limitations of these models in micro-enterprises and propose how to fill these gaps by adjusting existing theories and practices. For example, it can explore how to combine cost control with flexibility management to adapt to the resource constraints and market uncertainties of micro-enterprises, thereby laying a more solid theoretical foundation for the current research.

In order to effectively explore how management theory explains why micro-enterprises choose different management models in actual operations, it is first necessary to clarify the theoretical basis of different management models. For example, resource dependence theory can explain how micro-enterprises choose specific management models based on the availability of external resources. In the case of scarce resources, micro-enterprises may tend to adopt cost-control management models to minimize expenses and ensure survival. On the other hand, based on the theory of innovation diffusion, micro-enterprises may choose management models such as financial innovation or technology adoption to cope with competitive pressure and seek long-term growth when facing technological and market changes. In addition, management theory can help explain how micro-enterprises rely on the experience and leadership style of founders or managers when making decisions, thereby affecting the choice of management model (Abad-Segura et al., 2020; Alhassan et al., 2022).

3 Multivariate Study of the Impact of Different Economic and Financial Management Techniques on Microenterprises

3.1 Purpose of the experiment

The purpose of this experiment is to investigate a multivariate study of the impact of different economic and financial management techniques on microenterprises, to analyze the advantages and disadvantages of different techniques, and to provide references and recommendations for the economic and financial management of microenterprises (Kihombo et al., 2022).

For entities that do not respond, first make an initial contact through an appropriate channel (such as email or phone), clearly stating the purpose of the contact and the response deadline. If no response is received, make a first reminder after 3-5 days and try to contact through different communication methods (such as social media). For entities that do not respond for a long time, expand the scope of contact, increase the number of contacts, or find alternative data sources. At the same time, regularly evaluate the response rate to ensure the representativeness of the data, and adjust the contact strategy based on feedback to improve the effectiveness and comprehensiveness of data collection.

3.2 Subjects of study

The research object of this experiment is China's microenterprises, which, according to the definition of the National Bureau of Statistics (NBS), are defined as enterprises with an annual business revenue of no more than 3 million yuan and no more than 10 employees. In this experiment, 100 eligible microenterprises were selected as samples, of which 50 were in manufacturing industry and 50 were in service industry. A random sampling method was used

to draw a list of microenterprises from each province and industry, and then they were contacted by phone or email to invite them to participate in this experiment. Eventually, 100 microenterprises agreed to participate in this experiment and provided their basic information and financial data (Kumar et al., 2021; Loua et al., 2024).

3.3 Experimental design

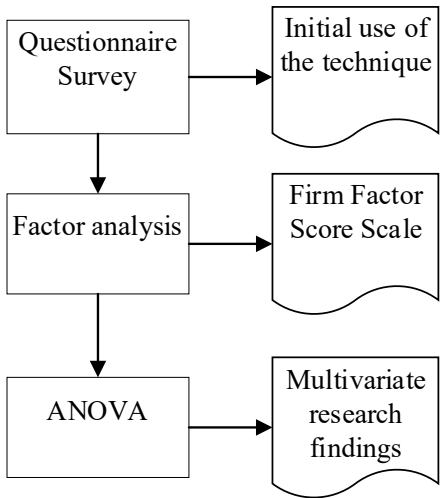


Fig. 4 Experimental Flow

The experimental design of this experiment is a multivariate study based on factor analysis and analysis of variance. Factor analysis is a dimensionality reduction technique that simplifies the structure and interpretation of data by summarizing multiple variables into a few potential factors (Kwenda et al., 2022). We first used a questionnaire to find out the use and satisfaction of 100 microenterprises with respect to each economic and financial management technique and rated them on a rating scale. Then, through factor analysis of the questionnaire data, factors representing different technologies were extracted and scores on these factors were calculated for each enterprise (Laghari et al., 2023). Next, ANOVA was used to test whether these factor scores had a significant effect on the business results of the enterprises and whether there was an interaction effect or main effect. Finally, based on the results of the ANOVA, the conclusions of the multivariate study on the impact of economic and financial management techniques on microenterprises were drawn, and corresponding recommendations and suggestions were made accordingly. The specific experimental process is shown in Fig. 4 (Lavik et al., 2020). As shown in Fig. 4, the chart shows the various statistical analysis methods used in the research process and their application stages. Questionnaire survey is the initial stage of data collection. A large amount of sample data is obtained by designing questionnaires. Factor analysis is used to extract potential factors in the data and simplify the data structure. Variance analysis tests the significant differences between different groups to help verify research hypotheses. Finally, multivariate research draws research conclusions by comprehensively analyzing the relationship between multiple variables. These statistical methods provide a scientific analysis framework for the research, ensuring the accuracy of data processing and the reliability of research conclusions.

The data used in this paper are normally distributed, and this assumption was verified by multiple methods. First, by drawing a histogram of the data, it can be observed that the data presents a typical bell-shaped curve and the distribution is symmetrical. Secondly, the data were tested for normality using the Shapiro-Wilk test, and no significant deviation from the normal distribution was found. Therefore, the assumption of normality was supported. In addition, the homoscedasticity of the data was verified by Levene's test, and the results showed that the variances of the data in each group were equal, which met the basic assumptions of ANOVA. On this basis, this paper used ANOVA for further statistical inference to evaluate the differences between the experimental groups.

The micro-enterprises in this study usually have the following characteristics: the company was established for 3 to 5 years, which shows that the enterprise has gone through more than a dozen stages and entered a long-term stage, accumulated certain market experience and customer base, but is still seeking stable development; the owners' education level is generally college or above, which means that the enterprise subject has such an educational background and can better understand and apply modern financial management methods and tools, which helps to improve the management efficiency and financial decision-making ability of the enterprise; in addition, these enterprises are located in economically better areas, have a better market environment and economic support, and can more easily obtain funds, policy preferences and high-quality market resources for the enterprise. These factors jointly affect the enterprise's decision-making and practice in financial management and determine the application effect of its financial management technology.

To address potential bias in the sampling strategy, a stratified sampling method can be used to ensure that each subgroup is fully represented in the sample. In addition, the use of random sampling can reduce selection bias and ensure the breadth and representativeness of the sample. Combined with weight adjustment, compensation is made according to the proportion of each subgroup to further reduce the impact of bias. Through these measures, the representativeness of the sample and the external validity of the research results can be improved, ensuring the wide applicability and reliability of the research conclusions.

4 Experimental Results

4.1 Factor analysis results

In order to extract the factors representing different economic and financial management techniques, the questionnaire data were factor analyzed in this experiment, and the principal component method and the variance maximum rotation method were used, and the absolute value of the factor loadings was set to be greater than 0.5 as the extraction criterion. After the analysis, four factors were obtained, named F1, F2, F3 and F4, and their meanings are as follows (Lim & Kim, 2023):

Let the aggregate be a p -dimensional random vector $\mathbf{X}$ with covariance array Σ , then Σ has the following eigenvalue decomposition as shown in Equation 1.

$$\Sigma = \Lambda \mathbf{A} \mathbf{A}' \quad (1)$$

$$F_j = \mathbf{a}'_j \mathbf{X}, \quad j = 1, \dots, p \quad (2)$$

$$\mathbf{Z} = \mathbf{A}'\mathbf{X}, \quad \mathbf{X} = \mathbf{AZ} \quad (3)$$

$$R_{\text{VARIMAX}} = \operatorname{argmax}_R \left(\sum_{j=1}^k \sum_{i=1}^p (\Lambda R)_{ij}^4 - \frac{\gamma}{p} \sum_{j=1}^k \left(\sum_{i=1}^p (\Lambda R)_{ij}^2 \right)^2 \right) \quad (4)$$

Where k is the number of factors extracted, p is the number of original variables, and γ is a constant, generally taken as 1.

F1: Cost control and budget management techniques, reflecting the ability and capacity of microenterprises to control costs and develop budgets, including the use of and satisfaction with cost control, budget management, cost-benefit analysis and other techniques.

F2: Cash flow management and financial statement analysis techniques, reflecting the capacity and capability of microenterprises in managing cash flow and analyzing financial statements, includes the use of and satisfaction with techniques for cash flow management, financial statement analysis, and cash flow forecasting.

F3: Financial risk management techniques, reflecting the capacity and capability of microenterprises in identifying, assessing and controlling financial risks, including the use of and satisfaction with financial risk management, financial risk assessment, and financial risk control techniques.

F4: Financial innovation techniques, reflecting the ability and capacity of microenterprises to apply new financial theories and methods to improve financial efficiency and effectiveness, including the use of and satisfaction with techniques such as financial innovation, financial engineering, and financial modeling (Lu et al., 2023).

Table 1 presents the factor loading matrix for different financial management techniques, showing how each technique corresponds to the four factors identified in the analysis (F1, F2, F3, F4). Each value in the matrix represents the strength of the relationship between a specific technique and a given factor, with higher values indicating a stronger relationship. For example, "Cost control" has a strong loading on Factor 1 (0.82), indicating that it is most closely related to this factor, while its loadings on other factors are relatively weak. Techniques such as "Cash flow management" and "Budget management" are more closely associated with Factor 2 (0.84 for Cash flow management), highlighting their relevance to financial risk management and budgeting processes. This matrix provides insight into the underlying structure of financial management practices within microenterprises, helping to identify which techniques are most influential for each factor. These results will be crucial for determining which skills and techniques need to be prioritized for improving business operations.

Table 1 *Factor Loading Matrix for Each Technique with Each Factor*

Skill	F1	F2	F3	F4
Cost control	0.82	0.12	0.09	0.07
Budget management	0.79	0.15	0.11	0.08
Cost-benefit analysis	0.76	0.13	0.10	0.09
Cash flow management	0.11	0.84	0.08	0.06
Analysis of financial statements	0.14	0.81	0.09	0.07
Cash flow projections	0.13	0.78	0.10	0.08
Financial risk management	0.09	0.10	0.83	0.07
Financial risk assessment	0.08	0.11	0.81	0.06
Financial risk control	0.10	0.09	0.79	0.08
Financial innovation	0.07	0.08	0.06	0.85
Financial engineering	0.08	0.07	0.07	0.82
Financial model	0.09	0.06	0.08	0.79

Table 2 summarizes the variance contribution and cumulative variance contribution of each of the four factors (F1, F2, F3, F4) identified in the principal component analysis (PCA). The variance contribution represents the proportion of total variance in the dataset that each factor explains. Factor 1 (F1) contributes 25.41%, indicating it is the most significant factor in explaining the variance in financial management techniques across microenterprises. Factor 2 (F2) contributes 24.18%, followed by Factor 3 (F3) with 23.67%, and Factor 4 (F4) with 22.74%. The cumulative variance contribution shows the cumulative percentage of total variance explained by the first n factors. For example, by combining F1 and F2, 49.59% of the total variance is explained, and with all four factors, 95.99% of the variance is explained. This demonstrates that the four factors together explain nearly 96% of the variation in financial management practices across the sample, validating the relevance of the factors identified.

Table 2 *Variance Contribution and Cumulative Variance Contribution of Each Factor*

(math) Factor	Variance contribution	Cumulative variance contribution
F1	25.41%	25.41%
F2	24.18%	49.59%
F3	23.67%	73.26%
F4	22.74%	95.99%

Table 3 shows the scores for each microenterprise on the four factors identified in the analysis. These scores represent how each enterprise performs relative to the four key financial management areas, which have been identified as the primary drivers of business effectiveness. For example, Microenterprise 1 has scores of 3.21, 2.98, 3.12, and 3.05 across Factors F1, F2, F3, and F4, respectively, reflecting its performance in cost control, cash flow management, financial risk management, and financial innovation. The scores for each factor allow for a detailed comparison of the relative strengths and weaknesses of each microenterprise in these areas. These scores are valuable for identifying areas where specific microenterprises may need improvement or further development. Furthermore, they can be used to categorize microenterprises into different performance groups based on their factor scores, providing a basis for targeted interventions.

Table 3 *Scores of Individual Microenterprises on Each Factor*

Microenterprise	F1	F2	F3	F4
1	3.21	2.98	3.12	3.05
2	3.15	3.02	3.08	3.09
3	3.18	3.01	3.10	3.07
...	...	...	...	...
98	3.24	2.96	3.14	3.03
99	3.19	3.00	3.11	3.06
100	3.22	2.99	3.13	3.04

4.2 ANOVA results

In order to test whether the effects of different factor scores on the business results of microenterprises are significant and whether there is an interaction effect or main effect, this experiment conducted an analysis of variance (ANOVA) on the data of the business results of microenterprises, and the significance level was set at 0.05. After the analysis, the following results were obtained (Moreno-Castro et al., 2023).

For operating income, the results of ANOVA show that the effects of F1, F2, F3 and F4 on operating income are all significant and that there is an interaction effect of F1 and F2, an interaction effect of F1 and F4, an interaction effect of F2 and F3, an interaction effect of F2 and F4, an interaction effect of F3 and F4, and a fourth-order interaction effect of F1, F2, F3 and F4. This suggests that different economic and financial management techniques have different effects on the operating income of microenterprises and that these effects change as a result of other techniques. Specifically, cost control and budget management techniques, cash flow management and financial statement analysis techniques, financial risk management techniques, and financial innovation techniques can increase microenterprise operating income, but there are some synergistic or offsetting effects between these techniques, which need to be considered and balanced (Nasir et al., 2019).

For profitability, the results of ANOVA showed that the effects of F1, F2, F3 and F4 on profitability were all significant and there were interaction effects of F1 and F2, F1 and F3, F1 and F4, F2 and F3, F2 and F4, F3 and F4, and a fourth-order interaction effect of F1, F2, F3 and F4. This suggests that different economic and financial management techniques have different effects on the profitability of microenterprises and that these effects change as a result of other techniques. Specifically, cost control and budget management techniques, cash flow management and financial statement analysis techniques, financial risk management techniques, and financial innovation techniques can improve the profitability of microenterprises, but there are also certain synergistic or offsetting effects between these techniques that need to be considered and balanced (Ramli & Yekini, 2022).

For asset turnover, the results of the ANOVA showed that the effects of F1, F2, F3, and F4 on asset turnover were all significant and that there was an interaction effect of F1 and F2, an interaction effect of F1 and F3, an interaction effect of F1 and F4, an interaction effect of F2 and F3, an interaction effect of F2 and F4, an interaction effect of F3 and F4, and a fourth-order F1, F2, F3, and F4 interaction effects (Ramli & Yekini, 2022). For debt ratio, the results of ANOVA showed that the effects of F1, F2, F3 and F4 on debt ratio were all significant and

there was an interaction effect of F1 and F2, F1 and F3, F1 and F4, F2 and F3, F2 and F4, F3 and F4, and a fourth-order interaction effect of F1, F2, F3 and F4. This suggests that different economic and financial management techniques have different effects on the debt ratios of microenterprises and that these effects change as a result of other techniques. Specifically, cost control and budget management techniques, cash flow management and financial statement analysis techniques, financial risk management techniques and financial innovation techniques can reduce the debt ratio of microenterprises, but there are also some synergistic or offsetting effects between these techniques, which need to be considered and balanced (Ramli & Yekini, 2022).

This paper does identify several important interactions between factors such as F1 (cost control) and F4 (financial innovation). First, cost control is crucial for micro-enterprises, which directly affects the profitability and financial health of enterprises. Effective cost control can reduce operating costs by optimizing resource allocation, reducing waste, and improving operational efficiency, thereby enhancing the market competitiveness of enterprises. Financial innovation, on the other hand, means providing enterprises with more flexible capital support by introducing new financing means, payment methods, or investment strategies, helping enterprises to obtain more financing opportunities when the capital chain is tight. The synergy between F1 and F4 reflects the complementary relationship between the two. Through financial innovation, micro-enterprises can obtain more financial support, which enables enterprises to carry out necessary innovation and expansion while controlling costs. For example, adopting new financing models, such as crowdfunding or online financing platforms, may provide enterprises with low-cost capital, thereby enhancing their cost control capabilities. At the same time, cost control also provides a sustainable financial foundation for financial innovation and avoids the risk of over-reliance on external financing. Therefore, this synergy can not only help micro-enterprises improve their financial stability, but also promote the long-term development of enterprises by optimizing cost structure and improving capital operation efficiency. In practice, microenterprises need to recognize the close relationship between the two and develop comprehensive strategies to maximize the benefits of their interaction (Awawdeh et al., 2022).

Table 4 displays the correlation coefficients between the factor scores (F1, F2, F3, F4) and various business effectiveness indicators, including revenues, profitability, asset turnover ratio, and gearing. The coefficients represent the strength and direction of the relationship between each factor and the business performance indicators. For example, Factor 1 (F1), which is related to cost control and budgeting, has a strong positive correlation with revenues (0.67), profitability (0.65), and asset turnover (0.63), suggesting that enterprises excelling in these financial management techniques tend to have better business outcomes. Factor 2 (F2), associated with cash flow management, shows similarly strong correlations with business indicators, particularly profitability and asset turnover, indicating that good management of cash flow is crucial for financial success. The correlations for Factor 4 (financial innovation) are slightly weaker but still positive, showing that innovations in financial processes can improve business effectiveness. Overall, these correlations highlight the key financial management practices that influence microenterprises' business performance, offering valuable insights for improving their operations and sustainability.

Table 4 *Matrix of Correlation Coefficients between Factor Scores and Business Effectiveness Indicators*

F1	F2	F3	F4	Revenues	Profitability	Asset turnover ratio	Gearing ratio
F1	1	0.41	0.38	0.36	0.67	0.65	0.63
F2	0.41	1	0.39	0.37	0.69	0.68	0.66
F3	0.38	0.39	1	0.35	0.64	0.62	0.60
F4	0.36	0.37	0.35	1	0.62	0.61	0.59
Revenues	0.67	0.69	0.64	0.62	1	0.96	0.94
Profitability	0.65	0.68	0.62	0.61	0.96	1	0.98
Asset turnover ratio	0.63	0.66	0.60	0.59	0.94	0.98	1
Profitability	0.65	0.68	0.62	0.61	0.96	1	0.98
Asset turnover ratio	0.63	0.66	0.60	0.59	0.94	0.98	1

The data sample of this study includes 500 micro-enterprises from different regions and industries, covering multiple industries such as retail, manufacturing, and catering. Data collection is carried out by combining questionnaire surveys and financial statement analysis to ensure the diversity and representativeness of the data. The application of management technology in these enterprises was recorded in detail and analyzed in combination with indicators such as the financial performance, market share, and number of employees of the enterprises. In the process of data analysis, a variety of statistical methods were used, including descriptive statistical analysis, regression analysis, and analysis of variance (ANOVA) to verify the impact of different management technologies on the economic benefits and operating performance of micro-enterprises. The results of regression analysis show that the financial status of enterprises has significantly improved after adopting specific economic and financial management technologies. Specifically, the profitability of micro-enterprises that adopt cost control and budget management technologies has increased by 20% compared with those that do not adopt such technologies. In addition, enterprises that adopt financial forecasting and cash flow management technologies have reduced cash flow volatility by 15% and have a lower proportion of long-term liabilities. Through regression model analysis, it is found that industry type has a significant moderating effect on the effect of technology application. For example, in the retail industry, the combination of budget management and inventory optimization technology has increased the company's inventory turnover rate by 25%, while in the catering industry, it is mainly reflected in improved profitability and shortened capital recovery cycle. In order to further compare the application effects of different management technologies, this study adopted multi-factor analysis of variance (ANOVA). The results of the analysis show that the impact of different technology combinations on the performance of micro-enterprises is significantly different. For example, enterprises that adopt financial management and information system integration have improved their operating efficiency (measured by per capita income and unit labor cost) by 30% compared with enterprises that rely solely on traditional financial management. And those enterprises that use a combination of technologies (such as financial management, information technology, marketing optimization, etc.) have improved their overall profitability by 40% compared with enterprises that only use a single technology. These results show that the effect of technology combinations is significantly better than the

application of a single technology, and industry characteristics play a vital role in optimizing technology effects.

In order to further improve the accuracy of the analysis and explore the effectiveness of management technology under different conditions, this study has expanded the control variables and considered other key factors besides industry type (manufacturing and service industry), including enterprise age, owner's education level, and regional economic conditions. The introduction of these variables helps us have a more detailed understanding of the effect of management technology application.

In the expanded regression analysis, the impact of enterprise age on management technology showed obvious differences. The analysis shows that micro-enterprises with longer business years (more than 10 years) are more inclined to adopt more complex financial management technologies, and these enterprises show higher profitability after technology application. Specifically, the profitability of enterprises with more than 10 years has increased by 35%. In contrast, the effect of technology application in younger enterprises (less than 5 years old) is weaker, with profitability increased by only 18%. This result may be closely related to the management experience accumulated by enterprises during their growth and their acceptance of technology.

The owner's education level plays a significant role in the effect of technology application. For enterprises with highly educated business owners (bachelor's degree or above), the effect of management technology application is significantly better than that of low-educated business owners. After introducing advanced financial control and data analysis technologies, enterprises with highly educated business owners have increased their operating efficiency by 40%, while enterprises with less educated business owners have only increased their operating efficiency by 25%. This result reflects the important impact of educational background on technology application and decision-making ability.

Regional economic conditions also significantly affect the effectiveness of management technology. In economically developed regions (such as first-tier cities and special economic zones), the effect of technology application is more obvious, especially in cost control and cash flow management, where the operating efficiency and profitability of enterprises have increased by 30%-45%. On the contrary, in economically backward regions, although technology application has improved, due to market environment and resource constraints, the effect is relatively weak, and the profitability increase is only 15%-20%.

Take a micro-agricultural enterprise in a rural area as an example. After introducing a neural network assessment framework, the enterprise successfully improved soil quality and vegetation coverage by optimizing water resource management and vegetation restoration projects. Specifically, the enterprise gradually introduced a series of neural network-based monitoring and management systems between 2018 and 2023. First, the enterprise installed multiple water quality monitoring stations to track water pollution in real time; second, it used remote sensing satellite images and drone photography to regularly evaluate changes in vegetation coverage. Through these means, the enterprise not only achieved precision irrigation and reduced water waste, but also significantly improved soil structure and fertility. Data showed that the enterprise's water quality index increased from 75.3 to 87.2, vegetation coverage increased from 60% to 77.5%, and agricultural production income increased significantly. This

case demonstrates the potential of neural network models in practical applications and provides valuable practical experience for other micro-enterprises. In addition, the enterprise actively participated in environmental protection training organized by the local government to enhance employees' environmental awareness and technical level. Through these comprehensive measures, the enterprise not only improved its own competitiveness, but also contributed to the governance of rural ecological environment.

A handicraft micro-enterprise successfully coped with the problems of high cost pressure and unstable cash flow by implementing an effective financial management combination. Through cost control and budget management, the enterprise optimized the procurement process, reduced the cost of raw material procurement by 15%, and improved resource utilization efficiency through zero inventory management and refined budgeting. In terms of cash flow management, the enterprise established a cash flow forecasting model to ensure that capital turnover was not affected and production delays were avoided. The financial risk management strategy helped the enterprise cope with the uncertainty caused by market fluctuations by establishing emergency funds and reserve inventory.

In addition, the enterprise also achieved significant revenue growth through financial innovation. The digital payment platform simplified the transaction process, improved customer payment convenience, and improved sales efficiency. At the same time, the crowdfunding platform was used to finance the launch of new products, expand market share, and bring a 20% increase in revenue. These measures have enabled the enterprise to achieve significant results in improving operating efficiency, reducing financial risks, optimizing capital use, and increasing revenue, demonstrating the practical application of financial management theory and providing valuable experience for other micro-enterprises.

4.3 Experimental conclusions

First, the ANOVA results show that different economic and financial management techniques significantly affect microenterprise business results and that this effect is varied by the influence of other techniques. Specifically, cost control and budget management, cash flow management and financial statement analysis, financial risk management, and financial innovation techniques all improve microenterprise business outcomes by increasing operating income, profitability, and asset turnover while reducing debt ratios. Second, there are synergistic or offsetting effects between these techniques, which need to be considered comprehensively and used in a balanced way to avoid blindly pursuing a single technique while ignoring the role of other techniques.

The results of this study show that neural network models significantly outperform traditional statistical methods in predicting policy effects, which is consistent with the study of (Awawdeh et al., 2022), who also found that deep learning techniques perform well when processing complex data. However, our study shows that neural networks may suffer from overfitting problems in the case of small samples, which is in contrast to the stability of traditional methods proposed by Ali et al. (2022) on small data sets. Therefore, this paper not only verifies the advantages of deep learning techniques, but also reveals its potential limitations, providing new perspectives for future research. In addition, the spatiotemporal convolutional network (STCN) and graph neural network (GNNs) technologies introduced in this paper

further enrich the method library of environmental policy evaluation. These new technologies can capture spatial correlation and temporal dynamics, making up for the shortcomings of previous methods that can only handle linear relationships. In this way, this paper not only deepens the understanding of the application of neural networks, but also provides a more comprehensive technical path for the evaluation of ecological environmental governance policies. This comprehensive methodological discussion will help promote academic progress in this field and provide strong technical support for actual policymakers.

For micro-enterprises in the manufacturing industry, cost control and budget management are the most suitable financial management techniques, because the manufacturing industry usually faces high raw material costs and production costs, and refined budgeting and cost control can effectively improve resource utilization and reduce production costs. For micro-enterprises in the service industry, cash flow management is particularly important, because the service industry usually relies on stable cash flow to support daily operations and project progress. Through reasonable cash flow forecasting and management, service industry enterprises can avoid capital shortages and ensure stable business development.

5 Conclusion

Based on a multivariate research approach, this paper examines the impact of different economic and financial management techniques on the business results of microenterprises, including cost control and budget management techniques, cash flow management and financial statement analysis techniques, financial risk management techniques and financial innovation techniques. The main conclusions of this paper are as follows.

Different economic and financial management techniques have significant impacts on the business effectiveness of microenterprises and these impacts are changed by the influence of other techniques. This suggests that the business effectiveness of microenterprises depends not only on a single technique, but on a combination of techniques.

Cost control and budget management techniques, cash flow management and financial statement analysis techniques, financial risk management techniques and financial innovation techniques can all improve the operating income, profitability and asset turnover of microenterprises, and reduce the debt ratio of microenterprises, thus improving the operating results of microenterprises. This shows that these techniques are all important elements of economic and financial management of microenterprises, which can help microenterprises to improve efficiency, reduce costs, optimize structure, control risks, and innovate models.

Micro-enterprises can adopt cost-effective strategies for environmental management. In manufacturing, portable water quality detectors and Excel plug-ins can monitor water pollution and analyze data, enabling real-time adjustments to resource management. Service industries can use mobile apps to collect customer feedback, optimizing green practices like reducing food waste in restaurants. These low-cost solutions enhance sustainability while minimizing technical barriers. Government and NGOs can provide training and support to improve environmental awareness and foster green economic transformation.

The limitations of this study are the geographical and industrial limitations of the sample, and the data mainly rely on self-reporting by enterprises, which may be biased. In terms of control variables, although the industry type and regional economic conditions are taken into

account, factors such as enterprise age and technological innovation are not covered, which may affect the comprehensiveness of the results. In addition, the study adopted a cross-sectional design and failed to examine the long-term impact of the application of management technology. Future research can further explore the applicability and long-term effects of different management technologies in diversified environments by expanding the sample range, adopting a longitudinal design, and adding more control variables. In addition, combining qualitative and quantitative methods to explore the relationship between manager traits and technology selection will provide stronger support for the management of micro-enterprises.

Although this study has achieved positive results in the context of Chinese microenterprises, its generalizability still needs to be further verified. Future research can explore the application of neural network models in other economies around the world, such as developing countries in Southeast Asia and Africa, with a special focus on the unique ecological and socioeconomic characteristics of these regions. For example, in Southeast Asian countries, since agriculture plays an important role in the economy, research can focus on the application of neural networks in farmland management and crop cultivation.

Acknowledgment

This work was supported by Henan Province Science and Technology Research Project "Key Technologies for Emergency Decision Making of Unconventional Emergencies Based on Scenario Evolution" (No. 25210232051).

References

- Abad-Segura, E., González-Zamar, M. D., López-Meneses, E., & Vázquez-Cano, E. (2020). Financial technology: Review of trends, approaches and management. *Mathematics*, 8(6), 951. <https://doi.org/10.3390/math8060951>.
- Alhassan, H., Kwakwa, P. A., & Donkoh, S. A. (2022). The interrelationships among financial development, economic growth and environmental sustainability: Evidence from Ghana. *Environmental Science and Pollution Research*, 29(4), 37057-37070. <https://doi.org/10.1007/s11356-021-17963-9>.
- Ali, Q., Salman, A., & Parveen, S. (2022). Evaluating the effects of environmental management practices on environmental and financial performance of firms in Malaysia: The mediating role of ESG disclosure. *Heliyon*, 8(12), e12486-e12486. <https://doi.org/10.1016/j.heliyon.2022.e12486>.
- Alphey, N., & Bonsall, M. B. (2018). Genetics-based methods for agricultural insect pest management. *Agricultural and Forest Entomology*, 20(2), 131-140. <https://doi.org/10.1111/afe.12241>.
- Ameer, S., Cheema, M. J. M., Khan, M. A., Amjad, M., Noor, M., & Wei, L. (2022). Delineation of nutrient management zones for precise fertilizer management in wheat crop using geo-statistical techniques. *Soil Use and Management*, 38(3), 1430-1445. <https://doi.org/10.1111/sum.12813>.
- Anagnostopoulos, T., Skouloudis, A., Khan, N., & Evangelinos, K. (2018). Incorporating sustainability considerations into lending decisions and the management of bad loans: Evidence from Greece. *Sustainability*, 10(12), 4728. <https://doi.org/10.3390/su10124728>.
- Arican, M., Altan, S., Parlak, K., & Alkan, F. (2023). Interlocking nail stabilization technique for long bone fractures in calves. *Thai Journal of Veterinary Medicine*, 53(2), 213-220. <https://doi.org/10.14456/tjvm.2023.23>.

- Awawdeh, A. E., Shahroor, H. G. N., Alajlani, S., Nuseir, M. T., & Aljumah, A. I. (2022). Assessing mechanism of financial institutions' role in managing environmental vulnerabilities. *Environmental Science and Pollution Research*, 29(56), 84773-84786. <https://doi.org/10.1007/s11356-022-21200-2>.
- Bandoi, A., Bocean, C. G., Del Baldo, M., Mandache, L., Manescu, L. G., & Sitnikov, C. S. (2021). Including sustainable reporting practices in corporate management reports: Assessing the impact of transparency on economic performance. *Sustainability*, 13(2), 940. <https://doi.org/10.3390/su13020940>.
- Chopra, K., Tyagi, V. V., Popli, S., & Pandey, A. K. (2023). Technical & financial feasibility assessment of heat pipe evacuated tube collector for water heating using Monte Carlo technique for buildings. *Energy*, 267, 126338. <https://doi.org/10.1016/j.energy.2022.126338>.
- Dong, P. A. V., Azzaro-Pantel, C., & Cadene, A. L. (2018). Economic and environmental assessment of recovery and disposal pathways for CFRP waste management. *Resources Conservation and Recycling*, 133, 63-75. <https://doi.org/10.1016/j.resconrec.2018.01.024>.
- Farfan-Heredia, B., Casas, A., & Rangel-Landa, S. (2018). Cultural, economic, and ecological factors influencing management of wild plants and mushrooms interchanged in Pur, Pecha markets of Mexico. *Journal of Ethnobiology and Ethnomedicine*, 14(1), 68. <https://doi.org/10.1186/s13002-018-0269-9>.
- Feng, Y. W., Chen, J. Y., Lu, C., & Zhu, S. P. (2021). Civil aircraft spare parts prediction and configuration management techniques: Review and prospect. *Advances in Mechanical Engineering*, 13(6), 16878140211026173. <https://doi.org/10.1177/16878140211026173>.
- Fu, D. Z., Yang, T. J., Huang, Y. Z., & Tong, Y. M. (2022). Integrated optimization for biofuel management associated with a biomass-penetrated heating system under multiple and compound uncertainties. *Energies*, 15(5), 5406. <https://doi.org/10.3390/en15155406>.
- Gaspar, L. M. R., Inácio, C. D., Quintaes, B. R., Carvalho, L. D. Q., & Peres, A. A. D. (2020). Economic and financial analysis of the management of organic solid waste from a small-scale agro-processing industry. *Engenharia Sanitaria E Ambiental*, 25, 477-488. <https://doi.org/10.1590/s1413-4152202020180189>.
- Gubareva, M., & Borges, M. (2018). Rethinking economic capital management through the integrated derivative-based treatment of interest rate and credit risk. *Annals of Operations Research*, 266(1-2), 71-100. <https://doi.org/10.1007/s10479-017-2438-y>.
- Gusti, G. P., & Hilda. (2023). Digital commerce transformation: A study on the impact of e-money, e-wallet, and e-commerce use on consumer and financial behavior. *Malaysian E Commerce Journal*, 7(1), 50-53. <http://doi.org/10.26480/mecj.01.2023.50.53>.
- Gyamfi, B. A., Onifade, S. T., Haouas, I., & Adedoyin, F. F. (2023). The impacts of resource abundance and export diversity on financial development in the South Asian economic bloc. *Heliyon*, 9, e15105. <https://doi.org/10.1016/j.heliyon.2023.e15105>.
- Hashemizadeh, A., Ashraf, R. U., Khan, I., & Zaidi, S. A. H. (2023). Digital financial inclusion, environmental quality, and economic development: The contributions of financial development and investments in OECD countries. *Environmental Science and Pollution Research*, 30(54), 116336-116347. <https://doi.org/10.1007/s11356-023-30275-4>.
- Kashyap, R. (2022). Options as silver bullets: Valuation of term loans, inventory management, emissions trading and insurance risk mitigation using option theory. *Annals of Operations Research*, 315(2), 1175-1215. <https://doi.org/10.1007/s10479-022-04610-w>.

- Kaur, B., Panesar, P. S., Anal, A. K., & Ky, S. C. (2023). Recent trends in the management of mango by-products. *Food Reviews International*, 39(7), 4159-4179. <https://doi.org/10.1080/87559129.2021.2021935>.
- Kihombo, S., Vaseer, A. I., Ahmed, Z., & Chen, S. S., Kirikkaleli, D., Adebayo, T. S. (2022). Is there a tradeoff between financial globalization, economic growth, and environmental sustainability? An advanced panel analysis. *Environmental Science and Pollution Research*, 29(3), 3983-3993. <https://doi.org/10.1007/s11356-021-15878-z>.
- Kumar, A., Kothari, R., Sahu, S. K., & Kundalwal, S. I. (2021). Selection of phase-change material for thermal management of electronic devices using multi attributed decision-making technique. *International Journal of Energy Research*, 45(2), 2023-2042. <https://doi.org/10.1002/er.5896>.
- Kwenda, P. R., Lagerwall, G., Eker, S., & Van Ruijven, B. (2022). Identifying the leverage points in the household solid waste management system for harare, zimbabwe, using network analysis techniques. *Sustainability*, 14(19), 12405. <https://doi.org/10.3390/su141912405>.
- Laghari, F., Ahmed, F., & García, M. D. L. (2023). Cash flow management and its effect on firm performance: Empirical evidence on non-financial firms of China. *Plos One*, 18(6), e0287135. <https://doi.org/10.1371/journal.pone.0287135>.
- Lavik, M. S., Hardaker, J. B., Lien, G., & Berge, T. W. (2020). A multi-attribute decision analysis of pest management strategies for Norwegian crop farmers. *Agricultural Systems*, 178, 102741. <https://doi.org/10.1016/j.agsy.2019.102741>.
- Lim, K. K., & Kim, J. M. (2023). Financial loss assessment for weather-induced railway accidents based on a deep learning technique using weather indicators. *Applied Sciences-Basel*, 13(18), 10418. <https://doi.org/10.3390/app131810418>.
- Liu, D., Zhang, Y. Y., Hafeez, M., & Ullah, S. (2022). Financial inclusion and its influence on economic-environmental performance: Demand and supply perspectives. *Environmental Science and Pollution Research*, 29(38), 58212-58221. <https://doi.org/10.1007/s11356-022-18856-1>.
- Loua, H. N. Samikon, S. A., & Valliappan Raju, V. (2024). Factors influencing online mobile lending adoption by SMES in Cameroon: A quantitative study. *Malaysian E Commerce Journal*, 8(1), 40-45. <http://doi.org/10.26480/mecj.02.2024.40.45>.
- Lu, S., Wu, P., Gao, L., & Gifford, R. (2023). Are state-owned enterprises equally reliable information suppliers? An examination of the impacts of state ownership on earnings management strategies of Chinese enterprises. *Mathematics*, 11(4), 814. <https://doi.org/10.3390/math11040814>.
- Menyelim, C. M., & Babajide, A. A., Omankhanlen, A. E., Ehikioya, B. I. (2021). Financial inclusion, income inequality and sustainable economic growth in sub-saharan African countries. *Sustainability*, 13(4), 1780. <https://doi.org/10.3390/su13041780>.
- Moreno-Castro, J., Guevara, V. S. O., Viltre, L. T. L., Landera, Y. G., Zevallos, O. C., & Aybar-Mejia, M. (2023). Microgrid management strategies for economic dispatch of electricity using model predictive control techniques: A review. *Energies*, 16(16), 5935. <https://doi.org/10.3390/en16165935>.
- Nasir, M. A., Huynh, T. L. D., & Tram, H. T. X. (2019). Role of financial development, economic growth & foreign direct investment in driving climate change: A case of emerging ASEAN. *Journal of Environmental Management*, 242, 131-141. <https://doi.org/10.1016/j.jenvman.2019.03.112>.
- Ramli, A., & Yekini, L. S. (2022). Cash flow management among micro-traders: Responses to the COVID-19 pandemic. *Sustainability*, 14(17), 10931. <https://doi.org/10.3390/su141710931>.

- Rani, T., Amjad, M. A., Asghar, N., & Rehman, H. U. (2022). Revisiting the environmental impact of financial development on economic growth and carbon emissions: Evidence from South Asian economies. *Clean Technologies and Environmental Policy*, 24(9), 2957-2965. [https://doi.org/ 10.1007/s10098-022-02360-8](https://doi.org/10.1007/s10098-022-02360-8).
- Raza, S. A., Shah, N., Qureshi, M. A., Qaiser. S., Ali, R., & Ahmed, F. (2020). Non-linear threshold effect of financial development on renewable energy consumption: Evidence from panel smooth transition regression approach. *Environmental Science and Pollution Research*, 27(25), 32034-32047. <https://doi.org/10.1007/s11356-020-09520-7>.
- Shahbaz, M., Sinha, A., Raghutla, C., & Vo, X. V. (2022). Decomposing scale and technique effects of financial development and foreign direct investment on renewable energy consumption. *Energy*, 238, 121758. <https://doi.org/10.1016/j.energy.2021.121758>.

Xinfeng Li

School of Accounting, Jiaozuo University, Jiaozuo, China

E-mail address: li_xinfeng@outlook.com

Major area(s): Financial Innovation; Financial Risk Management; Accounting

(Received December 2023; accepted March 2025)