The user cost of energy resource and its reasonable tax rate-A case of oil

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Abstract. The development and use of natural resources bring about the externality of resources depletion, especially for non-renewable resources. This paper takes oil as an example to analyze the user cost of energy resource with El Serafy User cost method, and discusses the rationality of the resource tax. Meanwhile, this paper determines oil resource tax rate in consideration of resource sustainable development. The results show that, the user cost of oil isn’t compensated fully, it is too low to make compensation to the environment and the profit of future generation, and the resource tax is a little low. At last of the paper, some conclusions and policy suggestions on resource tax reform are given.

1. Introduction
The development and use of natural resources brings the externality of resources depletion, especially for non-renewable resources, and the externality has intergenerational characteristic [1-2]. As resources optimal configuration using a natural extension of subject, resource depletion value accounting is to clear the purpose of scarcity resource depletion effect on the welfare of the offspring and eliminate the externality to achieve the optimal allocation of intergenerational, so it has the significance of sustainable development. Therefore, the current outstanding problems is that the resource depletion compensation is not in place. The conflicts between energy consumption, economy, and environment create oil price distortions [3]. Under the condition of invariable in oil prices, the part of missing are listed into the mineral resource tax, forming the excess profit of mining enterprises [4-5].

The energy price distortion degree should be measured considering scarcity features and environmental impacts. As such, Zhao [6] considered the use of non-renewable resources to have negative externalities on future generations. Li and Zhang [7] analysed the external cost of coal resources and compared its cost and taxes payable. The discount rate, which reflects people’s attitude to resource scarcity, is an important factor in evaluating this resource scarcity [8]. The larger the discount rate is, the less concerned people are about future generations’ interests. Unfortunately, few existing studies focus on the distortion degree of energy prices from the perspective of intergenerational equity. As mentioned by Kudlyak [9], the key components of energy scarcity are resource receipt, discount rate, and reserve-production ratio, and the evaluation of resource scarcity is sensitive to the discount rate. However, he had not reached a conclusion on the amount of the discount rate as the most reasonable choice for evaluation of energy price distortion.

Based on the theory of resource economics, it is the purpose of this article studies to discuss whether the resource tax need to reform. Taking oil as an example to discuss the rationality of the resource tax, determining oil resource tax rate, and grasping the macroeconomic effects of oil resource tax reform have a practical significance in reality.
The remainder structure arrangement of this article is as follows: the second part, using the user cost method to estimate China's oil resource depletion cost; the third part, setting theoretic tax rate of oil resources exploitation based on the user cost; the fourth part is the conclusions and policy Suggestions.

2. The depletion cost of oil
The User Cost Approach is a kind of calculating the user cost through measuring the depreciation of non-renewable resources. This method is proposed by EI Serafy [10], and is first used to examine the real income. Now it is mainly used to examine the non-renewable resources asset value loss. Its main idea described in mathematical formula is as follows:

At a discount rate $r$, the capitalized value of receipt $R$ is given by:

$$\sum_{n=0}^{\infty} R^n = R + \frac{1}{1+r} R + \ldots = \left( \frac{1}{1+r} \right)^n R = \frac{R}{1 + \frac{1}{1+r}}$$

(1)

and the capitalized value of true income $X$ is:

$$\sum_{n=0}^{\infty} X^n = X + \frac{1}{1+r} X + \ldots = \left( \frac{1}{1+r} \right)^n X = \frac{X}{1 + \frac{1}{1+r}}.$$  

(2)

To calculate user cost, we can convert the finite series of $R$ into a perpetual series of $X$ ($\sum_{n=0}^{\infty} R^n = \sum_{n=0}^{\infty} X^n$). If we equal the capitalized value of $R$ with the capitalized value of $X$, we can get

$$X = R \left[ 1 - \frac{1}{(1+r)^{n+1}} \right].$$

(3)

Therefore, the EI Serafy user cost $R - X$ will be:

$$R - X = R \frac{1}{(1+r)^{n+1}}.$$  

(4)

It is obvious that, both the RP ratio $n$ and the discount rate $r$ will affect the result.

Next, we calculate the resource receipt $R$. Referring to Lin and He [11], we can compute the annual resource receipt $R$ with the following equation:

$$R = (P_t \cdot AC_t) Q_t,$$  

(5)

where $P_t$ is the selling price of the resource, $AC_t$ is average production cost, and $Q_t$ is the exploitation quantity. As such, the EI Serafy user cost is:

$$R - X = \frac{(P_t \cdot AC_t) Q_t}{(1+r)^{n+1}}.$$  

(6)

The results from Eq. (6) are called total user cost.

After taking the derivative of Eq. (9) with respect to $Q_t$,

$$(R - X)' = \left[ \frac{(P_t \cdot AC_t) Q_t}{(1+r)^{n+1}} \right]'.$$  

(7)

Then,

$$MUC = \frac{P_t - AC_t}{(1+r)^{n+1}}.$$  

(8)

So far, the international general method of calculating the value of mineral resources exploitation depletion is the user cost method, but the choice of parameters is also arbitrary in calculating. How to scientifically and unitedly specify the choice of parameters in calculating the use cost using this method becomes an important problem that researchers must solve. This paper proposes to introduce the discount rate in estimation method to eliminate the rate selection of randomness, for getting the real user costs. The choice of discount rate is 1%, 3%, 5%, 7%, and on this basis, EI Serafy user cost
method is used to measure the user cost of oil resources in our country. The calculation results are showed in Figure 1.

![Figure 1. The user cost of oil resources](image)

From figure 1, we can find that before 2007, the user cost of oil resource shows an increase trend, and a decline in 2008 and 2009. We all know the global financial crisis in 2008, and it’s the main reason of this decline. We also find that the calculation result is affected by discount rate. The bigger the discount rate, the low the user cost.

3. The compensation of depletion cost and resource tax

3.1. Compensation measures
Mineral resources have value, and have reached a consensus on this. There are all kinds of debate about the implementation method of paying for use of mineral resources, especially how to implement paid use on the economy. Current forms of resource depletion cost can be summarized as resource tax and mineral resources compensation fee.

(1) Resource tax

Resources tax is levied to embody national rights and interests, regulate resources differential income, promote resource conservation use. The amount of consumption tax payable is calculated based on actual production (sales). Duty formula is:

\[
Tax\ payable = number * unit\ tax\ amount
\]

The unit tax amount for crude oil is 8 ~ 30 CNY/ton. On May 17, 2010, Chinese governments have issued some rules on issues of xinjiang oil and gas resource tax reform: the resource tax is fist reformed in xinjiang, the resource tax levy method is changed from volume to the AD valorem duty by the product sales.

(2) the mineral resources compensation fees

Mineral resources compensation refers to the fees that enterprise need to pay in mining mineral resources according to the certain proportion of mineral products sales income.

\[
Mineral\ resources\ compensation\ fee = minerals\ sales * rate
\]

Mineral resources compensation fees are included in the management cost in accounting. The collection is for the purpose of the continuation of mineral resources exploration and development, then realizing the sustainable development of mineral resources.
Some compensation measures, such as the resource tax and resource compensatory fee, are taken in China. The reform process of resource tax and mineral compensation fee are listed in Table 1.

**Table 1. Reform process of resource tax and mineral compensation fee**

| Year       | Tax         | Fee          |
|------------|-------------|--------------|
| Before 2009| 14–30 (CNY/ton) | 1% of sales  |
| 2010–2013  | 5% of sales | 1% of sales  |
| After 2014 | 6% of sales | -            |

The levy standard for the resource tax is not constant in China. The detailed levy information of resource tax and mineral compensation fee on China’s companies are listed in Table 2.

**Table 2. The detailed levy information of resource tax and mineral compensation fee**

| Year | Resource tax | Mineral resources compensation fee | Sum   |
|------|--------------|------------------------------------|-------|
| 2000 | 2.98         | 2.85                               | 5.83  |
| 2001 | 2.98         | 2.80                               | 5.77  |
| 2002 | 2.98         | 2.81                               | 5.79  |
| 2003 | 2.98         | 3.41                               | 6.39  |
| 2004 | 2.98         | 4.33                               | 7.30  |
| 2005 | 2.98         | 5.47                               | 8.45  |
| 2006 | 3.04         | 6.50                               | 9.54  |
| 2007 | 3.87         | 7.52                               | 11.39 |
| 2008 | 5.36         | 9.08                               | 14.44 |
| 2009 | 8.19         | 8.52                               | 16.72 |
| 2010 | 59.67        | 11.93                              | 71.60 |
| 2011 | 30.16        | 15.59                              | 45.75 |
| 2012 | 30.04        | 19.98                              | 50.02 |
| 2013 | 28.99        | 19.71                              | 48.70 |
| 2014 | 33.67        | 0.00                               | 33.67 |

From the table, we can know the compensation fees are showing an increase trend in general. By comparing the user cost and resource tax to get to know the compensation situation of oil resources. As shown in figure 2.

**Figure 2. Resource tax, compensation fee, and MUC for oil**

From the figure above, all compensation taxes and fees are significantly below MUC. In other words, in China, resource taxes and fees are far from full compensation to the user costs of oil resources.
Fortunately, as we can see in figure 2, the resource taxes of oil shows a significant upward trend since 2010, which can cause the user costs of oil to obtain more compensations. This indicates that a greater number of oil resources could be inherited by future generations under the current pricing mechanisms.

3.2. The determination of the resource tax rate
Sustainable real income theory claims that part of the resources exploitation income shall be used for investment, so as to realize sustainable development, and this part of the income is the user cost. Taxing oil to make up for the user cost of taxes on resources not only can reflect the value of depletion of non-renewable resources, reduce intergenerational externality effect, but also help to obtain the sustainability of the investment. The existence of the user cost of oil resources and its sustained growth show that collection of oil resource is very urgent. Now we need to set a reasonable tax rate range, and design oil resource tax according to the AD valorem. The tax rate may be obtained through:

\[
\text{TAX RATE} = \frac{\text{MUC}}{P}
\]

Where the TAX RATE is on behalf of the petroleum resource tax rate, MUC means marginal user cost, P represents the price of oil. Calculation result of oil resource tax rate is shown in figure 3.

![Figure 3: Oil resource tax rate and average user cost](image)

**Figure 3** Oil resource tax rate and average user cost

4. Conclusions and policy suggestions
This article uses El Serafy user cost calculation method to estimate the Chinese user cost of oil resources during 2000-2014. The results showed that due to economic crisis, the user cost of China's petroleum resources was down in 2008. In terms of overall trend, China's petroleum resources, the user cost is rising since 2000, and has rapid growth. According to the connotation of user cost, the trend indicates that, as China's oil production increased significantly, the available oil resources reduce rapidly, which increases the user costs of oil resource. By extension, the intergenerational problem is that the more modern mine and use oil resources, the greater the cost of future generations use of oil resources is, so oil price reform of resource taxes becomes obviously extremely urgent. Secondly, based on the principle of sustainable income, this paper estimates AD valorem tax rate of oil in consideration of the user cost, the result shows that China's theoretical tax rate keeps upward trend since 2000, mainly between 15% - 40% range.

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