An Empirical Study on the Factors Affecting the Layout of the Dairy Industry - Based on China's Provincial Panel Data Analysis

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Abstract

The dairy industry is an essential civilian production industry. The study aims to explore the main factors that affect the layout of the dairy industry and determine the extent of the impact of industrial scale, industrial technology, and industrial resources on the industrial layout. Based on statistical data on China's dairy industry, this paper mainly focuses on how the industrial scale, resources, and supportive policies towards the dairy industry distribution. The results show that the three of them significantly impact industrial distribution; meanwhile, the impacts of industrial policy on industrial distribution are performed more comprehensively. Then the paper discusses the influence and transmission mechanisms and provides recommendations to improve China's dairy industry layout.

Keywords: Dairy industry, Industrial layout, Moderating effect, Empirical research

Introduction

Food is necessary for human survival. Mainly because any food is of critical importance to our lives in the flavor of maintaining our healthiness (i.e., growth and immunity development) (De Piero et al., 2015), a food-related business has been multiplying for an extended period (Weinroth et al., 2018). With the advent of technology, the dairy industry may have adjusted its business model in line with consumer behavior for its own sake (i.e., business survival or maintaining its high profits) (Jolink & Niesten, 2015), particularly in the digital age. Such technology can make it more convenient (Collier & Kimes, 2013). Since food typically has too many types to be precisely classified, food can be likely divided into two central genes: 1) food for eating and 2) food for drinking (Willett et al., 2017), according to human-consumption. When doing related business, the more a business is attentive to human behavior, the more profits are

gained (Dube & Renaghan, 1994). China has the world's largest population, and doing nutrition-related business may sound perspective (Jayaraman, 2010). While waiting for commercial success, this achievement is attractive to aggressive competition due to high Chinese consumption rates. Foreseeably, such healthy beverage as milk currently calls people's attention and the healthiness of specific affected group of those people (i.e., children or aging) must be prioritized for life quality (Cheng et al., 2015). Given those factors (i.e., health and non-health concerns), this study focuses on

Two questions: (1) What is the impact of industrial resources, industrial technology, and industrial scale on the layout of China's dairy industry? (2) Does the industrial policy regulate the layout of China's dairy industry?

Literature review

Factors influencing the industrial distribution

The existing literature on the dairy industry distribution emphasizes industrial concentration as an explanatory variable, with the discussion of the industrial concentration on the regional economy, total production factors, social economy, and other aspects with less industry distribution as an explanatory variable (Weinroth et al., 2018) while more works of literature have focused on the impact of industrial distribution on social and economic-related indicators (Cheng et al., 2015), another literature such as Cheng, C. L(2005)- who considers the industry distribution as the explained variable to explore the related problems affecting the pre-factors of the industrial distribution. In addition, a few discussions like Chen, L.C. (2017) and Chen, X (2018) on the moderating effect of industrial policy empirically are mentioned. These related studies are focused on the impact of the dairy product distribution development in a factor of the relevant research conclusions may be with the actual situation of a certain deviation, the distribution of such dairy industry is also affected by various factors. In addition, China's dairy industry distribution and the impact of factors also need China's relevant data to verify further how to take advantage of industrial scale, industrial resources, industrial technology, and industrial policy to promote the layout of China's dairy industry and enhance the competitiveness of the dairy industry is an important theoretical problem.

Hypothesis proposal and model construction

According to the growth theory, the main factors affecting industrial distribution are industrial resources (such as raw materials), industrial technology (such as processing technology and storage technology), industrial scale (such as consumption and consumption scale, import and export volume, etc.) and industrial policies (such as government subsidy policy, and so on). These four main factors play a decisive role in the industrial distribution of a country or a region, so this article on the impact of China's dairy industry distribution factors

by the four aspects mentioned above of research and demonstration, and according to the results of the study put forward relevant policy recommendations.

(1) The impact of industrial resources on an industrial layout

Pei et al. (2011) proposed that industrial resources affect the industrial layout. In 2004, Tan W. (2011) inferred that due to an uneven distribution of resources, the dairy industry could increase the scale of production in resource-wealthy areas 2008,. Apart from the uneven distribution of resources, Hao et al. (2011) dually suggested that China's climate resources affect the layout of the Chinese dairy industry structure. Therefore, this study is to propose the hypothesis as follows:

H1: Industrial resources have a positive impact on the industrial layout.

(2) The impact of industrial technology on an industrial layout

Hu, Y. (2021) analyzed the sampled data of 23 provinces across China between 1992 and 2003 and found that technological progress was a key factor in advancing the national dairy industry. As a result, the 2nd hypothesis is:

H2: Industrial technology has a positive impact on the industrial layout.

(3) The impact of industrial-scale on an industrial layout

According to a study of Chenyang Liu, Lihang Cui , and Cuixia Li, they found that the scale of the dairy industry would affect the layout of the industry (Lui, et al., 2022). In line with the research conducted by Mr. Fuller, Mr. Huang, Hao & Gong (2011) in 2005 concluded that the development of the dairy industry affected the clustering and distribution thereof. For this reason, the following assumption can be drawn:

H3: Industrial scale has a positive impact on the industrial layout.

(4) A regulatory role of industrial policies

The relevant industrial policy is a crucial way of achieving technological progress, optimizing, upgrading the overall industrial structure, and promoting the rapid and stable development of the industry (He, Y.C., Zheng, N., Zeng, N. Y. 2010; Na, 2018).

The article makes the following hypothesis:

H4: Industrial policies have a regulatory effect on industrial resources and industrial layout.

H5: Industrial policies have a regulatory effect on industrial technology and industrial layout.

H6: Industrial policies have a regulatory effect on the industrial scale and layout.

According to the related theories, the empirical framework model is set forth below:

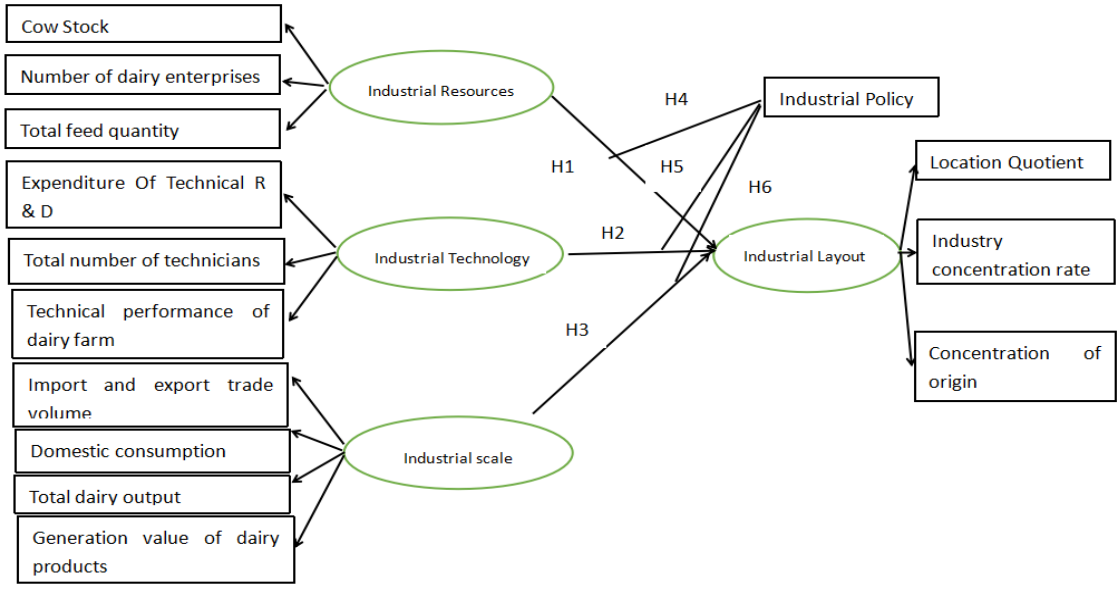

Figure 1 Research framework

Method

Variable measurement

The industry layout is measured by the following location entropy, industry concentration rate, and regional production concentration (Dai & Wang， 2014). Industrial resources are measured by dairy cattle slaughter, total feed, and the number of dairy companies (Caloghirou & Aggelos, 1999; Wang, Parsons, & Zhang, 2014). Three aspects measure industrial technology: the amount of investment associated with technology research and development, the total volume of technical personnel, and the technical performance of the farm (Wibowo et al., 2019). Four aspects measure the industry scale: the total output value of dairy products, the total output of dairy products, the import and export trade of dairy products, and the total domestic consumption. (Todd Gabe， 2003; Turco & Kelsey, 2004). Industrial policy: as a moderating variable. Based on the event analysis method, and China's "Five-Year Plan" as the policy basis for judging encouraging industries. This study refers to studies of Coleman (Coleman, 1988) and Jingsong et al. (2017) for extracting industrial policies to encourage industry keywords. When the province's industrial policy encourages the dairy industry, the value is 1; otherwise, it is 0. Combined with the existing literature, the empirical analysis of the above empirical model designs the above variable dimensions as follows:

Table 1 Main variable measurement dimension

Level indicators	The secondary indicators
Industrial Distribution	Location entropy (LQ)

	Industry concentration rate (CR)
	Concentration of origin (GC)
Industrial Resources	Cow inventory
	Number of dairy companies
	The total feed
Industrial Technology	Total technical personnel
	Technology research and development expenses
	Dairy farm technical performance
Industrial Scale	Total import and export
	Domestic consumption
	Total production of dairy products
	Dairy production value
Industrial Policy	National policy on the dairy industry

Data collection

The data used in this paper, are sourced from the Chinese agricultural statistical yearbook for the period of 2007-2020 concerning the main variables. Due to some missing data which cannot be obtained directly, this paper preprocessed these missing data by reasonable calculation. As for many indicators, this paper adopts the way of taking logarithms to avoid its influence, and ensure concrete regression results. After all, relevant data are duly prepared, the SEM model will be employed to complete the estimation.

Data analysis

This paper intends to use hierarchical regression to test the moderating effect, divided into three stages to construct and analyze three models to test the moderating effect of industrial policy. The specific steps are as follows:

Model 1: Design the basic model and test the correlation between explanatory variables (industrial scale, industrial resources, and industrial technology) and the explained variable (industry distribution) by linear regression. The model is constructed as follows:

$$PLI_{it} = \alpha + L.PLI_{it} + \beta_R Resource_{it} + \beta_T Technology_{it} + \beta_S Scale_{it} + \varphi_1 GDP_{it} + \varphi_2 Urban_{it} + \varphi_3 Pop_{it} + \varphi_4 Pi_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

The explained variable PLI_{it} represents the layout index of *i* province in the *t* year to describe the industrial dairy concentration. α is the constant and its explained variables are $Resource_{it}$、$echnology_{it}$、$Scale_{it}$ to represent the Index of dairy industry resources, industry technology and industry scale in *t* year of *i* province respectively; β is the marginal influence coefficient between variables, i is the province (i=1,2,3,4...12), t is the year (*t*=2007，2008，2009,...2018), λ_t and μ_i are the fixed effect of year and province, ε_{it} is random error term and disturbance term. α, β_R, β_T and β_S are to be estimated parameters.

Model 2: The moderating variable (industrial policies) is incorporated into the model, and the correlation between the moderating variable and the explained variable is tested by the linear regression method (Liy, H, 2021). The model is constructed as follows:

$$\begin{aligned} PLI_{it} = {} & \alpha + L.PLI_{it} + \beta_R Resource_{it} + \beta_T Technology_{it} + \beta_S Scale_{it} + \beta_M Policy_{it} \\ & + \varphi_1 GDP_{it} + \varphi_2 Urban_{it} + \varphi_3 Pop_{it} + \varphi_4 Pi_{it} + \lambda_t + \mu_i + \varepsilon_{it} \end{aligned} \quad (2)$$

Model 3: The product of the explained variable and the adjusted variable (industrial resources * industrial policy, industrial technology * industrial policy, and industrial scale * industrial policy) is respectively incorporated into the model, and the correlation between the product of the explained variable and the adjusted variable and the explained variable is tested by a linear regression method. The model is constructed as follows:

$$\begin{aligned} PLI_{it} = {} & \alpha + L.PLI_{it} + \beta_R Resource_{it} + \beta_{RM} Resource_{it} \times Policy_{it} \\ & + \varphi_1 GDP_{it} + \varphi_2 Urban_{it} + \varphi_3 Pop_{it} + \varphi_4 Pi_{it} + \lambda_t + \mu_i + \varepsilon_{it} \\ PLI_{it} = {} & \alpha + L.PLI_{it} + \beta_s Scale_{it} + \beta_{sM} Scale_{it} \times Policy_{it} \\ & + \varphi_1 GDP_{it} + \varphi_2 Urban_{it} + \varphi_3 Pop_{it} + \varphi_4 Pi_{it} + \lambda_t + \mu_i + \varepsilon_{it} \\ PLI_{it} = {} & \alpha + L.PLI_{it} + \beta_s Technology_{it} + \beta_{sM} Technology_{it} \times Policy_{it} \\ & + \varphi_1 GDP_{it} + \varphi_2 Urban_{it} + \varphi_3 Pop_{it} + \varphi_4 Pi_{it} + \lambda_t + \mu_i + \varepsilon_{it} \end{aligned} \quad (3)$$

If the test results of the above three models are correlated, the regulatory effect can be tested.

Results

Some variable is centralized processed to narrow the dimensional gap between data; c_ means centralized processing variables to facilitate the interpretation of the regulatory effect. The descriptive statistical results are shown in Table 2

Table 2 Shows the Descriptive Statistics for the particular mode

Variable	Sample Size	Mean	Standard deviation	Min	Max
Y	392	4.880	1	-1.171	3.768
F4	392	4.430	1	-1.171	3.768
c_X3	361	6.230	1	-1.161	3.115
F3	361	1.340	1	-1.161	3.115
c_X2	295	-1.750	0.712	-1.581	2.234
F2	295	-1.770	1	-2.658	2.364
F1	295	-3.100	1	-3.198	3.882
c_X1	295	-2.220	1	-2.658	2.364
F5	295	3.640	1	-1.055	3.851
X1_policy	361	0.002	0.788	-1.160	3.114
X2_policy	295	-0.066	0.421	-1.587	1.435
X3_policy	295	0.0156	0.554	-1.710	1.851
lnGDP	392	9.328	1.055	5.710	11.376
urban	392	0.514	0.148	0.168	895
lnPOP	392	8.122	0.825	5.676	9.323
pi	392	0.480	0.102	0.181	0.8118

Table 3 The Hausman Test for model

Model	Test Method	Statistical indicators	Value	H0	P	Result
Model(X3)	Hausman	chi2(6)	43.93	No individual effect	0.001	Reject random effects; choose fixed effects models
Model(X2)	Hausman	chi2(6)	16.51	No individual effect	0.012	Reject random effects; choose fixed effects models
Model(X1)	Hausman	chi2(6)	11.17	No individual effect	0.042	Reject random effects; choose fixed effects models

Table 3 shows that the Hausman Test statistical values of the regression model of the dairy industry distribution factors are 43.92, 16.5, and 11.18 (respectively). P-values are 0, 0.0113, and 0.0430, too. Reject the original hypothesis at the significance level of 5%. The fixed effect model can better fit than the random effect model based on the sample data selected in

this paper. Therefore, the fixed effect method is selected to estimate the model. According to the result of the Hausmann test, this section will use the two-way fixed effect model, adopt the stepwise regression method, and verify the hypotheses H1-H3 through the T-test method.

Analysis of regression results

Table 4 The regression result of industrial resources to industrial distribution

Variable	model 1	model 2	model 3	model 4	model 5
X1	0.012***	0.010**	0.012**	0.010***	0.012***
	(2.770)	(2.770)	(2.83)	(4.75)	(3.790)
lnGDP		0.035	0.017	-0.255	-0.120
		(0.170)	(0.095)	(-1.080)	(-0.450)
urban			0.291	0.624	0.406
			(0.430)	(0.920)	(0.581)
pop				-0.0280**	-0.031***
				(-2.520)	(-2.610)
pi					-0.453
					(-1.051)
_cons	-0.062**	-0.357	-0.329	3.159	2.392
	(-2.090)	(-0.20)	(-0.17)	(1.39)	(1.001)
Time effect	YES	YES	YES	YES	YES
Individual effect	YES	YES	YES	YES	YES
N	295	295	295	295	295
R2	0.820	0.823	0.829	0.755	0.853

t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01

Table 4 reflects the regression results of dairy industry resources on industry distribution. T-test is adopted to verify hypothesis 1. The fitting coefficient R2 (coefficient of determination) of model 1-5 is more significant than 0.8, indicating that the model has an excellent fitting degree. The regression results of model 1 show that when the control variables are not added, the influence coefficient of dairy industry technology on industry distribution is 0.011, and the corresponding T value is 2.78, which has passed the 1% significance test. According to model 5, after controlling the four variables of regional GDP, urbanization rate, population, and the proportion of the primary industry, the influence coefficient of dairy industry technology on industry distribution is 0.011, and the T value is 3.78, which has passed the 1% significance test.

Therefore, the dairy industry resources significantly positively impact on the industry distribution. Hypothesis 1 passes the test.

Table 5 The regression result of industrial technology to industrial distribution

Variable	model 6	model 7	model 8	model 9	model 10
X2	0.028***	0.027**	0.028*	0.026**	0.026**
	(3.590)	(2.570)	(2.110)	(2.360)	(2.483)
lnGDP		0.022	0.006	-0.255	0.105**
		(0.112)	(0.021)	(-1.080)	(2.382)
urban			0.324	0.637	0.398
			(0.485)	(0.951)	(0.571)
pop				-0.028**	-0.028**
				(-2.410)	(-2.491)
pi					-0.495
					(-1.151)
_cons	-0.061**	-0.258	-0.226	3.085	2.245
	(-2.170)	(-0.150)	(-0.121)	(1.361)	(0.942)
Time effect	YES	YES	YES	YES	YES
Individual effect	YES	YES	YES	YES	YES
N	295	295	295	295	295
R2	0.811	0.916	0.820	0.897	0.894

t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01

The regression results of model 6 show that when the control variables are not added, the influence coefficient of dairy industry technology on industry distribution is 0.029, and the corresponding T value is 3.58, which has passed the 1% significance test. According to model 10, after controlling the four variables of regional GDP, urbanization rate, population, and the proportion of the primary industry, the influence coefficient of dairy industry technology on industry distribution is 0.027, and the T value is 2.48, which has passed the 5% significance test. Therefore, the dairy industry regulation technology significantly impacts industry distribution and Hypothesis 2 passes the test. The regression results of the impact of industrial-scale on industry distribution are shown in Table 6.

According to model 15, after controlling the four variables of regional GDP, urbanization rate, population, and the proportion of the primary industry, the influence coefficient of the dairy industry scale on industry distribution is 0.005, and the corresponding T value is 2.28,

which has passed the 5% significance test. Therefore, the dairy industry scale significantly impacts industry distribution and Hypothesis 3 passes the test.

Table 6 The regression result of industrial scale to industrial distribution

Variable	Model 11	Model 12	Model 13	Model 14	Model 15
X3	0.014***	0.010**	0.011*	0.007***	0.006**
	(3.321)	(2.532)	(1.262)	(3.582)	(2.282)
InGDP		0.037	0.022	0.097	0.152
		(0.272)	(0.131)	(0.645)	(0.81)
urban			-0.235	-0.051	-0.388
			(-0.42)	(-0.091)	(-0.65)
pop				-0.017**	-0.018**
				(-2.09)	(-2.212)
pi					-0.747**
					(-2.09)
_cons	-0.032	0.297	0.228	1.664	0.141
	(-1.111)	(0.241)	(0.193)	(1.191)	(0.092)
Time effect	YES	YES	YES	YES	YES
Individual effect	YES	YES	YES	YES	YES
N	361	361	361	361	361
R2	0.865	0.81	0.882	0.812	0.892

t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01

According to model 15, after controlling the four variables of regional GDP, urbanization rate, population, and the proportion of the primary industry, the influence coefficient of the dairy industry scale on industry distribution is 0.005, and the corresponding T value is 2.28, which has passed the 5% significance test. Therefore, the dairy industry scale significantly impacts industry distribution and Hypothesis 3 passes the test.

Analysis of the moderating effect

Industrial policy is the moderating variable. Since the 12th Five-Year Plan in 2011, the government has started the dairy industry revitalization plan, and the provincial policies on dairy products have been paid attention respectively. Therefore, the value of provincial industrial policies before 2011 is 0; the value of the industrial policy after 2011 is 1.

Table 7 shows that the above conclusions are valid after adding control variables. This shows that the higher the interaction level, the higher the industry distribution level. Industrial policy positively regulates the impact of industrial resources on industry distribution, and Hypothesis H4 has passed the test.

Table 7 Multi-Level regression results on the moderating effect of industrial resources

Variable	Model 16a	Model 16b	Model 17a	Model 17b
c_X1	0.012***	0.002**	0.010***	0.002***
	(2.782)	(0.042)	(2.783)	(0.032)
policy	0.008***	0.027*	0.027**	0.024**
	(3.472)	(1.971)	(2.491)	(2.38)
X1_policy		0.105**		0.023**
		(2.382)		(2.18)
lnGDP			-0.118	-0.105
			(-0.442)	(-0.383)
urban			0.404	0.324
			(0.582)	(0.461)
pop			-0.031***	-0.031***
			(-2.61)	(-2.61)
pi			-0.453	-0.425
			(-1.051)	(-0.98)
_cons	-0.062**	-0.052*	2.392	2.292
	(-2.081)	(-1.671)	(1.01)	(0.961)
Time effect	YES	YES	YES	YES
Individual effect	YES	YES	YES	YES
N	295	295.000	295	295.000
R2	0.7193	0.7202	0.753	0.794

The results in Table 8 shows that the plausible conclusion is still valid after adding control variables. This show that the moderating effect of the interaction term is not significant, the industrial policy does not moderate the impact of industrial technology on industry distribution, and H5 still needs to pass the test.

Table 8 Multi-level regression results on the moderating effect of industrial

Variable	Model 18a	Model 18b	Model 19a	Model 19b
c_X2	0.028***	0.035*	0.026**	0.032**
	(3.57)	(1.852)	(2.47)	(2.292)
policy	0.0104***	0.0343**	0.0144**	0.0526***
	（9.18）	（4.485）	（2.47）	（3.64）
X2_policy		0.624	0.167	0.019
		(0.933)	(0.818)	(0.091)
lnGDP			0.105**	-0.102
			(2.381)	(-0.371)
urban			0.398	0.402
			(0.56)	(0.571)
pop			-0.028**	-0.027**
			(-2.48)	(-2.48)
pi			-0.493	-0.512
			(-1.151)	(-1.181)
_cons	-0.061**	-0.062**	2.243	2.216
	(-2.182)	(-2.201)	(0.943)	(0.931)
Time effect	YES	YES	YES	YES
Individual effect	YES	YES	YES	YES
N	295	295.000	295	295.000
R2	0.812	0.814	0.896	0.894

Table 9 shows that the above conclusion is valid after adding control variables. This shows that the higher the interaction level, the higher the industry distribution level, the industrial policy positively regulates the impact of industrial-scale on industry distribution, and H6 has passed the test.

Table 9 Multi-Level regression results on the moderating effect of industrial scale

Variable	Model 20a	Model 20b	Model 21a	Model 21b
c_X3	0.0131***	0.0161**	0.004**	0.011**
	(3.33)	(2.382)	(2.270)	(2.221)
policy	0.043***	0.053***	0.0106**	0.0876***
	(2.410)	(3.481)	(9.521）	(13.471）
X1_policy		0.012***	0.026**	0.008***
		(3.721)	(2.481)	(3.473)
lnGDP			(0.81)	0.165
			-0.388	(0.861)
urban			(-0.641)	-0.415
			-0.018**	(-0.681)
pop			(-2.22)	-0.022**
			-0.747**	(-2.223)
pi			(-2.081)	-0.714*
			0.141	(-1.951)
_cons		-0.032	(0.091)	0.018
		(-1.111)	0.152	(0.011)
Time effect	YES	YES	YES	YES
Individual effect	YES	YES	YES	YES
N	361.000	361.000	361.000	361.000
R2	0.762	0.857	0.812	0.862

Discussion and conclusion

According to regression result, industrial resources, technology, and scale positively impact industry distribution. Dairy industry resources (including cow stock, the number of dairy enterprises and the total feeding amount) positively impact the industry distribution. Therefore, in the development of the dairy industry, ensuring the source supply, improving the number of dairy cows and feed level, and enhancing the market size and quantity of dairy enterprises are conducive to the integrated development of the upstream and downstream supply chain of the regional dairy industry and improve the level of industry distribution.

Dairy industry technology (including the number of technicians, farm technical performance, and technology R & D expenses) positively impacts on the industry distribution. It still needs further strengthening of the R & D investment in the high-tech dairy industry (Hu, 2021). Finally, China should actively upgrade and transform traditional farms and improve the standardization and modernization of breeding bases in source areas.

The scale of such a dairy industry (including domestic consumption of dairy products, import and export volume of dairy products, output of dairy products, and resulting value) positively impacts the industry distribution. It should not only pay attention to the output, large-scale breeding, and production of dairy products at the supply end of the dairy industry but also pay attention to the domestic and foreign consumption of dairy products at the consumer end of the dairy industry and the total output value of the industry, to form a better industry distribution. Meanwhile, industrial policy has no moderating effect on industrial technology and distribution. It is worth noting that the implementation of the dairy industry policy is needed to strengthen the positive impact of industrial technology on industry distribution. The conclusions show deficiencies in formulating China's dairy industry policy from 2007 to 2018. It is suggested that China's relevant departments should take dairy industry technology as the key support direction when formulating dairy industry policies in the future. To sum up, suggestions can be promoted by integrating the industrial resource and improving. Technologies of the dairy industry, expanding the scale of the dairy industry, and the dairy industry policies-making.

Contributions and limitations

Unlike the existing literature, the paper innovatively takes the industry distribution as the explained variable and studies the industry distribution's pre-influencing factors, enriching the dairy industry distribution's empirical and theoretical research of the dairy industry distribution. This paper fills up the gaps in the research on the influence of industrial resources, industrial technology, and industrial scale on the industrial layout. Further, the paper explores the issue of the moderating effect of industrial policy on the industrial layout in China's dairy industry.

There are two limitations. First, the lack of some annual statistical data and the inconsistency of statistical caliber may have a particular impact on the results of this study. Second, only the relevant data at the provincial level can be obtained, and there are also significant differences between provincial and county levels, so how to develop dairy products at a county level needs further study.

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