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THE EFFECT OF INNOVATION RESOURCE MANAGEMENT AND BANK COMPETITION ON FIRM INNOVATION OUTPUT IN UKRAINE

BY

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Abstract

This study examines the impact of banking competition on the innovation output of Ukraine's industrial firms by analyzing data on city-level commercial bank branches, enterprise patent data, and Ukrainian industrial enterprises. The study finds that competitive banking market structures significantly promote enterprise innovation output, especially for non-state-owned and small and medium-sized enterprises. The paper also explores the ways in which banking competition affects the innovation output of enterprises from the perspectives of resource allocation and incumbent enterprises. The results show that competition in the banking industry can optimize the allocation of innovation resources among enterprises and increase innovation investment, particularly for non-state-owned and small and medium-sized enterprises. This research provides a basis for formulating innovation-driven financial development policies and expands the understanding of the microcosmic impact of banking competition on corporate innovation.

Keywords: *innovation resource management, banking industry competition, enterprise innovation, resource allocation.*

INTRODUCTION

The battle for technological innovation is a pressing issue in Ukraine. Research on how to promote corporate innovation has already found that the financial system has a screening function, and a competitive financial system can allocate capital to the most promising innovative companies, making it one of the basic institutional foundations of an innovation-driven economy [14]. In reality, Ukraine's bank credit sales are still dominated by the state-owned large banks, which allocate a large amount of credit to government-supported large enterprises and departments, while small and efficient enterprises face long-term credit problems and difficulties in meeting their innovation needs.

To improve the quality and efficiency of financial services for the real economy, Ukraine government has launched a series of policy measures, such as relaxing bank entry restrictions, to allow small and medium-sized banks to continue to grow and increase competition in the banking industry [14]. One of the important goals of deepening the structural reform of the financial supply side is to use the benign transformation of the banking industry to bring funds into innovative entities and achieve an increase in the efficiency of financial services for the real economy.

Currently, research on the impact of banking industry competition on corporate innovation is mainly based on the financing constraint perspective and is conducted through the "information hypothesis" and "market force hypothesis," with inconclusive results in both theory and empirical studies [7, 13, 15, 19].

Relevant empirical studies have mostly found that a competitive banking market structure can help promote corporate innovation. The internal logic is that competition drives commercial banks to increase their credit allocation to high-quality enterprises, easing their financing constraints and increasing innovation investment [1, 3, 8, 11, 20].

Studies provide useful references for understanding the relationship between Ukraine's banking industry competition and corporate innovation, but their research perspective remains at the overall level of corporate innovation and does not consider the structural configuration of innovation

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investment among enterprises [14]. Some studies have found that Ukraine's innovation resources are misplaced among enterprises: some enterprises invest too much in innovation, resulting in diminishing marginal returns and decreased innovation output, while some enterprises face a shortage of investment and have not yet reached their optimal innovation investment scale, thus having great potential for increasing innovation output.

If the efficiency of innovation investment allocation among firms is improved, Ukraine's corporate productivity could further increase by 1/3 to 1/2 [14]. In fact, the total innovation output of an economy is the sum of the output of various entities in the market, so theoretically, even if the quantity and quality of innovation investment do not change, higher total innovation output can be achieved simply by optimizing allocation among firms of different efficiency [9].

The main function of banks is to select the most competitive firms and projects, promote the optimization of resources among firms, and promote innovation. Therefore, to fully evaluate the policy effects of banking industry competition on Ukraine's corporate innovation, it is necessary to further analyze whether innovation funds flow to high-efficiency innovation firms and whether the allocation of innovation resources among firms is optimized under banking industry competition, and translate this into corporate innovation output growth.

However, from the existing literature, related studies mainly analyze the impact of banking industry competition on resource allocation from the meso-level (the level between the micro-level of individual entities or actors and the macro-level of society or the economy as a whole) perspective of regions, industries, and scales [12], and the specific transmission mechanisms and pathways are still a "black box," providing direct empirical evidence is crucial. Clarifying this issue will help provide a micro foundation for financial supply-side structural reform, which is more related to the top-level structure of the financial system.

Considering the crucial role that the market structure of the banking industry plays in the allocation of corporate credit funds, this study constructs a banking competition index using data from bank branches in various prefecture-level cities within the resource allocation framework. By combining this with relevant data from Ukrainian industrial enterprises, the study empirically examines the impact of changes in the banking industry structure on corporate innovation output.

The empirical results show that banking competition in Ukraine effectively promotes corporate innovation output. Furthermore, the mechanism test indicates that under intensified banking competition, more high-efficiency enterprises enter the innovation sector, more high-efficiency enterprises increase their innovation input, and the allocation of innovation resources among enterprises is optimized, thereby promoting corporate innovation output at the overall level [10]. The above mechanism is particularly significant in non-state-owned enterprises and small and medium-sized enterprises.

The marginal contribution of this study may be in the following aspects:

Firstly, while most current research analyzes the overall impact of banking competition on corporate innovation input, this study attempts to analyze the changes in corporate innovation input structure from the perspective of resource allocation under banking competition and forms a relatively complete logical chain of "banking competition to corporate innovation resource allocation to corporate innovation output" based on this analysis.

Secondly, this study examines the implementation pathways and mechanisms of the impact of banking competition on corporate innovation resource allocation from the perspectives of new entrants and incumbent enterprises, including incentivizing high-efficiency enterprises to enter the innovation sector and promoting high-efficiency enterprises to increase innovation input, thereby improving overall innovation output.

Finally, taking into account enterprise heterogeneity, this study finds that the role of banking competition in promoting corporate innovation output in Ukraine is mainly achieved by guiding the flow of innovation resources towards small and medium-sized enterprises and non-state-owned enterprises. The rest of this paper is organized as follows: Part II presents the theoretical analysis and research hypotheses, Part III describes the research design, empirical analysis and results, and further discussion, and the last part presents the research conclusions and policy implications.

1. Theoretical Analysis and Hypothesis Development

Previous research has shown that as competition in the banking industry continues to increase, banks are increasingly allocating credit to high-quality enterprises [2, 5], which in turn encourages more companies to increase their innovation investments [16]. Based on previous theoretical studies on resource allocation [1, 3], the impact of credit resource allocation on innovation output in enterprises mainly includes two paths: first, the impact on the entry of enterprises into the innovation sector; second, the change in innovation incentives for existing enterprises [8, 13], both of which can lead to changes in the ultimate innovation output of enterprises. Combining the current market structure of the banking industry in Ukraine and the innovation behavior of enterprises, this paper provides a theoretical analysis of how competition in the banking industry affects credit allocation to enterprises and thus influences innovation output.

First, competition in the banking industry, enterprise entry, and innovation output. Research has found that competition in the banking industry increases the availability of credit to high-efficiency enterprises [12], thereby increasing the probability of high-efficiency enterprises entering the innovation sector, which in turn leads to growth in innovation output.

Only when financing constraints are eased can enterprises transition from a "profit model" to a "growth model," with the

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motivation to purchase new equipment and hire research and development personnel, among other initial innovation costs, enter the innovation sector, and maintain subsequent innovation activities, thus promoting enterprise innovation [1, 15, 16].

Competition in the banking industry stimulates high-efficiency enterprises to enter the innovation sector mainly by increasing the availability of credit, with the following four main pathways: first, banks have "scale specialization," and small and medium-sized banks, due to their smaller asset size, find it difficult to lend to enterprises in the innovation sector, leading to increased credit availability for large banks [2].

Second, increased competition among banks leads to lower interest rates and increased loan maturity, thereby increasing the availability of credit for enterprises in the innovation sector [20].

Third, competition among banks can reduce the cost of obtaining credit information, making it easier for banks to assess the creditworthiness of enterprises in the innovation sector and increasing the availability of credit [15].

Fourth, competition among banks can also lead to improved loan performance monitoring, which can reduce the risk of lending to enterprises in the innovation sector and increase credit availability [2].

Large companies providing loans are motivated to seek potential enterprises and provide them with loans. New banks tend to provide relationship-based loans to potentially low-transparency enterprises because they find it difficult to compete for customer resources with large banks. Bank competition helps improve the bargaining power of potential enterprises, lower the value of collateral required for mortgage loans, and increase the availability of loans.

Furthermore, bank competition promotes the improvement of screening and reviewing techniques, which helps identify more potential enterprises and provide them with credit support. In general, bank competition helps increase the bargaining power of efficient potential enterprises with banks, ease the innovation financing constraints of these enterprises, and provide necessary funding conditions for more efficient enterprises to enter the innovation sector, thereby promoting the overall level of innovation output of enterprises.

Secondly, bank competition, innovation incentives for incumbent enterprises, and innovation output are interrelated. With the improvement of credit conditions, the entry of new enterprises or increasing competitive threats put pressure on incumbent enterprises, prompting them to form "escape entry" innovation incentives, thereby affecting innovation output [2].

In this process, the incentive effect of "escape entry" for incumbent enterprises is closely related to factors such as enterprise production efficiency. In the mechanism of survival of the fittest in the market, bank competition plays a "catalyst" role: efficient incumbent enterprises will receive more credit allocation, improve their production and research and development capabilities, greatly improve the probability of successful innovation, and obtain higher innovation output [19].

The credit funds obtained by inefficient incumbent enterprises are continuously reduced, accelerating their elimination. As this process continues, innovation funds are constantly transferred to high-quality incumbent enterprises, which further increase their innovation investment and allocate innovation resources among new products, innovation projects, research and development, and operations departments, promoting the overall level of enterprise innovation output.

Therefore, based on the above analysis, this article proposes the following hypothesis to be tested: under other conditions being equal, an increase in bank competition in Ukraine has a promoting effect on enterprise innovation output.

2. Research Design and Empirical Analysis

Data Source and Sample

This study primarily uses industrial enterprise data from the State Statistics Service of Ukraine and patent database data for empirical testing [17, 18, 21]. The author aims to obtain the maximum amount of effective sample data and ensure the scientific and rationality of the research sample data as much as possible. Specifically, in consideration of enterprise entry and exit, the author excluded enterprise samples that appeared only once to minimize the impact of statistical caliber changes. In addition, since the "research and development expenditure" indicator in the industrial enterprise database is not statistically counted every year, this study limits the examination period to 2017-2019 [22], deletes missing data enterprises, and performs Winsorization on observations at the top and bottom 1% of variables.

Competition Index of the Banking Industry

Due to data limitations, it is difficult to obtain regional banking data through public channels. This study uses the financial license information of all commercial bank branches in each prefecture-level city obtained.

The number of banks was further analyzed in this study. Additionally, the Herfindahl-Hirschman Index (HHI) was constructed using the market share of commercial bank branch numbers in each city, with the formula

$$\text{HHI} = \Sigma\ N_{(i=1)}\ \text{Si}^2,\ \text{for } i = 1 \text{ to n}, \qquad (1)$$

where S is the ratio of the number of branches of each commercial bank to the total number of branches in the city.

In this formula, HHI represents the Herfindahl-Hirschman Index, which is a measure of market concentration. ΣSi^2 represents the sum of the squares of the market shares of each firm in the market, where I represents each individual firm and n represents the total number of firms in the market.

Moreover, to ensure the robustness of the results, this study followed approach of using the top five banks' market share to measure the degree of competition in the banking industry, defined as

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CR5 = 1 - cr5, (2)

where cr5 is the proportion of the number of branches of the top five banks to the total number of branches in the city.

The CR5 index ranges from 0 to 1, with a value closer to 1 indicating a stronger degree of competition in the banking industry. It should be noted that regional commercial banks, especially rural commercial banks, have developed rapidly in recent years, with an increasing number of branch offices due to both market and policy factors.

However, due to the mismatched development of positioning and services, rural commercial banks focus more on supporting agriculture and small businesses, and may not have an advantage in financing innovative enterprises.

Therefore, to reduce the interference of the growth of rural commercial bank branches in the verification process, this study calculated the bank concentration index HHI2 after excluding rural commercial banks. These indices will be used to measure the market structure of the banking industry in terms of concentration and competition.

3. Innovation output and input indicators

Considering the data composition of Ukraine industrial enterprises and relevant literature on technological innovation [4, 6], the author matched industrial enterprise data with the Patent Database to construct the innovation output indicator based on "enterprise patent applications," including whether the enterprise has patent applications (Patentdum) and the patent variable Ln(patent) reflecting the level of innovation output of manufacturing enterprises based on the number of patent applications. In addition, the innovation input indicator, R&D input, is the ratio of R&D expenses to sales revenue, that is, the intensity of innovation input by the enterprise.

Control variables

In order to regulate various economic factors that affect a company's innovation output, this article considers factors such as innovation investment, company performance, corporate governance, ownership, and government intervention, based on previous relevant research. The article also controls for variables such as company size, age, debt ratio, asset profitability, and subsidy income [17]. Additionally, the article controls for variables that reflect important regional economic characteristics, such as GDP growth rate and population, which can also affect regional business innovation activities [18].

Table 1. Design of Research Variables

Variable name	Variable content	Variable description
HHI	Banking Concentration	Bank Industry Concentration is a measure of the degree of competition in the banking industry. A high level of concentration means that a few large banks have a significant market share, which may lead to reduced competition and potentially higher fees and interest rates for consumers. On the other hand, a low level of concentration means that the market is more competitive, with many smaller banks sharing the market share.
CR5	Competition in the banking industry	Top 5 banks / All branches of commercial banks in the city (Number of institutions)
HHI2	Banking Concentration	Based on the number of commercial bank branches after excluding rural commercial banks in each city (Herfindahl exponent)
Roa	ROA	Profit/total assets (%)
Debt	Corporate Debt Ratio	Liabilities/Assets (%)
Size	Enterprise size	The logarithmic value of the number of employees in the enterprise
Age	business age	Years of establishment
Rdinput	Enterprise R & D investment	Enterprise R&D expenses/sales revenue
Subsidy	subsidized income	Enterprise subsidy income/industrial sales output value
Gdp	GDP	City GDP growth rate
Population	population	Urban permanent population (10,000 people)

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Table 1.1. Explained variable

Ln(patent)	Enterprise Innovation Output	(Number of enterprise patent applications + 1) Take the logarithm
Patentdum	Whether the enterprise has innovation output	If there is a patent application, the value is 1; otherwise, it is 0

Descriptive statistics

The descriptive statistics of the main variables used in this paper are shown in Table 2 and Table 3 [17, 18].

Table 2. Descriptive statistics of main variables

Variable	Sample size	Average	Standard deviation	Minimum value	Maximum value
HHI	312,81	0,16	0,06	0,06	1,00
CR5	312,81	0,47	0,09	0,06	0,70
HHI2	312,81	0,18	0,06	0,09	1,00
Ln(patent)	312,81	0,08	0,39	0,00	8,53
Patentdum	312,81	0,05	0,23	0,00	1,00
Rdinput	312,81	0,01	0,01	0,00	0,06
Roa	312,81	0,08	0,17	-0,17	0,93
Debt	312,81	0,55	0,27	0,01	1,24
Size	312,81	9,89	1,15	8,53	13,96
Age	312,81	18,96	10,93	8,00	63,00
Subsidy	312,81	0,01	0,03	0,00	0,87
Gdp	312,81	14,66	4,51	2,70	108,00
Population	312,81	354,95	294,99	17,22	3235,32

Regarding the key variable of the banking industry's Herfindahl-Hirschman Index (HHI), it can be observed that the mean value between 2017 and 2019 was 0,1570. The maximum value in the sample was 1, while the minimum value was 0,0571, indicating significant differences in the market structure of the banking industry across cities and years.

To further observe the characteristics of different innovative behavior enterprises, this paper divided the observed enterprises into two groups: those with patents and those without patents. A t-test was conducted to compare the means, and the results are shown in Table 3. The test results rejected the null hypothesis of no significant differences between the two groups at a 1% level, indicating that there are significant differences between enterprises with patents and those without patents.

Table 3. Descriptive statistical analysis of main variables grouping

Variable	Average		Median		Standard deviation		Minimum value		Maximum value	
	yes	no	yes	no	yes	no	yes	no	yes	no
HHI	0,14	0,15	0,13	0,14	0,05	0,06	0,08	0,08	1,00	1,00
HHI2	0,18	0,19	0,16	0,18	0,05	0,05	0,09	0,06	1,00	1,00
Rdinput	0,01	0,01	0,01	0,00	0,02	0,01	0,00	0,00	0,06	0,06
Roa	0,07	0,09	0,05	0,03	0,11	0,17	-0,17	-0,17	0,96	0,92
Debt	0,56	0,55	0,57	0,56	0,22	0,27	0,01	0,01	1,24	1,24
Size	10,50	9,86	10,25	9,56	1,37	1,12	8,53	8,53	13,96	13,96
Age	22,04	18,77	17,50	15,00	13,31	10,72	8,00	63,00	63,00	63,00

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Model setting

The author tests on the basis of the following benchmark model

Equation (1): Ln(patent) = a0 + a1 * HHit + a2 * Zt + εt (3)

Equation (2): Patentdumt = a0 + a1 * HHit + a2 * Zt + εt. (4)

The dependent variables in the model, Ln(patent) and Patentdumt, both reflect a company's innovation output. The explanatory variables are the bank industry competition variable HHI and a set of control variables represented by Z. Before conducting the regression, this study first conducted a series of tests on the panel data. To eliminate the effects of year and industry differences on the results, time, industry, and region were also controlled in the tests. The parameter is a1 in the model characterizes changes in a company's innovation input under different levels of bank industry competition and is the main focus of this study's estimation results. If a1 is negative, it indicates that as the level of bank industry competition increases, companies are more likely to increase their innovation output, thus supporting the hypothesis of this study.

4. Empirical Test and Results Analysis

Table 4. Bank Industry Competition and Re-allocation of Innovation Resources in Regional Companies

	The dependent variable is Rdsfd			The dependent variable is Patentsfd		
HHI	0,09			0,21		
	(15,77)			(39,57)		
HHI2		0,07			0,26	
		(31,99)			(51,47)	
CR5			-0,04			-0,08
			(-35,94)			(-33,82)
Control Variable	Yes	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Area	Yes	Yes	Yes	Yes	Yes	Yes
Observations	312814	312814	312814	312814	312814	312814

The examination of the mechanisms above reveals that competition in the banking industry has encouraged the entry of more efficient businesses into the innovation sector and incentivized existing high-efficiency enterprises to increase their innovation efforts.

This, in turn, has promoted overall innovation improvements at the enterprise level, with this effect being particularly significant for non-state-owned and small and medium-sized enterprises.

This indicates that competition in the banking industry has spurred commercial banks to identify high-efficiency enterprises, especially those that are non-state-owned and small and medium-sized, thus promoting the reallocation of innovative resources such as funds between enterprises.

This re-allocation effect has greatly contributed to the growth of enterprise innovation output at the overall level. These findings demonstrating that competition in the banking industry not only encourages innovation investment by enterprises but also allows newly-entered incremental funds to have a more significant impact through the re-allocation of innovation resources between enterprises, ultimately leading to a dual improvement in enterprise innovation input and output.

Conclusions and policy recommendations

Exploring how competition in the banking industry affects corporate innovation has been a focus of academic research in recent years. To further clarify whether changes in the banking industry structure help optimize the allocation of innovation resources in enterprises and effectively translate into innovation output, this paper uses manually collected data from city-level banks to construct a competition index for the banking industry.

The paper then combines this with relevant data on industrial enterprise patents to empirically examine the impact of competition in the Ukrainian banking industry on innovation output. The study found that banking industry competition has an overall impact.

This article examines how bank competition affects innovation output in Ukrainian enterprises, with a particular focus on non-state-owned and small-to-medium-sized enterprises (SMEs), which are found to benefit significantly.

The study explores two pathways through which bank competition affects innovation:

1) its impact on the probability of different efficiency levels of enterprises entering the innovation sector;

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2) its effect on the level of innovation investment by different efficiency levels of enterprises.

The results show that bank competition leads to more efficient enterprises entering the innovation sector and increases innovation investment by more efficient enterprises.

This effect is particularly significant for non-state-owned and SMEs, indicating that bank competition is a vital factor in promoting innovation output in these types of enterprises.

The study suggests that bank competition improves financing support for high-efficiency enterprises, optimizing the allocation of innovation resources and promoting innovation output.

The findings have implications for policy-makers, including the need to cultivate innovation capabilities as a critical factor in Ukraine's economic development and to promote the growth of various types of innovative enterprises to enhance overall innovation capabilities systematically.

The article also recommends implementing inclusive science and technology finance policies, adopting market-based selection processes, and leveraging bank competition to allocate innovation funding efficiently.

Additionally, financial regulatory authorities should grant local banks credit business permissions, enhance their capacity to identify and select innovative enterprises, expand channels for science and technology credit, and promote technological upgrading to optimize the innovation industry's ecological environment, while effectively controlling risks.

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