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Quantitative Evaluation of County-level Economic Development in Henan Province Based on Multiple Statistical Regression Models

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ABSTRACT
County economic development directly affects the national economy, and the county economy of Henan Province has become the economic pillar of the province. The purpose of this paper is to analyze the county-level economic development of Henan Province and its economic influencing factors by using the quantitative evaluation method. From the time series, the level of economic development of 105 county units in Henan Province from 2000-2023 is analyzed from two perspectives, absolute difference and relative difference, using the indicator of GDP per capita. Screening of factors affecting the level of economic development of counties in Henan Province is carried out from the aspects of population, resources, policies, etc., and a four-aspect indicator system is constructed, namely, human capital, government regulation, industrial level, and economic vitality. A multiple linear regression model is established, and the regression model is fitted by the regression coefficients of each influencing factor, and the fit of the regression model is examined. Each county in Henan Province is divided into three development gradients: developed, generally developed and less developed counties. Panel data regression analyses were conducted on the overall county economy of Henan Province and the influencing factors of developed, generally developed and less developed counties respectively. In the overall economic development of counties in Henan Province, the degree of influence of physical capital investment and the structure of secondary and tertiary industries on the overall differences in county economies is particularly significant. It is manifested in the fact that for every 1% increase in the investment in fixed capital of the whole society, the output of GDP per capita increases by 0.09112% accordingly. Therefore, in order to improve the differences in the economic development of counties in Henan Province, local governments and enterprises should make efforts to improve the market and investment environment and adjust the structure of secondary and tertiary industries.

Keywords: multiple linear regression, GDP per capita, absolute difference, relative difference, county economic development

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1. Introduction

Over the past 40 years of reform and opening up, the economic scale of Henan has improved significantly, and Henan's economic and social development has made remarkable achievements [1-2]. Entering the new era, the quality of development requirements are increasingly prominent, and promoting high-quality economic development is the fundamental requirement for development in the current and future period, and Henan has a long way to go to promote high-quality economic development [3-5]. Henan is a populous province, resource province, factor endowment advantage is a major advantage of Henan's economic development, with the economic development into the new normal, Henan factor endowment advantage can not be effectively transformed into a development advantage, more and more highlights the overall economic big but not strong, innovation ability to enhance lagging behind the economic development and other issues [6-8], there are a lot of constraints on the development of high quality of the economy, comprehensive and accurate grasp of the development of high quality of economy, the current situation and existing problems, the development of high quality of Henan. The current situation and problems, Henan clear their own advantages, make up for the short board of development, accelerate the development of high quality of the economy, there is an important theoretical and practical significance [9-12].

County economy refers to the formation of an open, functional and regional economy with regional characteristics by integrating and optimizing economic and social resources within the territory of county-level administrative divisions [13-14]. The development and expansion of county economy is of great strategic and practical significance in solving China's “three rural” problems, promoting the modernization process of national economic and social development, and building a moderately prosperous society in an all-round way [15-16]. In Henan Province, there are 108 counties and county-level cities, with a total population of 80.682 million, accounting for 83.9% of the total population of the province. For Henan, the development of county economy is particularly important for improving the comprehensive strength of the province's economy and narrowing the development gap with advanced provinces [17-19]. Evaluating the unbalanced development of Henan's county economy, on the one hand, helps to improve the understanding of the current situation of Henan's county economic development, helps to reasonably plan the future development of Henan, especially the backward areas in central Jiangsu, and helps to further enhance the sense of urgency for the development of the county economy, on the other hand, it can provide reference suggestions for the development of the county economy [20-23]. Due to the comprehensiveness and complexity of the county economy, as well as the differences in the entry point of research in various disciplines, there are various research methods [24].

This paper briefly describes the economic development of Henan Province as a whole, and analyzes the topography, agriculture and water resources of Henan Province. The per capita GDP of 105 counties in Henan Province from 2000 to 2023 is used as the main data for analyzing the economic development of Henan Province's counties, which is substituted into the formula of extreme deviation and standard deviation, and the extreme deviation, standard deviation, coefficient of variation, and weighted coefficient of variation of the level of economic development of counties in Henan Province are calculated. From this, the absolute difference and relative difference of county economic development in Henan Province are analyzed. Screening the relevant factors affecting the level of economic development of counties in Henan Province, organizing the descriptive statistics of each influencing factor, and establishing the multiple linear regression model. Divide the level of county economic development and analyze the relevant factors affecting the economic development of counties in different gradients.

2. Time analysis of the level of economic development of counties in Henan Province

The county economy, as an economy within a county administrative region, belongs to the category of regional economy. The economic attributes are divided into two aspects, including both the urban economic attributes covering urban areas and the market town and village economies covering the vast rural areas, which are integrated economies. Agriculture is the foundation of the county economy and industry is the backbone of the county economy. The county economy is the aggregate of all economic factors and production behaviors within the county, and plays an irreplaceable role in providing agricultural and sideline products for society, providing employment for the vast number of rural residents, guaranteeing basic living needs, and promoting social stability.

2.1. Overview of economic development in Henan Province

The topography of Henan Province consists of plains, hills and mountains, which account for 55%, 17% and 26% of the total area respectively. The plains are mainly located in the eastern, central and southwestern Nanyang areas, where wheat, corn and rice are the main crops. The hilly areas are mainly located in the central and southern parts of the country where vegetables, fruits, tea and other cash crops are grown. The mountainous areas are mainly located in the Qinling Mountains in the west, the Taihang Mountains in the north and the Dabie Mountains in the south, mainly producing medicinal herbs and forest trees.

As a large agricultural province, Henan Province, agriculture plays an important role in the development of county economy. Over the years, Henan Province has been attaching great importance to the development of agriculture and rural areas, constantly consolidating the foundation of agriculture, actively improving the quality of agricultural products, optimizing the structure of the agricultural industry, focusing on the development of special agriculture, and implementing a number of agricultural subsidy policies.

Henan Province is also a large resource province. In terms of mineral resources, Henan Province has complete strata, complex geological structure, superior topographic conditions for mineralization, and rich mineral resources, making it a major province in China. Among the mineral resources with proven reserves, there are 8 kinds that rank first in the country, 19 kinds that rank first 3, 27 kinds that rank first 5, and 44 kinds that rank first 10.

In terms of water resources, Henan Province has more than 1,500 rivers including the Yellow River, the Huaihe River and the Yangtze River, with a total of 41.3 billion cubic meters of water resources, 4.905 million kilowatts of hydroelectric resources, with 3.15 million kilowatts of water resources available for development, and the Yellow River Xiaolangdi Water Conservancy Hub in the northwestern part of the country, which shows that Henan is a large province of water resources.

Henan Province is also a large province of tourism resources, there are more than 100 scenic spots and attractions for viewing and traveling. There are 25 key scenic spots in the province, including 5 national ones, 20 provincial ones and 23 nature reserves, which are famous for ancient culture, flower culture and other special tourism resources, providing superior conditions for the development of tourism in Henan Province.

2.2. Geographical units of the study and data processing

According to the latest administrative division of Henan Province, this paper takes the 105 county units under the jurisdiction of Henan Province in 2016 as the research object (counties with different administrative divisions from those in 2016 were excluded).

2.2.1. Data sources. Gross national product per capita (GDP per capita) is the ratio of a country's or region's gross domestic product (GDP) to the country's or region's resident population over an

accounting period (often referred to as a year). GDP per capita can more objectively reflect the level and degree of development of a certain region's society, with the meaning of social fairness and equality, and has a certain intrinsic connection with the process of industrialization and social stability, and is often used to measure the state of economic development.

In this paper, when analyzing the spatial and temporal economic level of counties in Henan Province, the per capita GDP of counties from 2000 to 2023 is used to measure the level of county economic development, and exploratory spatial data analysis is used for spatial analysis.

Because it is necessary to establish the spatial weight matrix, the absence of prefecture-level city indicators will affect the spatial distribution of county economic level, so the data of city districts will be analyzed instead of prefecture-level city data in the exploratory spatial data analysis.

The data information in this paper mainly comes from Henan Provincial Statistical Yearbook, China County Economic Statistical Yearbook, China Urban Statistical Yearbook, as well as statistical yearbooks and statistical bulletins of counties and cities in the corresponding years from 2000 to 2023. When obtaining road data, the road network data of Henan Province in 2000 is selected, and the data of each subsequent year is obtained based on the annual newly repaired roads.

2.2.2. Mathematical and statistical methods:

1) Polar deviation and standard deviation. The extreme deviation, or range error, is the difference between the largest and smallest values in the study data and is calculated by the formula:

$$R = X_{\max} - X_{\min} \tag{1}$$

In the formula, R represents the extreme difference value, $X_{\max}$ represents the comprehensive score value of the county with the highest level of economic development in the sample, and $X_{\min}$ represents the lowest score value. The difference between the two is the extreme deviation, the extreme deviation can reflect the range of changes in the level of economic development of the county on the time series.

Standard deviation, that is, the mean square deviation, is the arithmetic square root of the standard value in the data and its mean deviation square, reflecting the sample data in each study value and its first number of mean deviation. The larger the value obtained, the greater the difference between the data, and is calculated as follows:

$$S = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{2}$$

where S represents the standard deviation, x_i represents the county composite score score, and x represents the average of the composite scores of the counties within the region. n represents the number of counties in the study area. The larger the value of S, the more the study sample deviates from its mean. The smaller the value of S, the lower the degree of deviation of the study sample from its mean.

2) Coefficient of Variation and Terrell's Index. The coefficient of variation (CV), also known as the standard deviation rate, is the ratio of the standard deviation of the research sample to the mean value, mainly used to find out the degree of variation in the difference of data samples, and is an important indicator for studying the degree of regional economic dispersion. The larger the CV, the greater the difference in the level of regional economic development. The coefficient of variation can eliminate the error caused by the difference of scale on the degree of variation, and is calculated by the formula:

$$CV = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_i - \bar{Y})^2}}{\bar{Y}} \tag{3}$$

Where CV represents the coefficient of variation, n is the number of districts. Y_i represents the score score of i regions, and $\overline{Y}$ represents the mean value of the score score of each region. Measured by the coefficient of variation, it can more intuitively reflect the relative differences in the level of county economic development.

The Thiel index, with its decomposition inquiry, is able to decompose the overall regional differences into within-group and between-group differences. The study is analyzed by calculating the degree of difference between the regions and the study as a whole. Meanwhile, there are two methods of calculating the Thiel index, the T-index and the L-index. Among them, T-index is calculated by weighting GDP and L-index is calculated by weighting population. In this paper, we choose to take GDP as the weight and then calculate the T-index with the following formula:

$$T = T_w + T_B \tag{4}$$

$$Tw = \sum_i \left(\frac{Y_i}{Y}\right) \sum_j \left(\frac{Y_{ij}}{Y_i}\right) \lg\left(\frac{Y_{ij}/Y_i}{P_{ij}/P_i}\right) \tag{5}$$

$$T_B = \sum_i \left(\frac{Y_i}{Y}\right) \lg\left(\frac{Y_i/Y}{P_i/P}\right) \tag{6}$$

where T is the overall regional variance, T_w is the intra-regional variance T_B is the inter-regional variation, Y_i is the i total regional GDP. Y is total GDP, Y_{ij} is i total regional j county GDP. P for total population, P_i for i total regional population, P_{ij} for i regional j county population.

3) Multiple linear stepwise regression analysis. In linear regression analysis, it is possible that each research factor contains correlation links, so the multiple regression equation model is very likely to be affected by multiple covariance, and the stepwise regression method can solve these problems [25-27].

Multiple linear stepwise regression analysis is based on multiple regression modeling, i.e., when using the model for measurement, the selected variables can be eliminated when they are no longer important after the introduction of new variables, and they can be selected into the equation again when the eliminated variables become important again after the introduction of new variables. The classical multiple linear regression model is:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_n x_n \tag{7}$$

When one or more of the explanatory variables are correlated, there is multicollinearity in the explanatory variables.

If a relationship exists:

$$C_0 + C_1 X_{i1} + C_2 X_{i2} + \cdots + C_m X_{im} = 0 \tag{8}$$

where $i = 1, 2, \ldots\ldots, n$, then full covariance is said to exist for $X_1, X_2, \ldots\ldots, X_m$.

If there exists the relation Eq:

$$C_0 + C_1 X_{i1} + C_2 X_{i2} + \cdots + C_m X_{im} + v_i = 0 \tag{9}$$

Where $i = 1, 2, \ldots\ldots, n$, v_i are randomized intervention terms, then $X_1, X_2, \ldots\ldots, X_m$ is said to have approximate covariance. The research topic of this paper and the data washed with statistical yearbooks and cross-sectional data are somewhat correlated, so it is highly probable that covariance will occur in the selected research indicators. Because of the multi-faceted covariance easily lead to the least squares method does not exist parameter estimates, and the approximate covariance will lead to parameter estimates of the variance becomes large, easy to lead to parameter estimates of the economic meaning of the unreasonable, or variables of the significance of the test and prediction test

fails. The stepwise regression method is used for the test of multicollinearity, i.e., new variables are introduced one by one.

2.3. Analysis of absolute differences in the level of economic development of counties in Henan Province

The per capita GDP of 105 counties in Henan Province from 2000 to 2023 is substituted into the formula for calculating the extreme deviation and standard deviation. The extreme deviation, standard deviation, coefficient of variation, and weighted coefficient of variation of the level of economic development of counties in Henan Province are shown in Table 1. The value of county economy Cv in Henan Province from 2000 to 2023 stays within the range of 0.48 to 0.62.

Table 1. Statistics of the level of economic development in Henan county

Year	R	S	Cv	Cv_p
2000	11526.336	2326.221	0.4865	0.4652
2001	11975.212	2515.664	0.4914	0.4755
2002	13025.004	2835.787	0.4973	0.4832
2003	16532.212	3546.012	0.5462	0.5256
2004	21328.754	5698.541	0.5530	0.5385
2005	25639.211	7321.224	0.5785	0.5578
2006	30213.235	7569.557	0.6124	0.5424
2007	39664.221	9213.224	0.5985	0.5211
2008	55227.654	11017.696	0.6101	0.5325
2009	64354.996	12368.554	0.5965	0.5296
2010	78959.043	14023.616	0.5875	0.5321
2011	96369.545	16589.211	0.5952	0.5421
2012	98783.432	17780.286	0.5811	0.5252
2013	97869.013	18364.005	0.5746	0.4968
2014	90965.265	18969.544	0.5432	0.4797
2015	100235.221	19423.337	0.5246	0.4857
2016	111008.699	20125.036	0.5397	0.5213
2017	120307.542	22123.225	0.5454	0.5119
2018	132524.693	23569.996	0.5528	0.5236
2019	150203.448	25689.248	0.5663	0.5305
2020	150524.273	26478.994	0.5514	0.4854
2021	165229.546	27573.428	0.5289	0.4759
2022	170058.544	28662.314	0.5421	0.4967
2023	182669.201	29345.211	0.5326	0.5024

Changes in absolute differences in the level of economic development of counties in Henan Province are shown in Figure 1.

From 2000 to 2023 the economic disparity of counties in Henan Province is increasing. The extreme difference in the level of economic development of the study unit increased from 11526.336 in 2000 to 182669.201 in 2023, an increase of nearly 14.85 times. The standard deviation increased from 2326.221 in 2000 to 29345.211 in 2023, an increase of 11.61 times. The extreme deviation of per capita GDP increases year by year from 2001 to 2014, with the largest increase from 2007 to 2012. It indicates that the economic gap between counties in Henan Province has been widening from 2001~2012, and then decreased year by year in the following two years, indicating a trend of narrowing. The standard deviation of GDP per capita increases year by year from 2000 to 2023, in which the annual increase is more than 20% from 2003 to 2008, but compared with the extreme difference, it is relatively flat. The above shows that the absolute difference of county economies in

Henan Province is increasing, although there is a trend of narrowing after 2011, but this poses a certain threat to the coordinated development of Henan Province.

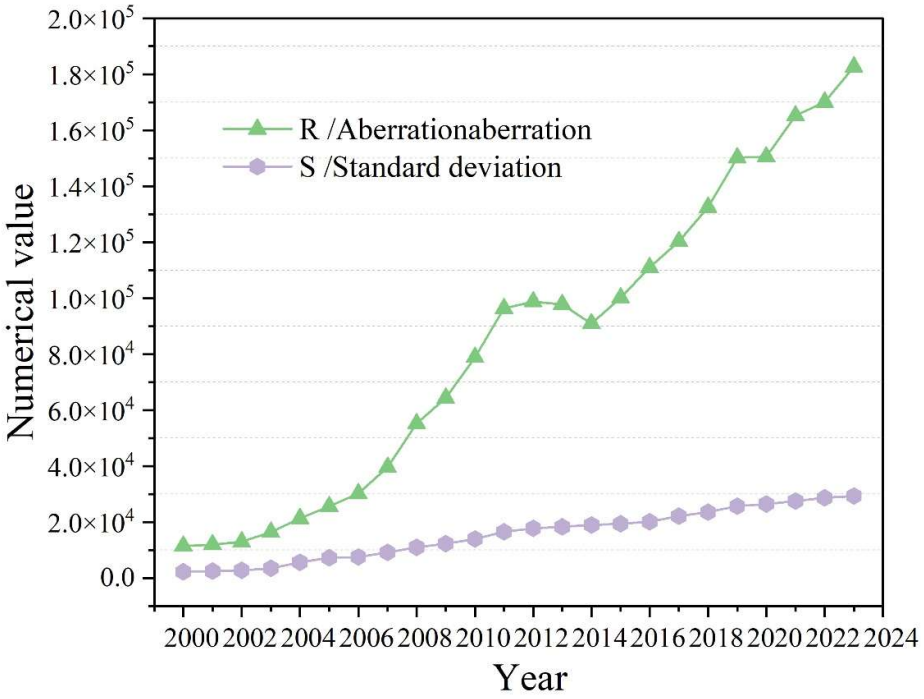

Fig. 1. Absolute difference in economic development level of county area

2.4. Analysis of relative differences in the level of economic development of counties in Henan Province

Absolute differences are susceptible to sample extremes, and the county economic differences reflected are not comprehensive enough, and the following analyzes the level of county economic development in Henan Province from the perspective of relative differences.

Relative difference selects the coefficient of variation and population-weighted coefficient of variation two indicators, and substitutes the per capita GDP of counties in Henan Province from 2000 to 2023 into the formula, the relative difference of the level of economic development of counties in Henan Province changes as shown in Fig. 2.

Both Cv and Cvp of the level of economic development of counties in Henan Province in 2000~2023 generally increase and then decrease, indicating that the relative difference of the study counties generally increases and then decreases, in which the value of Cv is concentrated between 0.4865-0.6124. Cv increases from the minimum value of 0.4865 to 0.6101 in 2000~2008, with a large change, in which the change is the largest in 2005~ 2006 had the largest change, indicating that the relative difference in the level of economic development of the study counties rapidly widened during this period.Cv slightly declined in 2006~2007, but then recovered to above 0.6 in 2008, and then gradually decreased to 2015, and then decreased to 0.5246 by 2015.This indicates that the relative difference in the level of economic development of the counties in Henan Province has been narrowing since 2008 .

The value of Cvp is concentrated in the range of 0.4652-0.5578, which is slightly smaller than the value of Cv and the magnitude of change is smaller than that of Cv. The change trends of Cvp and Cv are the same in the years of 2000~2006, 2008~2009, 2011~2014 and 2019-2023.

Overall, the relative difference in the level of economic development of counties in Henan Province increases slowly from 2000 to 2023, and although there are obvious differences between the years, the magnitude of change in the values is not large. 2000~2006 is an upward stage, affected by the reform and opening-up policy and China's accession to the WTO in 2001. after 2008, due to the economic crisis, the difference in the level of economic development of counties is a narrowing stage,

while the absolute difference in contrast shows a rising trend from 2001. The reason for this phenomenon is that the change of absolute difference in the level of county economic development is affected by the change of the overall level of the economy and the base etc., while the change of relative difference is only affected by the change of the overall level of the county economy. To a certain extent, the process of economic development in Henan's counties is consistent with the neoclassical theory of economic growth, which states that the overall distribution of economic activity is determined by the endowment given by the regional environment.

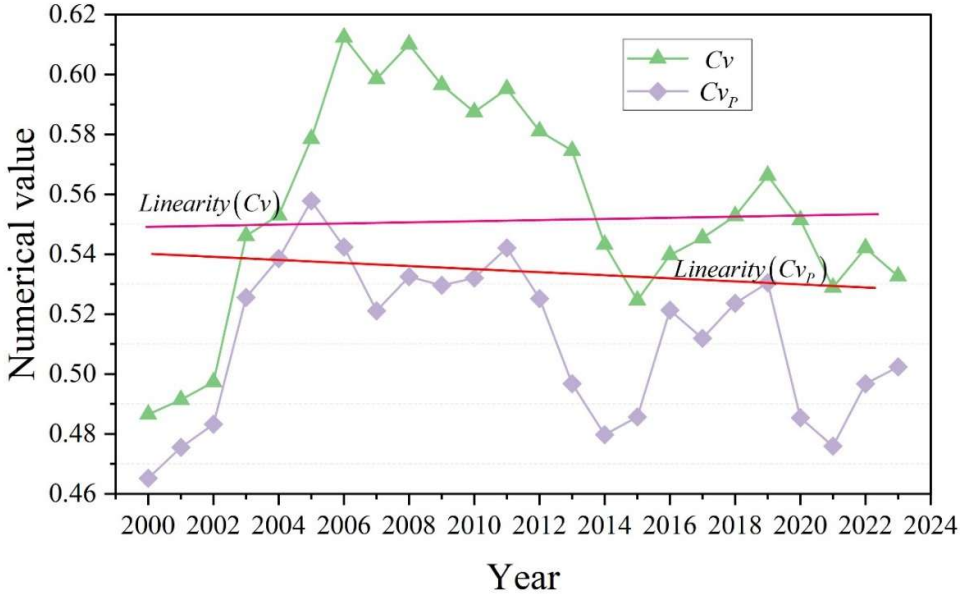

Fig. 2. Changes in the level of economic development in the county area

3. Empirical analysis of factors affecting differences in the level of economic development of counties in Henan Province

3.1. Impact Factors

The difference in the development of the county economy is generated by a number of factors, involving population, resources, policies and other factors, and all relevant factors work together to promote the existence of regional economic development differences. Therefore, the selection of factors affecting the differences in county economic development should be considered from various aspects and angles. The constructed index system is effectively verified to ensure the rationality and scientificity of the selected influencing factors.

In this paper, based on the theory of geographic information system and regional economic differences, combined with the research practice of many scholars on regional economic differences, and considering the objectivity and accessibility of the index factors and other principles combined with the actual situation of the county economy in Henan Province, we start from the four aspects of human capital, government regulation, industrial level and economic vitality, and select a total of 10 detecting factors to construct the index system, in order to explore the influence factors of the differences in the county economic development in Henan Province. development differences in Henan Province. The selection of each influencing factor is described as follows:

1) Human capital. In this paper, human capital is characterized by three indicators: resident population, employees in secondary and tertiary industries, and the proportion of employees in secondary and tertiary industries. Resident population refers to those who often stay at home or live at home for more than six months throughout the year, and also includes the floating population who live in the city where they are located. The development of county economy can not be separated from the support

of the labor force, the number of resident population in each county can intuitively reflect the strength of human capital in a region. Therefore, the resident population is chosen as one of the indicators of human capital. The number of employees in the secondary and tertiary industries can indirectly reflect the development of the county's economy, and the proportion of employees in the secondary and tertiary industries also reflects the local employment structure, which in turn reflects the economic development.

2) Government regulation. This paper characterizes government regulation by general public budget revenue and general public budget expenditure. These two indicators can comprehensively reflect the level of financial security of the local government. Higher local fiscal revenue is a strong support for fiscal expenditure, which can ensure the government to carry out its intervention function in investment attraction, public infrastructure construction, etc., and then promote the healthy development of regional economy in a comprehensive and coordinated manner. The level of government financial security is a basic condition for stabilizing local development, and areas with strong government financial strength have a relatively high degree of urban development and a high degree of economic development. For regions with slow economic development, the government can make up for the market's shortcomings in resource allocation. Through a series of regional development policies to macro-control the economy, so that the economic development of the regions more coordinated.

3) Industrial Structure. The so-called dual decomposition, i.e., first decompose the regional development imbalance into the sum of intra-regional imbalance and inter-regional imbalance. On this basis, the regional development imbalance is further decomposed into the sum of imbalances caused by different sources of income or industrial development [28].

Let i county type contain h_i county units, $\overline{y}_{ij}, P_{ij}$ denotes the GDP per capita and population of i county type j respectively. $\overline{Y}_i = Y_i / P_i$ denotes the per capita gross domestic product of i county type, where Y_i, P_i denotes the gross domestic product and total population of i county type respectively. $\overline{Y} = Y / P$ indicates the per capita GDP of the province, where Y, P indicates the province's GDP and total population, respectively, then the degree of unbalanced economic development of counties in Henan Province can be measured by the square of the population-weighted coefficient of variation:

$$C_V^2(Y) = \frac{1}{Y^2} \sum_{i=1}^{2} \sum_{j=1}^{h_i} \frac{P_{ij}}{P} (\overline{y}_{ij} - \overline{Y})^2 \tag{10}$$

The degree of unbalanced economic development in Henan Province's counties can be decomposed into:

$$C_V^2(Y) = \sum_{i=1}^{2} \frac{P_i}{P} \left(\frac{\overline{Y}_i}{\overline{Y}} \right)^2 C_V^2(Y_i) + C_V^2(\overline{Y}) \tag{11}$$

$$\begin{aligned} C_V^2(Y) = & \sum_{i=1}^{2} \frac{P_i}{P} \left(\frac{\overline{Y}_i}{\overline{Y}} \right)^2 \sum_{k=1}^{3} z_k \frac{1}{\overline{Y}_i \overline{Y}_{ik}} \sum_{j=1}^{h_i} \frac{P_{ij}}{P_i} (\overline{Y}_{ijk} - \overline{Y}_i)(\overline{Y}_{ijk} - \overline{Y}_{ik}) \\ & + \sum_{k=1}^{3} z_k \frac{1}{\overline{Y}_i \overline{Y}_{*k}} \sum_{i=1}^{2} \frac{P_i}{P} (\overline{Y}_i - \overline{Y})(\overline{Y}_{ik} - \overline{Y}_{ik}) \end{aligned} \tag{12}$$

The first term in equation (11) is the degree of imbalance within county types and the second term is the degree of imbalance between county types.

In equation (12), $z_{ik} = \overline{Y}_{ik} / \overline{Y}_i$ represents the share of GDP from k industries in the GDP within i county types, and $\overline{Y}_{ik} = \frac{1}{P_i} \sum_{i=1}^{h_i} P_{ij} \overline{y}_{ijk}$ represents the GDP per capita from k industries within i

county types. $z_k = \overline{Y}_{*k} / \overline{Y}$ denotes the share of GDP from k industries in the province. $\overline{Y}_{åk} = \frac{1}{P}\sum_{i=1}^{2} P_i \overline{Y}_{ik}$ represents the province's GDP per capita from k industries. Equation (12) is divided by $C_V^2(Y)$ on both sides to obtain the contribution of the three industries within and between county types to the imbalance in the development of the province's counties.

The industrial decomposition results of the unbalanced economic development of counties in Henan Province are shown in Table 2. Considering the stage-by-stage change characteristics of the unbalanced development of counties in Henan Province, this paper focuses on analyzing the causes of industries at four typical time points, namely 2016, 2020, 2021 and 2023.

The overall contribution of industrial development differences between the two county types to the unbalanced economic development of counties in Henan Province is above 30%. The contribution rates of the four typical time points are 35.91%, 33.26%, 32.57% and 30.45%, respectively, showing a gradually decreasing trend, which indicates that the contribution of the development gap of the three industries between poor and non-poor counties to the imbalance is decreasing.

In terms of the overall contribution of the differences in the development of the three industries among county types to the imbalance in the economic development of counties in Henan Province, the differences in the development of the industries within county types are the main reason, with the contribution rate higher than 60%, and the degree of their contribution has been increasing year by year, while the differences in the development of the industries among county types are the secondary reason.

Table 2. The industrial decomposition of the economic development of Henan county

Scale type	Contribution rate/%					
	2016			2020		
	First crop	Second production	Tertiary industry	First crop	Second production	Tertiary industry
In type	-3.21	45.63	20.12	-3.27	56.75	13.24
Poor county	0.16	3.96	0.85	0.09	4.15	0.95
Nonpoverty county	-3.21	43.21	19.03	-3.22	52.32	16.21
Intertype	-1.85	27.55	12.45	-2.15	23.87	11.05
Population	-7.31	73.69	33.62	-6.55	79.68	26.87
Scale type	Contribution rate/%					
	2021			2023		
	First crop	Second production	Tertiary industry	First crop	Second production	Tertiary industry
In type	-2.68	40.51	40.15	-2.98	53.69	19.65
Poor county	0.15	3.69	3.22	0.05	3.57	0.85
Nonpoverty county	-2.19	41.54	39.54	-2.91	49.61	19.64
Intertype	-2.73	18.96	16.07	-2.42	23.24	12.37
Population	-6.98	59.32	47.66	-5.67	72.55	33.12

4) Economic vitality. This paper uses per capita disposable income and economic base to characterize the economic vitality of counties. Per capita disposable income directly reflects the consumption potential and economic development vitality of each county. The higher the per capita disposable income, the greater the stimulus to the local market, the more powerful the economic development, which is conducive to the sustainable development of the local economy. The economic base is used to reflect the differences in the start of development of each county, as the economic base of each county

varies greatly due to historical and policy reasons, which indirectly leads to the subsequent development of the economy.

3.2. Modeling

3.2.1. Selection and description of indicators. According to the actual situation of the study area and the availability of data, while considering the ease of data acquisition and the representativeness of the factors to be selected. Select the resident population X_1, secondary and tertiary industry employees X_2, secondary and tertiary industry employee ratio X_3, primary industry added value X_4, secondary industry added value X_5, general public budget income X_6, general public budget expenditure X_7, per capita disposable income X_8, number of industrial enterprises above scale X_9, economic base X_{10} A total of 10 indicators, the establishment of the indicator system as shown in Table 3, to detect the differences in the economy of the counties in Henan province Analyze.

Table 3. Index system

Interpretation variable	Index	Unit
Human capital	Permanent population	Man
	The workers of the second and third generation	Man
	The proportion of workers in the second and third enterprises	%
Government regulation	General public budget income	10,000 yuan
	General public budget expenditure	10,000 yuan
Industrial level	The added value of the first production	10,000 yuan
	The added value of the second production industry	10,000 yuan
	The number of industrial enterprises above scale	Time
Economic vitality	Per capita disposable income	10,000 yuan per person
	Economic base (per capita GDP per capita in 2005)	10,000 yuan per person

For the indicator system constructed above, descriptive statistics are given for each of the impact factors, and the variables used all contain 110 samples.

The descriptive statistics of the model variables are shown in Table 4, from which the mean value of X_1 - X_{10} can be obtained. Permanent population X_1, employees in secondary and tertiary industries X_2, percentage of employees in secondary and tertiary industries X_3, value added of primary industry X_4, value added of secondary industry X_5, general public budget income X_6, general public budget expenditure X_7, per capita disposable income X_8, number of industrial enterprises above large scale X_9, and the mean value of economic base X_{10} are 853,622 people, 255,789 people, 32.15%, 396,407 million, 1526,355,000 yuan, 170,256,000 yuan, 505,126,000 yuan, 29,100 yuan per person, 152, 13,100 yuan per person.

Table 4. Descriptive statistics of model variables

Variable	MEAN	Standard deviation	MIN	MAX
X_1	853622	156632	153662	1903229
X_2	255789	10213	14218	723656
X_3	32.15	15.07	1.55	72.42
X_4	396407	16227	17549	956311
X_5	1526355	236995	239926	6754832
X_6	170256	45689	45648	812367

X_7	505126	213965	212996	1295123
X_8	2.91	1.78	1.75	7.855
X_9	152	14.05	14.26	523.66
X_{10}	1.31	0.41	0.41	4.21

3.2.2. Econometric modeling. In order to verify the rationality and feasibility of the indicator system, this paper constructs a multiple linear regression model by diagnosing the covariance of the constructed indicator system, i.e., the independent variables, through SPSS 20 software. The results of multiple linear regression are shown in Table 5, and the regression model is fitted as equation (13):

$$\begin{aligned} Y = &-0.315X_1 - 0.247X_2 + 0.181X_3 + 0.154X_4 + 0.769X_5 \\ &+0.003\,X_6 + 0.089X_7 + 0.144X_8 - 0.193X_9 + 0.234X_{10} \end{aligned} \tag{13}$$

As can be seen from the table, the model has a R^2 of 0.917, which is a good fit. The value of F is 125.97 and the value of SIG is 0.0000 which is less than 0.01 indicating that it passes the test of significance at 99% confidence level and is statistically significant. The DW value is 2.028, which is closer to 2, indicating that the variables are independent of each other. The maximum VIF value is 15.854, which is less than 30, indicating that there is no multicollinearity in this indicator system. This shows that the indicator system constructed by the 10 influencing factors selected from the four perspectives in this paper is more reasonable. It can effectively reflect the actual situation of economic differences in counties in Henan Province, and can be used for the detection and analysis of the subsequent impact factors.

Table 5. Multivariate linear regression

Variable	Coefficient	t	Significance	Tolerance	VIF
X_1	-0.315	-4.556	0.002	0.095	12.663
X_2	-0.247	-2.594	0.034	0.071	15.854
X_3	0.181	2.397	0.028	0.152	10.303
X_4	0.154	3.649	0.006	0.373	4.009
X_5	0.769	15.347	0.001	0.213	5.223
X_6	0.003	0.005	0.935	0.142	8.896
X_7	0.089	1.636	0.271	0.147	6.807
X_8	0.144	2.329	0.033	0.336	3.024
X_9	-0.193	-4.518	0.001	0.358	2.221
X_{10}	0.234	4.326	0.002	0.219	4.078
$R = 0.956, R^2 = 0.917, DW = 2.028, F = 125.97, SIG = 0.0000$					

3.3. Empirical test results and analysis

According to the latest administrative division of Henan Province, this paper takes the 105 county units under the jurisdiction of Henan Province in 2016 as the object of study, and uses stata software to analyze the data, and panel data is used for regression.

According to the gradient division of the previous article, this respectively from the county economy as a whole, developed, generally developed, less developed counties to carry out econometric regression research.

The regression results of the overall economic differences of counties in Henan Province are shown in Table 6, in which the physical capital investment and the structure of the second and third industries have passed the 1% significance test, which indicates that the degree of influence of these three indicators on the overall differences in the county economy is particularly significant. It can be shown that for every 1% increase in the fixed capital investment of the whole society, the per capita GDP

output increases by 0.09112% accordingly. This shows that capital investment will promote economic development, so in the subsequent development process, local governments and enterprises should strive to improve the market and investment environment, and constantly attract the influx of internal and external capital to promote economic development.

Table 6. The overall economic difference of the county area was returned

Variable	Coefficient	Standard error	T test value	Significance
Labor investment	0.08969	0.07291	1.35	0.203
Material capital input	0.09112	0.01503	-9.63	0.000
The added value of the second production industry	2.32561	0.00012	20.41	0.001
The added value of the third production industry	0.98775	0.12005	8.75	0.000
The employment structure of the second industries	0.09605	0.05569	1.64	0.124
The employment structure of the third industries	-0.06993	0.07124	-0.92	0.339
Population density	-0.02378	0.53169	-0.55	0.654
Government regulation	0.22354	0.07582	3.21	0.007
Constant term	15.12163	0.42236	34.96	0.000

3.3.1. Developed economy. The results of the regression analysis for economically developed counties are shown in Table 7, R^2 =0.7281, indicating a good fit. The regression results of the explanatory variables as a whole are significant, thus indicating that the economic development of developed counties is closely related to these factors.

The effects produced by labor input and physical capital input on the explanatory variables are both positively driven, with the former effect being stronger than the latter.

From the coefficient of the ratio of secondary and tertiary industries, it can be seen that the 3.19751 of the secondary industry is obviously larger than the 1.77977 of the tertiary industry, while the coefficient of the secondary industry in developed counties is also larger than that of the overall promotion, which, to some extent, indicates that the secondary industry in developed counties has a relatively large effect on the promotion of the development of the economy. Therefore, it is necessary to pay attention to the adjustment of industrial structure in developed areas and accelerate the further development of industrialization level.

In the results of the analysis of the employed personnel, it can be clearly seen that the regression coefficient of the proportion of the employed personnel in the secondary industry is negative, indicating that it will hinder the development of the economic level to a certain extent. According to the analysis of the actual development of developed counties, it may be caused by the fact that the secondary industry in the region absorbs a large number of surplus labor but does not correspondingly improve labor productivity. In addition, the control variables are all significant. Unlike the overall economic development, the regression results of population density show that it has a positive pulling effect on the economy of developed counties.

Table 7. Regression analysis results of economic development county domain

Variable	Coefficient	Standard error	T test value	Significance
Labor investment	0.32665	0.08569	4.85	0.0000

Material capital input	0.10213	0.12331	-10.91	0.0000
The added value of the second production industry	3.19751	0.25645	12.34	0.0000
The added value of the third production industry	1.77977	0.23116	13.76	0.0000
The employment structure of the second industries	-0.32032	0.14213	-5.81	0.0000
The employment structure of the third industries	0.36521	0.08599	6.50	0.0000
Population density	0.28966	0.67112	3.29	0.0000
Government regulation	0.95007	0.11251	8.33	0.0000
Constant term	16.27583	0.73669	22.37	0.0000

3.3.2. Generally developed economy. The results of the regression analysis for the generally developed counties are shown in Table 8. $R^2 = 0.6985$, the fit is relatively good. Labor input, physical capital input, the proportion of value added in the secondary industry, the proportion of value added in the tertiary industry, and the employment structure of the tertiary industry all passed the 1% significance test, indicating that these indicators have a more significant impact on the development of the county economy.

Table 8. The results of the regression analysis of the general hair county domain

Variable	Coefficient	Standard error	T test value	Significance
Labor investment	0.23256	0.06859	3.55	0.002
Material capital input	0.11787	0.01243	-10.24	0.001
The added value of the second production industry	2.66993	0.15669	19.56	0.000
The added value of the third production industry	1.34552	0.00081	12.33	0.004
The employment structure of the second industries	-0.10254	0.06993	-2.14	0.055
The employment structure of the third industries	0.27711	0.05524	3.97	0.000
Population density	0.14993	0.06019	2.15	0.001
Government regulation	0.46351	0.08914	6.04	0.022
Constant term	15.3778	0.53369	28.63	0.000

3.3.3. Economic underdevelopment. The results of regression analysis in less developed counties are shown in Table 9, R^2 is equal to 0.7506, indicating a good fit. Physical capital input, the proportion of value added of the second industry, and the proportion of value added of the third industry passed the 1% significance test, indicating that these indicators have a more significant impact on the development of the economy of the less developed counties.

From the viewpoint of industrial structure factors, the proportion of output value of secondary and tertiary industries all have a positive driving effect on the economy of underdeveloped counties. Among them, for every 1% increase in the proportion of output value of the secondary industry, the per capita GDP of developed counties increases by 2.25264%, which is greater than the driving effect on the overall economy, but smaller than the driving effect of developed and generally developed counties. It can be seen that the secondary industry has a great degree of influence on the development of the economy of less developed counties. Therefore, it is necessary to focus on strengthening the

development of industrialization level in the less developed counties in Henan Province as well as continuously optimizing the industrial structure to complete the progression from backward agricultural development to industrialization development.

Table 9. Regression analysis results of the field regression

Variable	Coefficient	Standard error	T test value	Significance
Labor investment	0.14687	0.07554	2.36	0.021
Material capital input	0.09113	0.01233	-8.41	0.000
The added value of the second production industry	2.25264	0.12612	19.21	0.000
The added value of the third production industry	1.32667	0.12237	10.03	0.000
The employment structure of the second industries	0.06593	0.06824	1.24	0.447
The employment structure of the third industries	0.00455	0.07459	0.08	0.836
Population density	0.14779	0.06592	2.31	0.031
Government regulation	0.25966	0.08124	3.64	0.002
Constant term	13.85567	0.56927	25.02	0.000

4. Conclusion

In this paper, the influence indicators are screened from four aspects, namely human capital, government regulation, industrial structure, and economic vitality, to construct a multiple linear regression model of the factors influencing the differences in the level of economic development of counties in Henan Province. Combined with the level of economic development of counties in Henan Province from 2000 to 2023, the factors related to the economic development of economically developed, generally developed and less developed counties are obtained.

The extreme deviation, standard deviation, coefficient of variation, and weighted coefficient of variation of the economic development level of counties in Henan Province are calculated by using the formula of extreme deviation and standard deviation. On the one hand, the absolute difference of county economies in Henan Province shows a growing trend, and the gap between the county economies in Henan Province is increasing from 2000 to 2023. On the other hand, the relative difference of Henan Province's county economies increased slowly during 2000-2023, and although there are obvious differences between the years, the magnitude of change in the values is not large. Especially in 2005-2006, the change is the largest, indicating that the relative difference in the level of economic development of the study counties is rapidly widening during this period.

Using the dual decomposition to analyze the development of county-level industrial structure in Henan Province, the value added of the primary industry and the value added of the secondary industry are taken as the main influencing factors of the industrial structure dimension. Combining the results of the multiple regression analysis of the overall and three different development gradient counties, the physical capital input and the proportion of secondary and tertiary industries are the common influencing factors. In terms of the overall economy of counties in Henan Province, when the investment in fixed capital of the whole society increases by 1%, the per capita GDP output increases by 0.09112% accordingly. Similarly, every 1% increase in the proportion of secondary industry can simultaneously promote the overall GDP per capita by 2.32561%. For every 1% increase in the proportion of the tertiary industry, the level of GDP per capita will increase by 0.98775%. It can be

shown that capital investment, the increase in the proportion of secondary and tertiary industries will promote the development of the economy.

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