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AN EMPIRICAL STUDY ON THE IMPACT OF FINANCIAL-INDUSTRIAL INTEGRATION ON ENTERPRISES' INNOVATION OUTPUT

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Abstract. *The core competitiveness of modern enterprises embodies mainly in the innovation output. Taking the listed A-share manufacturing companies as samples from 2007 to 2018, we study the impact of financial-industrial integration on innovation output based mediating effect model and static panel regression analysis method. The results show that the combination of industry and finance plays a positive role in their innovation output and R&D investment plays an intermediary role between the combination of financial-industrial integration and innovation output. Then combined with the different characteristics of the enterprises group, the results show that the positive impact of financial-industrial integration on innovation output is mainly reflected in large-scale, non-state-owned companies. However, the active impact is not reflected in small-scale, state-owned companies.*
Keywords: Financial-industrial integration, R&D investment, Innovation output, Intermediary role

1. **Introduction.** Technological innovation is the key and important driving force for the rapid development of China's economic. Enterprises are the main group of national science and technology innovation system and the main force of scientific and technological achievements transformation. Enterprises, especially manufacturing enterprises, need to invest a lot of funds in scientific and technological innovation activities. However, high-risk, long-term and strong-uncertainty of scientific and technological innovation make it difficult for enterprises to obtain funds. So the shortage of R&D funds has become the main factor hindering the innovation activities of enterprises. Most enterprises generally face the problem of external financing constraints in the process of R&D [1]. In recent years, financial service to the real economy has attracted much attention. Recently, financial-industrial integration has developed rapidly, and has become the booster of enterprise innovation and development.

Financial-industrial integration is a form of industrial organization formed by capital integration between entity enterprises and financial institutions through mutual participation in shares or personnel penetration. For the restriction of financial capital investment by policy in China, the way of financial-industrial integration is that enterprises hold shares in financial institutions. Therefore, financial-industrial integration is a kind of financial industry capital. Financial industry capital can improve the financing ability and profit ability of real enterprises [2]. Financial-industrial integration can ease the financing constraints of enterprises [3,4], increase the cash holdings of enterprises, and one of the important sources of R&D funds for enterprises [5].

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Most studies showed that enterprises with R&D strength tend to obtain more funds through financial-industrial integration, promote R&D investment, develop core technologies, and enhance the competitiveness of enterprises [6-8], but some scholars did not agree with this view. The study of Comanor and Scherer showed that the impact of financial-industrial integration on R&D investment is not entirely promoting, because there is uncertainty in the R&D process, and enterprises will reduce R&D investment after the combination of industry and finance [9]. And Wang et al. thought that the impact of financial-industrial integration on R&D investment shows an "N" nonlinear characteristic [10]. However, regardless of the relationship between financial-industrial integration and R&D investment, the ultimate goal of enterprise R&D investment is to obtain innovative output, but there are few researches on the financial-industrial integration and innovation output.

R&D investment can show the R&D wishes and R&D intensity of enterprises, and as the final product of R&D investment, innovation output can directly bring economic benefits to enterprises. Innovation output is the direct expression of enterprise core competitiveness. Compared with R&D investment, enterprises pay more attention to the result orientation of innovation output. Therefore, does the combination of industry and finance affect the innovation output? If so, what is the impact? What is the role of R&D investment? These problems are the focus of this paper.

Taking the listed A-share manufacturing companies in China as samples, this paper provides micro level support for the above research issues. Possible contributions include 1) clarify the mechanism of the combination of industry and finance on innovation output by researching the relationship of financial-industrial integration, R&D investment and innovation output; 2) explore the impact of the combination of industry and finance on the innovation output of enterprises with different characteristics, and help enterprises choose suitable financing methods according to their own situation.

2. Theoretical Analysis and Research Hypothesis.

2.1. Financial-industrial integration and innovation output.

According to the theory of endogenous growth, technological progress is the key factor to ensure sustained economic growth. R&D investment can directly promote technological innovation and product development, and the lack of R&D investment will inevitably affect the technological progress of enterprises. Capital is an endogenous variable of technological innovation. The higher the degree of financial development, the stronger the technological innovation ability of manufacturing enterprises [11]. As a manifestation of the degree of financial development, the combination of industry and finance has been attached great importance by the state in recent years, and the entity enterprises are gradually inclined to use the combination to obtain financing. Through the way of holding shares in financial institutions, the entity enterprises can obtain the funds needed for R&D investment from financial institutions for a long time, and then improve the innovation output. Research by Xiong and Gui [12] and Lu and Guan [13] showed that the financial-industrial integration can significantly promote the increase of enterprise patents. Therefore, the following assumption is put forward:

H1: Financial-industrial integration can promote the innovation output of enterprises.

2.2. The mediating effect of R&D investment.

The sustainable development of manufacturing enterprises depends on technological innovation. Constant research and development investment can provide continuous financial support for innovation output. The combination of industry and finance is regarded as the reservoir of funds, and holding financial institutions can increase the R&D investment of enterprises. R&D investment is the material basis of innovation output. Only through continuous R&D investment can enterprises obtain innovation output [14]. The amount of innovation output depends

on the size of R&D investment. The larger the R&D investment of enterprise is, the more innovative output it will be [15]. Based on the theoretical analysis of the above hypothesis, the combination of industry and finance can promote R&D investment and innovation output, and R&D input can promote the innovation output of enterprises. Therefore, according to the definition of intermediary variable mentioned in Wen et al.'s research [16], R&D investment has a mediating effect between the integration of industry and finance and innovation output. In conclusion, the following assumption is put forward:

H2: R&D investment plays a mediating role in the impact of financial-industrial integration on innovation output.

Based on the above analysis and hypothesis, this paper uses R&D input as the intermediary variable, and puts forward the mechanism and research framework of "combination of industry and finance – R&D input – innovation output", as shown in Figure 1.

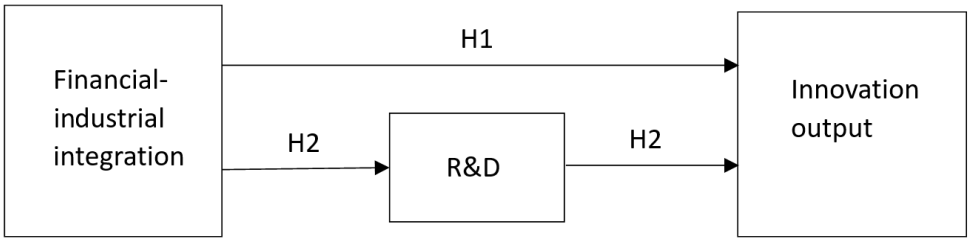

FIGURE 1. The structure of this article

3. Research Design.

3.1. Sample selection and data sources.

The manufacturing listed companies in Chinese A-share market from 2007 to 2018 are selected as the research samples. The data of financial-industrial integration and relevant financial data are from wind database, and patent data are from CNRDS database. The samples were screened according to the following order: 1) the ST companies, incomplete data and listed companies not normally traded in the year were excluded; 2) the samples with missing related variables were removed, and finally 10725 annual samples observations were obtained. In order to eliminate the influence of extreme values, winsorize was applied to 1% and 99% percentile of continuous variables.

3.2. Variable selection.

3.2.1. *Dependent variable.* Referring to the research of Li and Zheng [17], the total number of patent applications (TPA) represents the innovation output. In the robustness test, referring to the research of Zhong et al. [18], the innovation output is measured by the number of invention patent applications (IPA).

3.2.2. *Independent variable.* Referring to the research of Wang et al. [19], the variables of financial-industrial integration are measured by using the dummy variables. If the proportion of enterprises holding more than 5% of financial institutions is regarded as the achievement of financial-industrial integration, it is indicated by 1; if the shareholding ratio is less than 5%, it is not regarded as the combination of industry and finance, and is represented by 0.

3.2.3. *Intermediary variable.* This paper selects the ratio of R&D investment and total assets at the beginning of the period to measure R&D investment.

3.2.4. *Control variable.* Considering the influence of profitability, operating capacity, growth ability, equity concentration and asset liquidity on R&D investment, we choose ROA, TAT, SIZE, SHRCR10 and FXIZED as control variables. At the same time, we also control annual effect and industry effect. The specific variable descriptions are shown in Table 1.

TABLE 1. Definition of related variables

Variable type	**Variable name**	**Variable definition**
Dependent variable	TPA	Total number of patent applications
	IPA	Number of invention patent applications
Independent variable	INTE	If the shareholding ratio is greater than 5%, it is 1; otherwise, it is 0
Intermediary variable	R&D	R&D investment/total assets at the beginning of the period
Control variable	ROA	(total profit + interest expense)/total assets
	TAT	business income/total assets
	SIZE	Natural logarithm of total assets at the end of the period
	SHRCR10	The sum of the shareholding ratio of the top ten shareholders
	FXIZED	(total assets − current assets)/owner's equity
	YEAR	Dummy variable, if it is in year i, the value is 1; otherwise, it is 0
	INDUSTRY	Dummy variable, for high-tech enterprises, the value is 1; otherwise, it is 0

3.3. **Model building.** The following models are constructed for regression analysis test in order to verify the hypotheses proposed in this paper, in which $X_{i,t}$ is a group of control variables.

$$\text{R\&D}_{i,t} = \alpha_0 + \alpha_1 \text{INTE}_{i,t} + \alpha_i X_{i,t} + \Sigma\text{INDUT} + \Sigma\text{YEAR} + \varepsilon \tag{1}$$

$$\text{TPA}_{i,t} = \beta_0 + \beta_1 \text{INTE}_{i,t} + \beta_i X_{i,t} + \Sigma\text{INDUT} + \Sigma\text{YEAR} + \varepsilon \tag{2}$$

$$\text{TPA}_{i,t} = \gamma_0 + \gamma_1 \text{INTE}_{i,t} + \gamma_2 \text{R\&D}_{i,t} + \gamma_i X_{i,t} + \Sigma\text{INDUT} + \Sigma\text{YEAR} + \varepsilon \tag{3}$$

4. Empirical Analysis.

4.1. **Descriptive statistics.** The main variables statistical results are shown in Table 2. It can be seen from Table 2 that the maximum value of TPA of the sample enterprises is 436, and the minimum value is 0. It can be seen that there is a large gap in the total amount of patent applications among sample enterprises. The maximum R&D investment of the sample enterprises is 0.103, and the minimum value is 0, indicating that the R&D investment of sample enterprises is generally low. INTE is a dummy variable.

TABLE 2. Descriptive statistics of main variables

Variable	**Obs**	**Mean**	**Std.Dev.**	**Min**	**Max**
TPA	10725	22.885	59.741	0	436
R&D	10725	.024	.019	0	.103
INTE	10725	.058	.233	0	1
ROA	10725	.045	.058	−.168	.223
TAT	10725	.66	.385	.131	2.352
SIZE	10725	22.002	1.138	19.81	25.381
SHRCR10	10725	.568	.144	.219	.877
FXIZED	10725	.947	.697	.165	4.513

4.2. **Correlation analysis.** The correlation coefficients among the variables were less than 0.5 in Table 3, and it is determined that there is no multicollinearity among the variables. Furthermore, the VIF is less than the limit value 10, indicating that there is no significant multicollinearity among variables.

Table 3. Correlation analysis of main variables

Variables	TPA	R&D	INTE	ROA	TAT	SIZE	SHRCR10	FXIZED
TPA	1.000							
R&D	0.160***	1.000						
INTE	0.049***	−0.093***	1.000					
ROA	0.057***	0.244***	−0.049***	1.000				
TAT	0.097***	0.118***	0.035***	0.162***	1.000			
SIZE	0.268***	−0.040***	0.080***	0.006	0.127***	1.000		
SHRCR10	0.066***	0.099***	−0.056***	0.208***	0.063***	0.082***	1.000	
FXIZED	0.034***	−0.240***	0.107***	−0.340***	0.038***	0.251***	−0.093***	1.000

Note: ***, **, and * were significant at 1%, 5% and 10% levels.

4.3. **Regression analysis.** Hausman test shows that all models rejecting the original hypothesis are at 1% significance level (prob $> \chi^2 = 0.0000$), so we select the fixed effect model.

The regression results of model (2) in Table 4 shows that the coefficient of financial-industrial integration is 3.390, which is positive at the significance level of 10%. It indicates

Table 4. Regression analysis

Variable	(1)	(2)	(3)
	R&D	TPA	TPA
R&D			106.334***
			(3.51)
INTE	0.001**	3.390*	3.261*
	(1.98)	(1.92)	(1.85)
ROA	0.048***	14.633*	9.527
	(17.27)	(1.83)	(1.17)
TAT	0.008***	−6.567***	−7.405***
	(11.83)	(−3.43)	(−3.84)
SIZE	0.001***	1.709*	1.603*
	(3.28)	(1.96)	(1.84)
SHRCR10	0.019***	−1.976	−4.043
	(12.18)	(−0.43)	(−0.87)
FXIZED	0.000	1.366	1.368
	(−0.06)	(1.58)	(1.59)
CONS	−0.014***	−18.222***	−16.769***
	(−15.02)	(−6.97)	(−6.34)
YEAR	Control		
INDUSTRY	Control		
Adj.R^2	0.144	0.047	0.048
F	89.433	26.050	25.320
N	10725	10725	10725

Note: The values in brackets are the corresponding t values.
***, **, and * were significant at 1%, 5% and 10% levels.

that there is a positive relationship between financial-industrial integration and innovation output, and H1 passes the test.

The results of different scales (sorting the enterprise scale from small to large, finding a smaller tri quantile value, defining the enterprise size greater than the value as 1, otherwise 0) and property rights are shown in Table 5. Model (1) in Table 5 shows that the coefficient of financial-industrial integration of large-scale enterprise group is 4.742, which passes the 5% significance level test, while it does not pass the significance level test of small-scale enterprise group, which shows that compared with small-scale enterprises, the large scale enterprises tend to engage in innovation activities after the combination of industry and finance. The main reason may be that large-scale enterprises will be more motivated to engage in innovation activities and increase more innovative output in order to further expand production and operation and improve their competitiveness. The results of model (2) in Table 5 show that the coefficient of financial-industrial integration of non-state-owned enterprises group is 3.225, which passes the 10% significance level test, while the state-owned group is the opposite. The reason may be that compared with state-owned enterprises, non-state-owned enterprises want to maintain their survival and development through innovation activities.

TABLE 5. Regression analysis

Variable	**TPA**	**(1)**		**(2)**	
		Large-scale	**Small-scale**	**State-owned**	**Non state owned**
		TPA	**TPA**	**TPA**	**TPA**
INTE	3.390*	4.742**	0.077	1.827	3.225*
	(1.92)	(2.04)	(0.03)	(0.46)	(1.65)
ROA	14.633*	24.889**	−4.237	−13.920	23.535***
	(1.83)	(2.12)	(−0.48)	(−0.61)	(2.84)
TAT	−6.567***	−7.545***	−7.049***	−18.583***	−1.594
	(−3.43)	(−2.75)	(−2.78)	(−4.04)	(−0.76)
SIZE	1.709*	5.866***	2.356	4.742**	1.476
	(1.96)	(3.74)	(1.43)	(2.00)	(1.60)
SHRCR10	1.366	0.077	−12.027**	−22.176*	0.427
	(1.58)	(0.01)	(−2.11)	(−1.65)	(0.09)
FXIZED	0.021***	1.366	−1.008	−3.099	2.953***
	(2.67)	(1.13)	(−0.94)	(−1.44)	(3.19)
CONS	−18.222***	−25.685***	−10.614***	−21.806***	−13.676***
	(−6.97)	(−6.43)	(−2.97)	(−3.92)	(−4.63)
YEAR	Control				
INDUSTRY	Control				
Adj.R^2	0.047	0.061	0.038	0.096	0.039
F	26.050	22.247	5.994	11.645	16.992
N	10725	7190	3535	2145	8580

Note: The values in brackets are the corresponding t values.
***, **, and * were significant at 1%, 5% and 10% levels.

This paper examines the mediating effect of R&D investment by step-by-step method. When the model (1) and model (2) in Table 4 passed the test, the model (3) in Table 4 combining R&D investment in the model shows that R&D investment of intermediary variable is significantly positive at the level of 1%, and the independent variable of industry finance integration INTE is significantly positive at the significant level of 10%, and H2 passes the test. The coefficient of independent variable combination of industry and finance with INTE decreases from 3.390 of model (2) in Table 4 to 3.261 of model (3),

indicating that R&D investment has partial mediating effect but not complete mediating effect.

4.4. **Robustness test.** We replace TPA with IPA in order to ensure the robustness of the model, and the above tests are reassessed.

5. Research Conclusion and Suggestion.

5.1. **Research conclusion.** This paper uses the method of step by step test of intermediary effect to explore the impact of industry finance integration on innovation output, and the main conclusions are as follows. First, the combination of industry and finance promotes the innovation output of enterprises. Second, the enterprises of different characteristics have different performances. The combination of industry and finance has a significant positive impact on the innovation output of large-scale, non-state-owned enterprises, but has no significant impact on the innovation output of small-scale, state-owned enterprises. Last, the combination of industry and finance promotes innovation output through the intermediary role of R&D investment.

5.2. **Suggestion.** With the new normal economic development, scientific and technological innovation is the source of endogenous growth of enterprises and an important force to promote economic development. At the macroscopic level, the government should formulate relevant laws and policies to encourage the effective integration of real enterprises and financial institutions, make full use of the advantages brought by the combination of industry and finance, and help enterprises to improve their innovation abilities. The government should improve the relevant legal system of patent protection as soon as possible to ensure the necessary support and protection of intellectual property rights and achievements transformation, also can adopt financial subsidies, tax relief and innovation achievements incentives and other loose policies to improve the innovation enthusiasm of enterprises. At the microscopic level, the competent enterprises should appropriately increase the proportion of shareholding financial institutions, and increase the impact on financial institutions to realize the deep integration of industry and finance. Enterprises should make full use of the advantages brought by shareholding financial institutions to increase their R&D investment and increase innovation output.

This study used simple patent counts. This measure indicates the quantity of patenting activity without taking account of the impact of new product on the market, and future studies should examine the share of new products.

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