





# Safety Investment, New Quality Productivity Forces Forces and Financial Performance of Civil Aviation Enterprises- Empirical Analysis Based on Moderating Effect and Threshold Effect

Li-juan Lu<sup>a</sup> and Lin Yuan<sup>\*b</sup>

Civil Aviation University of China, Tianjin 300300, China

\*yuanlin2024mpacc@163.com

**Abstract.** Based on the practical issues of the coordinated development of safety and efficiency in the civil aviation industry, this paper introduces the new quality productivity into the analytical framework and deeply explores its influence mechanism on the safety investment and financial performance of civil aviation enterprises. By constructing a measurement model with the panel data of Chinese civil aviation enterprises from 2015 to 2025 as samples and conducting empirical tests, it is found that safety investment has a significant promoting effect on financial performance, and the new quality productivity plays a significant positive moderating role in this path. Moreover, the moderating effect has a dual-threshold characteristic, and the overall relationship shows a stepwise enhancement nonlinear pattern. This study not only provides theoretical explanations and empirical evidence for the assertion that "safety is benefit" from the perspective of new quality productivity, but also offers practical guidance and decision-making references for aviation enterprises to improve safety governance efficiency through technological innovation and optimal allocation of factors.

**Keywords:** Safety investment, new quality productivity forces, Financial performance, Moderating effect, Threshold effect, Civil aviation enterprises.

## 1 Introduction

Aviation safety is the lifeline [1]. The traditional view regards safety investment as an operational cost that erodes profits, but in essence, it is a strategic investment that can bring long-term returns [2] and achieve a coordinated improvement in safety and performance [3]. Incorporating the new quality productivity characterized by innovative allocation of elements into the analytical framework holds significant research and practical value [4]. Based on this, this paper selects the data of listed civil aviation enterprises from 2015 to 2025, systematically analyzes the impact mechanism of safety investment on financial performance, and introduces new quality productivity as a moderating variable to construct a model [5].

## **2 Theoretical Analysis and Research Hypotheses**

### **2.1 Impact of Civil Aviation Safety Investment on Financial Performance**

Based on safety economics, safety investment can create direct value through accident prevention and control, accumulate human capital to form indirect benefits [6], and obtain implicit gains through reputation and credit [7]. Based on this, the research hypothesis is proposed:

H1: The safety investment of civil aviation enterprises has a positive impact on financial performance.

### **2.2 Role of New Quality Productivity Forces in the Relationship between Civil Aviation Safety Investment and Financial Performance**

New-type productivity is an advanced form of productivity that is driven by innovation and conforms to the new development concepts [8]. Its essence lies in the optimized combination of laborers, means of labor, and objects of labor. When combined with safety investment, it can enhance the efficiency and quality of safety management, and thereby improve financial performance. Based on this, the research hypothesis is proposed:

H2: The new quality productivity forces of civil aviation enterprises plays a moderating role in the impact of safety input on financial performance.

### **2.3 There is a Threshold Effect of New Quality Productivity Forces in the Process of Promoting and Influencing the Efficiency of Civil Aviation Safety Investment**

The new quality productivity driver is centered on the application of new technologies. The practice of new technologies by enterprises is not a one-off replacement but a gradual iterative process [9]. Therefore, the new productivity relationship between civil aviation safety investment and financial performance shows a nonlinear feature, which is an inevitable result of new technologies reshaping the industry's operation model. Based on the above theoretical analysis, the following research hypotheses are proposed:

H3: There is a threshold effect of new quality productivity forces in the relationship between safety investment and financial performance of civil aviation enterprises.

## **3 Research Design**

### **3.1 Sample Selection and Data Sources**

This paper selects quarterly panel data of civil aviation listed companies from 2015 to 2025. The financial data are sourced from the public disclosures of enterprises, and the

rest of the data are obtained through research. After eliminating the missing values, a total of 601 observations are finally obtained. Stata is used for empirical analysis.

### 3.2 Definition of Variables

**Explained Variable.** Explained variable. This article selects a civil aviation enterprise return on assets (ROA) measures a civil aviation enterprise financial performance, in order to ensure the reliability of the research, to return on Stockholders' equity (ROE) for robustness test [10].

**Explanatory Variables.** Civil aviation safety input refers to the effective capital and resource [11] input that civil aviation production and operation units must guarantee in order to meet the legal safety production conditions. Therefore, the current safety investment expenditure of enterprises is selected to measure the level[12] of safety investment.

**Moderating Variables.** The new quality productivity is an advanced productive force formed by the revolutionary breakthrough of production tools and the innovative allocation of production factors (including labor force) [13]. Therefore, referring to the research method of Song Jia et al. [14], an index system as shown in Table 1 was constructed and the entropy method was adopted for calculation.

**Table 1.** new quality productivity forces index of civil aviation enterprises.

Influencing factors	Variables	Font size and style	Weight (%)
Labor force	Living labor	Proportion of R&D personnel = number of R&D personnel/total number of employees	35.36
		Proportion of R&D staff salary = R&D staff salary/salary salary	24.06
	Materialized labor	Proportion of highly educated R&D personnel = number of employees with bachelor degree or above/number of R&D personnel	2.07
		Proportion of fixed assets = total fixed assets/total assets	2.45
Tools of production	Hard technology	Manufacturing expense ratio = (total base - direct production related cash payments)/total base	2.80
		Direct R&D investment = R&D expenses/operating income	22.03
	Soft technology	Proportion of intangible assets = total intangible assets/total assets	5.43
		Total asset turnover = intangible assets/total assets	4.29

Inverse of equity multiplier =1/ asset-liability ratio	1.51
new quality productivity forces of enterprises	100

**Control Variables.** In order to accurately identify the impact of safety investment on corporate financial performance, this paper introduces a series of control variables to exclude the interference of other factors. The specific calculation methods are shown in Table 2.

**Table 2.** Definition, symbols and calculation methods of variables

Types	Name	Symbols	Calculation method
Independent variables	Safety input	Safety	Take the logarithm of current safety input expenditure
Dependent variable	Financial Performance	ROA	Net profit/average total assets
Moderating variables	new quality productivity forces	NQFP	$\sum$ new quality productivity forces index $\times$ Corresponding weights
	Capital structure	LEV	Total debt/total capital
	Enterprise size	Size	Natural logarithm of total assets at year-end
	Profitability	TTM	Net profit/operating income
Control variables	Development capacity	Growth	(Operating income for the current period - operating income for the previous period)/ operating income for the previous period
	Level of risk	Z-score	Financial risk early warning index calculated based on current ratio, asset turnover, profit margin, equity multiplier, etc
	Industry macro environment	ECI	Industry sentiment index released by AVIC Information Aviation Index

### 3.3 Model Construction

To empirically test the moderating and threshold effects of new quality productivity on the relationship between safety investment and enterprise performance, this paper constructs a two-way fixed effect model. First, the main effect of safety investment on financial performance is tested, and model (1) is constructed:

$$ROA_{i,t} = \alpha_0 + \alpha_1 Safety_{i,t} + \sum \alpha_k Controls_{i,t,k} + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{1}$$

On this basis, the interaction term is introduced to test the moderating effect of new quality productivity, and model (2) is constructed:

$$ROA_{i,t} = \beta_0 + \beta_1 Safety_{i,t} + \beta_2 Nqfp_{i,t} + \beta_3 Safety_{i,t} \times NQFP_{i,t} + \sum \beta_k Controls_{i,t,k} + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{2}$$

Further, taking the new quality productivity as the threshold variable, the threshold effect model (3) is constructed [15]:

$$ROA_{i,t} = \gamma_1 + \gamma_2 Safety_{1i,t} I(NQFP \leq \delta) + \gamma_3 Safety_{2i,t} I(NQFP > \delta) + \sum \gamma_k Controls_{i,t,k} + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{3}$$

In the formula: ROA represents financial performance, Safety represents safety investment, NQFP represents new quality productivity, Controls represent control variables,  $\mu_i$  and  $\lambda_t$  are respectively the fixed effects of enterprises and time,  $\varepsilon_{i,t}$  is the random disturbance term, and  $I(\cdot)$  is the indicator function.

## 4 Empirical Analysis

### 4.1 Descriptive Statistical Analysis and Correlation Test

The financial structure of the sample enterprises is stable, the scale differences are small, and the industry prosperity is moderate, which can effectively control the heterogeneity interference [16]. After Pearson correlation and VIF tests, the variance inflation factors of all variables are less than 5, and there is no serious multicollinearity, providing a reliable basis for regression analysis.

### 4.2 Regression Analysis

Table 3 shows the regression results of the main effect and moderating effect of safety input and new quality productivity forces on corporate financial performance. According to the main effect test results, the regression coefficient of safety input in Model 1 is 0.0036 and significant at the level of 1%, indicating that safety input has a significantly positive role in promoting the financial performance of enterprises, which verifies that the increase of safety input can effectively improve the return on assets and support the positive impact of safety input on economic growth.

**Table 3.** Regression results of main effect and moderating effect.

Variables	Main effects	Moderating effect
Safety	0.0036*** (6.11)	0.0019** (2.06)
NQFP	—	0.0021 (1.64)
NQFP×Safety	—	0.0002*** (2.84)
LEV	0.0145 (1.04)	0.0122 (0.93)
Size	0.0289*** (4.49)	0.0171*** (2.74)
TTM	0.0394*** (5.30)	0.0381*** (5.41)
Growth	0.0100** (2.54)	0.0068* (1.81)
Z-score	0.0033*** (5.34)	0.0026*** (4.38)
ECI	0.0294*** (9.71)	0.0298*** (10.05)
Constant term	4.0557*** (10.27)	3.8396*** (9.90)
Fixed effects	Individual and time	Individuals and Time
R2	0.4522	0.6068

### 4.3 Threshold Effect

The empirical distribution of the statistics was obtained through the self-sampling method to verify the threshold characteristics of the relationship between new quality productivity and enterprise safety investment and financial performance. From the test results, it can be seen that the model has a significant double threshold effect on the basis of a single threshold, and there is no triple threshold effect. Table 4 shows the threshold estimates of the new quality productivity as the threshold variable and their 95% confidence intervals. This paper further analyzed the differentiated impact mechanism of safety investment on enterprise financial performance.

**Table 4.** Threshold estimates and their confidence intervals.

NQFP	Threshold estimates	95% confidence interval
First threshold	0.2992	[0.2886, 11.0975]
Second threshold	13.039	[11.097, 13.0442]

The parameter estimation results of the impact of safety input on enterprise financial performance based on the dual threshold division of new quality productivity forces are shown in Table 5. According to the coefficient estimation results of the core explanatory variable safety input, as the level of new quality productivity forces crosses different threshold values, the impact effect of safety input on return on assets shows a significant step enhancement feature.

**Table 5.** Estimation results of double threshold parameters

Variables	Coefficient estimates
Safety (NQFP $\leq$ 0.2992)	0.0013 (1.36)
Safety (0.2992<NQFP $\leq$ 13.039)	0.0042*** (7.28)
Safety (NQFP $\leq$ 13.039)	0.0061*** (8.89)
LEV	0.0543*** (4.06)
Size	0.0150*** (3.13)
TTM	0.0739*** (11.92)
Growth	0.0067* (1.82)
Z-score	0.0027*** (4.32)
ECI	0.0001* (1.77)
Constant term	0.2592** (2.25)
R <sup>2</sup>	0.5844

In general, the new quality productivity forces has a significant positive moderating effect on the relationship between safety input and enterprise financial performance, and this moderating effect shows obvious threshold characteristics. With the improvement of the level of new quality productivity forces, the promoting effect of safety input on return on assets gradually increases.

### 4.4 Robustness Test

This paper verifies the reliability of the conclusion through multi-dimensional robustness tests and endogeneity treatment: replacing ROA with ROE, substituting the core

variable with safety input score and TFP, using high-dimensional fixed effects to control heterogeneity, and lagging safety input by two periods to alleviate endogeneity. The test results are all significant, the model fits well, and the core conclusion is robust and reliable.

## 5 Conclusion

This paper studies the influence mechanism of safety investment on financial performance from a financial perspective. The results show that safety investment in civil aviation enterprises has a significant positive impact on financial performance and is a strategic investment for sustainable returns. The new quality productivity plays a significant positive moderating role. The higher the level, the better it can optimize the allocation of safety resources and enhance the performance improvement effect. The new quality productivity has a double threshold. When it is below the first threshold, the synergy effect is insufficient. After crossing it, the positive effect is significantly released. After breaking through the second threshold, the synergy effect is deeply exerted and the conversion efficiency is optimal. Overall, it shows a stepwise enhanced nonlinear relationship.

## References

1. Zhang, H., Shi, Z., Li, Y. & Wang, Y. (2024). Theme identification of unsafe incidents in civil aviation regulation based on structural theme model. *Science and Technology of Work Safety in China*, 20(11), 163-169.
2. TANG S L, LEE H K, WONG K. (1997). Safety cost optimization of building projects in Hong Kong. *Construction Management and Economics*, (2), 177-186.
3. Nie, H., GUI, L. & Ruan, R. (2025). Safety and Benefit can be both: Evidence from China's coal industry. *The Journal of World Economy*, 48(03), 59-89.
4. Zhang, J., Liu, J., Zhang, J. & Zhai, J. (2025). Evolution, essence and accounting direction of new quality productivity forces. *Journal of Finance and Accounting Communication*, (17), 9-16.
5. Ye, F. (2025). The mechanism and path of the construction of the integrated management system of industry and finance driven by new quality productivity forces. *Communication of Finance and Accounting*, (19), 169-176.
6. Qi, G. (2025). Research on economic cost-benefit analysis and management promotion strategy from the perspective of safety production. *Chinese Collective Economy*, (30), 77-80.
7. Cui, W., Yao, H. & Fang, F. (2025). ESG rating performance and long-term value creation: mechanism and empirical test. *Technology and Industry*, 25(05), 301-309.
8. Huang, H. (2024). A profound understanding of the core meaning and practical requirements of developing new quality productivity forces. *Macroeconomics Management*, (07), 13-16.
9. Mi, J., Li, D. & Dong, C. (2025). From traditional productivity to new quality productivity forces: Substitution or iteration? *Xue Hai*, (01), 167-181+215-216.
10. Fan, T. & Zheng, W. (1998). On the comprehensive evaluation of economic benefits of civil aviation transport enterprises under modern enterprise system. *Civil Aviation Economics and Technology*, (08), 10-12.
11. Fei, H., Ye, J., Mu, D. & Gu, H. (2017). *Management Observation*, (35), 23-25.

12. Zheng, Y., Yin, Y. & Ying, L. (2017). Research on the impact of financial constraints on the safety investment of coal enterprises. *China Safety Science Journal*, 27(01), 151-156.
13. Xu, Z., Shen, C., Zhou, D. & Zhang, X. (2025). new quality productivity forces enabling enterprise high quality development: theoretical logic and empirical test. *Economic Issues Exploration*, (09), 20-37.
14. Song, J., Zhang, J. & Pan, Y. (2024). Research on the impact of ESG development on corporate new quality productivity forces: empirical evidence from Chinese A-share listed companies. *Contemporary Business Management*, 46(06), 1-11.
15. HANSEN B E. (1999). Threshold effects in non-dynamic panels: estimation, testing, and inference. *Journal of Econometrics*, 93(2), 345-368.
16. Zhang, L. & Zhao, J. (2025). Study on factors influencing carbon emissions of civil aviation enterprises based on PLS-SEM. *Journal of Environmental Engineering Technology*, 15(04), 1144-1150.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

