Technological and Financial Structure Affects Regional Ecological Efficiency

— A Case Study of Beijing-Tianjin-Hebei Urban Agglomeration

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Abstract. Leveraging the panel data of the Beijing-Tianjin-Hebei region between 2010 and 2020, the ecological efficiency of the Beijing-Tianjin-Hebei region was measured by the entropy method, and the relationship between technological and financial structure and regional ecological efficiency was empirically analyzed by the fixed effects model. The results showed that the bank-dominated technological and financial structure has an inhibitory effect on the ecological efficiency of the Beijing-Tianjin-Hebei region; urbanization level, per capita GDP, and environmental regulation were found to have a significant impact on regional ecological efficiency, among which a high urbanization level and strict environmental regulations curbs the enhancement of regional ecological efficiency, whereas an increase in per capita GDP effectively improves regional ecological efficiency.

Keywords: Technological and financial structure, Ecological efficiency, Fixed effects model

1 Introduction

The meteoric rise of China's economy triggers huge resource consumption and even devastating ecological problems. During the "14th Five-Year Plan" period, China's efforts in constructing ecological civilization reached a critical juncture. The primary focus shifted towards carbon reduction, promoted the synergy of pollution reduction and carbon reduction, and propelled comprehensive green transformation in economic and social development, ultimately leading to a transition in the ecological environment's improvement from quantitative changes to qualitative advancements [1]. Ecological efficiency is an important index to measure the development of the regional green economy. There are many factors to promote regional ecological efficiency, among which technology and finance play an important role. An increasing number of scholars have begun to draw attention to the impact of technology and finance on regional ecological

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efficiency, but the majority of them conduct studies from a quantitative perspective, such as the development level of technology and finance [2]. Actually, in different stages of economic development, the technological and financial structure may be mismatched with the current industrial structure and technological level [3], thus failing to achieve the optimal technological and financial structure, therefore further aggravating environmental pollution and hindering the improvement of ecological efficiency. This factor, as a key element influencing ecological efficiency, though, is usually ignored by most scholars. Therefore, this paper investigates the impact of technological and financial structure on the ecological efficiency of the Beijing-Tianjin-Hebei region and explores the impact degree by constructing the index system of regional ecological efficiency. The present study aims to provide insights on targeted countermeasures to improve regional ecological efficiency through technology and finance.

2 Theoretical mechanism analysis and related index analysis

2.1 Theoretical mechanism analysis

By definition, technological and financial structure refers to the distribution, relative scale, and collaboration of each component of technology and finance [4]. The impact of technological and financial structure on ecological efficiency is reflected in the following aspects. First of all, the optimization of technological and financial structure reduces the financing cost of general enterprises, helping them amass more funds for technological innovation. According to the endogenous growth theory, technology plays an important role in economic development. Hence, the optimization of the technological and financial structure can drive technological progress, promote economic development, and reduce pollutant emissions, ultimately enhancing regional ecological efficiency [5]. Second, the optimization of technological and financial structure integrates more funds into environmentally friendly enterprises and reduces the emission of CO_2 and other greenhouse gases, thus improving ecological efficiency. Finally, the optimization of technological and financial structure accelerates the upgrading of enterprise structure to technology-intensive companies and reduces the pollution emissions of enterprises during production [6]. However, academic circles in China hold contrasting perspectives regarding whether bank-oriented technological and financial structures or market-oriented technological and financial structures are more advantageous for environmental enhancement. On the one hand, banks are the main channels for Chinese enterprises to obtain funds, making it easier for local governments to procure financial resources [7]. As environmental protection has been integrated into the evaluation criteria for local officials, local governments have augmented investments in environmentally friendly enterprises. Furthermore, they have pushed for production technology reforms among heavily polluting and high-emission industries to mitigate environmental pollution. On the other hand, the market-oriented technological and financial structure loosens the supervision of enterprises to save more funds for innovative enterprises with high-risk characteristics [8]. The above analysis shows that technological and financial structure may be an important factor affecting regional ecological efficiency, but few scholars have studied the relationship between technological

and financial structure and regional ecological efficiency, and have not analyzed whether the bank-oriented technological and financial structure promotes regional ecological efficiency. Therefore, this paper takes the Beijing-Tianjin-Hebei urban agglomeration as an example to bridge this gap.

2.2 Variable selection and data description

2.2.1 Ecological efficiency measurement.

Ecological efficiency aims at minimizing environmental pollution and resource consumption while pursuing economic growth. In order to make the measurement of ecological efficiency more accurate, the current common practice in academic circles is adopted, which takes environmental pollution and resource consumption as inputs and the value of products or services as outputs. Among them, wastewater, waste gas, and solid waste are selected as the environmental pollution variables; water resources consumption, power consumption, and manpower consumption are included in the resource consumption variables; the value of products or services is represented by GDP, which is widely used in current research. The regional ecological efficiency index system is constructed in Table 1. Referring to the method of Pang et al. [9-11], the data of the Beijing-Tianjin-Hebei region from 2010 to 2020 are selected as the research object, and the regional ecological efficiency is calculated by the entropy method. Table 2 lists the ecological efficiency values of each province and city.

Table 1. Ecological efficiency evaluation index system

Indicators	Category	Description	Unit	Data source
Input index	Environmental pollution	SO_2 Emissions	Ton	*China Statistical Yearbook on Environment* *China City Statistical Yearbook* *China Statistical Yearbook* *Beijing Statistical Yearbook* *Tianjin Statistical Yearbook* *Hebei Statistical Yearbook*
		Total ammonia nitrogen discharge in wastewater	Ton	
		Output of solid waste	Million tons	
	Resource input	Manpower consumption	Ten thousand people	
		Water resources consumption	Billion cubic meters	
		Power consumption	Billion kilowatt-hours	
Output index	Economic development	Region GDP	Hundred million yuan	

Table 2. Ecological efficiency values

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beijing	0.875	0.859	0.856	0.863	0.869	0.886	0.880	0.901	0.902	0.948	0.949
Tianjin	0.680	0.802	0.801	0.803	0.803	0.807	0.837	0.833	0.839	0.843	0.844
Hebei	0.231	0.175	0.175	0.173	0.169	0.166	0.156	0.152	0.149	0.141	0.143

It can be seen from Table 2 that in the Beijing-Tianjin-Hebei region, Beijing has the highest ecological efficiency, and Tianjin ranks second, followed by Hebei. Specifically, the ecological efficiency value of Beijing has been above 0.85; that of Tianjin

falls between 0.68 and 0.85, showing an upward trend; and Hebei has seen a decrease in ecological efficiency, with its value standing below 0.24 throughout.

2.2.2. Technological and financial structure measurement.

This paper refers to Lin et al.'s [12-18] reckoning for the bank-oriented technological and financial structure index, which uses the relative share of large commercial banks in the banking system to represent the bank-oriented technological and financial structure.

2.2.3. Control variables.

Since ecological efficiency is affected by multiple factors, this paper selects urbanization level, per capita GDP, and environmental regulation as control variables. See Table 3 for specifics.

Table 3. Selection and definition of variables

Variable category	Name	Symbol	Definition
Explained variable	Ecological efficiency	cc	Calculated ecological efficiency value
Core explanatory variable	Technological and financial structure	fs	Total assets of large commercial banks/total assets of banking financial institutions
Control variable	Urbanization level	czh	Urban population/total regional population
	Per capita GDP	pgdp	Regional GDP/ total regional population
	Environmental regulation	reu	Logarithm of the total amount of pollution control investment

2.2.4. Statistical analysis of data.

This paper selects the annual data of the Beijing-Tianjin-Hebei region from 2010 to 2020 as observation samples, and the descriptive statistics of all variables are shown in Table 4.

Table 4. Descriptive statistical analysis of variables

Variable	Description	Observation value	Maximum value	Minimum value	Mean value	Standard error
cc	Ecological efficiency	33	0.949314	0.141455416	0.621453	0.325578
fs	Technological and financial structure	33	0.538693	0.249663643	0.378792	0.082338
czh	Urbanization level	33	87.55	44.5	73.76666667	15.8345

pgdp	Per capita GDP	33	16.4889	2.8668	8.550036364	3.752909
reu	Environmental regulation	33	6.477772	3.648838	5.338775657	0.818488

3 Model settings and analysis of empirical results

3.1 Basic model and variable selection

This paper mainly investigates whether the bank-oriented technological and financial structure has an impact on the ecological efficiency of the Beijing-Tianjin-Hebei region. The econometric model is constructed as follows:

$$ee_{it} = \alpha + \beta_1 fs_{it} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

where, 'ee' represents ecological efficiency value, 'fs' represents financial structure variable, 'X' represents control variable, 'ε' represents error term, 'i' represents province, 't' represents year.

3.2 Analysis of empirical results

Using stata15 to perform Hausman test on equation (1).The empirical test based on the logarithmic equation shows that the fixed effects model is suitable for this paper. The regression results of technological and financial structure on ecological efficiency are shown in Table 5.

Table 5. Regression estimate results

Variable	Model 1	Model 2
fs	-0.2452228**(-2.19)	-0.3918714**(-2.27)
czh		-0.0073263***(-3.36)
pgdp		0.007939**（2.38）
regu		-0.0234249*
Constant term	0.714341***（16.69）	1.367509***（5.00）
F value	4.80	8.46
Sample	33	33

Note: ***,* *, * respectively indicate significant at the 1%, 5%, and 10% levels.'()' the data in is the t-value.

From the regression results, for both Model 1 or Model 2, the technological and financial structure coefficient is significant at the level of 5%, and the signs are the same, which indicates that the regression results are robust. In Model 1, for every 1% increase in the technological and financial structure coefficient, the ecological efficiency value will decrease by 0.25%; in Model 2, variables such as urbanization level, per capita GDP, and environmental regulation are added, and it is found that the ecological efficiency value decreases by 0.39% for every 1% increase in the technological and financial structure coefficient, which shows that the bank-oriented technological

and financial structure has an inhibitory effect on the improvement of ecological efficiency in Beijing-Tianjin-Hebei region. The reason for this phenomenon is twofold. First, during the early stages of technological advancement, enterprises necessitate substantial funding while confronting the inherent uncertainty of technological innovation. Under a bank-oriented technological and financial structure, bank loans are the main source of funds for these enterprises. Nevertheless, banks frequently curtail loan amounts to businesses to mitigate risks, thereby impeding enterprises from accessing the necessary funds for production. Consequently, this obstacle hampers technological innovation and amplifies resource consumption during the production process. Second, local officials, encouraged by promotion, tend to leverage the "tangible hand" of the government to allocate bank loans to resource-intensive industries that have low risks and yield swift outcomes, which makes the distribution of financial resources uneven, which is not conducive to the optimization of industrial structure, reduces the utilization rate of resources and aggravates environmental pollution.

Among the control variables, every 1% increase in the urbanization level coefficient will reduce the regional ecological efficiency by 0.008%, which is significant at the level of 1%. This suggests that as the level of urbanization in this region increases, the prospects for enhancing ecological efficiency diminish. This is because when a region enjoys a high level of urbanization, although it facilitates the concentration of resources such as technology, talent, and capital, the surge in population leads to heightened demand for automobiles and infrastructure. Consequently, this intensifies regional resource consumption and pollution emissions, resulting in a decline in regional ecological efficiency. In addition, the regression coefficient of GDP per capita is positive and has passed the statistically significant test, which suggests that the increase in GDP per capita has a positive effect on regional ecological efficiency. Because as the per capita GDP increases, residents increasingly prioritize spiritual fulfillment, place greater emphasis on adopting a green lifestyle, employing clean energy, and reducing resource consumption, thus improving regional ecological efficiency. Furthermore, when the environmental regulation coefficient rises by 1%, the ecological efficiency value drops by 0.02%, which is significant at the level of 10%. This demonstrates that environmental regulations do not promote ecological efficiency. The escalation in investments towards environmental regulations leads local governments to enforce stricter environmental standards, such as imposing limitations on water and electricity usage in production processes. While this may enhance the regional environment, it constrains the production capabilities of enterprises, resulting in reduced production efficiency and, consequently, lower regional ecological efficiency.

4 Policy recommendations

4.1 Establish a multi-level capital market

We should speed up the development of the capital market and increase the proportion of direct financing. To be precise, the suggested measures include further enlarging the capital market's scope and reducing entry barriers for enterprises. The reform of the New Third Board should be intensified, leveraging the Beijing Stock Exchange's role

as a connection point in the multi-level capital market. This will help small and midsize enterprises (SMEs) achieve more efficient bond financing, thereby expediting structural reform and technological innovation within the SME sector. Additionally, reforms in the stock market should be promoted, accompanied by strengthened supervision and an increased focus on the bond market's share, etc.

4.2 Create a sound environmental governance system

The local government should find out the characteristics of regional pollution and adopt suitable environmental control measures accordingly. Enterprises responsible for significant environmental pollution should be instructed to rectify the situation within a specified timeframe, while receiving technical assistance and encouragement to upgrade their technology in order to minimize pollution emissions. Meanwhile, Sufficient funds should be allocated for ecological protection to support the construction of environmental protection facilities. Moreover, it is necessary to establish an environmental supervision mechanism to ensure that the investment in regional environmental governance is on the right track, thus improving the efficiency of environmental governance.

4.3 Promote the comprehensive energy-saving and efficient use of resources in the Beijing-Tianjin-Hebei region

We should accelerate the transformation of energy structure and promote the utilization of solar energy according to local conditions. For high-consumption industries such as glass and chemical industry, we must accelerate the transformation to low-carbon emissions and encourage clean and efficient utilization of energy. Simultaneously, local governments should encourage enterprises, universities, and research institutes to carry out independent innovation, strengthen cooperation, and promote research and development and industrialization of photovoltaic cells, wind turbines, among other technologies.

5 Conclusion

In this study, the ecological efficiency of the Beijing-Tianjin-Hebei region was measured by the entropy method. Findings revealed that Beijing consistently maintained an ecological efficiency level above 0.85, whereas Hebei's ecological efficiency was comparatively lower. Furthermore, by analyzing panel data spanning 2010 to 2020 for the Beijing-Tianjin-Hebei region, this research empirically examined the impact of a bank-oriented technological and financial structure on regional ecological efficiency. The results indicated that the bank-oriented technological and financial structure inhibited regional ecological efficiency. Moreover, the study identified that a high urbanization level and strict environmental regulations acted as constraints on regional ecological efficiency, while an increase in per capita GDP enhanced ecological efficiency.

References

1. Qin Xian. Research Course on Financial Structure, Finance Function Evolution, and Financial Development Theory. Economic Review.2005(3).pp39-45.
2. Xiaogao Liu, Qin Gou, Tianyu Jiang. Financial Structure, Economic Fluctuations, and Economic Growth: An Analysis Based on the Optimal Industrial Allocation Framework. Management World.2019(5).pp29-43.
3. Jie Zheng, Qiuyun Zhao, Huan Zhua.Financial Structure and Environmental Pollution: A Preliminary Theoretical Study of New Structural Environmental Finance, Inquiry into Economic Issues.2021(10).pp165-172.
4. Xing Liang. Evaluation of Regional Ecological Efficiency in China and Analysis of Influencing Factors, Statistics and Decision.2017(19).pp143-147.
5. Shiyi Yuan, Haichao Shang, Yingying Yu. Analysis of Ecological Efficiency and Its Influencing Factors in the Beijing-Tianjin-Hebei Region: Based on Shapley Value Variable Selection and Game Cross-efficiency Model, Journal of Harbin University of Commerce (Social Science Edition).2020(3).pp108-116.
6. Yurong Cai, Huiling Wang. Empirical Study on the Impact of Industrial Structure Upgrading on Regional Ecological Efficiency, Statistics and Decision.2020(1）.pp110-113.
7. Huize Yao, Lei Shi. Empirical Study on the Coordinated Development of Provincial Financial Spatial Evolution and Ecological Efficiency, On Economic Problems.2019(11).pp33-37.
8. Yingyuan Liu,Tianlun Yang. Influence of Technology and Finance Development on Regional Ecological Efficiency: Spatial Econometric Analysis Based on Provincial Panel Data, Wuhan Finance Monthly.2021(5).pp74-81.
9. Qinghua Pang, Mingzhen Li, Han Li. Spatial Coupling and Coordinated Development of Financial Agglomeration, Regional Innovation, and Ecological Efficiency in the Yangtze River Economic Belt, Journal of Industrial Technological Economics.2019(2).pp68-76.
10. Jian Hua, Yueming Shi, Yufang Wang. Technology and Finance Development, Industrial Structure Optimization and Regional Ecological Efficiency: An Empirical Analysis Based on Spatial Econometric Model, Journal of Technology Economics.2021(5).pp16-26.
11. Jingyan Fu, Zonglin Yuan, Pian Zeng. Measurement of Regional Ecological Efficiency in China and Analysis of Influencing Factors, Industrial Economic Review.2016(6).pp85-97.
12. Yifu Lin, Ye Jiang. Economic Structure, Banking Structure, and Economic Development: An Empirical Analysis Based on Provincial Panel Data, Journal of Financial Research.2006(1).pp7-22.
13. Yaoqun Zheng, Xing Ge. Spatial Econometric Analysis of the Spillover Effect of Financial Agglomeration on Regional Ecological Efficiency, Ecological Economy.2020(5).pp141-146.
14. Jiangfeng Wu. Spatial Econometric Empirical Study on the Relationship between Financial Agglomeration and Regional Ecological Efficiency, Statistics and Decision.2016(3).pp149-153.
15. Pengbo Wang, Tao Yu, Wangping Wang. Financial Development, Financial Structure, and Economic Growth: An Analysis Based on Provincial Panel Data, Inquiry into Economic Issues.2017(1).pp120-127.
16. Shuitu Qian, Zhengmao Li. Financial Structure, Technological Progress, and Industrial Structure Upgrading: Empirical Verification Based on Cross-National Data, Economic Theory and Business Management.2018(12).pp24-32.
17. Guba, Egon.(1989).Fourth Generation Evaluation. Sage Publications Inc. London.pp165-168.

18. Ugeux,Georges.(2023).International Finance Regulation The Quest for Financial Stability. John Wiley & Sons Inc. New York.pp112-115.