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How does Financial Development Affect Regional Economic Growth in China? A Mediating Role of Industrial Structure Optimization

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ABSTRACT

Financial development and industrial structure optimization are two-wheeled engines for promoting high-quality development, but the causal identification of the two is still poorly understood. This paper addresses this research gap by comprehensively analyzing the relationship between them. Regional economic growth is a necessary condition for achieving high-quality development. Taking China as an example, this study empirically examines the role of financial development and industrial structure optimization in high-quality development using the entropy method, fixed effects, mediation effects and instrumental variable regression. The study results show that (i) financial development has actively promoted regional economic growth. (ii) The driving effect on the central and western regions is greater than that on the eastern region. (iii) There are differences in the mediating effect of industrial structure optimization and rationalization between different levels of financial development and economic growth. (iv) In addition, the mediating effect of industrial structure optimization is larger in the eastern region than in the central and western regions. (v) The mediating effect of industrial structure rationalization is not obvious in the eastern region, but has a masking effect in the central and western regions. Our findings provide new strategies for financial development and industrial structure optimization in developing countries.

KEYWORDS

Financial development; Industrial structure; Economic growth; Entropy method; Intermediary effect

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1. Introduction

At present, China's economic development has shifted from growing at a fast pace to developing at a high level. Under the background of the epidemic outbreak, the world economy is at a point of momentum, and the financial industry plays a key role in promoting economic development. China has pointed out that in accelerating the construction of a new development pattern, building a modern industrial system, unswervingly following the path of financial development with Chinese characteristics, and promoting the high-quality development of the real economy, the financial industry should fully play its role of serving the real economy and promote the continuous optimization of the industrial structure. How to play its role under the current background of financial development, contribute to the upgrading of the industrial structure and promote the continuous development of the economy is the first problem to be solved.

Throughout the development process of various countries, economic growth has always been an issue of great concern to each country, and the issue of economic growth has generally attracted the attention of scholars. Since 2008, China's economic growth rate has declined significantly due to the severe impact of the US subprime mortgage crisis. In 2019, China's economic growth rate fell to 6%, much lower than the growth rate in previous years. In the face of years of economic slowdown, whether China is experiencing the "middle-income trap" has become a topic of great concern for the international community. In addition, the outbreak of COVID-19 in 2019, combined with the economic and trade frictions between China and the United States, the pressure from home and abroad has further exacerbated the weak Chinese economy. As the core of the modern economy, the financial industry has become increasingly important in driving the economy. In 2018, the financial industry's value added accounted for 7.68% of GDP, and in 2019, the financial industry's value added contributed 7.73% to economic growth, rising continuously for several years. The impact of the financial industry on regional economic growth is significant. By influencing savings and investment, finance indirectly affects the flow and allocation of resources, further improves the conversion efficiency of savings and investment, and the expansion of the scale of financial development lays a good foundation for economic growth. The process of continuous development of the financial industry is the process of continuous optimization of the financial structure. At present, there is still a wide gap between the financial industry of developing countries, represented by China, and that of developed countries. Problems such as small-scale financial development and uncoordinated internal structure still exist.

How to effectively address these issues to better promote the contribution of the financial industry to economic growth is a long-term issue that deserves our consideration. Financial development and industrial structure are two carriages of economic growth. Optimizing and upgrading industrial structure plays a crucial role in promoting economic growth. The optimization of industrial structure cannot be separated from the effective allocation of capital. Therefore, this study aims to (1) investigate the impact of financial development on regional economic growth and (2) introduce industrial structure optimization variables to investigate their mediating role. By exploring the role of industrial structure optimization in financial development and regional economic growth, this paper studies the impact of financial development on regional economic growth, forms a new research path of "financial development industrial structure optimization-regional economic growth", explores the relationship between them, and strives to provide a little reference for the development of financial industry and economic growth. Based on China's provincial panel data from 2006 to 2019, this paper empirically examines the impact of financial development on regional economic growth and the mechanism of industrial structure and puts forward relevant policy recommendations. The marginal contributions of this paper may be (1) the redefinition of financial development indicators into four dimensions, (2) the introduction of industrial structure optimization as a mediating variable, and (3) the inclusion of instrumental variables to further enhance the reliability of the article.

The paper is structured as follows: Part II Literature Review, Part III Theoretical Analysis and Research

Hypothesis, Part IV Research Design, Part V Analysis of Empirical Results, Part VI Testing of Mechanisms, Part VII Treatment of Endogeneity, and Part VIII Research Conclusions and Policy Recommendations.

2. Relation to the literature

2.1. Financial development and economic growth

Scholars at home and abroad have studied the relationship between financial development and economic growth. American scholar Goldsmith (1969) first started to pay attention to the relationship between financial development and economic growth, Author (1969) proposed to use the financial ratio as an indicator to measure the development of financial structure, that is, the ratio of the value of financial assets to the value of real assets. However, due to the lack of financial statistics in China, scholars mostly use the ratio of the sum of bank deposits and loans to GDP as an index to measure financial structure. In the 1970s, McKinnon and Shaw took developing countries as research objects and put forward the theory of financial deepening from the perspective of "financial repression" and "financial deepening", respectively, which further provided the theoretical basis for the financial and economic development of developing countries. Xie Ping, the first scholar to start research in this field in China, published the paper "Structure Analysis of Financial Assets", which showed the profound impact of financial deepening and financial industry reform on China's economic operation (Xie, 1992). With the deepening of theoretical research on financial development, scholars mostly start from empirical analysis and get different opinions from different angles and using different methods.

Some scholars argue that financial development has a positive impact on regional economic growth. King and Levine (1993) argued that financial development is closely related to economic growth and physical capital accumulation. Levine et al. (2000) argued that strengthening legal reform can help financial development to promote economic growth. Lin, Su and Jiang (2009) conducted a study that proposed the theory of optimal financial structure because the structure of factor endowments determines the nature of industrial and technological structure. Qin and Li (2013), based on the Keynesian-Schumpeter theory of money and finance, proposed that the financial structure should be changed through capital deepening to improve the low efficiency of the financial sector and then generate sustainable economic growth. Zhang (2016) established a static and dynamic spatial panel model, and found that financial development has a significant positive effect on the growth of the real economy in the short and long run.

Some scholars say that financial development does not have a significant impact on economic growth, or even has an inhibiting effect. Lu and Zhang (2012) argued that the development of China's financial industry is still at an early stage, the phenomenon of financial capital leaving the real economy is serious, and the appearance of financial prosperity hides the essence of the healthy development of the real economy. Zhou et al. (2014) argued that the speed of financial development in China was much faster than the speed of economic development, and the excessive expansion of the financial industry exceeded the needs of the real economy, resulting in a liquidity crisis and a financial crisis, which was not conducive to local economic growth. Tian (2017) found that there was a serious imbalance in domestic financial development and a serious polarization of resource allocation, which broke the precondition for financial development to promote economic growth, namely, to promote capital accumulation and optimize resource allocation, which was detrimental to economic growth.

2.2. Financial development and industrial structure optimization

The financial industry plays an important role in the process of industrial structure upgrading. Many factors affect the upgrading of industrial structure, among which financial development is the most important. Liang (1998) pointed out that the upgrading of industrial structure has benefited from the rapid development of the financial sector. Buera et al. (2002) argued that financial development can improve financing efficiency, which can reduce the

financing cost of enterprises and promote the upgrading of industrial structure. Chava et al. (2013) argued that the financial sector can reduce transaction costs and enterprise costs by relaxing regulations and improving information communication, thus promoting the upgrading of industrial structure.

Many scholars say that financial development affects industrial structure under the influence of intermediate variables. The development of financial industry plays an important role in promoting the upgrading of industrial structure through the intermediary variables of economic development level, capital allocation efficiency and technological innovation. (Mou, Sheng & Zhao, 2022; Li and Ran, 2021; Li, Su & Fu, 2022; Yi and Liu, 2018). Yang et al. (2022) confirmed that China's monetary and insurance financial services have a positive supporting effect on the optimization of industrial structure under the influence of the intermediate variables of scientific and technological innovation. Using the partial differential method of spatial regression model, He et al. (2020) found that internet finance has a positive spatial spillover effect on the upgrading of industrial structure, playing an important driving role in the optimization and rationalization of China's industrial structure. Lin and Zhao (2019), through the system GMM method, found that financial development plays an important role in improving the upgrading of industrial structure.

2.3. Financial development, industrial structure optimization, and economic growth

In recent years, there have been many papers on the relationship between financial development, industrial structure optimization and economic growth. Hu et al. (2013) studied the situation of private economy and found that private finance plays an important role in promoting China's economic growth, and this role is mainly realized through its impact on the secondary industry, namely industry, construction, and other industries. Su et al (2014), through panel cointegration and vector error correction model, found that financial development plays a significant role in promoting economic growth, but the direction of the role is different. Financial efficiency tends to inhibit the positive effect of financial development on economic growth, and the rapidly developing financial industry tends to promote the upgrading of industrial structure, thus playing a great role in promoting economic growth. Wang and Zhang (2022) divided the financial structure into banks and financial markets and argued that only when the adjustment of the financial structure and the financing needs of industrial structure upgrading are well matched, the development of the financial structure tends to promote economic growth by optimizing the efficiency of resource allocation. In addition, industrial structure upgrading can enhance the role of digital infrastructure construction in economic development (Hu and Zhang, 2023).

However, some scholars believe that the role of finance in promoting economic growth through industrial structure optimization is not obvious. Chen and Zhang (2017) argued that financial development promoted its development to a greater extent but had no significant impact on industrial structure optimization and economic growth. On the contrary, economic growth had a significant effect on financial development and industrial structure upgrading, and industrial structure upgrading promoted its financial development. Chen et al. (2020) through the methods of panel VAR model and impulse response, believed that the three did not reach the degree of coordinated development, the scale of financial development still has a strong externality on rural economic growth, and economic growth tends to promote further expansion of rural financial scale, thus laying a financial foundation for industrial structure upgrading, and the feedback effect on rural development is significant.

3. Theoretical analysis and research hypothesis

3.1. The impact of financial development on economic growth

The relationship between financial development and economic growth is still debated by most scholars.

Finance mainly absorbs funds through financing methods such as stocks, loans, securities and insurance, and then reallocates the funds to direct them to be invested in a more reasonable and efficient direction. The early theory of financial development holds that the continuous development of the financial industry creates a diversified financing model that can absorb a larger scale of deposits, and the increase in savings further promotes the increase in investment. According to the financial structure theory, the continuous development of the financial industry is the process of continuous change of the financial structure. At present, China still adopts the indirect financing mode through banks as the main mode. Compared with previous years, the proportion of deposits absorbed by banks has decreased, but it still accounts for a high proportion. Diversified channels meet the differentiated needs of different groups. The Keynesian macroeconomic theory mentioned that investment is one of the three carriages to promote economic growth. The financial industry realizes short-term economic growth by absorbing deposits and reinvesting them. More financing channels accelerate the operation of funds and further improve the rationality of capital allocation. The development of Internet finance has further improved the liquidity of funds. Under the influence of the Internet, the two major financial institutions, banks and stocks, have become more active, their liquidity has further improved, and more investment opportunities have been created. According to the theory of financial repression and financial deepening, government intervention distorts interest rates and exchange rates, which cannot truly reflect the relationship between the supply and demand of funds and reduces the efficiency of financing. A moderate reduction in government intervention tends to promote the development of the financial market. In addition, the development of the financial industry helps to reduce the cost of obtaining information. As a platform for raising funds, the financial industry provides financial services such as investment, financing, payment and settlement to the economy and society in various aspects, promoting consumption and investment, thus supporting economic growth. Based on the above analysis, although the development of the financial industry also tends to bring a certain degree of negative impact, it is more reflected in the promotion of economic development level.

Based on the above analysis, this paper puts forward hypothesis H1: financial development is conducive to improving the level of economic development and has a positive role in promoting economic growth.

3.2. Intermediary effect of industrial structure optimization on financial development and economic growth level

The most direct effect of financial development on industrial structure is to provide financial support. The financing function of the financial market can meet the demand for funds in the process of industrial structure optimization, guide the investment of funds, optimize the allocation of resources, and promote the flow of funds to the dominant industries with advantages in the industrial structure. The development of the financial market is conducive to improving information transparency, reducing the cost of enterprise information transactions, and can well solve the development of small start-ups with good development prospects but financing difficulties. Moreover, the financial market is not only conducive to the efficient allocation of resources in the process of industrial structure adjustment, but also conducive to the upgrading of industrial structure through its good adaptability to different industrial structure conditions. In the process of guiding capital flows, financial development tends to automatically protect industries on the verge of obsolescence and be more friendly to industries with large development space. Therefore, the development of finance contributes to the optimization of industrial structure, and the optimization of industrial structure tends to further promote the development of finance to a higher level and form a more reasonable financial structure. The continuous upgrading and optimization of industrial structure makes the use of social resources more efficient, attracts a large amount of capital and talents to the advantageous industries, further improves the employment rate and makes the allocation of human capital more reasonable, which has a great driving effect on economic development. The Paddy-Clark theorem points out that the income

gap between different industries tends to force the flow of human resources, and different industrial structures tend to lead to different production methods and factors of utilization efficiency, which tend to play different roles in economic growth. The upgrading of industrial structure promotes the innovation of science and technology. The different proportion of each industry depends on the continuous development of each enterprise, and innovation is one of the core elements of the long-term development of enterprises. The reasonable industrial structure creates a good competitive environment among industries through the development of superior enterprises, and enterprises increase R&D investment to form a new trend of industrial development. Driven by technological progress, the optimization and upgrading of industrial structure has a positive impact on economic growth.

Based on the above analysis, this paper puts forward hypothesis H2: the optimization of the industrial structure plays an intermediary role in the process of financial development promoting the level of economic development, that is, financial development promotes economic growth through the optimization of industrial structure.

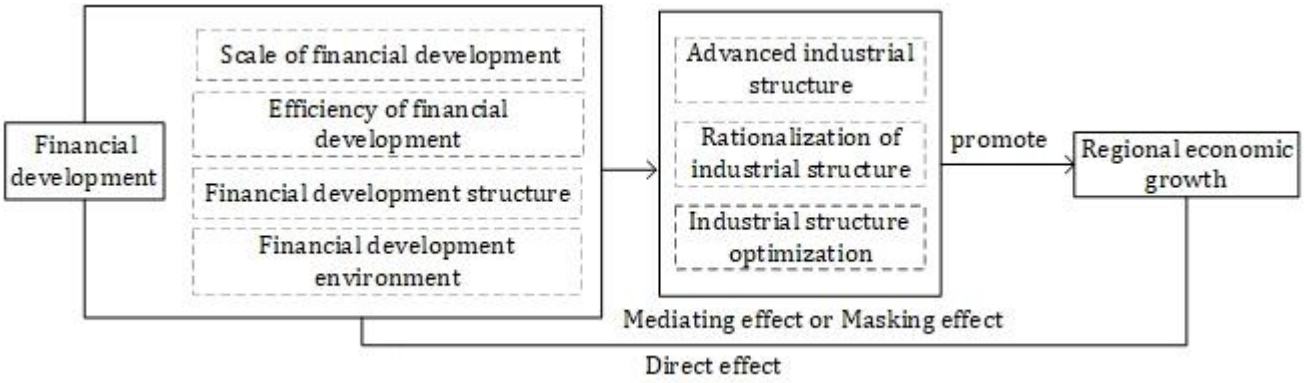

Figure 1. The mechanism of financial development, industrial structure optimization, and regional economic growth.

4. Research design

4.1. Model establishment

According to the above theoretical analysis, financial development tends to affect regional economic growth, and the optimization of industrial structure may have a mediating effect in the process of financial development affecting economic growth.

$$Economic_{i,t} = \alpha_1 + cFinance_{i,t} + \alpha_3 Controls_{i,t} + \mu_i + \varepsilon_{i,t} \quad (1)$$

In order to further test whether financial development affects regional economic growth through industrial structure optimization, this paper adopts the three-stage method to test the mediating effect of industrial structure optimization with reference to Wen & Ye (20-22) and Judd and Kenny (1981), setting up the following models (2) and (3). Models (1) - (3) are used to test the final mediation effect.

$$Industry_{i,t} = \beta_1 + aFinance_{i,t} + \beta_3 Controls_{i,t} + \mu_i + \varepsilon_{i,t} \quad (2)$$

$$Economic_{i,t} = \gamma_1 + c'Finance_{i,t} + bIndustry_{i,t} + \gamma_5 Controls_{i,t} + \mu_i + \varepsilon_{i,t} \quad (3)$$

In the above model, i represents the province, t represents the year, Economic is the measurement index of regional economic growth, Finance is the measurement index of financial development, Industry is the measurement index of industrial structure optimization, and Controls represents a set of control variables such as consumption level, degree of opening up, education level and government expenditure. The coefficient c in equation (1) reflects the total effect of the independent variable on the dependent variable, and the coefficient a in equation (2) reflects the effect of the independent variable on the mediating variable. The coefficient b in equation (3) is the

direct effect of the independent variable on the dependent variable after controlling for the mediating variable. The c' is the direct effect of the independent variable on the dependent variable after controlling for the mediating variable. μ_i represents the individual fixed effect and $\varepsilon_{i,t}$ represents the random error term. The basis for judging the existence of the mediating effect is as follows: If the coefficient a in equation (2), the coefficient b in equation (3) and the coefficient c in equation (3) are significant at the same time, the mediating effect is significant; if the coefficients a or b and c' are not significant, the mediating effect does not exist; If the coefficients a, b and c' are all significant and c' is less than the coefficient c, then there is a partial mediation effect; if a and b are significant but c' is not, then there is a full mediation effect.

4.2. Variable selection

4.2.1. Explained variable: regional economic growth

This paper selects regional GDP per capita to represent the level of regional economic development, takes 2006 as the base period to deflate the price index, takes its natural logarithm and expresses it as lnpgdp.

4.2.2. Core explanatory variable: financial development (fin)

As for the measurement standard of the level of financial development, it has evolved from a single variable to a multivariate structure. Scholars generally choose M2/GDP as the measurement index of the level of financial development (King & Levine, 1993). Li et al. (2011) used the level of development of the banking industry as a proxy variable for the level of financial development. Zhu et al. (2006) and Xie and Fang. (2011) used the Fan Gang index to measure the level of regional financial development. Su and Xu (2014) measured the level of financial development from two aspects: the scale of financial intermediation and financial efficiency.

Following the practice of Li (2020), this paper divides financial development into three aspects: scale, efficiency, and structure, and adds the environment of financial development. Among them, the scale of financial development is represented by the size of the financial market, the number of financial institutions and the level of financing to some extent. The efficiency of financial development is reflected in the ability of financial institutions to convert savings into investment. The sum of the number of funds raised by regional stocks (A-shares) and bonds measures the scale of financing through direct financing, and the balance of loans of financial institutions at the end of the year measures the scale of financing through indirect financing. In this paper, the ratio of the total funds raised by stocks and bonds (100 million yuan) to the balance of loans of financial institutions at the end of the year (100 million yuan) is used to measure the financial development structure by the ratio of direct financing and indirect financing, which is expressed as fis. The financial development environment is measured by the number of listed companies in the region at the end of the year. The more listed companies there are, the better the financial development environment in the region is represented by the fic.

4.2.3. Intermediary variable: optimization of industrial structure (iso)

Following to the method of Ke (2008), the hierarchical coefficient of the industrial structure is used to represent the optimization level of the industrial structure, which is denoted as iso1.

$$iso1 = \sum_{i=1}^{n} q_i * i = q_1 * 1 + q_2 * 2 + q_3 * 3 \quad (4)$$

In the above formula, q_i is the proportion of the secondary industry in the total value of the three industries, and the higher the level coefficient of industrial structure, the higher the level of industrial structure.

Another measurement index of industrial structure optimization is the rationalization of industrial structure. Referring to Wei & Zhong (2021), the deviation degree of industrial structure is used to express the rationalization

level of industrial structure, which is expressed by iso2. The index adopts the classical calculation formula:

$$iso2 = \sum_{i=1}^{n} \left| \frac{Y_i/L_i}{Y/L} - 1 \right| \quad (5)$$

By deforming the formula, we can obtain:

$$iso2 = \sum_{i=1}^{n} \left| \frac{Y_i/Y}{L_i/L} - 1 \right| \quad (6)$$

In the formula, iso2 is the deviation degree of industrial structure, Y represents the output, L represents the number of the labor force, i represents the industry, represents the number of industrial departments, represents the output of the industry, n represents the number of the labor force in the industry. Y_i represents the output of the industry and i represents the labor force of the industry. The closer the deviation degree of industrial structure is to 0, the higher the level of rationalization of industrial structure is. In the optimal state, the productivity of each industry is the same, that is, the per capita output value of labor is equal to 1, but the labor productivity between industries cannot be the same. Therefore, the deviation degree of industrial structure is chosen to represent the rationalization degree of industrial structure.

4.2.4. Control variables

Referring to the methods of Wang et al. (2017) and Wei and Zhong (2021), this paper selects the consumption level, labor input, degree of opening up and education level as control variables. Among them, the consumption level (*congr*) selects the growth rate of total retail consumption in the region in the current year as the measurement standard and deflates the price index with 2006 as the base period. Labor input (*labgr*) is measured by the sum of the number of private enterprises and individuals employed in local urban areas (tens of thousands). The degree of openness to the outside world (open) is measured by the total value of imports and exports in the current year (US$10,000) and expressed in logarithms. The level of education (*edu*) is represented by the number of students in ordinary higher education institutions (ten thousand). Government expenditure (gov) is represented by the share of local government expenditure in GDP of the current year.

4.3. Data sources and description

This paper mainly selects the panel data of 30 provinces in China (excluding Tibet, Hong Kong, Macau and Taiwan) from 2006 to 2019. The data mainly come from the statistical yearbooks of each province, China Financial Statistical Yearbook, China National Knowledge Infrastructure (CNKI) economic and social big data research platform, and Wind financial database. Table 1 shows the descriptive statistics of the main variables, and the observed value of the variable is 420. There are large differences between the level of economic growth, financial development and industrial structure optimization in each province.

Table 1. Descriptive statistics of main variables.

Variable names	Number of observations	Average	Standard deviation	Minimum	Maximum
lnpgdp	420	10.57	0.60	8.72	12.05
fin	420	0.16	0.11	0.05	0.61
iso1	420	2.34	0.13	2.10	2.83
iso2	420	1.74	0.69	0.64	6.03
congr	420	1.27	0.13	1.00	1.51
lnopen	420	15.08	1.63	10.90	18.51
edu	420	80.07	48.66	3.60	232.00
gov	420	0.203	0.09	0.08	0.55

5. Analysis of empirical results

5.1. Correlation test of main variables

Table 2 reports the correlation test of the main variables, and the results show that there is a strong correlation between the variables. The level of regional economic growth is significantly positively correlated with financial development and industrial structure optimization at the 1% level; industrial structure optimization is significantly negatively correlated at the 1% level; openness and education level are positively correlated at the 1% level; and government expenditure and consumption level are significantly correlated at the 5% and 10% levels respectively.

Table 2. Correlation test of major variables.

	lnpgdp	fin	iso1	iso2	congr	lnopen	edu	gov
lnpgdp	1							
fin	0.72***	1						
iso1	0.75***	0.81***	1					
iso2	-0.67***	-0.52***	-0.49***	1				
congr	-0.08*	-0.24***	-0.23***	0.05	1			
lnopen	0.71***	0.71***	0.55***	-0.58***	-0.05	1		
edu	0.33***	0.32***	0.07	-0.38***	0.04	0.63***	1	
gov	-0.13**	-0.23***	-0.03	0.31***	-0.12**	-0.66***	-0.61***	1

5.2. Empirical test on the impact of financial development on regional economic growth

Table 3 shows the empirical test of financial development and regional economic growth. Prior to the multiple regression analysis, the Hausman test can be used to determine the type of effect in the model. The null hypothesis is that there is no significant difference in the coefficient, if the p-value is <0.05, the null hypothesis is rejected and the fixed effect model is selected, otherwise the random effect model is selected. Based on the Hausman test, the statistical result is 30.28, Prob > chi2 = 0.0000, and the null hypothesis is rejected by the fixed effect model.

Table 3. Regression results of financial development and regional economic growth.

	(1) lnpgdp	(2) lnpgdp	(3) lnpgdp	(4) lnpgdp	(5) lnpgdp
fin	5.39***	5.85***	2.52***	1.92***	1.01***
	(0.34)	(0.35)	(0.25)	(0.28)	(0.25)
congr		0.66***	0.16*	0.14*	0.343***
		(0.14)	(0.09)	(0.09)	(0.07)
lnopen			0.63***	0.55***	0.45***
			(0.02)	(0.03)	(0.03)
edu				0.01***	0.01***
				(0.00)	(0.00)
gov					4.00***
					(0.31)
_cons	9.71***	8.80***	0.48	1.42***	2.01***
	(0.06)	(0.20)	(0.35)	(0.40)	(0.34)
N	420.00	420.00	420.00	420.00	420.00
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.34	0.37	0.77	0.78	0.84

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

As shown in the table, column (1) shows the influence of financial development on regional economic growth

without adding control variables, and columns (2) - (5) show the influence of financial development on regional economic growth by adding the control variables of consumption level, degree of openness to the outside world, education level and government expenditure level one by one. It can be seen from the table that by adding the control variables one by one, the effect of financial development on economic growth gradually decreases and is significant at the 1% statistical level. The effect of the control variables on economic growth is significantly positive at the 1% level, which has a positive effect on regional economic growth.

5.3. Endogeneity treatment and robustness test

5.3.1. Endogeneity treatment

Given the possibility of missing variables and reverse causality in the model, the lag of the core explanatory variables is used as an instrumental variable to reduce the impact of endogeneity as much as possible. The one-period-lagged explanatory variables were included in the model as instrumental variables, and the two-stage least squares (2SLS) method was used for regression analysis. Then, the one-period-lagged industrial structure optimization variables are included in the mediation effect model to test the robustness of the mediation effect.

The results are presented in Table 4. In column 1, the estimated coefficient of the regression of the corresponding explanatory variables by the instrumental variables in the first stage is significant, with a P value of 0.018, indicating that the instrumental variables have good explanatory power for the endogenous variables, and the F value is greater than 10, indicating that the instrumental variables meet the relevant conditions and there is no problem of weak instrumental variables. According to the second stage regression results, except for education level, which is not significant, other variables are significant at 1% level.

Table 4. 2SLS estimation of instrumental variables for regional economic growth.

	(1) First-Stage	(2) 2SLS	(3) 2SLS-FE
fin		1.15***	1.19***
		(0.23)	(0.30)
L.fin	0.98***		
	(0.018)		
congr	0.03**	-0.78***	-0.18*
	(0.01)	(0.20)	(0.10)
lnopen	0.01***	0.27***	0.39***
	(0.00)	(0.02)	(0.03)
edu	0.00**	-0.00	0.00***
	(0.00)	(0.00)	(0.00)
gov	0.10***	2.32***	3.27***
	(0.02)	(0.34)	(0.31)
_cons	-0.17***	6.97***	3.81***
	(0.03)	(0.53)	(0.38)
N	390.00	390.00	390.00
Model setting	FE	FE	FE
Adjusted-R2	0.96	0.72	
Hausman		0.000	

*Notes: *, **, and ***, indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

Table 5 shows the robustness test results of the mediating effect model. The optimization of the industrial structure still plays a partial mediating effect, and the mediating effect accounts for 22.61% of the total effect. The rationalization of the industrial structure plays a masking effect, and the mediating effect accounts for 17.19% of

the direct effect. However, the sign has not changed, while the size of the mediating effect has decreased. Therefore, it can be shown that the above conclusions are robust.

Table 5. Robustness test results of the mediating effect of instrumental variables.

	(1) lnpgdp	(2) L.iso1	(3) lnpgdp	(4) L.iso2	(5) lnpgdp
L.fin	0.96***	0.20***	0.74***	1.47***	1.16***
	(0.24)	(0.05)	(0.24)	(0.47)	(0.23)
L.iso1			1.08***		
			(0.23)		
L.iso2					-0.14***
					(0.03)
congr	-0.17*	-0.17***	0.02	-0.01	-0.17*
	(0.10)	(0.02)	(0.10)	(0.19)	(0.09)
lnopen	0.39***	0.01	0.38***	-0.16***	0.37***
	(0.03)	(0.01)	(0.03)	(0.05)	(0.03)
edu	0.01***	0.00***	0.00***	-0.01***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gov	3.50***	0.39***	3.09***	-4.27***	2.92***
	(0.29)	(0.07)	(0.30)	(0.58)	(0.30)
_cons	3.76***	2.26***	1.32**	5.25***	4.47***
	(0.37)	(0.09)	(0.63)	(0.75)	(0.39)
N	390.00	390.00	390.00	390.00	390.00
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.83	0.67	0.84	0.28	0.84

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

5.3.2. Robustness test

1. Bootstrap (independent sampling) test and Sobel test are used for robustness test of mediating effect

As shown in Table 6, 1000 random samples are sampled for each sample. The confidence interval of the mediating effect a*b of the rationalization of the industrial structure after bias adjustment at the level of 95% is (0.1409675-0.6549575), and the Sobel Z value is significantly positive, indicating that the mediating effect is valid.

Table 6. Bootstrap and Sobel test results.

	Test conclusions	Total effect C	Mediating effect a*b	Direct effect C'	a*b [95%conf. interval]	Sobel Z-score	Effect proportion calculation formula	Direct effect
Financial development => optimization of industrial structure => regional economic growth	Partial mediating effect	1.01	0.27	0.74	1.31 — 2.19	8.56*** (0.00)	$\frac{a*b}{c}$	26.99 %
Financial development => High deviation of industrial structure => regional economic growth	Masking effect	1.01	-0.28	1.30	0.14 — 0.65	3.14*** (0.00)	$\left\lvert\frac{a*b}{c'}\right\rvert$	21.88 %

2. Replace the explained variable

Since the core explanatory variable, the level of financial development, is composed of several indicators, this paper selects the proxy variable for the explained variable, the level of economic growth, for the robustness test and uses the level of regional real economic growth as a proxy for regional GDP per capita. The level of real economic growth is calculated by subtracting the value added of the real estate industry and the financial industry in the current year from the regional GDP excluding the price factor and taking the logarithm. The test results are shown in the following table and the results are robust.

Table 7. Financial development and real economic growth.

	(1) lnsgdp	(2) lnsgdp	(3) lnsgdp	(4) lnsgdp	(5) lnsgdp
fin	5.79***	6.56***	3.19***	2.51***	1.63***
	(0.92)	(1.18)	(0.559)	(0.616)	(0.49)
congr		1.09***	0.587***	0.561***	0.76***
		(0.13)	(0.11)	(0.11)	(0.09)
lnopen			0.64***	0.54***	0.45***
			(0.06)	(0.07)	(0.05)
edu				0.01*	0.01**
				(0.00)	(0.00)
gov					3.86***
					(0.47)
_cons	8.59***	7.09***	-1.33*	-0.25	0.32
	(0.15)	(0.33)	(0.72)	(0.79)	(0.63)
N	420.00	420.00	420.00	420.00	420.00
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.40	0.48	0.82	0.83	0.88

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

Table 8. Robustness test of the mediating effect of the real economy.

	(1) lnsgdp	(2) iso1	(3) lnsgdp	(4) iso2	(5) lnsgdp
fin	1.63***	0.17***	1.41***	1.69***	1.93***
	(0.24)	(0.05)	(0.23)	(0.44)	(0.23)
iso1			1.34***		
			(0.23)		
iso2					-0.18***
					(0.03)
congr	0.76***	-0.11***	0.91***	-0.09	0.74***
	(0.07)	(0.02)	(0.07)	(0.13)	(0.07)
lnopen	0.45***	0.01**	0.43***	-0.13***	0.43***
	(0.03)	(0.01)	(0.03)	(0.05)	(0.03)
edu	0.01***	0.00***	0.00***	-0.01***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gov	3.86***	0.63***	3.02***	-4.23***	3.10***
	(0.30)	(0.07)	(0.33)	(0.56)	(0.31)
_cons	0.36	1.98***	-2.34***	4.98***	1.21***
	(0.33)	(0.07)	(0.55)	(0.61)	(0.34)
N	420.00	420.00	420.00	420.00	420.00
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.87	0.70	0.88	0.32	0.88

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

Taking the real economic growth as the explained variable into the mediating effect model, the optimization of the industrial structure plays a partial mediating effect on the real economic growth, accounting for 13.73% of the total effect size, and the rationalization of the industrial structure plays a masking effect on the regional real economic growth, the effect size is 15.76%, which is consistent with the results of the basic regression model.

3. Winsorization

In this paper, the main continuous variables are winsorised at the 1% quantile to reduce the influence of extreme values on the empirical results. The positive promoting effect of financial development on regional economic growth is improved, the mediating effect of industrial structure optimization is 26.07%, and the masking effect of industrial structure rationalization is 18.52%. This paper further confirms the empirical results.

6. Mechanism analysis: Mediating effect analysis of industrial structure optimization

To investigate whether financial development can achieve regional economic growth through the optimization of industrial structure and the rationalization of industrial structure, the two are each used as mediating variables in the mediation effect analysis, and the results are shown in Table 9.

Table 9. Testing the mediating effect of industrial structure upgrading and rationalization.

	Model (1) lnpgdp	Model (2) iso1	Model (3) lnpgdp	Model (4) iso2	Model (5) lnpgdp
fin	1.01***	0.17***	0.74***	1.69***	1.30***
	(0.25)	(0.05)	(0.23)	(0.44)	(0.24)
iso1			1.64***		
			(0.23)		
iso2					-0.17***
					(0.03)
congr	0.34***	-0.11***	0.53***	-0.09	0.33***
	(0.07)	(0.02)	(0.07)	(0.13)	(0.07)
lnopen	0.45***	0.01**	0.43***	-0.13***	0.43***
	(0.03)	(0.01)	(0.03)	(0.05)	(0.03)
edu	0.01***	0.00***	0.00**	-0.01***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gov	4.00***	0.63***	2.98***	-4.23***	3.29***
	(0.31)	(0.07)	(0.33)	(0.56)	(0.32)
_cons	2.01***	1.98***	-1.24**	4.98***	2.85***
	(0.34)	(0.07)	(0.56)	(0.61)	(0.35)
N	420.00	420.00	420.00	420.00	420.00
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.84	0.70	0.86	0.32	0.89

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

As shown in the figure, model (1) tests the effect of financial development on regional economic growth, and the coefficient c is significantly positive; model (2) is the effect of financial development on industrial structure optimization; model (3) combines the effect of financial development and industrial structure optimization on regional economic growth, and the direct effect c' coefficient of financial development is positive and passes the significance test at the 1% level. Therefore, financial development significantly promotes regional economic growth. According to model (2) and model (3), financial development has a positive effect on the optimization of industrial structure, and the optimization of industrial structure has a positive effect on regional economic growth. The mediating effect of industrial structure optimization is significant at the 1% level, and the mediating effect a*b of

industrial structure optimization is equal to the indirect effect c' of financial development on economic growth. Therefore, the optimization of industrial structure has a partial mediating effect, and the proportion of the mediating effect in the total effect a*b/c is 26.99%. The level of consumption, the degree of openness, the level of education and the level of government expenditure have a positive effect on economic growth, and the results are significant at the 1% level. In conclusion, the optimization of the industrial structure plays a partial mediating role between financial development and regional economic growth.

Model (4) tests the impact of financial development level on the rationalization of industrial structure, and the coefficient is positive and significant at the level of 1%. Model (5) tests the impact of the financial development level and rationalization of industrial structure on regional economic growth, and the effect of financial development level on economic growth is significantly positive under the joint action of the two. However, the deviation degree of industrial structure has a significantly negative effect on regional economic growth. The level of consumption, the degree of opening to the outside world, the level of education, and government expenditure play a positive role in promoting regional economic growth, which is significant at the level of 1%. Because a * b and c' opposite signs, the cover effect, indirect effect, and the direct effect of the absolute value of ratio |a * b/c| of 21.88%.

7. Heterogeneity analysis

China is a vast country, and there are big differences in the level of financial development, industrial structure and economic growth in different regions. In order to obtain research results with regional differences, this paper divides the samples selected from 2006 to 2019 into the eastern and central regions and the western regions. This paper tests the mediating effect of industrial structure optimization between the level of financial development and economic growth, in order to investigate the influence of regional division differences on the mediating effect. The subsample regression results are shown in Table 10. The level of financial development has a larger impact on the central and western regions, while it has a smaller impact on the eastern region. The possible reason is that the eastern region has a relatively complete industrial chain structure and the coastal cities have developed foreign trade, while the central and western regions have relatively slow development and the effect of the financial sector on economic growth is in the dividend period.

Table 10. Regression results of heterogeneity test.

	(1) Total sample	(2) Eastern Region	(3) Midwest Region
	lnpgdp	lnpgdp	lnpgdp
fin	1.01***	0.75***	3.25***
	(0.30)	(0.28)	(0.90)
congr	0.34***	-0.10	0.62***
	(0.09)	(0.15)	(0.11)
lnopen	0.45***	0.74***	0.35***
	(0.03)	(0.08)	(0.03)
edu	0.01***	0.00	0.01***
	(0.00)	(0.00)	(0.00)
gov	4.00***	1.47*	3.58***
	(0.37)	(0.76)	(0.51)
_cons	1.91***	-1.90*	3.04***
	(0.48)	(1.09)	(0.47)
N	420.00	154.00	266.00
Model setting	FE	FE	FE
Adjusted-R2	0.92	0.90	0.89

*Notes: *, ** and *** indicate significance at the level of 10%, 5% and 1%, respectively, with robust standard errors in parentheses.*

When the industrial structure optimization is included in the equation, the test results of the mediation effect are shown in Table 11. Table 12. reports the mediation effect of the test results of the industrial structure optimization in the eastern region. Industrial structure optimization in the eastern region plays a role in the mediating effect, accounting for 46.78% of the total effect. Table 12 shows the mediation effect test results of industrial structure optimization in the central and western regions. Industrial structure optimization plays a partial mediating effect in the central and western regions, and industrial structure rationalization plays a masking effect in the central and western regions, which is consistent with the basic regression conclusion of this paper.

Table 11. Test results of the mediating effect of industrial structure optimization in the Eastern region.

	Model (1) lnpgdp	Model (2) iso1	Model (3) lnpgdp	Model (4) iso2	Model (5) lnpgdp
fin	0.75***	0.19**	0.40*	1.04	0.74**
	(0.28)	(0.05)	(0.22)	(0.71)	(0.29)
iso1			3.25***		
			(0.35)		
iso2					0.01
					(0.05)
congr	-0.10	-0.10***	0.21*	0.03	-0.10
	(0.15)	(0.03)	(0.19)	(0.18)	(0.15)
lnopen	0.74***	0.048***	0.58***	-0.22**	0.74***
	(0.08)	(0.01)	(0.07)	(0.09)	(0.08)
edu	0.00	0.00***	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gov	1.47*	0.93***	-1.54**	-1.71	1.49*
	(0.76)	(0.16)	(0.72)	(1.26)	(0.77)
_cons	-1.90*	1.79***	-7.73***	4.74***	-1.94*
	(1.09)	(0.18)	(1.22)	(1.296)	(1.15)
N	154.00	154.00	154.00	154.00	154.00
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.89	0.96	0.94	0.50	0.89

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

Table 12. Test results of the mediating effect of industrial structure optimization in Central and Western China.

	Model (1) lnpgdp	Model (2) iso1	Model (3) lnpgdp	Model (2) iso2	Model (3) lnpgdp
fin	3.248***	0.652***	2.757***	0.776	3.408***
	(0.904)	(0.184)	(0.834)	(1.148)	(0.799)
iso1			0.752**		
			(0.359)		
iso2					-0.206***
					(0.034)
congr	0.620***	-0.088***	0.686***	-0.216	0.575***
	(0.114)	(0.020)	(0.118)	(0.245)	(0.105)
lnopen	0.351***	-0.007	0.356***	-0.057	0.339***
	(0.033)	(0.006)	(0.033)	(0.065)	(0.028)
edu	0.006***	0.002***	0.005**	-0.010***	0.004***
	(0.002)	(0.000)	(0.002)	(0.003)	(0.002)
gov	3.580***	0.364***	3.306***	-4.400***	2.674***
	(0.507)	(0.104)	(0.485)	(0.687)	(0.492)
_cons	3.034***	2.209***	1.373	5.419***	4.151***
	(0.466)	(0.081)	(0.999)	(1.103)	(0.444)
N	266	266	266	266	266
Model setting	FE	FE	FE	FE	FE
Adjusted-R2	0.899	0.794	0.901	0.758	0.916

*Notes: *, **, and *** indicate significance at the level of 10%, 5%, and 1%, respectively, with robust standard errors in parentheses.*

8. Research conclusions and policy implications

This paper constructs a comprehensive index to measure the level of financial development from the four aspects of the financial development scale, efficiency, structure, and the environment through the entropy method, comprehensively considers the financial development of each region, tests its impact on the local economic growth level, and examines the mechanism of industrial structure optimization between the two.

8.1. Research conclusions

First, China's financial development level has a significant positive supporting effect on regional economic growth. The expansion of financial development scale, the improvement of financial savings into investment capability, the adjustment and optimization of financial structure, and the improvement of regional financial development environment have a positive effect on regional economic growth, and the driving effect on the economic growth of the central and western regions is greater than that of the eastern region.

Second, through the establishment of the intermediary effect model, it is found that the optimization of industrial structure plays a channel role, which can transmit the influence of financial development on regional economic growth. Part of the effect of the level of financial development on regional economic growth is realized through the optimization of industrial structure, a mediating variable. Bootstrap and Sobel are used to further prove that industrial structure optimization is an important channel from financial development to regional economic growth, and industrial structure optimization has a significant mediating effect between financial development and regional economic growth. It shows that the "financial development - industrial structure optimization - regional economic growth" transmission chain exists and is accurately reflected in China.

Third, there are differences in the mediating effect of industrial structure optimization between different financial development levels and economic growth. Specifically, the optimization of industrial structure played a partial mediating effect between financial development and economic growth; The rationalization of the industrial structure plays a significant masking role between the two. At the same time, the mediating effect of industrial structure optimization is different in different regions. The intermediary effect of industrial structure optimization in the eastern region is greater than that in the central and western regions. However, the rationalization of industrial structure did not play a mediating effect on the eastern region but played a masking effect on the central and western regions.

Fourth, other explanatory variables in the empirical study, such as the level of consumption, the degree of openness to the outside world, the level of education and government expenditure, tend to play a positive role in promoting regional economic growth.

8.2. Policy implications

Combined with the research conclusions of this paper, to improve financial development and promote regional economic growth, we should focus on the following four aspects:

First, continue to deepen financial system reform and further promote regional financial development. Financial development has heterogeneity in regional economic growth. Local governments should develop the financial sector according to the level of local resource endowment and industrial structure development, formulate appropriate policies for the development and supervision of the financial sector in the region, thoroughly analyze the gap between the development of the financial sector in different regions, and explore the influencing factors behind it. The eastern region should speed up the innovation of financial instruments and products under the current situation to meet diversified needs; the central and western regions should further optimize the region's financial development environment and attach great importance to the significance of the financial sector for the

region's economic development.

Second, we should build a sound financial market and promote the optimization of the financial structure. Financial development is basically the continuous improvement and optimization of the financial structure. At present, the indirect financing system is still dominated by the banking industry, and the development of direct financing methods such as stocks, bonds, funds and insurance is not perfect. Therefore, a diversified financial development system should be built, the proportion of direct financing should be increased, and the efficiency of financing should be accelerated, so as to better meet the various needs of high-quality economic development.

Third, we should speed up the upgrading of industrial structure. The optimization and upgrading of industrial structure is an intermediate path for financial development to indirectly promote regional economic growth, and the optimization of industrial structure helps the financial industry to play a role in regional economic growth. On the one hand, we should promote the continuous development of industrial structure upgrading, vigorously develop high-tech industries, eliminate backward industries with low production capacity, guide the flow of factor resources to sectors with high utilization efficiency, and promote the transformation of primary and secondary industries into tertiary industries. On the other hand, in the process of promoting the optimization of industrial structure, we should pay attention to the rationalization of industrial structure.

Fourth, we should guide the development of finance to match the local industrial structure and strengthen the integration strength and quality of the two. The financial sector should return to its roots and fully play its natural role of serving the real economy. Only by developing finance in line with the industrial structure can we promote sustainable economic growth.

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Author contributions

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