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A Study of Resource Curse Effect of Chinese Provinces Based on Human Developing Index

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Abstract: Traditional opinion considers that natural resources play an important positive role in economic development, while resource curse theory holds that natural resources usually obstruct economic increase. This debate needs further exploration. In most of empirical studies on resource curse theory, the economic development of an area is mainly evaluated by the Gross Domestic Product (GDP), however, the social and cultural contents of economic development are seldom considered. Thus, the Human Developing Index (HDI) was chosen to describe the comprehensive developing situation of an area in our study. Based on the panel data from the year of 2000 to 2011, the relationship between Human Developing Index and resource exploitation degree (RED) of 30 provinces in China (Tibet, Taiwan, Hong Kong and Macao were not included because of the restriction of data acquisition) was investigated by correlation coefficient analysis and regression analysis. We found that resource curse did exist over the entire country and its effect on 30 provinces were not exactly the same. According to the effects of resource curse, these provinces could be classified into four types: no resource curse provinces, slight resource curse provinces, severe resource curse provinces, and extreme resource curse provinces. Testing from two short time periods 2000–2005, and 2006–2011, the resource curse effect was not prominent. However, testing from the entire period of 2000–2011, the effect was obvious among each province.

Keywords: natural resources; Human Developing Index (HDI) resource curse; resource exploitation degree (RED) panel data

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1 Introduction

In traditional economic growth pattern, resource abundance has a positive effect on the economic development. The resource abundance of coal, oil and gas led to the prosperities of the countries with plenty of these resources (Cao *et al*., 2014). However, since the second half of the 20th century, some resource-poor countries, such as Japan and Singapore, have been experiencing a very quick economic development in the world, and some other countries full of natural resources (most located in South Africa and Middle-east area) developed slowly (Zhang, 1997). This phenomenon is known as ′resource curse effect′ (Auty, 1994), refers to paradox that countries with an abundance of natural resources tend to have less economic growth and worse development outcomes than countries with fewer resources (Xu, 1996).

The resource curse effect has been validated in recent years by many empirical studies (Gylfason *et al*., 1999; Rodriguez and Sachs, 1999; Papyrakis and Gerlagh, 2004) using different models, among which the S-W model was the most influential one (Sachs and Warner, 2001), although it was blamed to contain too small samples by later researchers. To resolve the problem of small samples, nonparametric test was introduced (Stijns,

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2006) and the curse effect still worked in this new model. The possible explanations of this effect include: 1) transmission mechanism, such as the 'Dutch disease' caused by manufactory shrinking (Perkins and Gillis, 1996; Yang *et al*., 2010); 2) decline of scientific research and education level (Murphy *et al*., 1991); and 3) the corruption caused by the weakening of a system (Robinson *et al*., 2006; Wilson, 2013). However, some researchers pointed out that the poor economic performances are mainly caused by resource-plundered international political system (Lear, 2005) and thus the resource curse effect needs to be tested by different regions in a particular country having the same political purpose (national welfare) and system but different development levels and resource abundances (Alxeev and Cornad, 2009).

Our study aimed to investigate the resource curse effect in China from provincial level. Previous studies showed that there was a resource curse effect in China. However, the resource abundances were mainly measured by two indices, the proportion of fixed investment of the mining industry in total fixed investment and the proportion of employee revenue of mining industry in the total employee revenue (Hu and Xiao, 2007) which might cause two shortcomings: 1) the strong relationship between the resource abundance and Gross Domestic Product (GDP) could influence the accuracy of the result (Zhang and Tian, 2010); and 2) other non-economic factors, such as the level of social and cultural development were not considered. Compare to pure economic index GDP, Human Developing Index (HDI) includes three aspects, the economic developing level, the educational level, and the quality of life, and thus was chosen as the indicator of development in our study.

2 Materials and Methods

2.1 Study area and data source

The total of 30 provinces, municipalities, and autonomous regions of China were chosen as the study area (Tibet, Taiwan, Hong Kong and Macao were not included because of the restriction of data acquisition). Six types of data from each province were collected: including life expectancy, adult literacy, comprehensive gross enrolment rate, GDP per capita, number of employees of the mining industry, and the total number of employees of each province from 2000 to 2011. Life expectancy, adult literacy, comprehensive gross enrolment rate and GDP per capita are four sub-indices of HDI. The number of employees in the mining industry and the total number of employees were chosen to calculate resource exploitation degree (RED) because they are independent of GDP and the ratio of the two indices reflects the development level of resource exploitation industry. All data sources were searched from the *China Statistical Yearbook* (National Bureau of Statistics of China, 2001–2012).

2.2 Methods

2.2.1 Human Developing Index

HDI was first introduced by the United Nations Development Programme (UNPD) in *Human Development Report 1990* to measure the social and economic development level of member states of the United Nations (Lu, 2012). This index contains three aspects: health index (reflected by life expectancy), educational index (adult literacy rate accounting for 1/3 of the weight and comprehensive gross enrollment rate accounting for 2/3 of the weight) and the index of the quality of life (reflected by GDP per capita) (Herrero *et al*., 2012). Each sub-index is calculated by Equation 1. HDI is the arithmetical mean of 3 sub-indexes (Equation (2)). The average growth rate of HDI of each province over a period is calculated by Equation 3.

$$S_i = \frac{S_{i\mathrm{acl}} - S_{i\min}}{S_{i\max} - S_{i\min}} \quad (1)$$

$$HDI = \frac{1}{3}S_1 + \frac{1}{3}(\frac{1}{3}S_2 + \frac{2}{3}S_3) + \frac{1}{3}S_4 \quad (2)$$

$$HDI_{00-11} = \frac{1}{11}\ln\frac{HDI_{11}}{HDI_{00}} \times 100\% \quad (3)$$

where S_i represents the value of sub-index i; S_1 is sub-index of life expectancy; S_2 is sub-index of adult literacy rate; S_3 is sub-index of comprehensive gross enrollment rate; S_4 is sub-index of GDP per capita; $S_{i\mathrm{acl}}$ is the actual sub-index i; $S_{i\min}$ is the minimum sub-index i; $S_{i\max}$ is the maximum sub-index i; HDI_{00-11} is the average growth rate of *HDI* from 2000 to 2011; HDI_{11} is the *HDI* of year 2011; HDI_{00} is the *HDI* of year 2000.The minimum and maximum values are determined by UNDP (Table 1). HDI ranges from 0 to 1. A high *HDI* implies good development.

Table 1 Maximum and minimum value of each sub-index

Sub-index	Maximum value	Minimum value
Life expectancy (year)	85	25
Adult literacy rate (%)	100	0
Comprehensive gross enrolment rate (%)	100	0
GDP per capita (USD)	40000	100

2.2.2 *Calculation of resource exploitation degree*

Rich resources do not influence the economic, social and cultural development unless they are explored and sold in the market. Thus, a more accurate index, RED was used in our study to evaluate the abundance of a resource. From the RED equation, the proportion of employees of the mining industry reflects the exploitation degree (Wang, 2011).

$$RED_{i,t} = \frac{Mining_{i,t}}{Employment_{i,t}} \times 100\% \qquad (4)$$

where $RED_{i,\ t}$ is the resource exploitation degree of province i in year t; $Mining_{i,\ t}$ is the number of employees in the mining industry of province i in year t; $Employment_{i,\ t}$ is the total number of employee of province i in year t.

The average RED is calculated by Equation (5).

$$\overline{RED_i} = \frac{\sum_{t=00}^{t=11} Mining_{i,t}}{\sum_{t=00}^{t=11} Employment_{i,t}} \qquad (5)$$

2.2.3 *Rank correlation coefficient*

The rank correlation is evaluated by rank of data instead of the data size (Chen *et al.*, 2008). In our study, the rank correlation coefficient analysis on the average value of RED and the average growth rate of HDI was tested by using Equation 6. The range of the rank correlation coefficient is: [–1, 1]. The correlation between the RED and the HDI is negative when the correlation coefficient is less than zero.

$$r = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)} \qquad (6)$$

where r is the rank correlation coefficient; d_i is the rank difference of the average value of RED and the average growth rate of HDI of province i; n is the number of provinces.

2.2.4 *Panel data model*

Panel data were used to perform the empirical analysis, and the software Eviews 6.0 was used for the estimation. The commonly used methods for calculating the panel data included the OLS model, the fixed effect model and the random effect model (Hu and Xiao, 2007), in which the fixed effect model was chosen for estimation in our study because of the initial difference among each province (Equation7).

$$HDI_{i,\ t} = C_i + \alpha RED_{i,\ t} + \mu_{i,\ t} \ (\ i = 1, 2, \ldots, N;\ t = 1, 2, \ldots, T) \qquad (7)$$

where $HDI_{i,\ t}$ is the HDI of province i in year t; C_i is the specific constant term of province i; α is the parameter of argument; $RED_{i,\ t}$ is the RED of province i in year t; $\mu_{i,\ t}$ is the perturbation error term of province i in year t.

3 Results

3.1 Preliminary test of resource curse effect

Before setting the econometric model, a preliminary empirical investigation on the relationship between the abundance of resources and the HDI of each province in China was conducted.

Average RED and average growth rate of HDI of different provinces from 2000 to 2011 are shown in Fig.1, the changes of RED and HDI from 2000 to 2011 using time series analysis are shown in Table 2. In the top six provinces having the highest growth rates of HDI, four provinces had lower average values of RED than the national average and they were all located in the eastern area. Moreover; in the last five provinces having the lowest growth rates of HDI, four of them had higher average value of RED than the national average. This preliminary observation illustrated a negative effect of natural resources on social comprehensive development level to a certain extent.

The distribution of provinces with a high RED and a high growth rate of HDI did not overlap. The provinces with high RED, such as Heilongjiang, Jilin, Shanxi and Ningxia, are mainly located in northeastern and central China. However, the provinces with high growth rate of HDI, such as Liaoning, Tianjin, Shandong, Jiangsu, and Zhejiang, are mainly located in the eastern coastal area and Beijing-Tianjin Region (Fig. 1). To show the relationship between the resource exploitation degree and the social comprehensive development level to a better effect, a scatter plot was also drawn (Fig. 2). A negative relationship between HDI and RED can be seen from Fig. 2, indicating that provinces with low resource

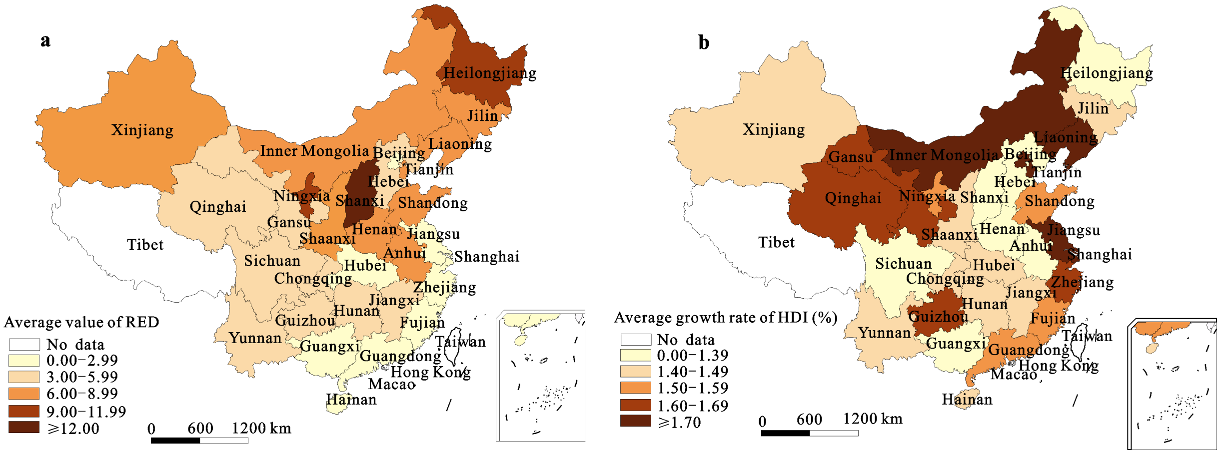

Fig. 1 Average value of resource exploitation degree (RED) and average growth rate of Human Developing Index (HDI) from 2000 to 2011

Table 2 Average value of resource exploitation degree (RED) and average growth rate of Human Developing Index (HDI) from 2000 to 2011

Province	Average growth rate of HDI (%)	Average value of RED
Tianjin	2.15	3.75
Inner Mongolia	2.07	7.99
Beijing	1.94	0.64
Shanghai	1.74	0.02
Jiangsu	1.74	2.34
Liaoning	1.74	6.24
Zhejiang	1.65	0.34
Gansu	1.64	4.82
Qinghai	1.60	3.99
Guizhou	1.60	5.07
Fujian	1.59	1.16
Ningxia	1.58	9.44
Shandong	1.51	7.43
Guangdong	1.50	0.45
Xinjiang	1.49	6.05
Hunan	1.48	3.08
Hubei	1.48	2.16
Chongqing	1.48	3.85
Yunnan	1.47	3.58
Jiangxi	1.45	3.62
Shaanxi	1.44	6.19
Jilin	1.44	6.73
Hainan	1.43	1.44
Sichuan	1.39	3.96
Anhui	1.38	8.59
Shanxi	1.38	17.93
Heilongjiang	1.36	10.88
Hebei	1.33	5.37
Henan	1.21	7.02
Guangxi	1.17	1.78
National average	1.49	4.61

exploitation degree developed faster than those with high resource exploitation degree. The resource curse effect was found to exist among the provinces.

3.2 Tests on spatial and temporal dimensions

3.2.1 Test on spatial dimension

The rankings of the average values of RED and the growth rate of HDI of each province between 2000 and 2011 are represented in Table 3.

There was a negative correlation between the average RED and the average growth rate of HDI, where the rank correlation coefficient is negative with an $r = -0.29$ ($r_{0.05} = 0.306$), implying that the exploitation of resource hindered the development of the social comprehensive development level.

The provinces could then be divided into four types according to the relationship between the ranking of RED and the growth rate of HDI from each province: provinces with no resource curse (the ranking of HDI was above that of RED), provinces with slight resource curse area (the ranking of HDI was lower than RED by less than 10), provinces with severe resource curse area (the ranking of HDI was lower than RED by 11 to 20) and provinces with extreme resource curse area (the ranking of HDI was lower than RED by more than 20) (Fig. 3). Liaoning and Inner Mongolia had high resource exploitation degrees and high growth rates of HDI, which can be regarded as a promotion effect. Shanxi, Heilongjiang, Anhui and Henan had a much higher rank of resource exploitation degree than that of the growth rate of HDI, which confirmed the resource curse. On the contrary, Tianjin, Beijing, Shanghai, Jiangsu, Zhejiang,

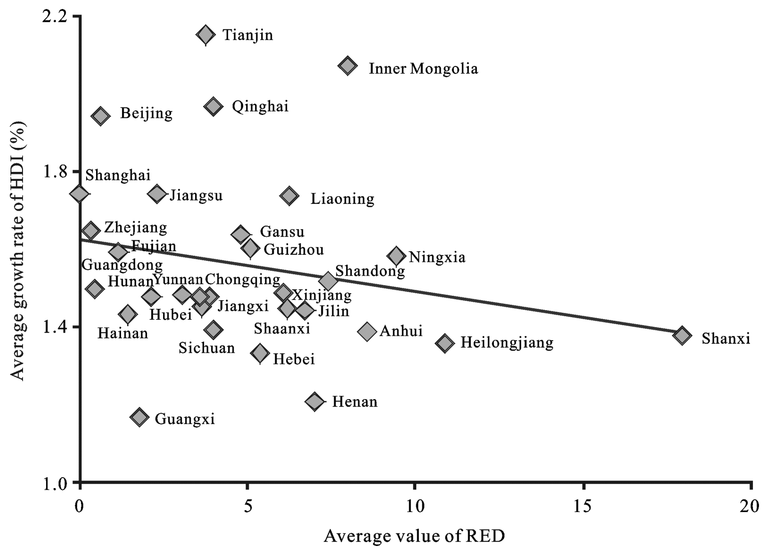

Fig. 2 Scatter plot of average value of resource exploitation degree (RED) and average growth rate of Human Developing Index (HDI)

Table 3 Ranking of average value of resource exploitation degree (RED) and average growth rate of Human Developing Index (HDI) (2000–2011)

Region	Province	Ranking of average value of RED	Ranking of average growth rate of HDI
North	Beijing	27	3
	Tianjin	18	1
	Hebei	12	28
	Shanxi	1	25
	Inner Mongolia	5	2
Northeast	Liaoning	9	4
	Jilin	8	21
	Heilongjiang	2	27
East	Shanghai	30	4
	Jiangsu	22	4
	Zhejiang	29	7
	Anhui	4	25
	Fujian	26	11
	Jiangxi	19	20
	Shandong	6	13
South	Henan	7	29
	Hubei	23	16
	Hunan	21	16
	Guangdong	28	14
	Guangxi	24	30
	Hainan	25	23
Southwest	Chongqing	17	16
	Sichuan	16	24
	Guizhou	13	10
	Yunnan	20	19
Northwest	Shaanxi	10	21
	Gansu	14	8
	Qinghai	15	9
	Ningxia	3	12
	Xinjiang	11	15

Fujian and Guangdong demonstrated a much lower rank of resource exploitation degree than that of the growth rate of HDI, which appeared to inverse of the resource curse effect. Provinces with serious resource curse effects were mainly located in Northeast and the central China. Although the resource curse effect was effective in China generally, it did not influence each province exactly the same. The resource curse effect was found to be avoided in certain areas.

3.2.2 Test on temporal dimension

To evaluate the relationship between resource and economic developments, some researchers proposed that the length of time can influence the resource curse effect. Rich resources have a positive effect on economic development in a short term but a negative effect in a long term (Xu and Wang, 2006). To investigate the effect of time on the relationship between RED and HDI, the duration between 2000 and 2011 was divided into two sections: 2000 to 2005 and 2006 to 2011. Choosing 2006 as the dividing time point was based on: 1) 2006 was the first year of national 'Eleventh Five-Year Plan', during which the government promoted the exploitation and utilization of various forms of energy. Many specific projects were conducted, such as a) speeding up the exploitation of coal in the 'three west' area (Hexi corridor and Dingxi Prefecture in Gansu Province and Xihaigu area in Hui Autonomous Region of Ningxia), oil in the central and coastal area, and hydropower resource in the southwestern area of China; and b) optimizing the development of onshore hydrocarbon resources and coal

Fig. 3 Depth of resource curse effect of Chinese provinces form 2000 to 2011

in the eastern area of China; 2) the restriction of the price of resources was removed in 2006, which influenced the exploitation of resources to some extent.

The entire 12-year data set was validated firstly. The regression analysis of the panel data is shown in Table 4. HDI decreased by 0.11% with RED increased by 1 unit. Theoretically, the range of values of HDI is between 0 and 1. However, 1 can only be achieved in the ideal condition where the social comprehensive development level is in the optimum status. Thus, the HDI change by 0.11% was significant. The exploitation of natural resource did have a negative effect on the social development level.

The panel data of 2000–2005 and 2006–2011 are shown in Table 5 and Table 6 respectively. The coefficients of RED of the two periods were 0.000218 and 0.000484; both of which were positive, implying that the resource curse effect had not been established over a short period. The resource exploitation did not hinder but increased the development of the social development level. However, the values of the probability of the two time ranges were very large, indicating that the estimation was not satisfactory and a certain error might exist.

In general, like some researchers described in the analysis of economic development, the influence of the time period does exist in the analysis of HDI. The effect of resource exploitation on the social comprehensive development level is a long-time procedure. Judging their relationship over a short period is difficult and may lead to an opposite result. Therefore, the resource curse effect should not be ignored arbitrarily. A long time investigation is required to obtain a more convincing result.

Table 4 Regression result of growth rate of resource exploitation degree (RED) and Human Developing Index in 2000–2011

Variable	Coefficient	*t*	*p*
Constant	0.557184	0.002513	0.0000
RED	–0.001143	0.000488	0.0197
$R^2 = 0.975543$			

Table 5 Regression result of growth rate of resource exploitation degree (RED) and Human Developing Index in 2000–2005

Variable	Coefficient	*t*	*p*
Constant	0.527317	0.002749	0.0000
RED	0.000218	0.000550	0.6927
$R^2 = 0.978982$			

Table 6 Regression result of the growth rate of resource exploitation degree (RED) and Human Developing Index in 2006–2011

Variable	Coefficient	*t*	*p*
Constant	0.571861	0.005431	0.0000
RED	0.000484	0.001036	0.6409
$R^2 = 0.986386$			

4 Discussion

In our study, HDI was chosen to investigate the resource curse effect. The main result of our study is that the exploitation of natural resource not only obstructed the development of the economy but also had a negative effect on the social comprehensive development. Although the findings that resource curse exists were in keeping with previous studies using traditionally used GDP per capita as the index, there were some interesting differences in the finding. Some provinces which were considered to have prominent resource curse effect in previous studies, such as Qinghai and Guizhou (Yao *et al*., 2011), seemed to eliminate the effect using our new evaluation system. On the contrary, some provinces without the finding of resource curse effect in previous studies, such as Hebei and Jilin (Yao *et al*., 2011) demonstrated a serious effect in our study. These different findings indicate that those provinces with high educational levels and harmonious living standards are less influenced by the resource curse effect, even if the economic levels do not increase very rapid, and vice versa. This indicates that the influences brought by the resource exploitation on a certain area are comprehensive. Results may be different when evaluating the influences from different perspectives. Previous studies always used economic development to assess the curse effect, but ignored the non-economic factors, which made the conclusions too simple and unconvincing. In our study, a more comprehensive index, HDI, was used. This new index includes not only economic development but also the living standard and education level. Thus, the influence of resource exploitation on social level of different provinces was investigated from different angles comprehensively.

The mechanism of the curse effect is very complex, although there have been some studies starting to focus on the issue. Difficulty exists because the curse effect is always determined by several factors and the main reason is difficult to find. Nevertheless, from some typical cases in our study, the preliminary mechanism can be found and demonstrated. First, the labor and capital elements, transferring from manufacturing and high-tech service industries to mining industry causes the 'Dutch disease' effect. For example, the investment in the mining industry of Shanxi province increased from 9.4×10^9 yuan (RMB) in 2003 to $1.4.6 \times 10^{11}$ yuan in 2011, and the proportion in the total investment grew up from 9.4% to 20.9%. While the proportion of the manufactory industry decreased from 34.1% to 20.0%. The manufactory industry stagnation makes the economic development lack of motivation. Second, the resources-dominated industrial structure restricts the human resources and technology developments. In an area full of natural resources, there is more demand of the cheap labor with low-tech instead of high-tech talents. As a result, the human capital becomes difficult to accumulate due to the ignorance of the education development. In another typical province Anhui, the proportion of employees in scientific research and poly-technical services industries decreased from 2.6% in 2000 to 2.2% in 2011. Third, the exploitation of natural resources is always accompanied by environmental pollution and casualty accidents because of the technical limitations, which would have a negative impact on the living conditions and resident health. Finally, some rich people shifted their money to those areas with better environment and social comprehensive development level. The loan-to-deposit ratio of Shanxi Province was high up to 1∶0.4 in 2009, indicating that more than half of the capital transferred to other regions. It can be inferred how the resource utilization influences the comprehensive development level from the above cases.

There were two provinces exhibited both high value of RED and growth rate of HDI, Liaoning and Inner Mongolia (Table 3). It seems that there was an anti-resource-curse effect in these two provinces. Tracking the development of the two provinces may provide useful information and help the other provinces. Taking Inner Mongolia as an example, Qi and Fu (2012) summarized a sustainable development pattern called 'Inner Mongolia Mode'. Inner Mongolia used three methods to keep the social development healthy by using this mode: 1) upgrading the industrial structure; 2) integrating the resources and improving the level of resource utilization; and 3) controlling the environment pollution. Although the time of starting economic growth was late beginning from early 21st century, the speed of industrialization of Inner Mongolia is faster than most other provinces. However, the point that is worthy attention is that the 'Inner Mongolia Mode' is a time-dependent mode in which the resource exploitation, environment and social development are all in a primary stage. If any factor changes, the development mode might be adjusted accordingly.

5 Conclusions

In our study, the HDI instead of the previously used GDP per capita was chosen in the investigation of the resource curse effect. We found that the exploitation of natural resource not only obstructed the development of the economy but also had a negative effect on the social comprehensive development level. From the spatial dimension, the resource curse effect existed in China. The exploitation degree of natural resources has a negative effect on the social comprehensive development level in general even though the curse effects on 30 provinces were not exactly the same. Although the exploitation of natural resources can make some economic achievements in certain areas, the resource curse effect still exists as long as this achievement comes with the sacrifice of cultural, social and even environmental development. From the temporal dimension, the resource curse effect also valid during entire period between 2000 and 2011. However, the effect disappeared when the time duration was divided into two short periods, 2000–2005 and 2006–2011. This means time is a very important factor in the evaluation of curse effect. Even in a short time the social comprehensive development level is improved by resource exploitation, the curse effect should not be neglected in the long term.

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