Natural Resource, Transmission Mechanism and Economic Growth : Literature Review and Future Directions

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Natural Resource, Transmission Mechanism and Economic Growth: Literature Review and Future Directions*

Shuai Chen**

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1 . Introduction

The relationship between natural resource and economic growth is always an interesting topic in modern economic field. Generally speaking, natural resource will have different influences on economic growth when conditions change. It is remarkable that, in the past hundreds of years, many countries have experienced high rates of economic growth from windfalls brought by large-scale resource exploitation. For example, the United States experienced rapid industrialization in the 19th century. Inversely, some countries, which are abundant in natural resources, don't benefit at all from resource extraction and processing. Their economics still keep low-level even negative growth, like many Gulf States (also called Oil States), despite their extensive reserves of natural wealth.

There are many explanations over this phenomenon. From Malthus's (1798) theory of absolute scarcity of natural resource, which reckons natural resources all over the world are exhaustible and will bring great disaster to people, more and more researchers begin to be concerned with resource and environment's great impact on growth. After many years, there exist both arguments of restrictions of natural resource shortage and curse of natural resource. The first argument believes that natural resource is a crucial factor of economic growth. If a country or region is troubled by resource shortage, the economy may fall into the danger of depression. The inverse argument, which considers that rich resources often frustrate a country or a region's economic growth, is usually called "natural resource curse".

From recent years' paper, more and more researchers prefer to accept the validity of the point

* I am very grateful to my reverent supervisor, Professor Chikayoshi Saeki, for his valuable comments. All remaining mistakes are mine.
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"natural resource curse", since it has been verified many times by historical events that resource-poor economies can usually outperform resource-rich economies. Moreover, it becomes increasingly important for many countries to examine their natural resources which may cause their economic depression, and check the transmission mechanisms which have negative impact on economic growth. This is also an essential segment for formulating and implementing effective policies to manage resource and promote growth.

As a new developing country with rapid economic growth, China needs a lot of natural resources to meet the demand from mining and quarrying, and manufacturing. Some resources are relatively abundant, whereas highly dependent on. There have existed 390 highly resource-dependent economic entities major in mining and quarrying. The ratio of economic entities is 20% at growth stage, 68% at maturity stage and 12% at decline stage separately[1]. It has become quite necessary for China to seek effective ways to avoid potential impact by the natural resource curse so as to make use of resources sustainably in the future.

Based on survey of the previous researches, this paper contributes to summarize their main points and methodologies, review these studies' advantages and disadvantages, and focus on what need to be improved and developed in next stage research. Moreover, it will give some implications and suggestions for China's natural resource management policy, combining with China's present circumstances.

The next section is devoted to give general concepts, measurements and analytical framework of natural resource, transmission mechanisms and economic growth. Also, I also explain why I am concerned with this issue, especially the case of China. Next, a detailed literature review will be conducted. Section 3 focuses on the relationship between natural resource and economic growth, and the existence of natural resource curse. Section 4 mainly discusses the transmission mechanisms from natural resource to economic growth and the corresponding management policies from different perspectives. Section 5 summaries main points of this paper, gives some implications of natural resource curse in China, and describe directions for future research.

2 . Natural Resource, Transmission Mechanism and Economic Growth

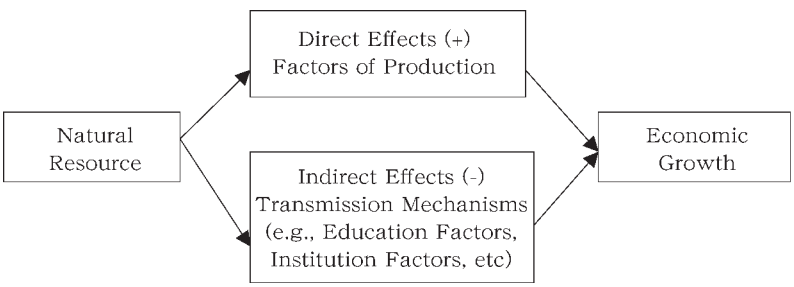
There are long-time debates over whether natural resource will affect economic growth and what transmission mechanisms really are. In traditional economic growth theory, the natural resource factors are not given enough attention. It is usually thought whether and how natural resource affect economic growth depends on how the theoretical conditions are established. Since the 1970s, some scholars have began to introduce natural resource factors into the analyti-

1) Conclude from China Mining Association Report 2005.

cal framework of new classical growth model and discussed the economic sustainable development under the situation of scarce and exhaustible resources. But most studies don't slip the leash of exogenous technology and pay little attention to the long-run economic growth constrained by scarce natural resource.

However, many empirical researches have indicated that the influence per se from natural resource to economic growth really exists, despite the relationship has unstable characters, which is usually caused by different indices for evaluation or low statistical accuracy. The mechanisms that natural resources have impact on economic growth are shown in the figure[2)] below.

Figure 1 Effects of Natural Resource on Economic Growth



As described in figure 1, natural resources have direct and indirect effects on economic growth. Firstly, the natural resource generally refers to natural resource abundance in most literatures, which often stands for the amount of resources in a certain place at a given time. Various measurements for resource abundance and methodologies are adopted, hence results are usually different. Secondly, as to the transmission mechanisms, which are often considered to be different from factors of production, they don't affect economic growth endogenously but have impact on factors that exogenously shock economic system. Thirdly, for the economic growth, there is no dispute that GDP/GNP growth rate or GDP/GNP growth rate per capita can be taken as appropriate measurement indices. Reviewing previous papers, the indices adopted for measurement can be summarized as table 1.

Since researchers have different comprehension on indices and methodologies, they are inclined to derive different even inverse conclusions. On the whole, there are some inspirations for next stage research drawn from their studies. On one hand, since the hypothesis of natural resource curse has been widely accepted, is it applicable to all the countries or regions? As depicted from table 1, different measurements may lead to diverse results, so can some sufficient conditions be satisfied to obtain a constant hypothesis? On the other hand, are there any implications for the

2) Manninig, A. (2004). Human Capital as a Transmission Mechanism of the Resource Curse. *The Park Place Economist*, Volume Ⅻ, 76.

Table 1 The Adopted Indices in the Previous Empirical Research

Natural Resource Abundance	Resource Dependence (RD)	The Proportion of Primary Resource Exports in GDP/GNP, The Proportion of Natural Resource Capital in Total Capital, Real Natural Resource Revenue in GDP/GNP, The Resource Dependence of Certain Type of Resource
	Resource Endowment (RE)	Natural Resource Exports (Per Capita), Real Natural Resource Capital (Per Capita), Real Natural Resource Revenue (Per Capita), The Coal Equivalence of Natural Resource Production, The Resource Endowment of Certain Type of Resource (Per Capita)
Transmission Mechanism		Investment (the "Dutch disease" effect), Education Factors (Schooling, Human Capital Accumulation, etc), Institution Factors (Corruption, Rent-seeking, etc), Openness Policy, R&D (Innovation)
Economic Growth		GDP Growth Rate, GDP Growth Rate Per Capita, GNP Growth Rate, GNP Growth Rate Per Capita

new developing countries like China? Since China has a great variety of natural resources located dispersedly, does the natural resource curse hold for every region and every type of resource? Do transmission mechanisms have any new implications during its period of rapid industrialization?

Surveying previous researches, there are some representative papers on this issue. They provide us a basic analytical framework for next stage studies. Matsuyama (1992) derives a formal model called "linkages approach", which divides the whole economy into two sectors: agriculture and manufacture, and describes the role of natural resource in economic growth. He finds that the openness of an economy is a significant factor which decides the relationship between natural resource and economic growth. Following this, Auty (1993) refers to the concept of "natural resource curse" for the first time. One of the most representative researches in this field is completed by Sachs and Warner, hereafter referred to as "S&W". They publish three typical papers consecutively in 1995, 1999 and 2001. They generalize Matsuyama's model and create the classical dynamic "Dutch disease" endogenous growth model, which divides the economy into tradable natural resource sector, tradable non-resource sector (manufacturing sector) and non-tradable sector. The greater the natural resource abundance, the higher is the demand for non-tradable goods, and consequently the smaller will be the allocation of capital and labor into the manufacturing sector. This "Dutch disease" is an actual problem for the economy if there is something special about the sources of growth in manufacturing, such as the "learning-by-doing" stressed by Matsuyama[3)].

3) Stijns, J. P. C. (2000). Natural Resource Abundance and Economic Growth Revisited. University of California at Berkely: Unpublished Manuscript.

3 . Natural Resource Abundance: Curse or Blessing?

3.1 Impact of Natural Resource Abundance on Economic Growth

Researchers have done a lot of jobs on the impact of natural resource abundance on economic growth. Now, there have existed two inverse points on the issue.

One point is the restrictions of natural resources shortage. They believe that rich natural resource endowments can boost regional economic growth, and vice versa. The representative studies (Habakkuk, 1962; Wright, 1990; David & Wright, 1994) argue that the successful industrialization of the United States in 19th century has a close connection with its large-scale exploitation of non-renewable resources such as oil, coal, natural gas, copper and iron ore. The manufactured products are made with high density non-renewable resources for about half a century before the great depression (Wright, 1990). Conversely, before the First World War, Italy's economic depression is caused by coal reservation shortage (De long & Williamson, 1994). Gylfason and Thorvaldur (2001) find that Norwegian great economic booming gains from its successful management of abundant natural resources. Lewis believes that people can make better use of abundant resources than scarce resources in the same situations[4].

However, the inverse point, which believes that rich natural resource frustrates a country or region's economic growth, is called "natural resource curse" hypothesis. It is firstly referred by Auty (1993) and has been a well-documented economic hypothesis. This point is typically verified from the Netherlands versus Spain in the 17th century. Sachs and Warner's research is representative in this field. According to their dynamic "Dutch disease" growth model, S&W complete an empirical research in detail under the analytical framework shown as the set of equations below[5].

$$GEA7090 = \alpha_0 + \alpha_1 * SXP + \alpha_2 * SOPEN + \alpha_3 * INV7090 + \alpha_4 * RL + \alpha_5 * LGDP70 + \varepsilon_1 \quad (1)$$

$$INV7090 = \beta_0 + \beta_1 * LPIP70 + \beta_2 * RL + \beta_3 * SOPEN + \beta_4 * SXP + \varepsilon_2 \quad (2)$$

$$SOPEN = \theta_0 + \theta_1 * SXP + \theta_2 * SXP^2 + \theta_3 * LAND + \varepsilon_3 \quad (3)$$

$$RL = \eta_0 + \eta_1 * SXP + \eta_2 * LGDP70 + \varepsilon_4 \quad (4)$$

$$LPIP70 = \gamma_0 + \gamma_1 * SXP + \gamma_2 * LGDPEA70 + \gamma_3 * SOPEN + \varepsilon_5 \quad (5)$$

Under the basic analytical framework, S&W demonstrate that economies with a high ratio of natural resources exports to GDP in 1970 tended to have low growth rates during the subsequent period 1970 to 1990. This negative relationship holds true after controlling for variables found

4) Conclude from Lewis' relevant theories of economic growth.

5) Sachs, J. D. and A. M. Warner (1997). Natural Resource Abundance and Economic Growth. Center for International Development and Harvard Institute for International Development. Harvard University, Cambridge MA, pp. 22.

Table 2 Simple Descriptions of Variables in Sachs and Warner's Model

Variables	Implications
GEA7090	Average annual growth in real GDP divided by the economically active population between 1970 and 1990
SXP	Share of exports of primary products in GNP in 1970 (Primary products or natural resource exports are exports of "fuels" and "non-fuel primary products")
SOPEN	The fraction of years during the period 1970-1990 in which the country is rated as an open economy according to the criteria in Sachs and Warner (1995)[6]
INV7090	Natural log of the ratio of real gross domestic investment (public plus private) to real GDP, averaged over the period 1970-1990
RL	Rule of Law index, constructed by the Center for Institutional Reform and the Informal Sector (IRIS). It "reflects the degree to which the citizens of a country are willing to accept the established institutions to make and implement laws and adjudicate disputes" Scored 0 (low) to 6 (high).
LGDP70	Real purchasing power parity adjusted GDP per capita from Summers and Heston version 5.6[7] in 1970 (1985 International Prices)
LPIP70	The log of the ratio of the investment deflator to the GDP deflator in 1970
LAND	The log of the ratio of total land area to population in 1971 (Land area rarely changes dramatically over time)
LGDPEA70	Natural log of real GDP divided by the economically-active population in 1970

to be important to economic growth, such as initial per capita income, openness policy, investment rates, human capital accumulation rates, changes in external terms of trade, government expenditure ratios, terms of trade volatility, and efficiency of government institutions. A striking "non-parametric" support of the findings is very few cases of resource-abundant developing countries that sustained 2% per annum growth during 1970-90: only Malaysia and Mauritius, out of 18 countries.

Based on S&W's analytical framework, most of the subsequent researches go into wide analysis, mainly on the model's applications and modifications. Hausmann and Rigobon's (2002) empirical study shows that highly resource-dependent countries usually have low economic performance. The countries (Saudi Arabia, Nigeria, Zaire and Venezuela) which highly depend on oil and other resources have been in the difficult economic situations since 1980. Kronenberg (2004) analyzes the natural resource curse in the transition economies and finds that among the former "Eastern Bloc"[8], a negative relationship between natural resource abundance and economic growth can be observed. A large part of the variation in growth rates can be attributed

6) Sachs, J. D. and A. M. Warner (1995). Natural Resource Abundance and Economic Growth. *NBER Working Paper*, No.5398, 19-20.
7) Summers, R. and A. Heston (1991). The Penn World Table (Mark V): An Expanded Set of International Comparisons, 1950-1988. *Quarterly Journal of Economics*, 106(2), 327-68.
8) The Soviet Bloc: the former Soviet countries.

to the curse of natural resources. After controlling for many other factors, this relationship still holds. He believes that the prime reason for the curse in transition economies is corruption, by studying the relationship separately among resource abundance, common accepted transmission channels and economic growth. The "Dutch disease" effect and a neglect of education can also partly account for the curse.

Arezki and Ploeg (2007) consider institutional quality and openness as instrumental variables, put geographic location, openness and other institutional factors as controlling variables, and derive that natural resource export takes negative effect on income per capita directly in cross-countries. The natural resource curse will have more negative impact on economic growth in the comparatively closed countries.

Papyrakis and Gerlagh (2007) use a lot of data and make a deep research on the relationship between the United States' resource abundance and economic growth. They make use of 49 states data and obtain that U.S. states converge to approximately the same steady-state income levels. The result also shows that resource abundance is a significant negative determinant of growth. This study examines the natural resource and economic growth of different regions in a representative homogeneous country, which is a bit different from previous studies that compare different countries' cases. It covers most of U.S. states and specifically explores 4 typical resource-abundant states. As a result, the negative relationship still holds for the four states, but a bit different in transmission channels.

The effect of natural resource abundance on economic growth is a controversial topic which has been examined from different perspectives. In summary, the point of natural resource curse has become a relatively dominant theory, especially with the common adoption of openness policy by many countries and the rapid development of globalization nowadays.

3.2 Test of the Natural Resource Curse

Since S&W's research, the issue of natural resource curse becomes increasingly attractive. A lot of studies are conducted using various methods to test the existence of natural resource curse.

Lane and Tomell (1999) and Torvik (2002) prove that natural resource abundance will increase incentives of obtaining natural resource rents by involving the non-manufactured activities. This confirms the negative relationship between natural resource and economic growth. Brunnschweiler (2006) re-examines the effect of resource abundance on growth using new measurements of resource endowments and including roles of institutional quality. The results show that the positive resources effects are strong in both Ordinary Least Squares (OLS) regressions and Two-Stage Least Squares (2SLS) regressions. Papyrakis and Gerlagh (2007) analyze natural resource curse, transmission mechanism with different variables and some exceptional samples of U.S. states. The results all demonstrate that even in a relatively homogeneous sample, resource

abundance can have a substantial negative impact through affecting various economic fundamentals.

China's scholar Xu Kangning cooperates with other researchers, and publishes three papers continuously about China's natural resource abundance and economic growth between 2005 and 2006. From their study, it has been shown that resource curse exists in China's regional and provincial economies, which is also a significant reason for China's large disparities among regional economies. Moreover, the manufacture depression and institutional weakness caused by intensive resource exploitation are main reasons for natural resource curse in China. Li Gang, Chen Zhi, Jin Bei and Cui Yun (2007) estimate the size of mineral resource restrictions on China's economic growth. The results indicate that mineral resource restrictions have gradually risen about 4.96% on China's GDP in 2006 and about 5.74% predicted for 2007. But the long-term restrictions on GDP are limited and converge to around 0.23%.

Nevertheless, when different measurements are used in the test of natural resource curse, the results may be completely opposite. One type of tests is the use of different indices or statistical methods of resource abundance and economic growth.

Ding and Field (2005) test natural resource curse by distinguishing different indices. First, if the natural resource dependence (RD, proportion of natural resource capital in total production assets) is used as measurement for resource abundance, which is also used by S&W, it will demonstrate that resource have negative impact on economic growth. However, if the index is changed to resource per capita, which is actually natural resource endowment (RE), the impact will be positive. Moreover, different models are used in this paper. At the first step, they use a one-equation model combining new capital data with other data from S&W. Then a three-equation model, which allows for endogeneity in resource dependence and introduces endogenous human capital, is estimated. The result shows that the effects of natural resource on growth are not significant.

Stijns (2005 and 2006) adopts the indices of land endowments, and reserves and yields of fuel and non-fuel mineral resources per thousand residents. He obtains that higher land endowment will introduce resource curse by weakening political systems but this relationship is uncertain for mineral resource. His study inspires us the importance of distinguishing the types of natural resources. This is also a direction for future research.

Brunnschweiler (2006) doubts S&W's conclusions and includes the institutional quality as one essential factor in growth with natural resources. As a result, both OLS and 2SLS estimation results contradict with most of the literature about resource curse so far. Besides, from his study, there is no evidence of negative indirect effects of resource on growth through institutional channel. It is a great challenge to the hypothesis of natural resource curse.

The other type of test is that diversified types of resources (land, oil, coal, natural gas and

mineral resource) can be adopted to evaluate the natural resource curse.

Rodriguez and Sachs (1999) take oil as example, introduce factors of production (labor and capital) into a Ramsey model, and demonstrate that the economy has the overshooting effect. They argue that resource abundant economies tend to have higher, not lower levels of GDP per capita with respect to resource poor countries. The economy surpasses its steady state level of income in finite time and then comes back to its steady state, displaying negative rate of growth. Using a dynamic computable general equilibrium model, they show that Venezuelan negative growth path in 1972 to 1993 get explained reasonably.

To find out the "curse" resources, test of relationship between mineral resource reserves and economic growth is necessary. Some studies (Robson, 1980; Romer, 1990; Schou, 1995; Scholz and Ziemes, 1996) bring non-renewable resource into the model to analyze reasons for economic growth or solve the social equilibrium problem. Grimaud and Rouge (2003) build a new Schumpeter model, including the non-renewable resource, to analyze the optimization problem of economic growth. They use different methods to find what kind of natural resources restrict the economic growth.

Moradi's study (2006) derives an inverse conclusion of resource curse using Iran's oil data over the period 1968 to 2005. He analyzes the effects of oil resource abundance on economic growth and income distribution in Iran. Under the production function approach, the results confirm that the overall long run effect of oil abundance on GDP is positive and significant, and income distribution is negative and significant, which means that oil revenues is improving Iran's income inequality. What need to be mentioned is, in order to demonstrate his argument clearly, many econometric methodologies are used to test the curse of Iran. Firstly, the ECM cointegration test and the autoregressive distributed lag (ARDL) bounds technique are employed to test the relationship between economic growth and its determinants, then the relationship between Gini coefficients and its determinants. After documenting these basic cointegration results, the long-run estimates are derived using the ARDL model.

To sum up, it has been verified many times that the hypothesis of natural resource curse holds in most cases. Tests of resource curse have been applied in many ways, mainly to check whether resource curse exists in different countries or regions and how it affects the economy. Based on test results, it will be natural to make corresponding strategies and management policies to avoid negative impact led by resource curse.

It is worth mentioning that, from the researches above, if different indices and methodologies are adopted, test results may be completely different. Combining with China's situations, whether every type of natural resources have the "curse" impact is still uncertain. So it adds difficulties of making appropriate management policies to achieve the sustainable resource utilization. This issue will be a future research direction too.

4 . Transmission Mechanism and Resource Management Policy

Since natural resource curse has become a commonly accepted argument, more and more researchers come to be concerned with the transmission mechanism of resource curse on economic growth. It is believed that natural resource generally takes direct and indirect effect on growth. The direct channels mainly contains production factors (input of labor and capital), while indirect channels consist of investment (the "Dutch disease" effect), education factors, institutional factors, openness policy and R&D (Innovation). Researchers have their own opinions on these channels, so it is obvious that they study resource curse's transmission mechanisms from their own perspectives, and then offer corresponding management policies.

Gylfason and Thorvaldur (2001) construct a precise development model applied in Norwegian resource exploitation: nearly 80% oil rents are collected through taxes and dues. Then they are invested into foreign bonds in order to keep fair distributions between generations in case the revenue substantially increased. Shaxson (2005) and Hjort (2006) hold the same opinion that it is better to create national development funds from natural resource rents to invest in infrastructure, human capital and education, which can help improve the economy's competitive and growth power.

Manning (2004) takes human capital as a main transmission channel of resource curse and examines the relationship between natural resource abundance, human capital (literacy rate) and economic growth. The empirical results prove his basic hypothesis that rich resource endowments firstly reduce the investment on human capital then slow down economic growth. The indirect effect from resource to growth is greater than the direct effect. We can go further on these transmission channels to evaluate their internal connections and impacts.

Iimi and Ojima (2005) construct an endogenous growth model with exhaustible natural resources, empirically finding that natural resources curse still holds, but that for government with a sufficient ability to implement sound policies of resource management, resource richness is an instrumental economic development tool. In this study, Ordinary Least Squares (OLS) regressions and Instrumental Variables (IV) regressions are both performed. For most of estimations, both of them can give clear explanations. The government factor (government effectiveness) tends to stimulate economic growth according to OLS estimation, but loses statistical significance in IV regression. The OLS estimations may be biased by endogenous problem, so the impact of government effectiveness on growth is unclear.

In addition, this study offers a good mirror that endogenous growth model could be created by including the interaction term between resource abundance and government effectiveness. For further study, we can improve the corresponding econometric methods and add more detailed

governance factors into study. Since these factors play various roles in natural resource management, we can get more policy implications for sustainable resource use.

Papyrakis and Gerlagh (2007) argue that, in the U.S. states, natural resource abundance decreases investment, schooling, openness and R&D expenditure, but increases corruption. These effects fully explain the negative effect of resource abundance on growth. Especially, among these transmission channels, empirical study shows that schooling appears to be the most important factor, accounting for one fourth of the negative impact of resource-abundance on growth for U.S. regions. Then it is easy to make corresponding policy that can prevent negative impact of resource on growth.

Moreover, from this paper, we can obtain more implications for the subsequent study. If we decompose the measure of natural resource abundance into its constituent parts and test whether the results hold for different classifications and definitions of resource wealth[9], the conclusion may be different. In addition, since the United States' natural resource situations are similar to China, it provides us with wide space to think over China's issue.

Baggio and Papyrakis' paper (2009) has a distinct perspective and study transmission mechanisms of resource curse from ethnic heterogeneity. They explore the inter-linkages between natural resource abundance and both measures of ethnic heterogeneity (ethnic fractionalization and polarization on institutions) through constructing a two-simultaneous equation system. The results show that while ethnic fractionalization has a direct negative impact on effectiveness of property rights, polarization affects institutions only in a resource-rich context, and resource wealth lowers income in ethnically polarized rather than fractionalized countries. This paper focuses on ethnic heterogeneity, one of the transmission channels, and give us a deep impression that internal mechanisms of resource curse is complicated. If some mechanisms or conditions are changed, the relationship between resource and growth may be different. This is also why Norway and Australia can benefit from their rich natural wealth through successful resource management.

In conclusion, the researches on the transmission mechanisms haven't achieved a uniform opinion over what kind of channels would affect economic growth indirectly. The commonly accepted factors have different impacts in every country. Therefore, for next stage, firstly, we need try to seek theoretical evidences that can account for the large disparities among different countries and a country's internal regions. Then subsequent empirical research could be believable. Additionally, the pertinence of natural resource management policy is a bit weak to solve the problem caused by the transmission factors, which actually have damaged in many regions. This is just what the policy and governance experts need to attach importance to. As to China's

9) Papyrakis, E. and R. Gerlagh (2007). Resource Abundance and Economic Growth in the United States. *European Economic Review*, 51, 1029.

situation, comparison of different countries' resource policy can provide us with illuminations of making policies so as to avoid bad impact of resource curse like Norway and Canada. In the future, the transmission mechanisms in China and its wide-gap regional economies would be examined. Also, policy suggestions focused on resource management would be emphasized for the new developing countries endowed with rich natural wealth.

5 . Conclusion

The hypothesis of natural resource curse has given us a deep understanding on economic growth disparities among different countries and regions. The transmission mechanism of the curse is the foundation for us to make reasonable resource management policies. This study mainly focuses on the relationship between natural resource abundance, transmission mechanism and economic growth from the perspective of literature review. The followings are summaries and conclusions of the paper.

(1) Surveying previous literatures, it is believed that slow economic growth in resource abundant regions, which is called "natural resource curse", is mainly due to different performances of the market economy, social foundations and geographic positions. The "curse" of plenty of natural resources restricts economic growth by affecting the flow of endogenous production factors, and the transmission mechanisms (especially the arrangement of institutions, the speed of innovation, and the education factors, etc).

However, it is not difficult to find that, in their studies, the concepts and indices of natural resource abundance are confused, which leads to different results. Actually, this confusion has connected with present analyses that focus less on the economic theoretical research on the issue. Moreover, the methodologies used before are limited to estimation and regression analysis and lack checking the relationship between resource abundance, transmission mechanisms and economic growth from dynamic and systematic perspectives. Nevertheless, these variables fluctuate largely in different periods.

For the transmission mechanism and resource management policy, the recent literature highlight that a proper natural resource share mechanism can balance benefits among resource's exploitation, production and consumption. It is usually thought that market-based property rights modes, and mixed market with public and private property rights can remedy deficits of natural resource property rights, which actually points out directions for the future reform and development of resource-abundant regions.

(2) As a rapid industrialization country, China is also faced with multi-plicate natural resource restrictions, while non-renewable resources have taken irreplaceable effect on the high economic growth. From macro-perspective, the national economic growth is controlled by deficient supply

of natural resources. From mid-perspective and micro-perspective, the growth is controlled by superfluous supply of resources[10]. These phenomena is challenging China's natural resource policies which is actually mainly aim to solve the national problems but lack of sound regional targets. According to previous researches, in order to deal with resource restrictions from different levels, the transmission channels like rearrangement of institutions, innovation of technology, transformation of economic structure, and distribution of benefits should be taken into account. However, because of space forbids and limited time, the case of China is not discussed in detail in the paper, which will become important theme in future study.

(3) Based on the literature review and analysis of China's case, some research directions will be taken into account in future.

Firstly, based on recent development of economic growth theory, for further study, it is better to explore the theoretical principles of natural resource curse firstly. Thereafter, appropriate empirical methods and indices are adopted that could entirely reflect situations of resource abundance. Another way is to choose typical types of resources, like oil in Iran, which has a dominant proportion in the whole resource revenues in this country.

Secondly, China has a great variety of natural resources, but they have dissimilar characteristics in different regions. It is assumed that proper classifications of resource types would get more scientific results. Refer to Papyrakis and Gerlagh's (2007)[11] suggestions, I suppose decomposing measure of resource abundance into its constituent parts like "intensive resource" and "discrete resource", and test whether resource curse still holds for different classifications and definitions of resource wealth. Besides, the geographic factors (geographic positions, resource distributions, etc) may take effect on China, which would add transport and exploitation costs, and increase difficulties of transactions.

Last but not least, as far as I am concerned, the research on transmission mechanisms of resource curse of China is still less. Most current studies pay attention to nationwide transmission mechanisms without enough provincial or regional analyses, which need attaching importance to. Moreover, with regard to some significant and commonly accepted indirect effects like institution factors and innovations, what implications we can obtain from China is also a very interesting topic.

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