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Factors Affecting Regional Economic Synergy in China – Based on Research on High-Tech Industry

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ABSTRACT High-tech industry has a powerful impact on developing countries' regional economy development. The diffusion effect of high-tech industry as the main driving force of economic development on some developed regions has been examined. However, in developing countries, especially, in China, the literature is less focused. Besides, the mechanism of factor flow is still unclear in China. We use the panel data of high-tech industries in 28 provinces of China from 2004 to 2016. This article analyzes the mechanism of industrial diffusion and factor mobility on the coordinated development of the regional economy by establishing the system GMM model and threshold model empirically. The system GMM results show that under the conditions of controlling R&D capital investment, deposit and loan balance, property rights structure, etc., capital flow can promote the coordinated development of regional economy, industrial diffusion, labor mobility and technology flow inhibit the coordinated development of regional economy; threshold regression results show The factor flow has a double threshold effect based on industrial diffusion for the coordinated development of regional economy. This study integrates the factor flow of knowledge into high-tech industry development, examining the impacts of industrial diffusion effect. The findings offer an industry developing frame to explain regional economy growth, which is beneficial to the local government's economic decisions.

INDEX TERMS Factor flow, GMM system, industrial diffusion, regional economy.

I. INTRODUCTION

Under the background of "new normal" and "new era," technological innovation has become the first driving force for economic development in China. In the Chinese government work report of the Second Session of the 13th National People's Congress held on March 5, 2019, it was proposed that innovation should be taken to lead development, and new and dynamic energy should be cultivated without reforming the innovative technology research and development and industrialization application mechanism. Due to the escalation of Sino-US trade friction, the development of China's high-tech industry has been impacted. For instance, the US government has included Huawei in the "list of entities" and Some American companies have been banned from cooperating with Huawei.[1]

It is an urgent issue to recognize the status quo of China's high-tech industry development and propose solutions. High-tech industries are a vital force for promoting the development of coordinated regional industries and promoting the transformation of economic growth [1]. However, due to the location advantage and strong economic foundation, the region has won the support of the priority development strategy. Besides, the late-developing regions have not been

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[1]see: http://m.elecfans.com/article/942288.html

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able to vigorously develop high-tech industries due to insufficient resources, resulting in an unbalanced trend in the growth of high-tech industries [2].

The influences of various channels for technology in regional economy have been studied in existing literature [3]–[5]. The industrial diffusion is a crucial way to coordinate the regional economy, which is conducive to solving the congestion cost brought about by the high industrial concentration. At the same time, the process of industrial diffusion must be accompanied by the flow of factors. As an essential carrier of factor flow, industrial diffusion can effectively undertake the allocation of resources and optimize the structure of production factors in various regions [6]. Both industrial diffusion and factor flow can be strictly linked to the interaction between regional economic strengthening regions, gradually narrowing the regional economic gap and achieving coordinated regional economic development.

Most of the researches focus on the industrial agglomeration effect between regions [7], [8]. Audretsch and Feldman [9] examined concentration of China's manufacturing industries, proposing that local protectionism obstructs the concentration of industries. Moreover, Rosenthal and Strange [10] investigated urban industrial agglomeration interacts with the intra- and inter-regional externalities. They demonstrate that the specialized industrial structures facilitate the dissemination to nearby cities. However, the research on factor mobility focuses less on high-tech industries. In summary, this paper examines the impact of industrial diffusion and factor flow of high-tech industry on the coordinated development of the regional economy from the empirical perspective, and verifies the relationship between each factor.

This paper is devoted to using the system GMM model and threshold model to solve the impact of China's industrial diffusion and factor flow on the coordinated development of the regional economy. It is concluded that under the conditions of controlling R&D capital investment, deposit and loan balance, property rights structure, etc., capital flow can promote the region. Coordinated development of economy, industrial diffusion, labor mobility, and technology flow inhibited the coordinated development of the regional economy; the threshold regression results show that the factor flow has a double threshold effect based on industrial diffusion for the coordinated development of the regional economy.

The remainder of the paper is organized as follows: Section II shows the research conclusions of some predecessors related to this article. Section III describes the construction of indicators and models. Section IV uses the system GMM model and threshold model for empirical research. The last section presents our conclusions.

II. LITERATURE REVIEW

Focusing on the impact of different industry diffusion and factors flow, this paper is related to three research streams: diffusion and clustering of high-tech industries, the flow of factors and regional economic development.

Firstly, scholars are interested in studying the impact of policies or environment on the diffusion and clustering of high-tech industries, as well as the impact of innovative industrial clusters on other industries. As we know, the spread of the currently flourishing computer technology can greatly affect the output of the industry, and even the technology transmission and output of surrounding countries, which has been confirmed by the study of Faruk and Umurcan [13]. Humphrey and Schmitz [14] confirmed this conclusion by embedding clusters in different ways into global value chains. Gibbs *et al.* [15] studied the key global, environmental and policy factors that determine the diffusion of e-commerce industry based on systematic comparison of case studies in 10 countries including China and the United States. The three of them studied industrial clusters and diffusion, and placed them in independent and dependent variables. Based on the data set of the world's R&D intensive enterprises, Aldieri and Vinci [16] analyzes the role of industry influence research knowledge diffusion process in the employment effect of sustainable development investment of large international enterprises. In addition, Castellacci [17] discussed the relationship between innovation and industrial competitiveness from two different perspectives. Mirata and Emtairah [18] believed that industrial symbiotic networks have potential contributions in promoting environmental innovation at the regional level. Porter [19] published an important paper on the role of clusters in competitive microeconomics and geographical position in competitive advantage. Ketels [20] discussed how to use clusters to formulate economic policies and the roles of different stakeholders in this process. Liu and Li [21] investigated the diffusion process of China's mobile Internet industry and discussed the determinants driving the use of mobile Internet. Taking the wall system innovation as an example, Taylor and Levitt [22] discussed the influence of industry structure on the diffusion of residential construction industry, as well as the influence of innovation scope and inter-organizational knowledge flow. These scholars combine industrial diffusion and cluster with technology and knowledge flow, so we continue to discuss factor diffusion.

Secondly, existing researches mainly include but not limited to the flow of factors, such as high-tech flow, knowledge flow and human capital flow, especially the flow of knowledge and technology. Silicon Valley is the birthplace of high and new technology. The study of Saxenian [23] found that Silicon Valley engineers born in China and India could accelerate the development of their own information technology industry through technology spillover and make contributions to highly localized entrepreneurial experiments and upgrading process. For broadcasting communication, which is the fastest growing corporate communication medium. Chitty [24] believe that corporate communication needs to go beyond one-way information transmission to realize a real interactive medium and effectively promote behavior change. Hu and Jaffe [25] used patent citation as an indicator of knowledge flow to study the knowledge diffusion model from the United States, Japan to Korea and Taiwan. They explicitly simulate the effects of technology proximity and knowledge decay and diffusion over time. Besides these, the flow of capital, labor and other factors related to the study of this paper is also mentioned. The analysis of Reardon [26] thoroughly explains the sudden explosion and subsequent exponential growth of supermarkets in the late 1990s and early 2000s. They argue that the flow of modern retail investment creates ''Favourable conditions'' for growth. Mody and Murshid [27] investigated the relationship between capital flows and domestic investment in 60 developing countries from 1979 to 1999. In the 1990s, although liberalisation attracted new capital flows, foreign capital did not stimulate domestic investment as much as in the previous decade. With the deepening of financial integration in recent years, governments have accumulated more international reserves and domestic residents have diversified through overseas investment. In the international environment, Bruno and Shin [28] found that the spillover effect of monetary policy had an impact on cross-border bank capital flows and dollar exchange rate through the banking sector. Neffke *et al.* [29] studied the labor mobility between industries by using German social security data and found that the labor mobility between industries was highly concentrated in a few industrial pairs. Bojnec *et al.* [30] analyzed the determinants of agricultural labor mobility and the role of human capital in this process based on the labor force survey in Slovenia from 1993 to 1999. The empirical results clearly show that human capital investment to improve labor mobility and flexibility is a key means to reduce labor mismatch and improve labor mobility adjustment efficiency. Malecki [31] pointed out that in recent years, competition between local governments has expanded to attract immigrants, tourists, media and investment in the future. The most competitive regions are multifaceted in their appeal and have made the transition to a knowledge economy. The latest focus is on attracting migrant workers and mobile investment. Moreover, there are other element flows that are mentioned. Roberts [32] used the two-region SAM model to analyze the urban-rural spillover effect, which took into account the commodity flow and factor income between the two regions. The results show that the spillover effect of cities to Grampian countryside is stronger, and vice versa. Lin [33] developed a research model based on the knowledge management perspective, innovation diffusion theory and technology-organization-environment framework to study the environmental impact of competitive pressure of small and medium-sized enterprises in the context of the application and implementation of knowledge management. Gharavi *et al.* [34] developed a conceptual framework to explore the ICT diffusion of stock brokerage industry. This framework can be used to improve understanding of how information technology innovations are spread in technology-oriented industries.

Thirdly, for regional economic development, scholars tend to associate it with policy support, technological innovation and other factors. Taking the smart meter industry as an example, Strong [35] analyzed the determinants of the development of smart meter companies and other American companies from a micro perspective. The empirical results show that government policies and regulatory support have a significant positive impact on the popularity of smart meters. Zakharova *et al.* [4] emphasized the various aspects of regional clustering policy formation and implementation, which, in his view, played a considerable role in the analysis of existing approaches to identify clusters of sectors promising to implement regional economies. Liu *et al.* [36] believe that policy and institutional structure, economic growth and urbanization are the main driving factors of URED pattern determined by China and its changes. Tödtling and Trippl [37] connected regional economy, policy support and technical innovation. He argues that innovation has become the focus of regional policy in the past decade. Specific policies are shaped by ''best practice models'' from high-tech sectors and well-performing regions. Takeda *et al.* [38], taking the industrial structure of Yamagata prefecture in Japan as an example, studied the role of dense inter-organizational network in regional innovation system. Koo [39] believe that technology spillovers and agglomeration are the key issues of regional economic development. Local technology spillover effect in the region attracts enterprises, which leads to higher level of agglomeration. On the other hand, the agglomeration of enterprises promotes local spillovers through local innovation networks. Shearmur and Polèse [40] proposed a simple model of regional employment growth based on agglomeration economic review to predict employment growth indicators across Canada. Among other studies, Huggins *et al.* [41] critically reviewed the structure and function of regional networks and the patterns of collaboration between universities and business. It has been argued that although networks between universities and the business community are developing, it is often difficult to attribute the increase in regional competitiveness to the development of knowledge-based infrastructure. They also argue that collaboration between universities and business must be based on an understanding of the interplay of networks and knowledge of markets. The conclusion is that, in many areas, universities may be given too much responsibility to become a base of commercialized knowledge. Gereffi [42] used the perspective of global commodity chain to analyze the social and organizational dimensions of international trade network, and linked international trade with industrial upgrading to analyze regional industrial development.

At present, there are shortages and deficiencies in the study of the above three aspects: international specialization theory and international industrial diffusion theory are directly applied to the study of domestic industrial diffusion, ignoring their applicability. And most studies focus on the inter-regional industrial cluster effect. The research on factor flow is less focused on high-tech industries, and factor flow is more focused on the thin flow of knowledge. In conclusion, this paper proves the influence of industrial diffusion and factor flow of high-tech industry on the coordinated development of regional economy from the theoretical level and the empirical level, and verifies the functional relationship among the three factors.

III. MATERIALS AND METHODS

Learn from He *et al.* [43] use of dynamic panels to estimate the degree of innovation in renewable energy technology in tires. Our research objects are high-tech industries in 28 provinces and cities from 2004 to 2016. Tibet, Qinghai and Xinjiang were not included because of insufficient data. The data were obtained from China statistical yearbook, China statistical yearbook of high and new technology industry and statistical yearbooks of provinces and cities from 2001 to 2017. The following is a description of the related variables and measures.

A. INDUSTRY DIFFUSION (ID)

The term decoupling comes from physics and can also be translated as "decoupling." The original meaning is that the interrelationship between two or more physical quantities with influential relationships ceases to exist. Inspired by this, Chen and Wang [44] pioneered the application of the decoupling theory to the evaluation of regional industrial agglomeration and diffusion, and constructed the calculation formula of industrial dynamic decoupling index: this paper proves the influence of industrial diffusion and factor flow of high-tech industry on the coordinated development of regional economy from the theoretical level and the empirical level, and verifies the functional relationship among the three factors.

$$DA_{tp} = \frac{r_{tp}}{R_{tp}} = \frac{\sqrt[t]{\frac{V_{ie}}{V_{is}}} - 1}{\sqrt[t]{\frac{\sum_{i=1}^{m} V_{ie}}{\sum_{i=1}^{m} V_{is}}} - 1} \tag{1}$$

In the formula, DA_{tp} indicates the industrial dynamic decoupling index of **tp** period, r_{tp} represents the average growth rate of an industry in the region **i** in **tp** period, and R_{tp} is the average growth rate of the industry in the **tp** period. V_{is} and V_{ie} represent the total output value of the industry in the region **i** at the beginning and end of the **tp** period, respectively, and $\sum_{i=1}^{m} V_{is}$ and $\sum_{i=1}^{m} V_{ie}$ are the sales revenues of the new products of the industry in the beginning and end of the **tp** period, respectively. **m** is the number of regions in a country, and **t** is the number of years between the **tp** periods. The decoupling state corresponds to industrial diffusion, and the negative decoupling (coupling) state corresponds to industrial agglomeration. See table 1 for details.

By using this method, the dynamic decoupling index of the high-tech industry in China is calculated and analyzed. As the table shows, we obtain different types of industrial diffusion and industrial agglomeration, which have been defined in various conditions. This Table would help us to define the development situations of regional economy.

B. FACTOR FLOW

1) CAPITAL FLOW (CF)

For the measurement of capital flows, we first calculate the capital stock of China's high-tech industry. The specific method refers to the work of Wu [45], using the perpetual inventory method to measure the R&D capital stock.

After calculating the capital stock of each region in each year, the increment of the proportion of capital stock in each region to the national capital stock is used as an indicator to measure capital flows. The calculation method is:

$$CF_{it} = \frac{K_{it}}{\sum_{i=1}^{28} K_{it}} - \frac{K_{i(t-1)}}{\sum_{i=1}^{28} K_{i(t-1)}} \tag{2}$$

If CF > 0, it means that there is capital inflow in the region this year. If CF < 0, it means that there is capital outflow in the region this year.

2) LABOR MOBILITY (LF)

The labor mobility is calculated by the location quotient, and the specific calculation method is:

$$\mathbf{LQ} = \frac{L_{Hit}/L_{Hi}}{L_{Ht}/L_H} \tag{3}$$

LQ is the rural labor transfer location quotient, where L_{Hit} refers to the average number of employees in high-tech industries.

In a certain area, L_{Hi} refer to the number of employed persons in a certain area, L_{Ht} refers to the average number of employees in the national high-tech industry, and L_H refers to the number of employed persons in the country.

3) TECHNOLOGY FLOW (TF)

Drawing on the research ideas of Dai [46], imitating the method of FDI technology spillover, Using total factor productivity as an indirect measure of technology spillover. This paper is based on the DEA-Malmquist index. The output index of total factor productivity is selected from the provincial high-tech industry output value. The input indicators are the average number of employees in the provincial high-tech industry and the actual capital stock.

C. COORDINATED DEVELOPMENT OF REGIONAL ECONOMY (CD)

This paper draws on the three criteria for judging regional economic adjustment developed by Luo and Luo [47]: the degree of economic linkage between provinces, the economic gap between provinces, and the economic growth between provinces to calculate the degree of coordinated development of regional economy, specific index design is shown in Table 2.

D. CONTROL VARIABLES

R&D Capital Investment (RDCI): Schumpeter's innovation theory believes that innovation in production technology and changes in production methods play a crucial role in the economic development process. Due to Chinese industry

TABLE 1. Criteria for regional industrial agglomeration and diffusion based on decoupling theory.

Trend	State	Decision condition	Characteristics
Industrial Diffusion (decoupling)	Weak diffusion Ⅰ type	$R_{tp}>0$; $r_{tp}>0$; $\frac{1}{2}<DA_{tp}<1$	The x industry is in the growth stage in both the whole country and a certain region, but the growth speed of the region is less than the average growth rate of the whole country, which indicates that the industry spreads out from the region. Weak type Ⅰ said diffusion degree, Ⅱ type diffusion degree is stronger.
	Weak diffusion ⅠⅠ type	$R_{tp}>0$; $r_{tp}>0$; $0<DA_{tp}<\frac{1}{2}$	
	Strong diffusion	$R_{tp}>0$; $r_{tp}\le 0$; $DA_{tp}\le 0$	The x industry is in the growth stage in the whole country, but the industry has started to decline in a certain region, which indicates that the industry is absolutely spreading from the region to the outside.
	Recession diffusion	$R_{tp}<0$; $r_{tp}<0$; $DA_{tp}\ge 0$	The x industry is in decline both nationally and regionally, but the region is declining faster than the country, indicating that the industry is spreading outward from the region.
Industrial Agglomeration (negative decoupling)	Expansion Agglomeration Ⅰ type	$R_{tp}>0$; $r_{tp}>0$; $1\le DA_{tp}\le\frac{3}{2}$	An industry is growing in the country and in a certain region, but its growth rate in the region exceeds the national average growth rate, indicating that the industry is relatively concentrated in the region. Type I indicates a weaker degree of aggregation and type II is stronger.
	Expansion Agglomeration ⅠⅠ type	$R_{tp}>0$; $r_{tp}>0$; $DA_{tp}\ge\frac{3}{2}$	
	Strong agglomeration	$R_{tp}<0$; $r_{tp}\ge 0$; $DA_{tp}\le 0$	An industry is in a recession stage across the country, but it is growing in a certain area, indicating that the industry is absolutely concentrated in the area.
	Weak agglomeration	$R_{tp}<0$; $r_{tp}<0$; $0<DA_{tp}<1$	An industry is in a recession stage across the country and in a certain region, but the rate of decline in the region is slower than that of the country, indicating that the industry is relatively concentrated in the region.

development [48], we measure the innovation elements with R&D's internal expenses. Deposit and Loan Balance (BDL): This variable is expressed in the balance of deposits and loans of local financial institutions. It can reflect the soft economic power of each region and measure the degree of regional economic development. Property Rights Structure (PRS): Government behavior may also affect regional economic development. Therefore, the total output value of state-owned enterprises accounts for the proportion of the whole industry to measure the property rights structure and reflect government behavior.

E. THE DATA PROCESSING

All the price variables in the index are converted based on the year 2003. Entropy weight method was used to weight multiple secondary indicators. The specific weighting method was as follow:

TABLE 2. Degree of coordinated development of regional economy.

indicators	Indicators significance	Indicators show
Degree of inter-provincial economic ties	$ER_{ijt}=\frac{\sqrt{G_{it}P_{it}}\bullet\sqrt{G_{jt}P_{jt}}}{D_{ijt}^2}$	ER is the degree of economic contact, G is the GDP of the region, P is the total population of the region, D is the distance between provinces and cities, i,j is the provinces and cities, t is the year. The higher the index, the closer the economic link.
Interprovincial economic disparity	$ED_{ijt}=\left\lvert\frac{pG_{it}-pG_{jt}}{\max(pG_t)-\min(pG_t)}\right\rvert$	ED is the economic gap, pG is the per capita GDP. The bigger the index, the bigger the economic gap.
Economic growth difference between provinces and regions	$EF_{ijt}=\left\lvert\frac{G_{it}-G_{i(t-1)}}{G_{i(t-1)}}-\frac{G_{jt}-G_{j(t-1)}}{G_{j(t-1)}}\right\rvert$	EF refers to the gap in economic growth. The greater the index value, the greater the gap in economic growth.

Data normalization: Positive indicators: $x'_{ij}=(\frac{x_{ij}-\min(x_{ij})}{\max(x_{ij})-\min(x_{ij})})\times 0.9+0.1$, Negative indicator: $x'_{ij}=\frac{\max(x_{ij})-x_{ij}}{\max(x_{ij})-\min(x_{ij})}\times 0.9+0.1$, x_{ij} is the value of index j in region i $(i=1,2,\ldots,30; j=1,2,\ldots,m)$, $x_{ij}{}'$ is the value of index j in region i after normalization.

The proportion of i province in the index of item j: $p_{ij}=x_{ij}{}'\Big/\sum_{i=1}^{n}x_{ij}{}'$, $i=1,2,\ldots,30, j=1,2,\ldots,m$. calculate the entropy value of item j: $e_j=-k\sum_{i=1}^{n}p_{ij}\ln(p_{ij})$, where $k=1/\ln(n)>0$. calculate the information entropy redundancy: $d_j=1-e_j$. calculate the weight of each index: $w_j=d_j\Big/\sum_{j=1}^{m}d_j$. Calculate the comprehensive index score of each region: $s_i=\sum_{j=1}^{m}w_j\cdot x_{ij}$

Consider the heteroscedasticity problem, take logarithm of each variable index. In order to obtain balanced panel data, all indicators are translated, namely: $x'_{ij}=x_{ij}+0.5$

F. MODEL ESTABLISHMENT

This paper measures the flow of factors from three aspects: capital, labor, technology, etc., quantitatively studies the impact of industrial diffusion and factor flow on the coordinated development of regional economy, and sets the following measurement mode (4), as shown at the bottom of this page.

Among them, CD is the explanatory variable, indicating the coordinated development of regional economy; ID indicates industrial diffusion, CF indicates capital flow, LF indicates labor flow, TF indicates technical flow, and the above four are explanatory variables; RDCI indicates R&D capital investment, BDL indicates existence Loan balance, PRS indicates the structure of property rights, the above three are control variables; indicate the provinces, indicating the year, ε indicating the residual.

IV. RESULTS

A. THE OVERALL PANEL DATA REGRESSION

Each model of panel data estimation has a corresponding assumption, and if the premise is not met, it may get wrong conclusions. In order to obtain robust measurement results, the paper uses the panel data fixed effect (FE), panel data random effect (RE), differential generalized moment estimation (DIFF-GMM) and system generalized moment estimation (SYS-GMM) model pairs to be interpreted. The relationship between variables, explanatory variables, and control variables was further analyzed. The processing software was stata14.0. The estimated results are shown in table 3.

Note: The value in parentheses is the value of t for the regression coefficient. "***," "**," "*" indicate the level of significance of 1%, 5%, and 10%, respectively.

$$\ln CD_{it}=\beta_0+\beta_1\ln ID_{it}+\beta_2\ln CF_{it}+\beta_3\ln LF_{it}+\beta_4\ln TF_{it}+\beta_5\ln CD_{it}+\beta_6\ln RDCI_{it}+\beta_7\ln BDL_{it}+\beta_8\ln PRS_{it}+\varepsilon_{it} \quad (4)$$

TABLE 3. Panel data regression results.

Variable	(1) FE	(2) RE	(3) DIFF-GMM	(4) SYS-GMM
L.CD			0.84*** (236.03)	1.10*** (1603.43)
LnID	0.080 (1.20)	0.092 (1.37)	-0.045*** (-15.05)	-0.027*** (-15.26)
LnCF	0.13 (1.65)	0.090 (1.29)	0.025*** (5.98)	0.015*** (14.77)
LnLF	-0.025 (-0.29)	-0.030 (-0.59)	0.0014 (0.14)	-0.017*** (-4.40)
LnTF	-0.25*** (-2.60)	-0.179** (-2.29)	-0.061*** (-4.71)	-0.06*** (-14.84)
LnRDCI	-0.26** (-2.43)	-0.231** (-2.40)	-0.17*** (-6.84)	-0.16*** (-14.49)
LnBDL	0.34*** (4.47)	0.281*** (3.91)	0.12*** (9.99)	0.06*** (21.75)
LnPRS	0.073** (1.97)	0.043 (1.25)	0.032*** (10.31)	0.013*** (10.70)
R-sq	0.068	0.065	/	/
F value/Wald	16.33	20.54	1.76e+06	8.49e+07
AR (2) P-Value	/	/	0.22	0.24
Sargan Value	/	/	0.30	0.50

Table 3 shows the estimation results of (4). In the above model, the main explanatory variables are not significant, which leads us to think about potential endogenous problems between variables. After comprehensive consideration, we introduce the explained lag. The first phase was used as an explanatory variable, and the robustness of the regression results was tested using DIFF-GMM and SYS-GMM.

Columns (3) and (4) in Table 2 report the estimation results of the difference GMM and the system GMM respectively. From the report results, the p-values of the Sargan statistic of the difference GMM model and the system GMM model are both higher than 0. 1. The statistical value of AR(2) is greater than 0.1, so the tool variable is valid, and the model does not have an over-identification problem, which has certain rationality. After comparing the results, Equation 4 with good robustness was selected for analysis. From the results of the regression analysis of the overall panel data, we find that for every 1% increase in the degree of industrial diffusion, the coordinated development of the regional economy has decreased by 0.027%, and it has passed the test at a significant level of 1%. However, the result of the low marginal contribution rate of regional economic development from the spread of high-tech industries is such low. The reason may be that although China's high-tech industry has begun to take shape, its contribution to the national economy is still not outstanding, and it does not have the main characteristics of a high-tech industry in the real sense.

In the flow of factors, except for the positive effect of capital flow on the coordinated development of the economy, both labor flow and technology flow have a negative inhibitory effect on the explanatory variables. Considering that the flow of labor in China is mainly from the underdeveloped areas to the developed areas, the employment-driven labor flow hinders the economic development of the outflow, which also explains the "labor migration puzzle" in a certain sense. Obviously, technological flows in underdeveloped regions cannot enhance economic coordination in developed regions. Moreover, this regression phenomenon reflects that China's investment in high-tech industries does not really affect technological innovation.

The study also found that the increase in R&D capital investment has made regional economic development uncoordinated, which is in line with the results of the above-mentioned technology flows. In addition, the balance of deposits and loans and property rights structure of local financial institutions have passed the test of 1% significance level, indicating that for every 1% increase in local deposit and loan balance, the coordinated development of regional economy has increased by 0.06%; The total output value of state-owned enterprises accounted for 1% of the total industry, and the coordinated development of regional economy increased by 0.013%.

B. THE THRESHOLD EFFECT ON THE COORDINATED DEVELOPMENT OF REGIONAL ECONOMY

In the previous subsection, we made a regression and empirical analysis of the impact of industrial diffusion and factor mobility on the coordinated development of the regional economy. In addition, the interaction between the explanatory variables will also affect the economic coordination of each

TABLE 4. Significance test and confidence interval of threshold variables.

		F value	p value	Threshold (10%)	Threshold (5%)	Threshold (1%)	Threshold value	95% confidence interval
CF (Model1)	Single	18.74	0.083	16.80	24.47	68.73	0.0723	(0.0560, 0.0724)
	Double	20.52	0.040	10.67	18.88	37.16	0.056	(0.0538, 0.0723)
LF (Model2)	Single	12.53	0.073	11.60	13.57	26.11	-0.0024	(-0.0108, -0.0016)
	Double	26.75	0.003	7.98	9.60	15.09	-0.0108	(-0.0118, -0.0024)
TF (Model3)	Single	11.28	0.097	11.04	13.00	24.05	0.0723	(0.0560, 0.0724)
	Double	28.51	0.0033	7.84	10.32	14.40	0.056	(0.0538, 0.0723)

region to a large extent. That is to say, the effect of factor flow on coordinated development will be affected by the level of industrial diffusion, not only in the process of industrial diffusion, but also in the flow of various factors of production, and the flow of factors will also induce the spread of industries among regions. Then, will the three factors flow change for the coordinated development of the regional economy as the degree of industrial diffusion deepens? To this end, we further put forward the hypothesis and conduct an empirical test on it.

We use the panel threshold regression model proposed by Hansen to test the above hypothesis. The model is characterized by the ability to automatically determine the threshold value and its number and to perform parameter estimation and hypothesis testing on the threshold value with strict statistical inference methods. The constructed threshold regression model is as follows, and the corresponding variables have the same meaning as before (5), as shown at the bottom of this page.

In order to determine whether there is a double threshold value with the degree of capital deepening as the threshold, the stata14.0 software is used to test under the assumption of a single threshold and double threshold. Then, the test statistic p value is obtained by repeatedly sampling 300 times by "Bootstrap" (Bootstrap), and it is judged whether the threshold effect is significant. The results are shown in Table 4.

Taking Model 1 as an example, the three critical values of 10%, 5% and 1% have been successively listed in Table 4. The F value of a single threshold is greater than the threshold value of 10%, indicating that it is significant under 10% significance. In other word, there is a single threshold effect, and the first threshold is 0.0723. At the same time, in the double threshold effect test, the F value is 20.52, indicating that the capital flow also has a double threshold, and the threshold is 0.056.

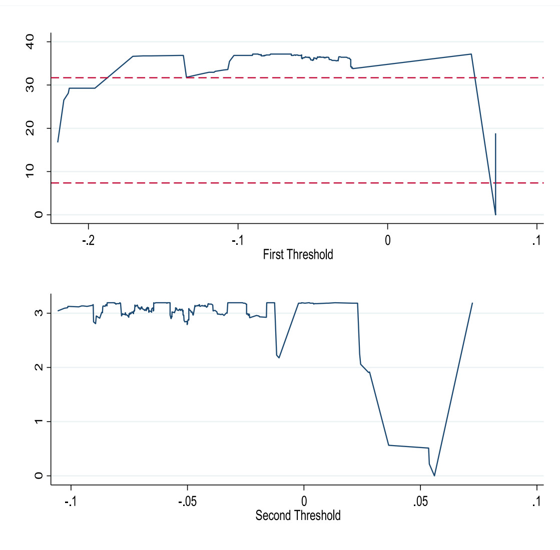

FIGURE 1. Authenticity test of the model 1 threshold.

The result could be explained intuitively by the figure. For instance, Figure 1 shows the authenticity test of Model 1 above, which illustrates the similar analysis result as Table 4 shows. The value of the dotted line near the X axis is 7.35, which is the critical value at the 5% significance level, and the dotted line below the 95% confidence interval for the

$$\begin{aligned}
\ln CD_{it} &= \alpha_1 \ln CF_{it} \times I(ID_{it} \leq \gamma_1) + \alpha_2 \ln CF_{it} \times I(\gamma_1 < ID_{it} \leq \gamma_2) + \alpha_3 \ln CF_{it} \times I(ID_{it} > \gamma_2) + \beta_1 \ln RDCI_{it} + \beta_2 \ln BDL_{it} + \beta_3 \ln PRS_{it} + \mu_i + \varepsilon_{it} \\
\ln CD_{it} &= \alpha_1 \ln LF_{it} \times I(ID_{it} \leq \gamma_1) + \alpha_2 \ln LF_{it} \times I(\gamma_1 < ID_{it} \leq \gamma_2) + \alpha_3 \ln LF_{it} \times I(ID_{it} > \gamma_2) + \beta_1 \ln RDCI_{it} + \beta_2 \ln BDL_{it} + \beta_3 \ln PRS_{it} + \mu_i + \varepsilon_{it} \\
\ln CD_{it} &= \alpha_1 \ln TF_{it} \times I(ID_{it} \leq \gamma_1) + \alpha_2 \ln TF_{it} \times I(\gamma_1 < ID_{it} \leq \gamma_2) + \alpha_3 \ln TF_{it} \times I(ID_{it} > \gamma_2) + \beta_1 \ln RDCI_{it} + \beta_2 \ln BDL_{it} + \beta_3 \ln PRS_{it} + \mu_i + \varepsilon_{it} \qquad (5)
\end{aligned}$$

TABLE 5. Regression results of threshold effect model of factor flow on coordinated development of regional economy.

	variable	Coef	t	p	significant
Model 1	Ln RDCI	-0.29	-2.25	0.025	**
	Ln BDL	0.42	4.52	0.000	***
	Ln PRS	0.072	1.61	0.109	/
	Ln CF×I(ID<0.0723)	0.18	1.87	0.062	*
	Ln CF×I(ID>=0.056)	0.26	-0.82	0.414	/
Model 2	Ln RDCI	-0.29	-2.25	0.025	**
	Ln BDL	0.41	4.50	0.000	***
	Ln PRS	0.064	1.44	0.151	/
	Ln LF×I(ID<-0.0108)	-0.043	-0.42	0.673	/
	Ln LF×I (-0.0108<=ID<-0.0016)	-0.044	-0.21	0.832	/
	lnLF×I (ID>=-0.0016)	-0.11	-0.98	0.329	/
Model 3	Ln RDCI	-0.29	-2.28	0.023	**
	Ln BDL	0.41	4.46	0.000	***
	Ln PRS	0.074	1.65	0.100	*
	Ln TF×I (ID<0.0723)	-0.29	-2.53	0.012	**
	Ln TF×I (ID>=0.056)	-0.24	-1.85	0.065	*

threshold parameter. The Figure shows that capital flow has double threshold effect.

According to results, we find labor mobility and technology flow also exist double threshold effect, and the threshold value is −0.0108 and 0.056, respectively. Then we use the threshold effect model to analyze the different variables results in the next subsection.

C. THRESHOLD MODEL ESTIMATION RESULTS AND ANALYSIS

Regression results of the relationship between the influences of three factor flows on the coordinated development of regional economy affected by threshold variables are shown in Table 5.

As can be seen from table 5, the two thresholds of capital flow in model 1 are 0.0723 and 0.056 respectively. When the degree of industrial diffusion is less than 0.0723, the marginal influence coefficient of capital flow on the coordinated development of regional economy is 0.18. When the degree of capital deepening is greater than 0.056, the marginal influence coefficient of capital flow on the coordinated development of regional economy is −0.26. It can be seen that with the deepening of industrial diffusion, the impact of capital flow on the coordinated development of regional economy is obviously different. When the degree of industrial diffusion is less than 0.0723, the capital flow can promote the coordination of regional economy; if the degree of diffusion is greater than 0.056, the capital flow will deepen the imbalance of regional development. Therefore, there is a change point between 0.056 and 0.0723, and the capital flow before and after this point has an opposite impact on the coordinated development of economy.

The two thresholds of labor mobility in model 2 are −0.0108 and −0.0016, respectively. However, none of the three zones in the interaction term is significant, which indicates that in the process of the change of industrial diffusion degree, labor flow may have little impact on regional economic development.

The two thresholds for technology flow in model 1 are 0.0723 and 0.056, respectively. When the degree of industrial diffusion is less than 0.0723, the marginal influence coefficient of technology flow on the coordinated development of regional economy is −0.29. When the degree of industrial diffusion is greater than 0.056, the marginal influence coefficient of technology flow on the coordinated development of regional economy is −0.24. The negative effect of technology flow on the coordinated development of regional economy mirrors the view above, which indicates that the large-scale investment in scientific and technological innovation has not been truly transformed into the technological innovation capacity of high-tech industries.

V. CONCLUSION

Firstly, through theoretical analysis, this paper explores the relationship between industrial diffusion and factor flow to the coordinated development of the regional economy. Combined with the panel data of 28 provinces in China's high-tech industry from 2004 to 2016, this paper uses the systematic GMM method to analyze the high empirically. The impact of technological industry diffusion and factor flows on the coordinated development of regional economies. On this basis, it is further tested whether the influence of factor flow on the coordinated development of the regional economy has the effect of the industrial diffusion threshold. Finally, the following conclusions are drawn: (1) Industrial diffusion and factor flow have significant effects on the coordinated development of the regional economy, but only capital flows have positive effects, and the rest are adverse effects. (2) The threshold regression results show that the factor flow has a double threshold effect based on industrial diffusion to promote regional economic coordination. In the threshold regression, it also shows that when the diffusion degree of the high-tech industry crosses the threshold, capital flow has a change point to promote regional economic coordination. Labor mobility and technology flow have no or even negative impact on regional economic coordination.

This paper makes use of the system GMM model and threshold model to empirically analyze the impact of China's industrial diffusion and factor flow on the coordinated development of regional economy and draws capital flow under the conditions of controlling R&D capital investment, deposit and loan balance, and property rights structure. It can promote the coordinated development of regional economy, industrial diffusion, labor mobility, and technology flow inhibit the coordinated development of the regional economy; the threshold regression results show that there is a double threshold effect based on industrial diffusion in the coordinated development of regional economy. In the future, we will broaden our research scope, not just China; and we will focus on more elements than traditional capital, labor, and technology.

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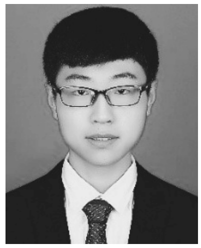

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