Research on the Coupling of Science and Technology Finance and Agricultural Industry Upgrading in Beijing-Tianjin-Hebei Region

Jianying Li[1, *], Yingying Zhang[2] and Shuang Zhan[3]

[1]Institute of Economics Study, Hebei University of Economics undefinedamp; Business, Hebei University of Economics and Business, Shijiazhuang, 050061, China

[2]School of Finance, Dongbei University of Finance and Economics, Dalian, 116025, China

[3]School of Finance, Hebei University of Economics and Business, Shijiazhuang, 050061, China

Abstract

Based on panel data of three provinces (municipalities) in Beijing-Tianjin-Hebei Region from 2010 to 2020, this paper uses the improved entropy method to measure the level of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region, and analyzes the coupling coordination degree and influencing factors of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region through coupling coordination degree model and multiple regression model. The results show that the coupling coordination degree of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region is concentrated between 0.4 and 0.9, and they influence and promote each other. The science and technology finance basic resources and science and technology finance input of science and technology finance subsystem has a significant positive correlation with the coupling coordination degree. While the science and technology finance output has a negative and insignificant correlation. The rationalization and upgrading of agricultural industrial upgrading subsystem have the same effect on the coupling coordination degree. It is suggested to increase government policy support, strengthen talent introduction, build a good financial innovation atmosphere in Beijing-Tianjin-Hebei Region, and promote the realization of the benign resonance of Beijing-Tianjin-Hebei Region with high coupling.

Keywords

Beijing-Tianjin-Hebei Region; Science and Technology Finance; Upgrading of Agricultural Industry; Coupling Coordination.

1. Introduction

As an important region with the largest and most dynamic economy in northern China, the Beijing-Tianjin-Hebei Region is the country's core growth pole and a "potential stock" for high-quality development. The key to promoting coordinated development of the Beijing-Tianjin-Hebei Region is to release non-capital functions from Beijing in an orderly manner, and to take the lead in making breakthroughs in key areas such as upgrading and relocating industries in the region. As one of the agricultural centers in northern China, the coordinated development of agricultural industry in Beijing-Tianjin-Hebei Region is particularly important. At present, a regional agricultural layout with the Beijing-Tianjin-Hebei Region as the core has been basically formed, comprehensive agricultural benefits have been steadily improved, and the integration of agriculture with the secondary and tertiary industries has become increasingly obvious. At present, the imbalance of scientific and technological innovation ability of rural industrial chain in the Beijing-Tianjin-Hebei Region, the slow upgrading of rural industrial chain, and the insufficient support of science and technology financial services to rural industrial chain has

become one of the key factors restricting the implementation of the Beijing-Tianjin-Hebei coordination strategy and rural revitalization strategy. In 2021, the first comprehensive deployment of agricultural science and technology was made in the No.1 Central Document. Under the background of the vigorous development of science and technology finance, science and technology finance innovation extends to the industrial chain and upgrades the value chain to promote the integrated development of the agricultural industry and becomes a new channel to promote the transformation and upgrading of the agricultural industry in the Beijing-Tianjin-Hebei Region. To enhance the innovation ability of agricultural science and technology through science and technology finance is an important measure to promote the upgrading of agricultural industry in Beijing-Tianjin-Hebei Region, and has important practical significance for the development of modern agriculture, smart agriculture and ecological agriculture.

Based on the panel data of 2010-2020 in Beijing-Tianjin-Hebei Region, this paper uses the improved entropy method to calculate the coupling coordination degree between science and technology finance and agricultural industry, explores the development characteristics of the coupling and coordination degree of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region, and conducts regression analysis of the factors affecting the coupling and coordination of science and technology finance and agricultural industry upgrading in the region, so as to seek a path to promote the effective matching of regional science and technology finance and agricultural industry upgrading, thereby promoting agricultural industry upgrading and achieving agricultural industry prosperity.

2. Review and Mechanism

2.1. Literature Review

The theory of industrial upgrading has always been a hot topic in the research of industrial economics. M. Peters believed that industrial upgrading is a process in which high-value products replace low-value products, in which high-value products are capital-intensive and low-value products are labor-intensive [1]. Li Fostered would think that industrial upgrading is the adjustment of industrial structure [2]. Y.Y. Wu added the content of coordinated industrial development on the basis of Li Fostered's definition of industrial upgrading [3]. W.P. Zhu and L. Chen believed that the reason for industrial upgrading was the change of market supply and demand and the transfer of resources [4]. A.W. Xue believed that industrial upgrading refered to the increase of total industrial volume and optimization of industrial structure [5]. The connotation of agricultural industry upgrading in this paper includes two aspects: first, coordinating the upgrading of relations. For the upgrading of agricultural industry, the first thing we should pay attention to is the coordination of its internal relations, which is the premise and foundation of industrial upgrading. Poon believed that the most important thing for industrial upgrading was the coordination and optimization of intra-industrial relations [6]. Z.H. Jiang and Y. Bai even hold that the process of industrial upgrading was a transformation process of more harmonious industrial relations [7]. T.R. Xia believed that industrial upgrading would not happen without coordinated industrial relations. Second, industrial upgrading [8]. Emstbelieved that industrial upgrading was a process dominated by the production of tangible goods and the provision of intangible services [9]. T.R. Xia proposed that the ratio of this industry to the total industry could be used to measure [8]. Therefore, the upgrading of agricultural industry was the process of the transformation of agricultural industry to a higher level, the improvement of production efficiency and the continuous optimization of the allocation of factors. The measurement standard of the upgrading of agricultural industry was: rationalization of agricultural industry upgrading and upgrading of agricultural industry ([10-11]).

Science and technology finance was proposed by the Shenzhen Municipal Science and Technology Bureau as early as 1993. About the concept of financial science and technology, different scholars put forward their own views, Y.K. Tang, C.W. Zhao, and C.F. Chen argued that financial belonged to the financial innovation of science and technology, financial innovation was not only reflected in the innovation of financial tools, also included the innovation of the financial system and financial policies [12]. P. Xie believed that the combination of science and technology and finance was the embodiment of financial services in the real economy, and the purpose was to promote the industrialization of scientific and technological output [13]. H.T. Fang believed that techno finance was essentially a deep combination of innovation and capital [14]. On July 4, 2011, the Ministry of Science and Technology issued the "National "Twelfth Five-year" Science and Technology Development Plan", which proposed the definition of science and technology finance :Financial means of science and technology through the reform of national financial investment in science and technology innovation fund, improve financial product service types, service mode, service platform, direct finance capital includes the banking system, stock system, insurance system, etc., for all stages of enterprise development (entrepreneurship, growth, maturity, recession) provide a good financial and technical support.

2.2. The Coupling Mechanism

Coupling theory refers to the process in which the coupling system contains multiple subsystems, in which various components are related to each other, and then form a benign state of mutual coordination and promotion among subsystems, thus forming a synergistic amplification effect on the external environment. As for the coupling mechanism of science and technology finance and agricultural industrial upgrading (see Figure 1), it can be seen that the coupling relationship between the two is shown in three levels:

2.2.1. Within the System

The two subsystems maintain a certain degree of independence and have their own evolution trajectories, and realize internal dynamic development through coupling of elements in the system. On the one hand, the subsystem of science and technology financelaw includes the basic resources, input and output of science and tecenology finance. Firstly, science and technology finance needs basic resources, such as scientific research personnel and a certain level of financial development. Secondly, science and technology finance creates science and tecenology output through the input of science and tecenology finance. On the other hand, the subsystem of agricultural industry upgrading includes the rationalization of agricultural industry upgrading and the upgrading of agricultural industry, which reflects the process of the transformation of agricultural industry to a higher level, the improvement of production efficiency and the continuous optimization of factor allocation ([15-16]).

2.2.2. System Between

On the premise of coupling of many elements in the system, the coupling degree and coordination of the subsystem of scientific and technological innovation and the subsystem of financial innovation are enhanced. On the one hand, science and technology finance can help raise funds for agricultural technological innovation activities, provide financial assets for agricultural enterprises to carry out high-tech activities, and promote the upgrading of agricultural industry. Science and technology finance can rationally allocate innovation resources, reduce transaction costs, avoid resource waste, and point out the direction for agricultural industry upgrading. By introducing financial subjects such as banks, venture capital and credit guarantee, science and technology finance can establish incentive and supervision mechanisms and stimulate the enthusiasm of agricultural industry. On the other hand, the upgrading of agricultural industry can attract the injection of financial capital, guide the technological innovation of science and tecenology finance, accelerate the development of more science and tecenology financial products, and promote science and technology finance to

create higher performance. At the same time, the upgrading of the agricultural industry means that the investment in science and technology finance gets a return, which further drives the development of science and tecenology finance.

2.2.3. The External Environment

On the basis of the integration of the internal elements of the two subsystems and the mutual coupling between the two subsystems, the overall effect of promoting regional economic development is generated thanks to the support and guidance of government policies.In the coupling process of subsystems, the government plays a very key role. Its policies and institutions provide basic guarantee for the upgrading of science and technology finance and agricultural industry, and promote the improvement of their coupling and coordination. Science and technology finance and agricultural industrial upgrading can improve labor productivity, attract more manpower, technology and information to this region, and drive regional economic growth.
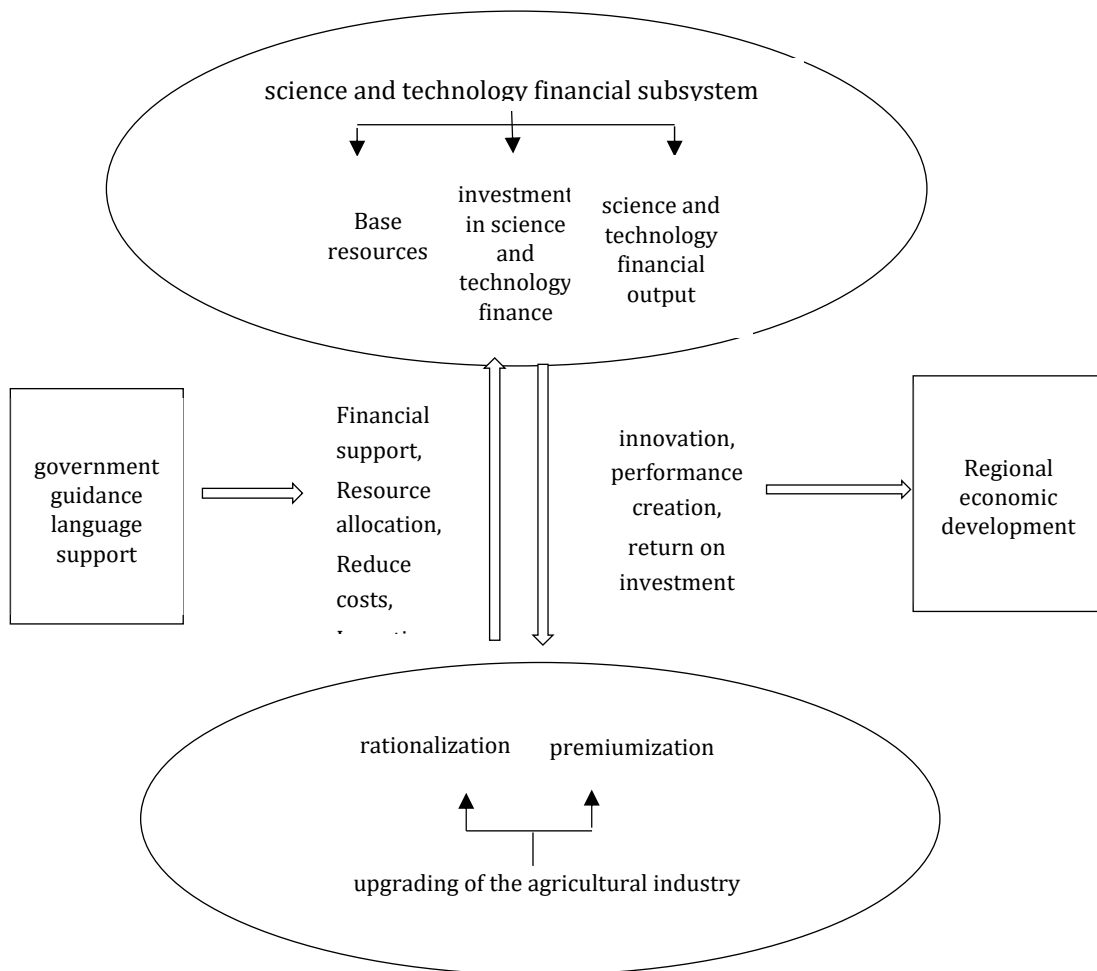
Figure 1. Coupling mechanism of science and technology finance and agricultural industrial upgrading

3. Model Construction and Index Selection

3.1. Model Building

In this paper, the improved entropy method is first used to measure the level of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region. Then, the coupling coordination degree model is used to measure the coupling coordination degree of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei

Region. Finally, multiple linear regression method is used to analyze and explore the factors influencing the coupling and coordinated development of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region. The methods and model construction involved in this paper are as follows:

3.1.1. Improved Entropy Method

In order to evaluate the research objectively and avoid the subjectivity of weight assignment by Delphi method and Analytic hierarchy process, the improved entropy method is used in this paper to establish the weight. Its calculation formula is as follows:

In order to evaluate the research objectively and avoid the subjectivity of weight assignment by Delphi method and Analytic hierarchy process, the improved entropy method is used in this paper to establish the weight. Its calculation formula is as follows:

$$\lambda_{ij} = \frac{u_{ij}}{\sum_{i=1}^{n} u_{ij}} \tag{1}$$

In Formula (1), λ_{ij} is the proportion of the i-th sample index value under the j-th index.

$$e_j = [-1/\ln(n)]\sum_{i=1}^{n} \lambda_{ij} \ln \lambda_{ij} \tag{2}$$

In Formula (2), e_j is the entropy value of the j-th indicator, and the length of n time series, namely, the number of years.

$$W_j = \frac{1-e_j}{\sum_{i=1}^{n}(1-e_j)} \tag{3}$$

In Formula (3), W_j is the weight of the J-th index, where, $\sum W_j = 1$

The science and technology financial system and the agricultural industrial upgrading system respectively contain several subsystems, and the comprehensive weight of each subsystem can be achieved by applying the weighted method to the weight of the contained indexes, and the comprehensive evaluation value U can be calculated by the following formula.

$$U = \sum_{j=1}^{n} \lambda_{ij} u_{ij}, \sum_{j=1}^{n} \lambda_{ij} = 1 \tag{4}$$

In Formula (4), U is the comprehensive evaluation value of technology finance System (U_f) and Agricultural Industrial Upgrading System (U_t), λ_{ij} is the weight of each index calculated by using the improved entropy method in the two systems, u_{ij} is the standardized 0-1 value of each indicator of the two systems.

3.1.2. Coupling Coordination Degree Model

Take the dual-system model as an example: Suppose A and B are the two target systems, $A(x)$ is including $x_1, x_2, \cdots, x_i$ and other indicators feature evaluation function; $B(y)$ contains $y_1, y_2, \cdots, y_j$ and other m indicators feature evaluation function, where:

$$A(x) = \sum_{i=1}^{l} a_i x_i^T, B(y) = \sum_{j=1}^{m} b_j y_j^T \tag{5}$$

Then the coupling degree calculation formula of system A and system B is:

$$C = \{A(x) \cdot B(y) / [0.5A(x) + 0.5B(y)]^2\}^{\frac{1}{2}} \tag{6}$$

The value range of coupling degree C is $C \in [0,1]$, and the coupling degree increases with the increase of C value.

Due to the interlocking, dynamic and unbalanced characteristics among the systems, the coupling coordination coefficient is defined on the basis of coupling degree by referring to relevant scholars' literature, as shown below:

$$D = \sqrt{C \cdot T} \quad T = \alpha A(x) + \beta B(y) \tag{7}$$

The value range of D in the formula is $D \in [0,1]$, α and β are coefficients to be assigned according to the importance degree of the two systems. T is the weighted average comprehensive evaluation index of the two systems.

3.1.3. Multiple Regression Model

In this paper, coupling coordination degree is taken as the explained variable, science and technology financial subsystem and agricultural industrial upgrading subsystem as the explanatory variables, and the multiple regression model is shown as follows:

$$Y_{it} = \alpha_0 + \alpha_1 FT_{1it} + \alpha_2 FT_{2it} + \alpha_3 FT_{3it} + \alpha_4 RAI_{it} + \alpha_5 UAI_{it} + \gamma_i + \eta_t + \mu_{it} \tag{8}$$

Wherein, Y represents the coordination degree between science and technology finance and agricultural industry upgrading, FT_1 represents basic resources of science and tecenology finance, FT_2 represents input of science and tecenology finance, FT_3 represents output of science and tecenology finance, RAI represents rationalization of agricultural industry upgrading, UAI represents advanced upgrading of agricultural industry. α_0 is a constant term, α_1 , α_2, α_3, α_4 and α_5 are the coefficients of science and technology financebasic resources, science and technology finance input, science and technology finance output, agricultural industry upgrading rationalization and agricultural industry upgrading, λ_i stands for individual effect, η_t represents the time effect and μ_{it} represents the residual term.

3.2. Index Selection and Data Source

In order to study the coupling coordination degree of the two systems of science and technology finance and agricultural industrial upgrading, science and technology finance is divided into three first-level indicators, namely, science and technology finance basic resources, science and technology finance input and science and technology finance output, according to the selection principles of indicators, such as scientificity, importance and operability. The agricultural industry upgrading is divided into two first-level indexes (see Table 1), namely, rationalization of agricultural industry upgrading and upgrading of agricultural industry upgrading. On this basis, second-level indexes are selected, so as to construct the evaluation index system of coupling coordination degree between science and technology finance and agricultural industry upgrading. In this paper, the data structure for the 2010-2020 in Beijing,Tianjin and Hebei three provinces (municipalities) panel data. The datas are from ."China Economic Network Statistical Database.", "China Science and Technology Statistical Yearbook.", "China Finance Yearbook.", "China High-tech Industry Statistical Yearbook.", "China Industrial Economic Statistical Yearbook." and "China Township Enterprises and Agricultural Products Processing Yearbook".

Table 1. Evaluation indexes of science and technology finance and agricultural industrial upgrading

Target layer	Level Indicators	Secondary indicators	Index Measure
Science and Technology Finance(TF)	Basic resources of Science and Technology Finance(TF$_1$)	Scientific researchers	full time equivalent of R&D personnel/total population
		Scientific research institutions	number of R&D institutions/total population
		Level of financial development	financial sector GDP /GDP
	Investment in Science and Technology Finance(TF$_2$)	Funding	financial appropriation/expenditure
		Enterprise investment	enterprise R&D investment/GDP
		Loans from financial institutions	technology loans to financial institutions /GDP
	Science and Technology Finance Output(TF$_3$)	Number of patent applications accepted	number of patent applications accepted/total population
		Number of patent applications granted	number of patent applications granted/total population
		Technology market transaction	Technology market contract value /GDP
Upgrading of Agricultural Industry (AI)	Rationalization(RAI)	Thiel Index	$\text{RI}=\sum_{i=1}^{n}\left(\frac{Y_i}{Y}\right)\ln\left(\frac{Y_i}{L_i}\bigg/\frac{Y}{L}\right)$
	Premiumization(UAI)	Refer to Gan Chunhui[2](2011)	Agricultural products processing/agriculture, forestry, animal husbandry and fishery output value

Table 2. Weight of evaluation index system of science, technology, finance and agricultural industrial upgrading in Beijing, Tianjin and Hebei provinces (municipalities)

Target layer	Level Indicators	Beijing	Tianjin	Hebei
Science and Technology Finance(TF)	Basic resources of Science and Technology Finance(TF$_1$)	0.322	0.281	0.253
	Investment in Science and Technology Finance(TF$_2$)	0.447	0.388	0.319
	Science and Technology Finance Output(TF$_3$)	0.231	0.342	0.429
Upgrading of Agricultural Industry(AI)	Rationalization(RAI)	0.512	0.551	0.674
	Premiumization(UAI)	0.488	0.449	0.326

The improved entropy method was used to calculate the relevant index datas of science and technology finance and agricultural industrial upgrading in Beijing-Tianjin-Hebei Region respectively, and the weights of the two systematic evaluation index systems of science and technology finance and agricultural industrial upgrading in Beijing, Tianjin and Hebei provinces

(municipalities) were obtained, as shown in Table 2.

According to Table 2, the calculation formula of the comprehensive evaluation of the two systems of science and technology finance and agricultural industrial upgrading in the three provinces (municipalities) of Beijing-Tianjin-Hebei Region can be obtained. The descriptive statistics of each variable are shown in Table 3.

Table 3. Descriptive statistics of each variable

| Variables	Size	Mean	St	Min	Max
Y	33	0.654	0.134	0.413	0.925
FT_1	33	0.144	0.077	0.008	0.276
FT_2	33	0.138	0.082	0.008	0.393
FT_3	33	0.158	0.114	0.012	0.429
RAI	33	0.348	0.220	0.027	0.674
UAI	33	0.260	0.122	0.082	0.488

4. Empirical Analysis

4.1. Coupling Coordination Degree Analysis

This paper uses the coupling coordination degree to identify the coordinated development degree between Beijing-Tianjin-Hebei science and tecenology financial system and agricultural industrial upgrading system.Based on the research of relevant scholars, this paper divides the evaluation criteria and basic types of the coupling and coordinated development of financial development and scientific and technological innovation as follows (Table 4) :

Table 4. Evaluation criteria and basic types of coupling coordinated development

Coupling coordination	[0,0.2]	[0.2,0.4]	[0.4,0.6]	[0.6,0.8]	[0.8,0.9]	[0.9,1]
Degree of coordination	disorders	on the verge of disorder	barely coordination	moderate coordination	well coordination	excellent coordination

In order to further understand the coupling and coordinated development of science and technology financial system and agricultural industrial upgrading system in the three provinces (municipalities) of Beijing-Tianjin-Hebei Region, this paper calculated the coordination degree of the two according to the coupling coordination degree formula and drew a broken line graph of their development trend, as shown in Table 5 and Figure 2:
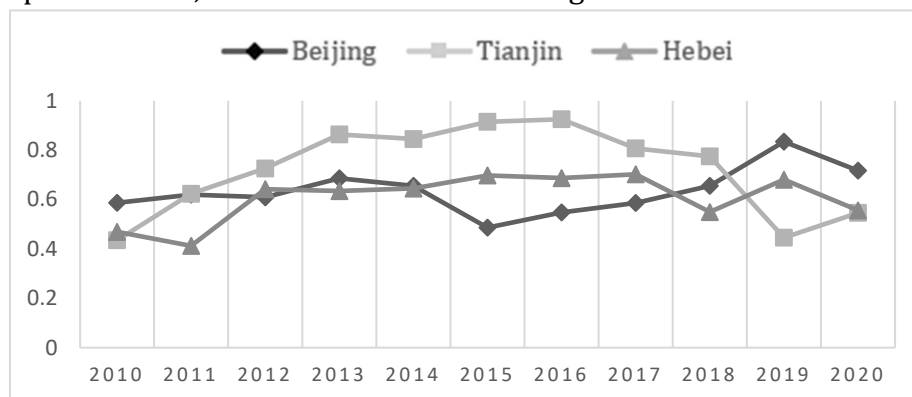
Figure 2. Coupling coordination degree of science and technology finance and agricultural industrial upgrading in Beijing, Tianjin and Hebei province (municipalities)

Table 5. Coupling coordination degree values and types of science and technology finance and industrial upgrading in Beijing, Tianjin and Hebei provinces (municipalities)

Year	Beijing		Tianjin		Hebei	
	Coupling coordination	Coupling coordination type	Coupling coordination	Coupling coordination type	Coupling coordination	Coupling coordination type
2010	0.587	barely coordination	0.435	barely coordination	0.469	barely coordination
2011	0.620	moderate coordination	0.623	moderate coordination	0.413	barely coordination
2012	0.609	moderate coordination	0.726	moderate coordination	0.642	moderate coordination
2013	0.686	moderate coordination	0.864	well coordination	0.635	moderate coordination
2014	0.656	moderate coordination	0.845	well coordination	0.645	moderate coordination
2015	0.487	barely coordination	0.915	excellent coordination	0.698	moderate coordination
2016	0.548	barely coordination	0.925	excellent coordination	0.687	moderate coordination
2017	0.586	barely coordination	0.807	well coordination	0.702	moderate coordination
2018	0.656	moderate coordination	0.775	moderate coordination	0.550	barely coordination
2019	0.835	well coordination	0.445	barely coordination	0.681	moderate coordination
2020	0.717	moderate coordination	0.546	barely coordination	barely coordination	barely coordination

As can be seen from Table 5 and Figure 2, the characteristics of the coupling and coordinated development of the technology and finance system and the agricultural industrial upgrading system in the three provinces (municipalities) of Beijing-Tianjin-Hebei Region are as follows:

(1) On the whole, the coupling coordination degree of science and technology finance system and agricultural industrial upgrading system in the three provinces (municipalities) of Beijing-Tianjin-Hebei Region concentrates between 0.4-0.9 during 2010-2020, indicating that the two systems of science and technology finance and agricultural industrial upgrading in the three provinces (municipalities) of Beijing-Tianjin-Hebei Region affect and promote each other. Although the financial development level and technological innovation level of the three provinces (municipalities) in Beijing-Tianjin-Hebei Region differ in different years, the development pace of the two provinces is relatively consistent on the whole, and they have experienced three stages from barely coordinated to moderate coordinated and then to barely coordinated. This indicates that the science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region maintain a strong mutual influence relationship during the study sample period, that is, science and technology finance can provide timely services for agricultural industry upgrading, and agricultural industry upgrading in turn effectively promotes the development of science and tecenology finance.

(2) In terms of provinces, the trend of coupling coordination degree in different provinces is not synchronous. The coupling coordination degree of science and technology finance and agricultural industry upgrading in Tianjin is higher than that in Beijing and Hebei in most years. Specifically, from 2010 to 2016, the upgrading of science, technology and finance and agricultural industry in Tianjin gradually developed from barely coordinated to moderately

coordinated, well coordinated, and even reached excellent coordination. In Beijing-Tianjin-Hebei three provinces (municipalities) only reached excellent coordination degree in tianjin, tianjin science and technology financial and agricultural industry upgrading works best in Beijing-Tianjin-Hebei Region coordinated development, namely the financial in promoting agricultural science and technology has played a good role in the process of industrial upgrading, the upgrade of agricultural industry in turn, promote the financial development of science and technology.From 2016 to 2020, the upgrading of science and technology finance and agricultural industry in Tianjin gradually developed from excellent coordination to good coordination, moderate coordination, and even dropped to barely coordinated coordination. It shows that the synergistic development effect of Tianjin's science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region is declining year by year, that is, the promotion effect of science and technology finance on agricultural industry upgrading is declining year by year, and the promotion effect of agricultural industry upgrading on science and technology finance development is weakening year by year.It is worth noting that in 2019-2020, due to the impact of COVID-19, the growth of all walks of life was sluggish, and the agricultural industry was no exception. The coupling coordination degree of Tianjin's science and technology finance and agricultural industry upgrading declined rapidly, which was undoubtedly negatively affected by the macroeconomic environment.

(3) By province, the coupling coordination degree of science and technology finance and agricultural industry upgrading in Beijing and Hebei show obvious convergence. Specifically, at the initial stage, Beijing (2010) and Hebei (2010, 2011) were barely coordinated. At this time, the coordinated development of science and technology finance and agricultural industrial upgrading was not ideal. But soon, under the guidance and support of the government, the coupling coordination degree of science, technology, finance and agricultural industry upgrading in Beijing and Hebei rose to moderate coordination. In addition, the upgrading of science and technology finance and agricultural industry has experienced many years of development. Beijing maintained moderate coordination for 4 years (2011-2014), then Beijing declined from moderate coordination to barely coordination for 3 years (2015-2017), and Hebei maintained moderate coordination for 6 years (2012-2017). This difference may be due to the fact that Beijing as the capital of the country, focuses more on the secondary and tertiary industries. Beijing is the financial and political center of the country, and agricultural development is not its key industry. Hebei is a large agricultural province with a vast area and a key population. Agricultural development has always been one of the key industries in Hebei, so Hebei will pay more attention to the agricultural industry. In the later stage, the coupling coordination degree of science and technology finance and agricultural industry upgrading in Beijing changed from barely coordinated to moderate and well coordination, and the coupling coordination degree of science and technology finance and agricultural industry upgrading in Hebei changed from moderate to barely and moderate coordination. Similarly, Beijing and Hebei were negatively affected by the macroeconomic environment (COVID-19), but showed moderate coordination, indicating that the synergistic development effect of science and technology finance and agricultural industry upgrading was less affected by the environment than that of Tianjin.

4.2. Analysis of Influencing Factors

The coordinated development of science and technology finance and agricultural industry upgrading is the result of their joint action, but the differences of science and technology finance policies and agricultural development level in Beijing, Tianjin and Hebei provinces are different. In order to study the influencing factors of the coordinated development of science and technology finance and agricultural industrial upgrading in Beijing, Tianjin and Hebei, this paper takes the coupling coordination degree as the explained variable, and the science and

technology finance subsystem and agricultural industrial upgrading subsystem as the explanatory variables, and carries out an empirical analysis on the panel data of Beijing-Tianjin-Hebei Region from 2010 to 2020. Explore whether these factors can effectively improve the coordinated development level of science and technology finance and agricultural industrial upgrading. As the data structure of this paper is short panel, the HT test suitable for short panel is adopted to conduct panel unit root test on the data of the three provinces (municipalities) in Beijing-Tianjin-Hebei Region. The results of panel unit root test for each variable are shown in Table 6. As can be seen from Table 6, the panel unit root test results of all variables are stable, and the data of all variables are stable.

Table 6. Unit root test for each variable panel

Variables	HT test	P value	Result
Y	-5.735	0.000	stable
FT_1	-4.625	0.000	stable
FT_2	-3.542	0.002	stable
FT_3	-2.123	0.017	stable
RAI	-4.131	0.000	stable
UAI	-4.992	0.000	stable

STATA 14.0 software is used to perform regression on the multiple regression model (Formula (3-8)) constructed in this paper, and the empirical results of the multiple regression model were obtained as shown in Table 7. As can be seen from Table 7, the goodness of fit of the regression model is 0.8283, F value is 26.05, and the associated P value is 0.000, indicating that the multiple regression model is generally significant and the empirical regression has a good effect.

Table 7. Empirical results of multiple regression model

Variables	C	FT_1	FT_2	FT_3	RAI	UAI
coefficient	0.279	1.226	0.463	-0.239	0.275	0.296
t value	5.610	3.360	2.570	-1.250	3.410	2.290
P value	0.000	0.002	0.006	0.224	0.002	0.030

Based on the analysis of the empirical results of the multiple regression model in Table 7, it can be found that the coupling coordination degree of the science and technology finance system and agricultural industrial upgrading in Beijing, Tianjin and Hebei provinces (municipalities) are significantly affected by the subsystem of science and technology finance and agricultural industrial upgrading. In the subsystem of science and tecenology finance, the basic resources of science and technology finance(FT_1) and the input of science and technology finance(FT_2) are significant at the significance level of 1%, and are positively correlated with the coupling coordination degree. Among them, the basic resources of science and technology finance (FT_1) coefficient is the largest, which is 1.226, while the input of science and technology finance (FT_2) is 0.463.In the subsystem of science and tecenology finance, the output of science and technology finance(FT_3) is negatively correlated with the coupling coordination degree, and it is not significant at the statistical level. In the subsystem of agricultural industry upgrading, the rationalization of agricultural industry upgrading (RAI) and upgrading of agricultural industry (UAI) are significant at the significance level of 5% and 1% respectively, and are positively correlated with the coupling coordination degree.In addition, agricultural industry upgrading rationalization (RAI) and agricultural industry upgrading upgrading (UAI) have almost the

same effect on coupling coordination degree.

Further analysis shows that: on the one hand, the influence of science and technology finance subsystems on the coupling system is not consistent, and good science and technology finance basic resources are the most important driving factor in promoting the coordinated development of science and technology finance and agricultural industry upgrading in Beijing, Tianjin and Hebei provinces (municipalities). The coordinated development of science and technology finance and agricultural industry upgrading can be significantly promoted by increasing the number of scientific research personnel and institutions and improving the level of financial development in various regions. This is because the basic resources of science and technology finance are the premise for science and technology finance to promote the upgrading of agricultural industry. Only with the basic resources, science and technology finance can promote the upgrading of agricultural industry. And the more perfect the basic resources of science and tecenology finance, the more sufficient the conditions for promoting the upgrading of agricultural industry.The input of science and technology finance also promotes the coordinated development, which is mainly reflected in the financial support, incentive and supervision of science and technology finance to the upgrading of agricultural industry. However, the output of science and technology finance is not conducive to coordinated development, which may be because there are obstacles in the transformation of science and technology finance achievements, and the output of science and technology financeis not enough to effectively support the upgrading of agricultural industry, mainly reflected in the resource allocation of science and technology finance to the upgrading of agricultural industry needs to be improved, and the cost should be further reduced. On the other hand, in promoting the coordinated development of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region, the rationalization and upgrading of agricultural industry are positive driving factors. This is because no matter the agricultural industry is upgraded and rationalized or advanced, the industrial upgrading is inevitably accompanied by technological innovation or the demand for new technologies, which naturally promotes the development of science and technology finance. Moreover, the rationalization and advanced upgrading of agricultural industry also means the success of science and tecenology financial investment and promotes the continuous improvement of science and tecenology financial performance and investment return.

5. Research Conclusions and Policy Recommendations

5.1. Research Conclusions

Based on panel data of three provinces (municipalities) in Beijing, Tianjin and Hebei from 2010 to 2020, this paper uses the improved entropy method to measure the level of science and technology finance and agricultural industry upgrading in Beijing, Tianjin and Hebei region, and uses the coupling coordination degree model to measure the coupling coordination degree of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region. Then, multiple linear regression method is used to analyze and explore the influencing factors of the coupling and coordinated development of science and technology finance and agricultural industry upgrading in Beijing-Tianjin-Hebei Region.The findings:

5.1.1. Taken as a Whole

From 2010 to 2020, the coupling coordination degree of science and technology finance system and agricultural industrial upgrading system in Beijing, Tianjin and Hebei provinces (municipalities) is concentrated between 0.4 and 0.9, and the two influence and promote each other. The development pace of coupling coordination degree between science and technology finance and agricultural industry upgrading in different provinces (municipalities) is relatively consistent, which has experienced three stages from barely coordinated to moderate

coordinated and then to barely coordinated.

5.1.2. By Province

In terms of provinces, the coupling coordination degree of science and technology finance and agricultural industry upgrading in Tianjin is higher than that in Beijing and Hebei in most years, and the coupling coordination degree of science and technology finance and agricultural industry upgrading in Beijing and Hebei shows obvious convergence.However, the negative impact of environment on the synergistic development effect of science and technology finance and agricultural industry upgrading in Beijing and Hebei is less than that in Tianjin.

5.1.3. In the Subsystem of Science and Tecenology Finance

In the subsystem of science and tecenology finance, there is a significant positive correlation between science and technology finance basic resources and science and technology finance input and coupling coordination degree, while in the subsystem of science and tecenology finance, there is a negative correlation between science and technology finance output and coupling coordination degree and it is not significant.The rationalization of agricultural industry upgrading and the upgrading of agricultural industry upgrading have little difference on coupling coordination degree, and are almost the same.

5.2. Policy Suggestions

First, increase government policy support to build a good financial innovation atmosphere in Beijing-Tianjin-Hebei Region. First, government departments should issue relevant policy documents to encourage the investment of science and technology and finance in agricultural industry; Provide support to related agricultural enterprises through financial tax reduction and exemption, improve agricultural development mechanism and optimize team structure; We should pay attention to guiding the agricultural industry with development potential and improve supporting service facilities. And actively build a normative and scientific credit rating mechanism for agricultural enterprises with various subjects in the financial system. Second, encourage and guide Beijing-Tianjin-Hebei Region science and technology enterprises and research institutions to cooperate with first-class colleges and universities, establish a talent training center for science and technology financial intermediaries, cultivate a team of science and technology financial experts as the backbone force, improve the basic resources of science and technology finance around the region, and build a good atmosphere for financial innovation in Beijing-Tianjin-Hebei Region.

Secondly, strengthen the introduction of talents to promote the high-quality development of agriculture in Beijing-Tianjin-Hebei Region. Talent competition is the main melody of today's industry development, talent is an important guarantee for the upgrading of agricultural industry. First, make a good internal training plan. Local governments need to integrate scientific research institutes, high-quality enterprises and other institutions, build an internet talent pool for agricultural industry, and manage professional talents by classification. The second is to hold a series of special lectures, organize employees of upstream and downstream enterprises of the agricultural industry chain to participate in training, build an online course system to carry out vocational education, and provide targeted training for those who have a certain foundation. The third is to establish a sound talent introduction policy to provide high-end talents with necessary living conditions. Give full play to the role of relevant industry associations and actively recommend professional talents for the development of modern agriculture.

Finally, increase investment in science and technology and finance to promote the realization of high coupling benign resonance. The Beijing-Tianjin-Hebei Region should properly increase the investment in science and technology and finance, especially the R&D investment. The more financial industry invests in R&D, the more scientific and financial innovative products will be

developed, and the competition between financial institutions will be more and more fierce. The result of the competition is to promote more scientific and financial innovation, so as to promote the upgrading of agricultural industry in Beijing-Tianjin-Hebei Region. In addition, it is not enough to simply increase the investment. We should also accelerate the reform of the management system of science and technology finance funds, control the flow of science and technology finance funds, realize precise risk compensation and loan subsidies for agricultural enterprises, and promote the coordinated development of science and technology finance and the upgrading of agricultural industry.

Acknowledgments

References

[1] M. Peters, R. House, J Lewandrowski, etal: Economic impacts of carbon charges on US agricultur, Climatic Change, Vol.50(2001) No.4, p.445-473.

[2] P.Y. Li: Analysis on the Demand of industrial Upgrading strategy in backward region, Management World, (2003) No.7, p.76-80+89.

[3] Y.Y. Wu: Research on industrial chain link based on grey clustering evaluation method, Science and technology management research, Vol. 30(2010), No.15, p.176-179+196.

[4] W.P. Zhu, L. Chen: Research on the Connotation and Mode of Industrial Upgrading -- Taking Guangdong Industrial Upgrading as an example, Economist, (2011) No.2, p.60-66.

[5] A.W. Xue: Study on the Path of China's Industrial Upgrading from the Perspective of Factor Flow (Ph.D., Shanghai Academy of Social Sciences, China 2015).

[6] T.S. Poon: Beyond the global production networks:a case of further upgrading of Taiwan information technology industry, International Journal of Technology and Globalization, Vol.1(2004) No.1, p.130-144.

[7] Z.H. Jiang, Y. Bai: Analysis of industrial Structure upgrading and its Influencing Factors, Contemporary Economic Research, (2016)No.10, p.53-56.

[8] T.R. Xia: Trade Iberalization and Industrial Structure Change from a Global Perspective (Ph.D., Shanghai Jiao Tong University, China 2015).

[9] D. Emst: Global Production Networks and Industrial Upgrading Aknowledge-centrol Approach, East-west Center Working Paper. (2001).

[10] C.H. Gan, R.G. Zheng, S.F. Yu: The impact of Industrial structure change on Economic growth and volatility in China, Economic Research Journal, (2011) No.5, p.4-16.

[11] J.J. Chen:The Effect of Foreign Trade Structure on Industrial Structure Optimization in China (Ph.D., Shanxi University of Finance and Economics, China 2015).

[12] C.W. Zhao, C.F. Chen, Y.K. Tang: Technology Finance (Beijing: Science Press, China 2009).

[13] P. Xie, C.W. Zou: Research on the Internet Finance model, Financial Research, (2012) No.12, p.11-22.

[14] H.T. Fang: The nature of science and technology finance from the perspective of innovation, High Technology and Industrialization, (2016) No.3, p.40-45.

[15] Y.H. Fu, X.S. Ye, Z.X. Wang: Manufacturing Industry structure change and economic growth efficiency improvement, Economic Research Journal, (2016) No.8, p.86-100.

[16] X.J. Li: The influence of industrial structure change on economic fluctuation in China: Based on spatial econometric Model, Journal of Technology Economics and Management, (2017)No.3, p.105-109.