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DOI: <https://doi.org/10.20535/2307-5651.36.2026.360559>**Jingwen He**

PhD student

(corresponding author)

ORCID ID: 0009-0003-4070-9129

**Qiang Bai**

PhD student

ORCID ID: 0009-0000-3521-8120

National Technical University of Ukraine

"Igor Sikorsky Kyiv Polytechnic Institute"

## THE IMPACT OF TECHNOLOGICAL INNOVATION ON THE COMPETITIVENESS OF FIRMS IN EMERGING ECONOMIES

*This study investigates the impact of technological innovation on the international competitiveness of Chinese A-share listed manufacturing firms from 2016 to 2021. It identifies a positive relationship between technological innovation and international competitiveness, clarifies the mechanisms by which innovation enhances competitiveness, and focuses on firms in emerging markets. The findings suggest that increased R&D investment significantly improves a firm's export technology complexity, thus strengthening its global market position. The study also highlights the importance of strategic innovation management, knowledge accumulation, and technological capability development in driving sustainable competitive advantage. The results provide practical implications for policymakers and firm managers seeking to enhance the global performance of companies operating in emerging economies.*

**Keywords:** technological innovation, international competitiveness, emerging markets, financial performance.

**Цзінвен Хе, Цян Бай**

Національний технічний університет України

«Київський політехнічний інститут імені Ігоря Сікорського»

## ВПЛИВ ТЕХНОЛОГІЧНИХ ІННОВАЦІЙ НА КОНКУРЕНТОСПРОМОЖНІСТЬ ПІДПРИЄМСТВ У КРАЇНАХ З ЕКОНОМІКОЮ, ЩО РОЗВИВАЄТЬСЯ

*Статтю присвячено аналізу впливу технологічних інновацій на міжнародну конкурентоспроможність китайських виробничих компаній, акції яких котируються на біржі A-share, у період з 2016 по 2021 рік. Основна мета роботи полягає у визначенні того, яким чином інвестиції в технологічні інновації сприяють підвищенню здатності підприємств конкурувати на глобальному ринку, особливо у контексті економік, що розвиваються. Виявлено, що існує стійкий позитивний зв'язок між рівнем технологічних інновацій та міжнародною конкурентоспроможністю компаній, а також визначено ключові механізми, через які інновації підвищують конкурентні переваги. Зокрема, результати показують, що збільшення інвестицій у дослідження та розробки значно підвищує технологічну складність продукції, яка експортується, що, у свою чергу, зміцнює позиції компаній на світовому ринку. Дослідження також підкреслює роль стратегічного управління інноваціями, накопичення знань та розвитку технологічного потенціалу як факторів, що забезпечують стійку конкурентоспроможність. Крім того, робота висвітлює практичні наслідки для політиків і менеджерів підприємств, пропонує рекомендації щодо оптимізації інвестицій у R&D, формування інноваційних стратегій та підвищення технологічної складності продукції для покращення глобальної позиції компаній у країнах, що розвиваються. Дослідження сприяє поглибленому розумінню взаємозв'язку між інноваціями та міжнародною конкурентоспроможністю і надає основу для подальших досліджень у сфері інноваційного менеджменту та розвитку підприємств на глобальному ринку. Перспективи подальших досліджень включають вивчення впливу цифровізації та штучного інтелекту на конкурентоспроможність підприємств, аналіз ролі інтеграції у глобальні виробничі та інноваційні ланцюги, а також порівняння ефективності технологічних інновацій у різних секторах промисловості. Такі дослідження можуть надати глибше розуміння того, як компанії в економіках, що розвиваються, можуть зміцнювати свої позиції на глобальному ринку та формувати довгострокові конкурентні переваги.*

**Ключові слова:** технологічні інновації, міжнародна конкурентоспроможність, ринки, що розвиваються, фінансові показники.

**Problem statement.** In today's globalized and highly competitive business environment, technological innovation is increasingly recognized as a key driver of international competitiveness [1]. To stand out in global markets and secure a competitive edge, firms must excel at developing and commercializing new technologies, a crucial step for maintaining growth and capturing market share. This is particularly true for innovative firms that

rely on technological capabilities to navigate and thrive in dynamic and unpredictable environments.

The relationship between technological innovation and international competitiveness has been widely studied, with research exploring the role of R&D investment and the impact of innovation on export performance. However, despite the extensive literature, several key areas remain underexplored. Specifically, there is a need



for deeper investigation into the mechanisms through which technological innovation enhances international competitiveness. While existing studies have established a general link between innovation and competitiveness, the specific pathways and processes by which innovation translates into superior financial performance and success in international markets remain poorly understood [2; 3].

Another notable gap in the literature is the limited focus on emerging markets. Most research on technological innovation and international competitiveness has concentrated on developed economies, such as the United States and Europe [4; 5]. Given the rapid growth and increasing prominence of Chinese firms in the global economy, gaining a deeper understanding of the role of technological innovation in shaping their competitiveness can provide valuable guidance for managers and policymakers seeking to promote innovation and economic growth in China and other emerging markets.

The remainder of this paper is structured as follows: we first review the relevant literature and develop our hypotheses, then describe our data and methods in detail. We then present our empirical results and discuss their implications for theory and practice.

**Analysis of recent research and publications.** Technological innovation, encompassing the development and commercialization of new technologies, products, and processes, enables companies to differentiate themselves from competitors, penetrate new markets, and secure sustainable competitive advantages. This is particularly crucial in international business, where firms must continuously innovate to withstand intense competition from foreign rivals and maintain their market position [6; 7].

In previous studies, the Resource-Based View (RBV) has provided a theoretical framework for understanding the link between technological innovation and international competitiveness [8; 9]. According to RBV, firms possess unique resources and capabilities that can be leveraged to achieve a competitive advantage [10; 11]. Technological innovation, in particular, is viewed as an indispensable resource that enables firms to enhance their performance and differentiate themselves in the market [12].

Empirical research confirms that technological innovation is a critical driver of firm performance [13; 14; 15]. Studies show R&D intensity positively correlates with key financial metrics, including ROA, sales growth, and profitability [16; 17], and that innovative firms better differentiate themselves and capture market share, enhancing their international competitive position.

Based on these insights, we propose the following hypothesis:

1) Firms enhance their international competitiveness through technological innovation by improving financial performance.

Firm size moderates the innovation-competitiveness relationship. While larger firms possess greater resources for R&D investment, they tend to face bureaucratic inertia and slower decision-making. In contrast, SMEs benefit from organizational flexibility and dynamic capabilities that enable rapid adaptation to market trends. Empirical evidence confirms that R&D investment yields greater competitive gains for small firms than large ones [10; 18; 19; 20].

Based on the above views, we put forward the following hypothesis:

2) Firm size negatively moderates the relationship between technological innovation and international competitiveness.

Emerging economies present an important yet under-researched context for studying innovation and competitiveness. Most existing studies focus on developed economies, overlooking the unique institutional, cultural, and economic factors shaping emerging markets [21; 22]. To fill this gap, this study focuses on China's A-share-listed manufacturing enterprises from 2016 to 2021, aiming to provide actionable insights for managers and policymakers in these rapidly developing regions.

**Formulating the purposes of the article.** This study examines the impact of technological innovation on the international competitiveness of Chinese A-share listed manufacturing firms from 2016 to 2021, making three marginal contributions: first, it identifies a positive effect of technological innovation on international competitiveness; second, it clarifies the specific mechanisms through which technological innovation influences international competitiveness; and third, it focuses on firms in emerging economies, an increasingly important yet under-researched group in the global economy.

**Methodology.** We selected data on China's A-share-listed manufacturing enterprises from 2016 to 2021. This period is particularly appropriate, as it coincides with a phase of rapid technological development in China and intensifying global competition, making it well-suited for examining the relationship between technological innovation and international competitiveness. The data comes from the China Stock Market and Accounting Research (CSMAR) database. After removing financially distressed firms and missing data points, we obtained 7,209 valid data points and truncated the continuous variables at the 1st and 99th percentiles, respectively. This study examines the impact of technological innovation on enterprises' international competitiveness. Considering the individual differences between enterprises, such as management practices, strategic choices and other factors that may affect international competitiveness, we use fixed-effect models to explain these differences. In addition, macroeconomic conditions, industry trends, policy changes, and other factors will affect enterprises over time. Therefore, we use a two-way fixed-effects model, including individual and time fixed effects, to construct the regression model specified in Equation (1).

$$TechComplex_{it} = \alpha_0 + \alpha_1 RD_{it} + \alpha_2 X_{it} + \varphi_t + c_i + \varepsilon_{it} \quad (1)$$

Based on the mechanism and transmission path analysis discussed above, enterprise technology innovation has a positive impact on international competitiveness by improving operational performance. Therefore, we introduce operational performance into the regression model as a mediating variable, as shown below:

$$ROA_{it} = \gamma_0 + \gamma_1 RD_{it} + \gamma_2 X_{it} + \varphi_t + c_i + \varepsilon_{it} \quad (2)$$

$$TechComplex_{it} = \delta_0 + \delta_1 RD_{it} + \delta_2 ROA_{it} + \delta_3 X_{it} + \varphi_t + c_i + \varepsilon_{it} \quad (3)$$

Enterprises of different sizes tend to allocate resources and focus in different ways, especially in R&D investment. This observation raises an important question: Will the scale of enterprises moderate the relationship between

R&D intensity and international competitiveness? To examine this issue, this study has developed a moderation model in which  $SIZE_{it}$  is the key variable representing the enterprise's scale. The model formula is as follows:

$$TechComplex_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 SIZE_{it} + \beta_3 SIZE_{it} * RD_{it} + \beta_4 X_{it} + \varphi_t + c_i + \varepsilon_{it} \quad (4)$$

where  $i$  denotes the firm and  $t$  denotes the year, spanning from 2016 to 2021.  $TechComplex_{it}$  represents the export technological complexity of firm  $i$  in year  $t$ , measured as the natural logarithm of export technology complexity.  $RD_{it}$  represents the R&D intensity of firm  $i$  in year  $t$ .  $ROA_{it}$  represents the return on assets.  $SIZE_{it}$  represents firm size, measured as the natural logarithm of total assets.  $X_{it}$  denotes a vector of control variables, as described in Table 1.  $\varphi_t$  captures year fixed effects,  $c_i$  represents firm fixed effects, and  $\varepsilon_{it}$  denotes the error term.

Presentation of the main research material. There are various ways to measure international competitiveness. This study draws on the research methods of Ardito et al., and uses export complexity as a proxy for firms' international competitiveness [2]. Export complexity not only reflects the diversity of enterprise products but also their technological complexity and added value, thereby indirectly reflecting enterprises' competitive position in the global market. Since international market competition largely depends on technical advantages and innovation capabilities, export complexity, as a comprehensive indicator, can effectively assess enterprises' technological innovation and product differentiation performance. Based on the above considerations, we believe that export complexity is a reasonable and effective indicator of international competitiveness.

This research focuses on enterprise technology innovation. Drawing on the research by Exposito and Sanchis-Llopis, we use R&D intensity as an indicator, defined as the ratio of an enterprise's R&D expenditure to its total operating income [6].

Given the mediating role of financial performance in the relationship between technological innovation and international competitiveness in the existing literature, this study uses return on assets (ROA) as a proxy for enterprise performance [23; 24]. As an intermediary variable, ROA reflects the impact of technological innovation on financial performance, enabling us to further test whether improvements in ROA enhance international competitiveness. Similarly, in order to test whether the size of an enterprise regulates the relationship between R&D investment and international competitiveness, this study draws on the methods of Ahmed et al. and Tadevosyan, and adopts firm size (measured by the logarithm of total assets) as the moderating variable [24; 25]. This variable helps to reveal the differential impact of technological innovation on the international competitiveness of enterprises of different sizes.

Table 1 provides a specific description of each variable. By carefully constructing and rigorously screening these variables, this research aims to establish a solid theoretical and empirical basis for examining the impact of technological innovation on the international competitiveness of enterprises and, at the same time, to provide a variable design framework for future research.

Before constructing the model, descriptive statistics and correlation analysis were carried out in this study to evaluate the suitability of the data for regression analysis.

Table 2 shows the descriptive statistics of the dataset containing 7,209 observations. A comprehensive overview of the relevant variables demonstrates the data set's stability and its applicability to subsequent regression analysis. The average R&D intensity is 10.969, with a standard deviation of 2.067, indicating a significant difference in R&D expenditure. The average export technological complexity is 18.082, with a standard deviation of 1.342, indicating that the sample's export technological complexity is at a medium level. There are significant differences in R&D expenditure across the samples, and the level of export technological complexity is moderate and relatively stable. The relationship between technological innovation and

Table 1

**Variable Definitions**

Variable	Symbol	Definition
Export Technology Complexity	<i>TechComplex</i>	Natural logarithm of export technology complexity
R&D Intensity	<i>RD</i>	R&D expenses / Total operating revenue
Return on Assets	<i>ROA</i>	Net income after taxes / Average net assets
Number of Employees	<i>ln_emp</i>	Natural logarithm of the number of employees
Firm Age	<i>lnfirm_age</i>	Natural logarithm of firm age
Firm Size	<i>SIZE</i>	Natural logarithm of firm size
Patent Technological Output	<i>Patent_output</i>	Natural logarithm of patent technological output

Source: compiled by the authors

Table 2

**Descriptive Analysis**

VarName	Obs	Mean	SD	Min	Max
<i>TechComplex</i>	7209	18.082	1.342	9.971	22.802
<i>RD</i>	7209	10.969	2.067	0.000	13.899
<i>ROA</i>	7209	0.048	0.097	-3.164	0.664
<i>ln_emp</i>	7209	7.550	1.125	3.497	12.211
<i>lnfirm_age</i>	7209	1.800	1.034	0.000	3.434
<i>SIZE</i>	7209	21.977	1.188	17.806	27.307

Source: compiled by the authors

international competitiveness needs further analysis in the following analysis.

Table 3 presents the results of the correlation analysis, indicating a significant positive correlation between R&D intensity and the complexity of export technology. In addition, the number of employees and the years of the company's establishment also have a significant positive correlation with the intensity of R&D and the complexity of export technology. This shows that larger, longer-established companies are more likely to increase their investment in R&D, thereby producing more technologically complex products.

The multicollinearity analysis shown in Tables 4 and 5 indicates that the average variance inflation factor (VIF) across variables is 1.30, indicating low to medium multicollinearity and no substantial impact on regression reliability. The results of the Hausman test further support the fixed-effect model over the random-effect model in this study. The chi-square statistic is 16.38, and the p-value is close to zero, indicating that the fixed-effect model is a more suitable choice.

Table 6 shows the regression analysis results of the impact of R&D investment on the export technology complexity (TechComplex).

In column (1), when the control variable is not included, the coefficient of R&D input is 1.58e-10 and the t statistic is 2.09, indicating that there is a statistically significant positive relationship between R&D input and export complexity at the significance level of 5%. This shows that even under the basic model setting, the increase in R&D investment is positively associated with export complexity. Column (2) introduces control variables, and the coefficient is slightly increased to 1.68e-10 (statistics = 2.22). The improvement in t-statistics and the magnitude of the coefficient indicate that accounting for additional enterprise-level characteristics can strengthen the relationship between R&D input and export complexity. Column (3) also includes fixed effects for year and enterprise. After including these additional controls, the coefficient on R&D investment increased slightly to 1.73e-10, and the t statistic rose to 2.31, confirming that, even after controlling for heterogeneity in time and enterprise

Table 3

**Correlation Analysis**

	Tech Complex	R&D	ln_emp	lnfirm_age	ROA	SIZE
Tech Complex	1					
R&D	0.083***	1				
ln_emp	0.354***	0.151***	1			
lnfirm_age	0.196***	0.199***	0.424***	1		
ROA	0.011	0.037***	-0.030**	-0.196***	1	
SIZE	0.392***	0.279***	0.835***	0.481***	-0.031***	1

Source: compiled by the authors

Table 4

**Multicollinearity Analysis**

Variable	VIF	1/VIF
R&D	1.45	0.690501
ln_emp	1.24	0.808154
lnfirm_age	1.22	0.819740
Mean VIF	1.30	

Source: compiled by the authors

Table 5

**Hausman Test**

Test	F-test	Prob > F	chi2(3)	Prob > chi2
F-test	16.38	0.0000		
Hausman Test			7.68	0.0000

Source: compiled by the authors

Table 6

**Regression Analysis**

Indicator	TechComplex		
	(1)	(2)	(3)
R&D	1.58e-10** (2.09)	1.68e-10** (2.22)	1.73e-10** (2.31)
Constant	9.035*** (42.99)	8.818*** (49.20)	8.483*** (39.18)
Control variables	-	Yes	Yes
Year fixed effects	-	-	Yes
Corporate fixed effects	-	-	Yes
Observations	7209	7209	7209
R2	0.059	0.072	0.086

Source: compiled by the authors

factors, the positive impact of R&D investment on export complexity remains robust. The  $R^2$  value increased from 0.059 in column (1) to 0.086 in column (3), indicating that the explanatory power of the model is improved as more variables and fixed effects are incorporated. Overall, these results show that higher R&D intensity significantly increases the technological complexity of enterprises' export products, thereby supporting the view that R&D investment contributes positively to international competitiveness.

On the basis of the previous discussion, this study further explores the mechanism of enterprise innovation to improve international competitiveness. R&D investment drives technological innovation by promoting product development, process efficiency and overall operational capacity. These innovations, in turn, enhance firms' financial performance, as reflected in higher returns on assets (ROA), indicating improved profitability and more efficient asset utilization. This improvement in financial performance provides enterprises with the resources and credibility to further invest in technology development and expand their businesses in international markets.

Table 7 shows the analysis of the mediating effect and examines the mediating role of enterprise financial performance (ROA) in the relationship between R&D investment and export technology complexity (TechComplex). In column (1), the regression of TechComplex on R&D shows a significant positive effect of R&D on export complexity, with a coefficient of 1.73e-10, indicating that increased R&D investment is associated with improved export complexity. In column (2), the regression analysis of ROA on R&D shows that R&D investment has a significant positive impact on financial performance, thus confirming that R&D helps to improve ROA. As shown in column (3), when R&D and ROA are included in the regression model of TechComplex at the same time, the coefficient of R&D drops slightly to 1.61e-10, and ROA exerts a significantly positive effect on export complexity. The addition of ROA has led to a decline in the R&D coefficient, indicating that part of R&D's impact on export complexity is achieved by improving financial performance. Overall, the research results show that R&D investment not only directly promotes the improvement of the complexity of export technology but also indirectly strengthens the complexity of export technology by improving the return on assets (ROA) of enterprises, thus confirming the mediating role of enterprise financial performance in the relationship between technological innovation and international competitiveness.

Based on the benchmark and intermediary analysis results from the preceding analyses, this study further explores whether the positive impact of R&D intensity on export technology complexity varies by enterprise size.

Table 8 shows that enterprise size moderates the relationship between R&D intensity and export technological complexity. Although the R&D coefficient is significantly positive, its value is very small, suggesting that R&D effectiveness is not uniform across emerging-market enterprises, prompting us to regard firm size as a key regulatory factor.

The positive coefficient of firm size shows that large-scale enterprises tend to have a higher baseline level of export technological complexity, holding other factors constant. This may be because they have richer resources

Table 7

**The mediating effect of corporate financial performance**

Indicator	(1)	(2)	(3)
	TechComplex	ROA	TechComplex
R&D	1.73e-10 ** (2.31)	9.36e-12*** (2.62)	1.61e-10** (2.15)
ROA	–	–	1.319*** (5.34)
Constant	8.483*** (39.18)	0.023** (2.26)	8.452*** (39.10)
Control variables	Yes	Yes	Yes
Corporate fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	7209	7209	7209
R2	0.086	0.064	0.089

Source: compiled by the authors

Table 8

**Heterogeneity of Firm Scale**

	(1)
	TechComplex
R&D	-1.46e-10 * (0.000)
SIZE	0.823*** (0.037)
R&D * SIZE	-0.506*** (0.037)
Constant	-3.609*** (0.605)
Control variables	Yes
Corporate fixed effects	Yes
Year fixed effects	Yes
Observations	720
R2	0.106

Source: compiled by the authors

and better infrastructure, which can support more complex technological innovation.

More importantly, the scale of enterprises has a significantly negative moderating effect on the relationship between R&D intensity and international competitiveness. As the enterprise scales up, the positive impact of R&D intensity on export technological complexity gradually weakens. Specifically, although R&D investment is beneficial to all enterprises, smaller enterprises seem to gain a relatively greater competitive advantage from R&D work. This may be due to their flexibility and ability to implement innovative changes faster, while larger enterprises may be constrained by more rigid organizational structures.

The evidence in Table 8 not only highlights the different reactions of emerging market enterprises to R&D investment, but also calls for differentiated innovation policies – not only to make full use of the flexibility of small enterprises, but also to support the more complex structure of large enterprises.

Overall, these findings provide a detailed perspective on innovation in emerging market economies. The basic advantages of large enterprises in terms of technological complexity are offset by small enterprises' strong ability

to translate R&D results into internationally competitive performance. This insight is crucial for policymakers and business strategists aiming to improve international competitiveness, because it shows that R&D policies and support mechanisms tailored to differences in firm size can yield more effective innovation outcomes.

**Conclusions.** This study investigates the impact of technological innovation on the international competitiveness of innovative firms, focusing on A-share listed manufacturing firms in China from 2016 to 2021. The research reveals several key findings: First, firms with higher R&D intensity demonstrate stronger international competitiveness. Second, the relationship between technological innovation and international competitiveness is mediated by financial performance, indicating that innovation's influence on competitiveness is both direct and enhanced by profitability. Moreover, the effect of technological innovation on international competitiveness varies according to firm size, with smaller firms benefiting more

from increased R&D investment. This may be due to their greater flexibility and agility in leveraging R&D efforts for innovation.

Given the significant impact of R&D intensity on international competitiveness, managers should prioritize resource allocation to R&D activities and maintain consistent investment over time. Beyond formal R&D investments, managers should also foster an organizational culture that encourages creativity, experimentation, and continuous improvement. Additionally, innovation strategies should be tailored according to firm size. Smaller firms may benefit from focusing on rapid, iterative product development and leveraging their agility to quickly respond to market opportunities. Conversely, larger firms may need to streamline their R&D processes and cultivate a more entrepreneurial mindset to overcome bureaucratic inertia. The insights provided by this study offer guidance for policy formulation and strategic planning not only in China but also in other emerging markets facing similar challenges.

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