Study on China's Advanced Industrialization

Jinghuai She[1], Yuan Sun[2,*] and Yuan She[3]

[1]Capital University of Economics and Business, 121Zhangjialukou, Fentai District, Beijing P.R. China country
[2]Capital University of Economics and Business, 121Zhangjialukou, Fentai District, Beijing P.R. China country
[3]Wuhan University, Mout.luojia, Wuchang, Wuhan, P.R. China
*Corresponding author

Abstract—**This article has built a system of China's advanced industrial measurement. By applying the datum from 2004 to 2013, we estimate the level of development and current status of China's advanced industrialization(AI), and evaluate the measurement results by establishing Hierarchical Linear Model (HLM). We confirmed that China's AI is in the rapid development trend. And due to the difference of initial conditions in AI development there is a greater imbalance. In contrast, a region with poor initial condition of has a relatively fast development speed.**

Keywords-measurement of advanced industrialization(AI); hierarchical linear model (HLM)

I. INTRODUCTION

AI means that using IT to propel industrialization, accelerate scientific development and improve industry with high-tech. Not only improveing the economic benefits and international competitiveness, but also reducing the consumption of resources, decreasing emission of pollutions and stick on the way of sustainable development. JudAIng China's AI development level accurately becomes an important indicator to test the AI and guide developing it, especially the developing status of different reAIons. This article is based on the background, combined with the industrialized classical theory, while constructing the index system of the AI in China, and applying the statistical datum from 2004 to 2013 to measure the 30 reAIons in China. Using hierarchical linear models (HLM) statistical methods to evaluate the results. This article has revealed the developing tendency of China's AI and the developing imbalance in those reAIons which are caused by the difference of initial conditions, especially those places in disadvantage with a higher speed to develop the industrialization.

II. THEORY AND HYPOTHESIS

A. Index System of AI

The research of scholars majorly focused on the inevitability, path, content and characteristic of China's AI. For example, Lu Zheng (2002) , Jiang Xiaojuan (2002), Qu (2004), Wei Liqun (2004) , Hu Angang (2004), Li Yue (2004) , Jin Bei (2004) , Wu Jinglian (2005) , Young Man (2005) , Chen Dong (2006) , Sun Xueguang (2013) , etc. They were about how to handle those relations such as a AI and information, resource-environment relationship; also they confirmed how to take and how to realize the AI. Moreover, the study of the AI has promoted the relevant measurement. Such as Li Jian(2004), based on input-output method. Xie Delu(2004), Yang Jie(2005), based on characteristics of AI. Wu Xiaoqing(2007), based on the AI connotation; Xie Chun (2011) focuses on technology and resource environment. These studies were growing along from the speed and quality in single angle of industrialization..

AI revealed the interaction between information and industrialization, and AI is a process which takes the technology progressing as motive force and enhancing economic efficiency and international competitiveness as center. Thus the indicator system should reflect intensive and sustainable developing two factors. In all, based on the predecessors' theories and methods, we extract seven aspects which have the most typical connotation of AI as the sub-elements of the system and recompose them into 35 indicator elements and 50 measurable indicators to reveal the connotation and characteristics of AI.

III. DATA AND PROCESSING

This paper applied data from 2004 to 2013, all data are comes from the China statistical Yearbook, Industry statistics report, the science and technology statistical Yearbook, Environmental statistics Yearbook, The ministry of information and industry and other authoritative data. When evaluating the level of industrialization of China, the paper applied the 2004 – 2013 years' data, and standardization the raw data with dimensionless treatment, using a weighted method to calculate the index value of AI. Because there is no other means to deal with the original data, the index value represents of China's AI during this period, so called "development level"

In the empirical part of this article, the data is from 2002 to 2013. In the seven years, 30 provinces and cities try their best being industrialization which are different in resource endowments, economic development stage, history and geographical situation. We must select an appropriate method to deal with the longitudinal data so that we can analyze advanced trends as well as industrial growth differences between different provinces. The current method of researching variables growing trend using longitudinal data are Repeated Measures Analysis of Variance, Time Series Analysis and the Hierarchical Linear Model which is relatively late start, but developed rapidly.

IV. EMPIRCAL ANALYSES

Although a detailed analysis have been done from many Angle to China, contained from 2004 to 2013 AI stage of development, present development situation, the difference of AI level between provinces, the elements of advanced type industrialization constitution and so on, but the sample value just a symptom of development, the true discipline behind these sample points must through the establishment of the model can get real realization. For example, 30 provinces and cities of China in the process of the AI is different or not, whether the initial level of advanced type industrialization have influence to industrialization process, and how effective of advanced industrial factors to the AI process, all these can be solved only through the establishment of statistical model .

A. HLM

Through the preliminary analysis of development trend for the 30 provinces and cities, finding that the process of AI development all provinces and cities has a different in development rate and initial development level, that is to say, the intercept and slope is not same in each of the regression model. So, when using the provinces as sample group analysis the regression of the overall country, it is a set of random coefficient regression model, once using the time series model analysis the overall development trend, there will be heteroscedasticity and correlation problem, this will not be able to use OLS effectively estimates parameters, it can't directly use time series model dealing with layer structural data with individual differences. At the same time, because of the repeated measurement of variance analysis used to analysis overall development trends exist limitations, also cannot be used to analysis differences of individual development between regions. Therefore, this study used a advanced statistical method of data processing track which has been widely accepted - hierarchical linear models (HLM).

The so-called random coefficient regression model mainly set on the second floor of the linear development (growth) model. The second model is the equation about the first layer model intercept and slope, so the second model, without prediction variables, became a purely random effects equation. At this time, the linear development model has become a random coefficient regression model, also can be referred basic linear development model. The basic form is as follows:

The first layer model:

$$GI\ level = \beta_0 + \beta_1(time) + r \qquad (1)$$

The second layer model:

$$\beta_0 = \gamma_{00} + u_0 \qquad (2)$$

$$\beta_1 = \gamma_{10} + u_1 \qquad (3)$$

The equation is an unconditional model, for the second floor, there is no any variables. Although this model did not consider the factor influenced the level of industrialization, but you can use this model and the results analysis the initial level and individual variation, providing a reference for the next evaluation of the second layer model with variables.

In this model, the "time" encoding different variables, the results of model have a different interpretation. If the 2004 year make up for "0", the intercept of first layer model was the average level of AI of all provinces in 2004, the slope was units growth rate from 2004 to the next few years; if the 2013 series as "0 ", the intercept of first layer model was national average of AI on the 2013, the slope was unit growth rate after 2013. In this study, two different codes were calculated to last level and initial level to an explanation.

In this study, the model used the HLM software which is specifically used for calculation of hierarchical linear model, developed by Stephen W. Raudenbush and others. We generated the original data using SPSS13.0 version, and calculated the final result using HLM6.08 version. In order to demonstrate the output in the form HLM6.08 software, using 2004 years as the initial level, we rearrange the output to the general table format according to the software, as shown in Table 1 and Table 2.

Table1 shows, the estimated average intercept and average slope was 47.4 and 1.2 respectively. The results show that the initial implementation of AI in 2004 the national average was 47.4 industrial units, which means that in 2004 the country's industrialization process has not come to the half, but the average annual growth rate was 1.2 percent after the implementation of the AI strategy since 2004, showing that the overall level of China's AI was a growing trend. Its "t" value is large enough, and P <0.001, so using these two factors is necessary to describe the growth of China's AI.

Table1 estimated average intercept and slope were 54.7 and 1.2, as the model 2013 Numbers for 0, the intercept here was the average level of AI in 2013, that is to say in 2013, China's AI average level has reached 54.7, so only from the results of model, China's AI level from the average 47.4 in 2002 have been developed to 54.7. Because average slope is 1.2, it can expect China's AI annual growth rate is 1.2 since 2013, and hypothesis that two coefficients of testing results were significantly passing.

TABLE I. AI MODEL OF LINEAR GROWTH (UNCONDITIONAL, 2004)

Fixed effects	Coefficient	S.t error	t-ratio
Intercept β_0	47.371429	2.254750	21.010***
Slope β_1	1.214286	0.172327	7.046***
Random effects	Variance	df	χ^2	Reliability
Intercept u_0	154.65454	29	1465.78146***	0.980
Slope u_1	0.68150	29	111.30746***	0.739
The first layer of error r 6.72333				

$* P < 0.05$, $** P < 0.01$, $*** P < 0.001$

Table2, For AI growth model, the variance of the estimated value for the two parameters β_0 and β_1 are 154.3 and 0.68.In the χ^2 test, the χ^2-statistic of the two are 1462.2 and 111.3,the degree of freedom of the both two are 29,both the P values less than 0.001,significantly pass. Such results turn out that from 2004 the initial implementation of AI, 30 provinces and cities have existed significant differences, and from the value of variance, the level of AI in 2004 for China's 30 provinces and cities are very significant different. The slope of the variance shows from 2004 to 2013, seven years of development, the growth rate of 30 provinces and cities exists significant differences. 0.68 form the slope of the variance and standard deviation of 0.82, so for the specific area, if its growth rate is greater than the average value one standard deviation, it can reach 1.2+0.82=2.02percentage points of growth. Of course, for the slow-development region, it will develop by a speed of standard deviation below 1.2.

TABLE II. AI MODEL OF LINEAR GROWTH (UNCONDITIONAL, 2013)

Fixed effects	Coefficient	S.t error	t-ratio
Intercept β_0	54.657143	2.251987	24.271***
Slope β_1	1.214286	0.172327	7.046***

Random effects	Variance	df	χ^2	Reliability
Intercept u_0	154.26820	29	1462.19219***	0.980
Slope u_1	0.68150	29	111.30746***	0.739
The first layer of error r	6.72333			

B.   The Relations Between Initial Level of Regional AI Growth Speed

According to literature, it can get related consistent estimates between initial conditions and real changes by use data repeatedly observed. Studying the relationship between the mentioned two above, generally determined by using the correlation between variance, the formula is:

$$\hat{\rho}(\beta_0,\beta_1) = \hat{\tau}_{01} /(\hat{\tau}_{00} + \hat{\tau}_{11})^{1/2} \tag{4}$$

Using equation (4) and HLM6.08 software, calculated the correlation coefficient is -0.202, as the negative correlation coefficient, the relationship for each region of the growth speed and the initial level of AI has a negative relationship, the low initial level of advanced industrial areas, the development has a faster speed.

C.   The Study on the Influence of Regional Difference on AI

Variation of the process of AI, what percents are due to regional differences in the level of AI is an important issue which is worth focusing on. If regional differences influence on China's overall AI level can be reasonably measured, we can base the degree of difference and quantify the contradiction between regional differences in the development and AI strategy,. So we can decide how to choose between the two problems.

Hierarchical linear models have a linear cross-level concepts , Cross-level to be addressed is related to the total variance in the dependent variable is due to how many units of the second layer of the model caused by individual differences. The process of calculation is: firstly, the model for the first layer and the second layer of the model were created a pure random model, which can measure separately the random variation of the first and second floors. Among them, the first layer models' random variation is the total variation of dependent, which is caused by the second individual variation. Using the following formula:

$$\rho = \frac{\tau_{00}}{\tau_{00} + \sigma^2} \tag{5}$$

ρ stand for Cross-class correlation coefficient, τ_{00} is variance of individual variation, σ^2 is variance of total variation.

TABLE III. THE FIRST LAYER AND SECOND LAYER STOCHASTIC MODEL CALCULATED RESULTS

Random effects	Variance	df	χ^2	Reliability
The first layer model	146.91099	29	1821.10673	0.000
The second layer model	16.64127			

Calculated using the software HLM6.08 the first layer and second layer stochastic model results shown in Table 4.3, and then use (5) provides the calculation of inter-class correlation formula can calculate the cross-class correlation coefficient of the AI was 89.8%, the following formula:

$$\rho = \frac{\tau_{00}}{\tau_{00} + \sigma^2} = \frac{146.91099}{146.91099 + 16.64127} \times 100 = 89.8\%$$

Among the total variances of the development of AI, there are 89.8% are due to the 30 provinces and cities caused by the difference between the AI, which fully shows that the outstanding differences between the China region, while China also shows that advanced industrial development in narrowing the differences between regions is a very important issue.

D.   China's AI Initial Level and the Confidence Level of the Growth Rate

As already described, reliability is used to describe the estimation accuracy of model. Estimation accuracy of a model calculation for testing the validity of the model is very important because if the model parameters estimated from the variation of most of the errors caused by the model itself, then

this model will be very unreliable, the use of such model for China's AI level of analysis, would be a mistake. Reliability is the variance divided by the estimated parameter variance, total variance equal to the parameter estimation error variance and the sum. With the formula is:

$$reliability (\beta_{0j}) = \tau_{00} / (\tau_{00} + \upsilon_{00}) \qquad (6)$$

$$reliability (\beta_{1j}) = \tau_{11} / (\tau_{11} + \upsilon_{1j}) \qquad (7)$$

Table1 has been the reliability of the results list, the reliability of the intercept and slope of 0.980 and 0.739, respectively, belong to the relatively high credibility. The results show that both the intercept and the slope, the data have sufficient amount of information, each parameter can be as individual-level variables for modeling.

About the size of reliability, Raudenbush et al. (2004) described, usually, lower reliability does not prove that the statistical analysis carried out is not valid. Only when the reliability is very small, such as less than 0.1, research indicates that only the best will in the random coefficients as fixed factors, random items will be removed in order to facilitate subsequent model analysis.

E. The Empirical Results

Empirical results support our all previous assumptions, as follows:

• The average growth trajectory of China's AI from 2002 to 2013 shows sustained steady upward trend. The strategy implementation process of AI from 2004 to 2013, China's total AI level made a steady effects, AI index rise 54% in 2004 to 63% in 2013, while most of the provinces' AI level has considerable progress, although the albeit is different, the growth effect is obvious.

• There are large regional differences in China's AI. The results of the hierarchical model, the model intercept and slope variance test have passed a significant test, which means that the variance is significantly different from 0. From the perspective of the slope, the slope of the different provinces exist big differences, that is to say the advanced industrial growth in each region is very different..

• The initial level of industrialization and development rate within a certain range shows negative correlation. Pace of development of AI and regional initial level in a certain range exist negative correlation, the correlation coefficient is -0.202. In other words, the initial low level of AI's areas, the growth rate slightly faster, but the initial high level of regional growth at a slower pace.

V. CONCLUSION

This article measured the development level and status of China's AI by building index system. And give evaluation,

analysis and reasonable explanation on the development trend of China's AI and the effects that basic conditions will have on the AI of 30 areas by using hierarchical linear models (HLM) statistical methods. In our opinion, as regional differences have big influence on the development of AI, the government should plan the development policies of AI for different regions and promote the coordinated development; In addition, in the process of AI, because of different regional conditions ,we do not take the same road, according to the different regional resource endowments and historical conditions, we can follow our own pattern to achieve success.

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