

# Transformation of Resource-Based Cities in China

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**Abstract:** The resource-based cities are the cities which are driven by the exploitation of mineral, forests and other natural resources, and the leading industry is based on the processing of those resources. The resource-based cities have been providing a lot of energy for the development of China, but around 2000, the economic depression of resource-based cities began to arouse people's attention. In this paper, the impact of energy competition among the resource-based cities and the function of renewable energy in the transformation of resource-based cities in China will be explained.

**Keywords:** Resource-Based City; Transformation; Renewable energy; China;

## Introduction

In previous researches, the life cycle curve of resource-based cities based on the resource reserves and resource outputs has been discussed widely. According to the life cycle curve, the researcher classified the life cycle of the resource-based cities into 3 stages. They are developing stage, mining stage, and decline stage. And the policy maker used the method divided all resource-based cities into four categories, besides the cities based on above three stages, they added regenerate resources-based cities, which almost get rid of resource dependence.

But when the author explored the coal output of Jiaozuo city, one of the representative decline resource-based cities, the author found the coal output of Jiaozuo city encountered some dramatically increase instead of decreasing during its decline stage, and even reached a new peak. And this kind of phenomenon has also appeared in some other decline resource-based cities. It seems like that sometimes the resource output of resource-based cities is not fully follow the life cycle curve. So it is inappropriate to simply apply the life cycle curve when considering the economic fluctuations of resource-based cities. In this paper, the economic fluctuations of resource-based cities will be explained from the viewpoint of market, and as the expansion of the research, if the renewable energy is taken into consideration will also be discussed.

## Methodology

First, this paper will be based on the theory of production cost cycle, though inverting the life cycle curve of resource-based cities in previous research. and there are several assumptions.

As for the resource-based cities, assumptions one says, all of the resource-based cities provide resources with the same utility. That's to say, the alternative between different resource-based cities will not be considered. Assumption two, all of the resource-based cities have enough resource reserves to make it possible for large-scale development. And all of them have the same development capabilities. In terms of this assumption, all those resource-based cities will have the same minimum cost achieving the scale development. And for the convenience, the technical progress will not be considered here.

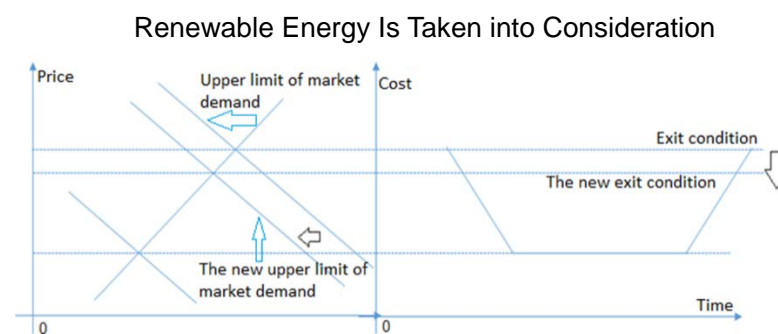
Next, there are also some assumptions for the resource market. Assumption one, the resource market is a perfectly competitive market. So all of the resource-based cities will face with the same resource price. Assumption two, transaction cost of resources is assumed to be zero in our

analyses. Assumption three, the resource markers are stable and reasonable. Under this assumption, the resource price based on their production will not keep rising indefinitely. And the highest price which will be equal to the production cost of the last unit of coal, and the lowest price will be the output cost when the scale development achieved.

Base on the above assumptions, when market demand drops and price goes down, due to the lower production costs, the cities in mining stage may still be in production process, but they will reduce their output according to the market demand. However, the cities during their decline stage will stop production because of their higher production cost. Then, when market demand rises and price goes up, the cities in mining stage will earn more profits with the same production units, and those cities in declining will also restart production if the price exceeded their cost.

when assumption1 of resource-based cities is relaxed, and the substitution effect is considered, same result will come out. For example, if the oil price falls, the demand of oil will rise and the demand of coal will drop. As a result, the coal price becomes much lower, and coal cities in decline stage will stop production if the coal price even lower than their production cost. Then, economic stagnation will most probably take place.

However, in this model, all of the resources are considered fossil energy, if there are not any new substitute resources, finally, all of the resource price will rise with the resource depletion. So the resource-based cities will not exit the resource market until the resource being completely exhausted, and thus the potential highest and lowest price in the resource market will not change largely either. But, if taking renewable energy into Consideration, something will be changed. Because the renewable energy could be supplied sustainably, It's unlikely that energy price would rise largely in the long term, especially because of the cost reduction led by technological progress. So in a stable and reasonable resource market, if the renewable energy price is low enough to replace the fossil fuel, the prospective maximum market demand of fossil energy will fall, and the potential highest price of fossil energy also be changed. It means that the condition of market exit of resource-based cities would be different, and then the resources may not be exploited completely.



source: by author

As an extreme case, if the renewable energy price reached the same level of the lowest cost of fossil energy, and once the later one is not sustainable for large-scale development in the future, the resource-based cities will eventually exit the resource market, and then, the decline stage will never come.

## Empirical Analysis

This paragraph is the statistical analysis to verify the data of resource-based cities in China. First, the competitive market for the same resources will be analyzed. According to the assumption one of a resource market, the resource market is a perfectly competitive market and all the resource-based cities will face the same resource price. So the competition amongst different resource-based cities could not be verified through the way of price elasticity. But based on the correlation between price and resource output, the competition between the high production cost and low production cost resource-based cities could be verified. As the hypothesis here, there are two points as follows.

First, based on the previous researches, the resource output will decrease in resource-based cities which belong to decline stage. However, this research considers that the resource output of all resource-based cities will change along with the resource price. It means that even in decline stage, the resource output may still grow if the resource price rise. So positive correlation between price and resource output is expected.

Second, the low production cost resource-based cities are considered that it could adjust their resource output more flexible according to the market demand, and the high production cost resource-based cities will stop their production when the market price is lower than their cost, and they will not resume their production until the market price is higher than their cost. So a stronger correlation in the lower production cost resource-based city is expected.

As the subjects, cities from a total of five provinces of China are selected in this paper: Heilongjiang province, Liaoning province, and Jilin province, which regarded as the high cost resource-based cities. And cities in Shanxi province and Inner Mongolia are the low cost resource-based cities in this paper. The time period spans from 1991 to 2011.

Then, the competitive market of different resources will be analyzed through the measurement of energy elasticity of substitution. In this part, the elasticity of substitution between each resource consumptions and total consumptions, and the elasticity of substitution between deferent resources will be measured.

This research considers that if there exists elasticity of substitution in different resources, or between each resource consumption and the total consumption, coal consumption will drop while the relative price of other resources drops. And if the total coal consumption drops, the resource-based cities in decline stage may stop production due to the competition of the same resource. As the result, a negative elasticity of substitution is expected.

For the period of research, the data period from 1996 to 2012 is selected. Due to the different characteristics of each industrial classification, not only the total industry, but also 49 sub-sector industries of China will be observed in this research. The calculation method is as follows.

The elasticity of substitution between each resource consumption and total consumption in different industrial sectors

$$\ln\left(\frac{E_{ij}}{E_i}\right) = C + a_1 * \ln\left(\frac{P_j}{P_t}\right) + a_2 * \ln\left(\frac{E_{ij}^{-1}}{E_i^{-1}}\right)$$

The elasticity of substitution between deferent resources in different industrial sectors

$$\ln\left(\frac{E_{ij}}{E_{ij'}}\right) = C + a_1 * \ln\left(\frac{P_j}{P_{j'}}\right) + a_2 * \ln\left(\frac{E_{ij}^{-1}}{E_{ij'}^{-1}}\right)$$

$E_i$ : The total consumption of coal, oil, natural gas and electricity in industrial sectors j.

$E_{ij}$ : The consumption of resource j in industrial sectors i.

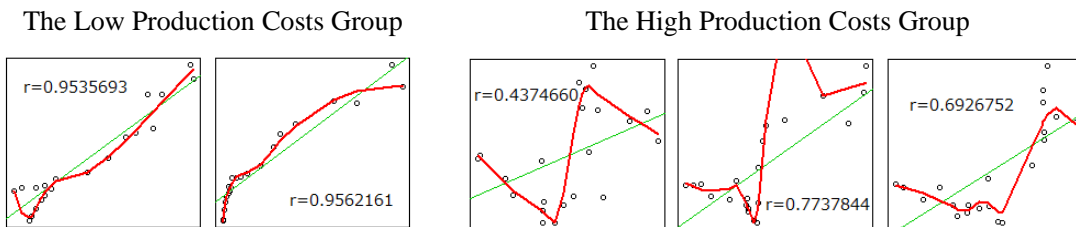
$P_t$  : composite resource price index.

$P_j$  : price index of resource j.

-1 is the previous period.

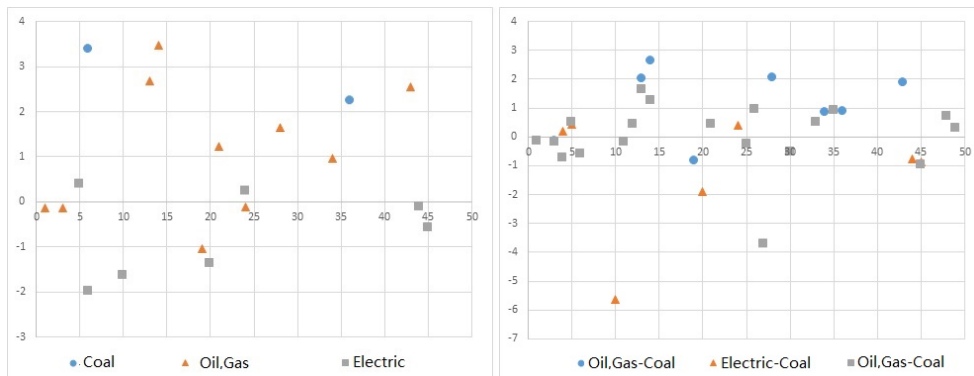
## Results

From the results of the competitive market for the same resources, as expected, the correlations between price and resource output in all the subjects are positive, and the correlation in low cost subjects is higher than the group of high-cost subjects. While, from the results of the competitive market of the different resources, a significantly negative elasticity of substations could not be funded there. It may indicate that, during the selected period, the decline of resource-based cities is mostly caused by the competition of a same resource.



source: by author

The Elasticity of the Substitution Between Each Resource Consumption and Total Consumptions (left), The Elasticity of Substitutions Between Deferent Resources in Different Industrial Sectors(right).



\*Only the results which significance level  $\alpha < 0.01$  are listed.

source: by author

But the competition of different resources should also be paid some attentions. Although, at present stage, the elasticity of substitution effect among some different resources is not obvious, but the elasticity value of substitution effect of electricity is larger than others. In a foreseeable future, with the improvement of environmental policies, the external costs of fossil energies in

China will be taken seriously, and the total cost of fossil energies will be increased. At the same time, because of the sustainability and environmental-friendly nature of the electricity from renewable energy, the government will provide more supportive measures, including subsidies and related industrial policies, and thus the cost of renewable energy could be reduced. When the scale of the electricity from renewable energy reaches a certain level, the elasticity of substitution effect of different resources will not be ignored any longer.

### **Policy Suggestions**

Resource-based cities must reduce production cost in order to obtain a competitive advantage. And a lower production cost will also help the resource-based cities reduce the influence from the change of market demand. So large-scale production and technological advances innovations need to be encouraged.

Improve the resource pricing mechanism. From results of the competition of different resources, the coal consumptions raised with the coal price. As the reason, this research think it has something with the reasonless coal price mechanism. During the period of planned economy, the Chinese government intervened a lot to the coal pricing, and restricted the coal price within a lower level, and during the transformation to market economy, the coal price will rise up again to a normal level. At the same time, with the fast development of Chinese economy, the coal demand was also increasing rapidly. Finally, the coal consumptions raised with the coal price. So, under the unreasonable coal price mechanism, the resource-based cities did not get the corresponding development funds to develop advanced industries. And after the resource being exhausted, resource-based cities declined due to a lack of continuous industries. For that reason, the improvement of resource pricing mechanism would help the resource-based cities get reasonable development funds supportive for the development of the city.

Promote the development of renewable energy. As mentioned above, the resource pricing mechanism should be improved, but from the view of current energy consumption structure in China, that will lead to a higher coal price, further, a higher consumer price. It is also why Chinese government has intervened the coal price several times so far. Therefore, through promoting the development of renewable energy, the current structure of energy consumption in China can be optimized, and the coal demand can be relieved, the coal price can be stabilized too.

The goal of existing policies is achieving the sustainable development of resource-based cities, but which ignores an important part of the urban sustainable development: the sustainable supply of energy. Without a sustainable supplement system of energy, the existing policies could only help to achieve the goal that transform the resource-based cities from resource-output to resource-dependence, and with the success of the transformation, though the energy demand of new cities will be still dependent on other resource-based cities, totally speaking, the country will not reduce get rid of the fossil energies dependency. From the other hand, the transformation without renewable emerge may lead to more fossil energy consumptions, and it will bring serious environmental problems.

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