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Exploration on the Balanced Economic Development in the North and South of China

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Abstract: The uneven level of balanced development in economic, social, ecological and livelihood areas objectively lead to the unbalanced development of North and South regions in China. The purpose of this study is to evaluate the level of development of North and South in various aspects, clarify the influencing factors of North and South regional development and analyse the reasons behind the disparity factors, so as to provide reference basis and policy suggestions for promoting the work of narrowing the relative gap between North and South regional development in China. A comprehensive evaluation of the cross-sectional data of 22 provinces in the North and South in 2020 is conducted using the rank sum ratio evaluation method to reflect the current situation; based on this, endogenous growth model is used to explore the key factors affecting the imbalance between the North and South regional development for the panel data from 2011 to 2020.

Keywords: region gap; rank sum ratio evaluation method; endogenous growth model

JEL Classification: B16; O18

1. Introduction

In recent years, the problem of regional development, especially the uncoordinated level of development between the north and the south, has seriously hindered the pace of China's development from an overall well-off society to socialist modernization. Twenty ten reports proposed to speed up the construction of a new development pattern, focus on promoting high-quality development, and promote regional coordinated development is one of the requirements to achieve high-quality development, the formation of complementary advantages of the national spatial system has become an unstoppable trend, therefore, in the face of the current situation of unbalanced development between the north and south of China, the core problem should be identified and combined with the actual solution. The problem of north-south disparity is the result of a combination of various influencing factors, and is the result of the continuous southward shift of China's economic centre of gravity since the reform and opening up. Correct understanding of the north-south gap problem, profound analysis of the factors behind it and reasonable policy recommendations are inevitable conditions for the realization of the great rejuvenation of the Chinese dream.

Research on this issue reveals that the national transaction efficiency has been significantly improved in the Internet era, and the transaction efficiency in the south has improved faster than that in the north (Hu, 2022), and Geng (2020) used ESDA spatial data analysis to discover the differences in the economies of China's provincial administrative regions and obtain a

regional evolution map of China's inter-provincial administrative regions' economic hotspots, among others. It was found that although the development level of the north and south regions of China generally showed a growing trend, there were obvious unevenness and aggregation characteristics between regions, and their changes were mainly influenced by factors such as transaction efficiency and information industrialization. In addition, many scholars have launched in-depth analyses around also on resource heterogeneity (Dai, 2020), coefficient of variation and Sill coefficient, total factor productivity (Fu, 2006) and other issues.

The Qinling Mountains and Huaihe River is used as the boundary to divide the north-south region, which includes sixteen provinces in the south and fifteen provinces in the north. Eleven provinces are selected for the northern measurement provinces including Beijing, Shaanxi, Gansu, Hebei, Inner Mongolia, Ningxia, Liaoning, Qinghai, Shandong, Tianjin, and Xinjiang. The 11 provinces selected for the southern measure include Guangdong, Guangxi, Sichuan, Fujian, Guizhou, Hainan, Jiangsu, Shanghai, Yunnan, Zhejiang, and Chongqing. Based on the data of 22 provinces and regions from 2011 to 2020, this study establishes an indicator system with five measurement levels: economic development, innovation drive, people's life, ecological environment, and foreign investment, and uses the normalization and rank sum ratio method to conduct the measurement study, and then uses the endogenous growth model to explore the key factors affecting the gap between the north and south development levels. The findings of the study can provide necessary references and policy inspirations for the practical promotion of the coordination of the North-South development level.

2. Methodology

2.1. Construction of Index System

In " *Why Doesn't Capital Flow from Rich to Poor Countries?*", Alfaro et al. (2008) points out that the fundamental reason for the different levels of economic development in different regions and even in different countries is that the level of innovation and technology affects human capital differently, which leads to different output per unit of labor. Technological innovation can directly affect human capital through dry school, which is a kind of Harold-neutral technological progress, it is to enhance the effective labor of the labor force, improve the quality of labor and labor efficiency, and thus cause income inequality between countries and regions.

Therefore, taking into account the multiple dimensions of human capital proposed by UNESCO, the total amount of human capital is influenced by five dimensions: economic development, innovation drive, people's life, ecological environment and foreign investment, and the representative indicators in each field are selected, and the entropy value method is chosen to give the weight to each indicator.

In terms of industrial structure, we selected the industrial structure upgrade index proposed by Xu and Jiang (2015), and the Paddy-Clark law suggests that industrial structure upgrading means the change of industry and the improvement of efficiency. In order to comprehensively and accurately reflect the purpose of this paper and the connotation of industrial structure upgrading, the following draws on the study of Xu and Jiang (2015) to

construct an industrial structure upgrade index to represent the level of industrial structure upgrading, and the specific measurement is shown in the formula:

$$ISU = \sum_{i=1}^{3} I_i \times i = I_1 + I_2 \times 2 + I_3 \times 3 \quad (1)$$

The level of openness is based on the existing theoretical analysis: David Ricardo's trade theory states that an open market can lead to a wider competition and make all participants benefit, while in recent times, with the development of multinational enterprises, foreign investment theory states that foreign direct investment can cause an increase in the level of competition in the local market, with spillover effects of competition and management experience. Two dimensions are selected to measure the level of foreign investment: the total investment of FIE (foreign-invested enterprises) and the number of FDI projects.

Table 1. Composition of the index system

subsystem	Specific indicators	measurement units	data sources	weight (%)
1. economic development	Per capita GDP	yuan	State Stat. Bureau	4.509
	Urban-rural disposable income gap	yuan	State Statistical Bureau	1.575
	Urban-rural consumption expenditure gap per capita	yuan	State Stat. Bureau	1.287
	Industrial structure upgrade index	/	State Stat. Bureau	6.995
2. innovation-driven	Number of R & D personnel	person	State Stat. Bureau	11.751
	R & D personnel expenditure	ten thousand yuan	State Stat. Bureau	9.563
	Number of patents authorized	piece	State Stat. Bureau	10.334
	Sales revenue from new products	ten thousand yuan	State Stat. Bureau	11.176
3. people's life	General public services expenditure	ten thousand yuan	State Stat. Bureau	4.535
	Per capita education expenditure	yuan	State Stat. Bureau	4.317
	Health technicians per thousand population	person	State Stat. Bureau	4.019
	Engel's coefficient	%	Provincial Stat. yearbook	1.225
4. ecological condition	Energy consumption per GDP	Tons of standard coal per ten thousand yuan	State Stat. Bureau	1.079
	Percentage of forest cover	%	State Stat. Bureau	3.925
	Harmless domestic waste treatment rate	%	State Stat. Bureau	0.722
	Urban sewage treatment rate	%	State Stat. Bureau	1.469
5. foreign investment	Total investment of FIE	million dollars	State Stat. Bureau	9.629
	Number of FDI projects	number	State Stat. Bureau	11.889

2.2. Data Processing

The missing values of the variables are quickly viewed using the command misstable in the stata software, which is presented in a tabular form. Missing values are handled by

regression interpolation, using the relationship between variables to build a regression model, and for variables containing missing values, by building a regression equation of the missing term on the observed term and using the predicted values obtained from this equation to fill in the missing values.

Using the summarize command, the relationship between the standard deviation and the mean is easily determined, and then the histogram command is used to clearly determine whether there are outliers based on the generated histogram. The outlier processing is selected as a tailing process, in which the data in a set that exceeds a specified percentile value is replaced by the value near the specified percentile. When the sample data is large enough, the tailing process can help to remove the effect of extreme values.

The rank-sum ratio method was selected for the comprehensive evaluation of 22 provinces and cities in 2020. The method combines parametric and non-parametric statistics, with descriptions and inferences, and has powerful statistical information functions through the operation of rank substitution.

Table 2. Results of the linear regression analysis

	Non-standardized coefficients		Standardization coefficient	p	VIF	Adjust R2	F
	B	standard error	Beta				
constant	-0.62	0.041	-	0.000***	-	0.973	F=759.265
Probit	0.218	0.008	0.987	0.000***	1		P=0.000***

From the analysis of the results of the F test, we can get that the significance P-value is 0.000*** and the level presents significance, which rejects the original hypothesis that the regression coefficient is 0. Meanwhile, the goodness-of-fit R^2 of the model is 0.973, and the model performance is relatively excellent, so the model basically meets the requirements. For the performance of variable co-linearity, VIF is all less than 10, so the model has no multiple co-linearity problem and the model is well constructed. The formula of the model is as follows: y = -0.62 + 0.218 * Probit.

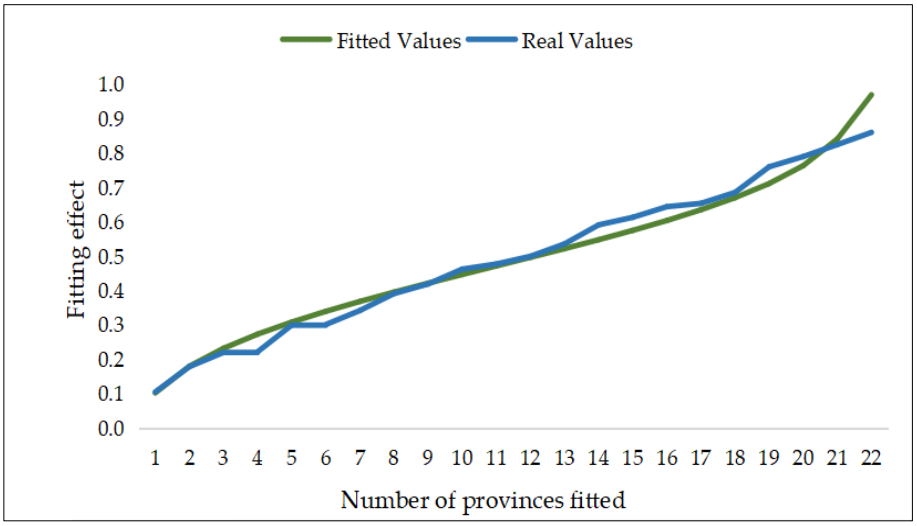

Figure 1. Fits the effect diagram

Table 3. Stile sorting critical value table

Level	The percentile cut-off value	Probit	RSR cut-off value
The first gear	<15.866	<4	<0.2535
The second gear	15.866 ~	4 ~	0.2535 ~
The third gear	84.134 ~	6 ~	0.6902 ~

Table 4. Summary of the grading and level results

Province	RSR_Rank	Probit	RSR Regression	Level
Guangdong	1	7.278	0.969	3
Jiangsu	2	6.691	0.841	3
Zhejiang	3	6.335	0.763	3
Shandong	4	6.097	0.711	3
Shanghai	5	5.908	0.670	2
Fujian	6	5.748	0.635	2
Beijing	7	5.605	0.604	2
Sichuan	8	5.473	0.575	2
Hebei	9	5.349	0.548	2
Liaoning	10	5.230	0.522	2
Chongqing	11	5.114	0.497	2
Tianjin	12	5.000	0.472	2
Shaanxi	13	4.886	0.447	2
Guangxi	14	4.770	0.422	2
Yunnan	15	4.651	0.396	2
Guizhou	16	4.527	0.369	2
Hainan	17	4.395	0.340	2
Nei Monggol	18	4.252	0.309	2
Xinjiang	19	4.092	0.274	2
Gansu	20	3.903	0.232	1
Ningxia	21	3.665	0.180	1
Qinghai	22	3.309	0.103	1

3. Results

According to the summary of the results in Table 4, there are four provinces and cities with Level 3 (the best level): Guangdong Province, Jiangsu Province, Zhejiang Province, and Shandong Province, fifteen provinces and cities with Level 2 (the median level): Shanghai, Fujian, Beijing, Sichuan, Hebei, Liaoning, Chongqing, Tianjin, Shaanxi, Guangxi, Yunnan, Guizhou, Hainan, Inner Mongolia, and Xinjiang, and three provinces and cities with Level 1 (the lowest level): Gansu Province, Ningxia Province, and Qinghai Province. Level 1 (the lowest grade) there are three provinces and cities: Gansu Province, Ningxia Province, Qinghai Province. It is not difficult to find that the development balance between the north and the south is not optimistic: only Shandong is the northern province and city among the four provinces and cities with Level 3 (the best grade), while the three provinces and cities with Level 1 (the lowest grade) are Gansu, Ningxia and Qinghai, all of which are northern provinces and cities.

The mean vectors of Level 1, Level 2 and Level 3 provinces and cities in 2020 are further calculated based on the index values after data processing, and the mean vectors of Level 1

regions are used as the benchmark, and the mean vectors of Level 2 and Level 3 are converted into multiples (the inverse of the multiples is taken for negative indicators), and Radarchart in the fmsb package of R software is applied to the plot is obtained as Figure 2. The radar map of the mean value of cross-sectional data in the north and south regions in 2020.

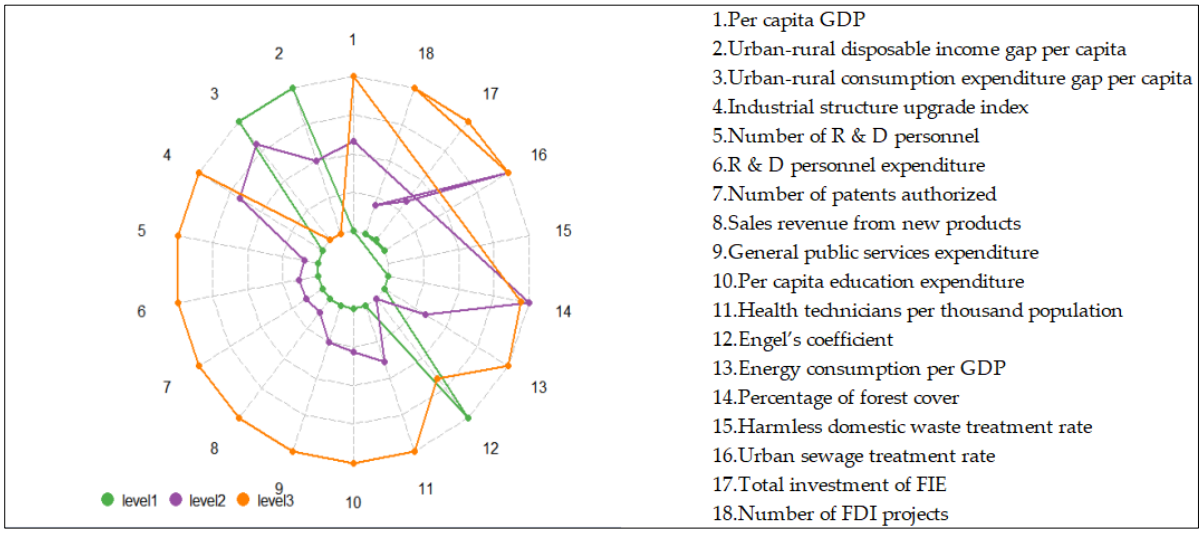

Figure 2. Radar plot of mean of 2020 section data by Level

In Figure 2, it is easy to see that the mean value of most indicators in Level 3 is much higher than Level 1, while some data in Level 2 are much higher than Level 1, and the gap with Level 3 is not significant, while some data are close to Level 1. The data show the difference between Level 1 and Level 2 in Urban-rural disposable income gap per capita, Urban-rural consumption expenditure gap per capita, Number of R&D personnel, R&D personnel expenditure, Number of patents authorized, Sales revenue from new products, General public services expenditure, and Per capita education expenditure. Urban-rural consumption expenditure gap per capita, Number of R&D personnel, R&D personnel expenditure, Number of patents authorized, Sales revenue from new products, General public services expenditure, and Per capita education expenditure, etc., urban-rural income distribution, R&D research and development, and public services still need to be further promoted, while such aspects as Industrial structure upgrade index, Harmless domestic waste treatment rate and urban sewage treatment rate is very small, implying that China is relatively average at the level of industrial structure, and the geopolitical factors do not have a large impact and incline industrial optimization and upgrading, while the same of domestic garbage harmless treatment rate and urban sewage treatment rate represents a better implementation effect at the ecological environment level such as garbage sorting policy and new regulations on sewage treatment.

4. Discussion

The capital output impact factor and human capital impact factor are constructed. The capital output factor is considered to be influenced by foreign direct investment, general public service expenditure and industrial structure upgrading index; considering the

multiple dimensions of human capital proposed by UNESCO, the total amount of human capital is influenced by multiple dimensions such as health care, education level, science and technology innovation. Therefore, with GDP per capita as the explanatory variable and other variables as explanatory variables, the following endogenous growth model is established.

$$\begin{aligned} Y &= H[\eta_t(K^{\alpha})][K_A^{\alpha 1} L_A^{\beta 1} \theta_t L] \\ \eta_t &= FDIK^{\alpha 2} FDIP^{\beta 2} G^{\xi} ai^{\theta} \\ \theta_t &= id^{\alpha 3} ie^{\beta 2} he^{\xi 2} right^{\xi 3} in^{\xi 4} \end{aligned} \tag{2}$$

Table 5. List of model-building variables

variable	Y	K	L	H	η_t	FDI	θ_t
meaning	GDP	stock of capital	The number of labor	Production function allowance	Capital output impact factor	Total investment of FIE	Human capital impact factor
variable	G	Ie	He	Id	Ai	Right	In
meaning	General public services expenditure	Per capita education expenditure	Health technicians per thousand population	Urban-rural disposable income gap per capita	Industrial structure upgrade index	Number of patents authorized	Sales revenue from new products

Both sides of the above equation are divided by L, at the same time, and then the natural logarithm is the following equation that can be statistically regressed:

$$\begin{aligned} &\ln y = \alpha 2 \ln FDIK + \beta 2 \ln FDIP + \xi G + \theta \ln ai + \\ &\alpha \ln k + \alpha_1 \ln K_A + \beta_1 \ln L_A + \alpha 3 \ln id \\ &+ \beta_3 \ln ie + \xi_2 \ln he + \xi_3 \ln right + \xi_4 \ln in + \ln H \end{aligned} \tag{3}$$

The Hausman test showed a p-value of 0.000, which suggested that a fixed effects model (FE) should be used, taking into account the time effect, and testing the joint significance of all annual dummy variables,which was found to include time fixed effects in the model.

Under the Fe_trend model, the industrial structure upgrade index has a significant positive effect on per capita GDP at the level of 5%, and the time has a significant positive effect on per capita GDP at the level of 0.1%.

5. Conclusion

In this paper, we study the balanced development of north-south regions by using panel data from 2011 to 2020, and use the comprehensive evaluation of the rank and ratio of cross-sectional data in 2020 to obtain the probit threshold value, according to which the regional ranking is graded, among the four provinces and cities with the graded level of Level3 (the best level), only Shandong is a northern province and city, while the three provinces and cities with the graded level of Level1 (the lowest level) are Gansu, Ningxia and Qinghai, all of which are northern provinces and cities. Based on this classification, a fixed-effects model with time effects is tested and selected to investigate the key influencing factors, and it is

	(1) OLS	(2) FE_robust	(3) FE_trend	(4) FE	(5) RE
lnId	0.157*	0.0668	-0.0468	0.0668	0.157**
	(0.0670)	(0.0622)	(0.0490)	(0.0501)	(0.0541)
lnai	1.245	-0.530	-2.694*	-0.530	1.245*
	(1.207)	(1.306)	(1.034)	(0.549)	(0.561)
lnright	0.0703	0.0689*	-0.0297	0.0689*	0.0703*
	(0.0364)	(0.0277)	(0.0275)	(0.0265)	(0.0295)
lnIn	0.0285	0.0487	0.0262	0.0487*	0.0285
	(0.0429)	(0.0476)	(0.0346)	(0.0231)	(0.0233)
lnG	0.130	0.474***	0.254	0.474***	0.130*
	(0.110)	(0.0815)	(0.143)	(0.0676)	(0.0627)
lnHe	0.0115**	0.00913	0.00504	0.00913*	0.0115*
	(0.00370)	(0.00453)	(0.00303)	(0.00432)	(0.00481)
lnFDI	0.0600	0.0698*	0.0360	0.0698**	0.0600**
	(0.0393)	(0.0330)	(0.0218)	(0.0215)	(0.0229)
时间			0.0733***		
			(0.0131)		
_cons	5.693***	5.638***	-136.1***	5.638***	5.693***
	(0.832)	(0.888)	(25.43)	(0.456)	(0.499)
N	220	220	220	220	220

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Figure 3. Summary of the empirical test results

found that the industrial structure upgrading index has a significant positive effect on GDP per capita at the 5% level.

Based on the research findings, the following policy insights are obtained from this paper:

- Development impetus should be driven from relying on factor inputs such as resources and low-cost labor to innovation. According to the conclusion of North's analysis, institutional innovation is even more important than technological invention for long-term economic growth, and institutional innovation can be optimized in terms of property rights mechanism, motivation mechanism, decision-making mechanism and coordination mechanism.
- According to local conditions, different regions should make differentiated policies, for example, the southern region should invest resources into R&D and promote the transformation of enterprises to knowledge-intensive and technology-intensive. While the northern regions should expand the scale of foreign investment and focus on scientific research and innovation, rather than building infrastructure as the main focus, in order to narrow the economic differences with the southern regions through rapid economic growth and industrial structure upgrading.

Conflict of interest: none.

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