Eco-Factor of Economy Growth Evaluation Method

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Abstract

Gross Domestic Product (GDP) is often used as a measure of social welfare, though it is not intended to be so. One shortcoming of this indicator is that it fails to account for ecological declines. Thus Green GDP is proposed, using specific accounting systems such as SEEA. However, it is quite difficult to accurately transform the non-marketed values into marketed ones in such systems. Besides, a certain accounting system is only suitable to limited regions with similar characteristics. For that, two new indicators, Ecology Consumption Index Q and ECO-Factor of Economy Growth (EFEG) are proposed in this paper. Case studies, which concerns with a region's EFEG performance in a series of time span and different regions' EFEG performances during the same time period, are presented and discussed in this paper. Results show that EFEG and other indicators can better represent the economic growth health trend from ecological aspect.

Key words
EEO-Factor of Economy Growth, Green GDP, sustainable development

1. Introduction

The impacts of human economy activities are always twofold. On the one hand, they create wealth which is measured by GDP; on the other, they consume natural resources, energy and may cause pollution to the environment, which could not be reflected in the present GDP system. As a result, some countries are blindly seeking for higher GDP, neglecting of these factors, which are one of the most important parts of a nation's sustainable economy growth system. Absurdities and trivialities would arise, when threats to ecological system could make GDP increase. For instance, flood is by all means a kind of disaster to people, but because of the fund used in building banks and the need of more employees in building these banks, it makes GDP higher. Another vivid example is that pollution makes people suffer but it also brings wealth to the medical treatment industry.
In solving the above problems, Green GDP is proposed, which is calculated by deducting two factors from GDP. One factor is called nature factor. It includes all the ecological factors. The other factor is called human factor and the cost of medical care, unemployment, crime, illiteracy and a booming and uncontrollable population are

included.[1]-[3]As it is very difficult to obtain data of the latter factor, it is normally not considered in the existing Green GDP calculation system. For instance, SEEA (system of Integrated Environmental and Economic Accounting) by United Nations of Statistical Commission[4] , SERIEE (European System for the Collection of Economic Information on the Environment) by European Environmental Economic Information Collection System[5] , NAMEA (National Accounting Matrix including Environmental Accounts) and SAMEA (Social Accounting Matrix including Environmental Accounts) [6] ,etc..

In these Green GDP calculation systems, it is quite difficult to accurately transform the non-marketed values in nature factor into marketed ones. Besides, a certain accounting system is only suitable to limited regions with similar characteristics. Meanwhile, the subtraction of two variables would cause a great loss of information and accuracy. So there is not any formal Green GDP data published by the government. For that, some new evaluation method is necessary, not only by revising the present GDP system. The Chinese government has set a goal that by the year 2020, GDP should increase by 4 times with energy consumption only increase by 2 times. This aim is simple but realizable. In this way, a simpler indicator, EFEG (Eco-Factor of Economy Growth) as well as some other indicators is proposed to evaluate economic, ecological and environmental development for a region in this paper.

2. Eco-Factor of Economy Growth--EFEG

EFEG (Eco-Factor of Economy Growth) is to measure the healthy degree of economy growth trend during one period of time. It is expressed via Ecology Consumption Index Q and GDP Index I (preceding year=1) as in formula (1):

$$EFEG = \frac{I}{Q} \tag{1}$$

where Ecology Consumption Index Q is the measurement of the consumption of resources, energy and the decline of the environment, as in formula (2):

$$Q = \sqrt[3]{W_1\left(\frac{\sum_{i=1}^{m} w_{1i} R_i}{m}\right) \times W_2\left(\frac{\sum_{j=1}^{n} w_{2j} E_j}{n}\right) \times W_3\left(\frac{\sum_{k=1}^{p} w_{3k} P_k}{p}\right)} \tag{2}$$

where R_i is certain natural resource decline ratio； E_j is certain energy consumption ratio； P_k is certain pollution increase ratio; w_{1i}, w_{2j}, w_{3k} are weight coefficients related to R_i , E_j and P_k respectively ; W_1, W_2, W_3 are weight coefficients related to natural resource, energy consumption and pollution respectively.

EFEG could be cumulated. N years' EFEG is the product of each year's EFEG as shown in formula (3):

$$(EFEG)_N = \prod_{i=1}^{N} EFEG_i \qquad (3)$$

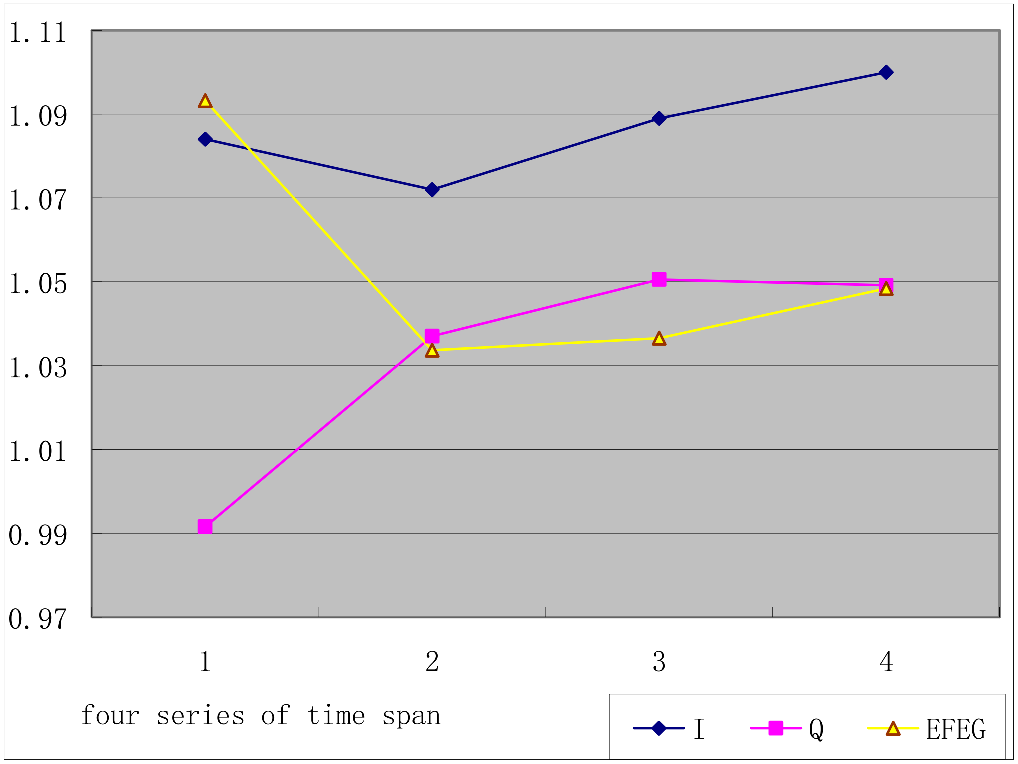
Unlike the calculation of Green GDP, the calculation of EFEG is quite flexible. For instance, m, n and p are variable according to attainable data. The more data we have, the more reliable the result is. For most cases, coal, crude oil, pig iron, cement and timber could represent natural resources (m=5); annually energy consumption in million tons of standard coal equivalents (SCE) could be found from National Energy Statistical Yearbook; Pollution could be represented by waste water, waste gas and waste residue (p=3). And if allowed, more factors could be considered. Case studies are presented in the following sections (all weight coefficients=1).

3. Case Studies

Using the multiple indicator system including I, Q and EFEG, different cases are studied to compare and analyze a region's EFEG performance in a series of time span and different regions' EFEG performances during a same time period. The analysis objects include China' four series of time span, China's five regions during the period of 2001-2002 and five countries from 1990 to 2000.

1) The Analysis to China' Four Series of Time Span from 1999-2003

Fig.1 – Fig.3 are plotted as follows after the calculation using basic data from reference [7]-[13]:



1----1999-2000,2----2000-2001, 3----2001-2002, 4----2002-2003

Fig.1 I, Q and EFEG Transformation

From Fig.1, we could conclude that:

First of all, EFEG broadens the change of I, which makes it easier for comparison, especially when the change of I is tiny.

Second, EFEG reaches its highest in 1999-2000 and lowest in 2000-2001. This is because that in 1999-2000 I is comparatively high and Q is the lowest (as the energy consumption is the lowest which is only 1.001), and in 2000-2001 I reaches its lowest and Q is somewhat high.

Third, as I reaches its lowest and Q is high during 2000-2001 period, I increases in the immediate period of 2001-2002. This shows that the increase of Q could bring the increase of I, but it is not healthy in the long run.

A further discussion is made from Fig.2.

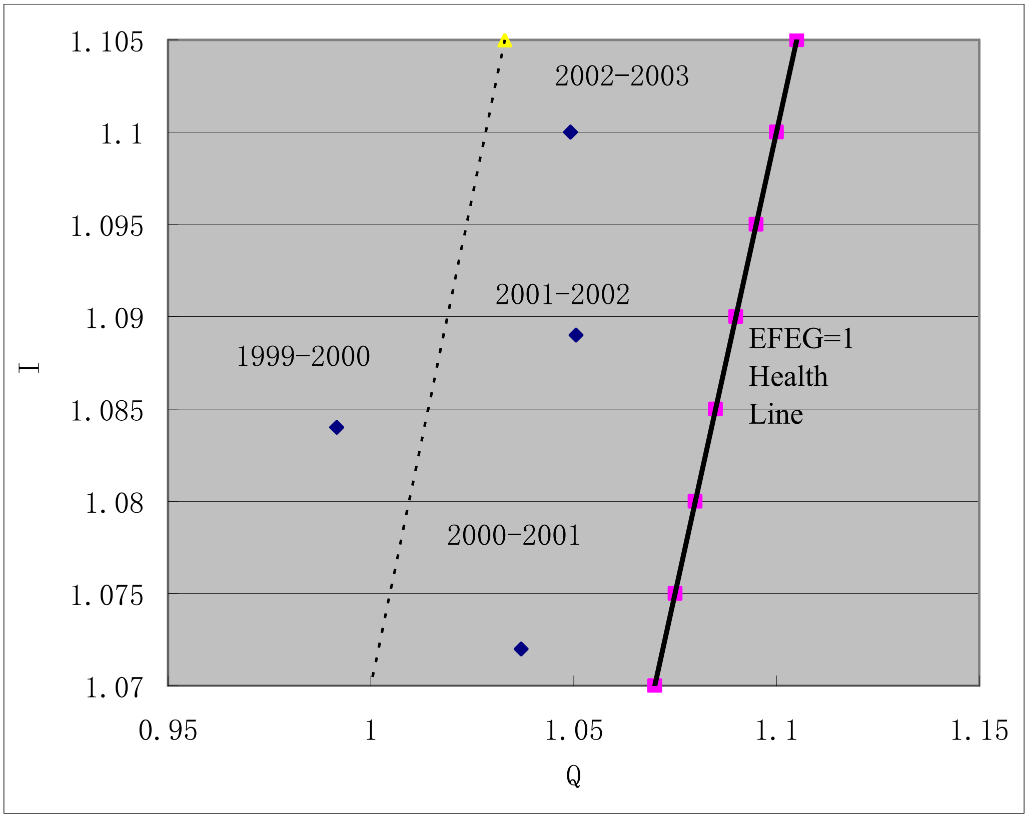


Fig.2 China's Q-I figure during 1999-2003

A slope=1(EFEG=1) line could be plotted on Fig.2. It is defined as Health Line as points on this line has the characteristic of the same Q and I transformation speed. Health Line divides the figure into two parts. Dropping on the left part means I changes faster than Q and dropping on the right means the opposite. But only the former is healthy. From Fig.2, we could see that all the four periods are healthy. However, even if EFEG equals 1, depletion of resources, energy and pollution may still exist, so dropping on the left part is only a prerequisite to a healthy growth.

A parallel line to the Health Line could be plotted through each point that represents one of the four time periods. We could imagine that the farthest to the Health Line is the healthiest. From this perspective, the same conclusion as in the previous discussion could be drawn.

Because of the limitation of quality and quantity of the present data in natural resources, all the previous discussions are neglecting of this factor. Now we are going to use the yields of certain industrial products to make further estimations (Fig.3).

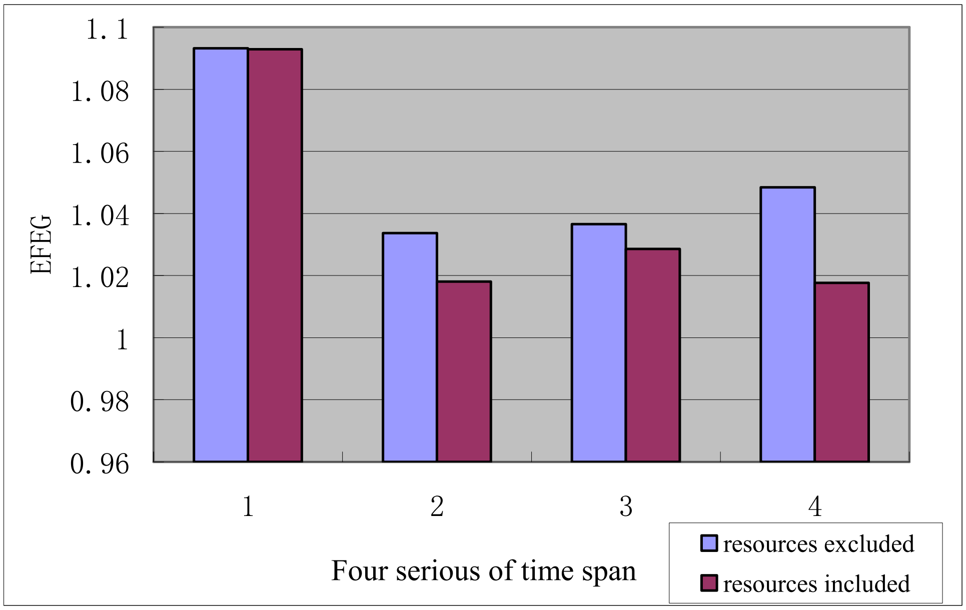
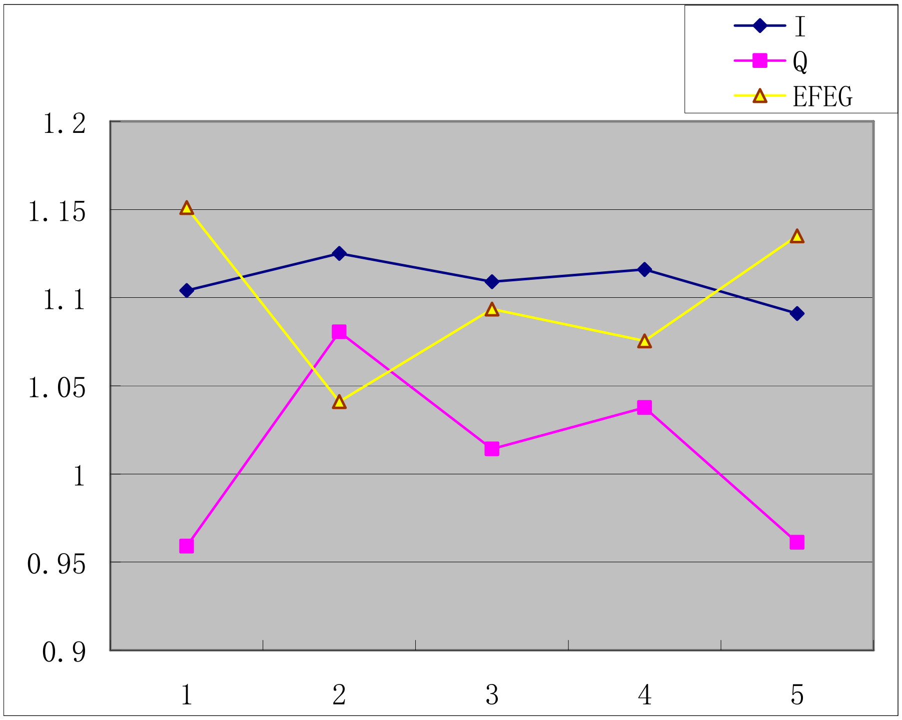


Fig.3 The Influence of Resources to EFEG

From Fig.3, the transformation trend is roughly the same no matter resources included or not, so estimations could still be made if certain data is lacked. The change during 2002-2003 is the greatest, for its natural resource decline (=1.147) is the biggest of the four period.

2) The Analysis to China's five Regions during the Period of 2001-2002 (resources excluded)

Fig.4 and Fig.5 are plotted as follows after the calculation using basic data from reference [7]-[13]:



1——Beijing，2——Tianjin，3——Shanghai，4——Jiangsu，5——Guizhou

Fig.4 Five Regions' I,Q and EFEG Figure

Comparing I and Q in Fig.4, we could find out that the figure of Q is the vertical stretch of the figure of I, meaning that ecological cost could bring GDP increase.

Take Tianjin as an example. During 2001-2002, I is the highest (1.125) but EFEG is the lowest (1.041). The reason is that Q is comparatively high. To be more specific, among the five cites, the increasing discharge rate of waste water and waste gas in Tianjin are the highest, and the increasing discharge rate of waste residue ranks 2nd. Besides, the increasing rate of Greenbelt in Tianjin is the smallest of the five. When the differences between their energy consumption rate is small, Tianjin gets the biggest Q and the smallest EFEG.

Now take Guizhou as another example. Though Guizhou has the smallest I (1.091), its increasing releasing rate of waste water and gas, and the energy consumption rate are the smallest of the five. Moreover, its increasing rate of Greenbelt is the biggest (2.507), far exceeding the second biggest one (1.450). As a result, Guizhou has the smallest Q and the second highest EFEG.

This could also be reflected in Q-I figure, as in Fig.5:

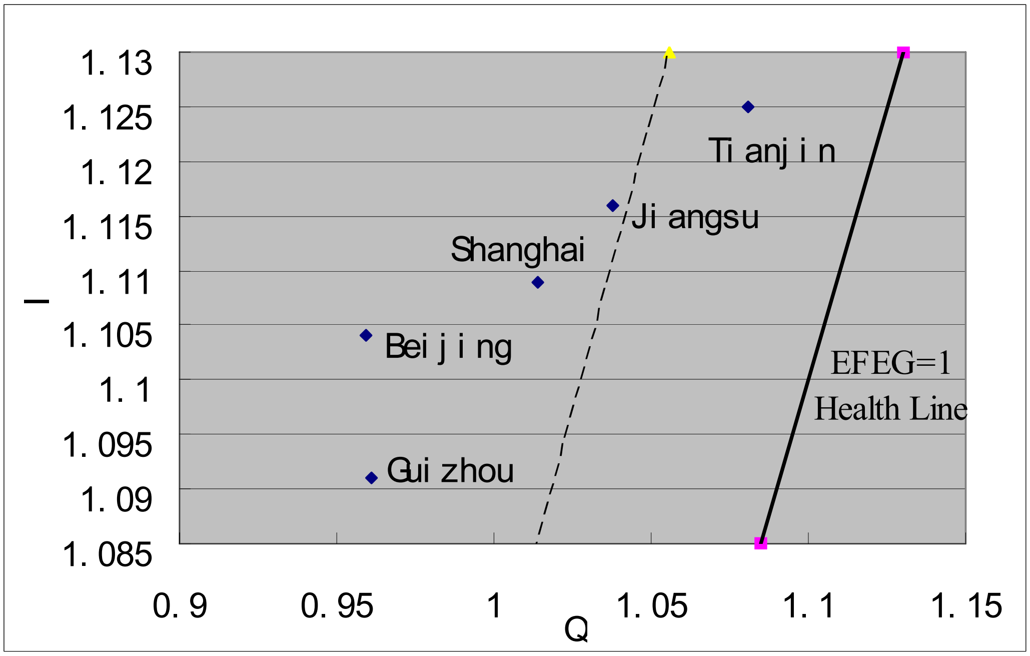
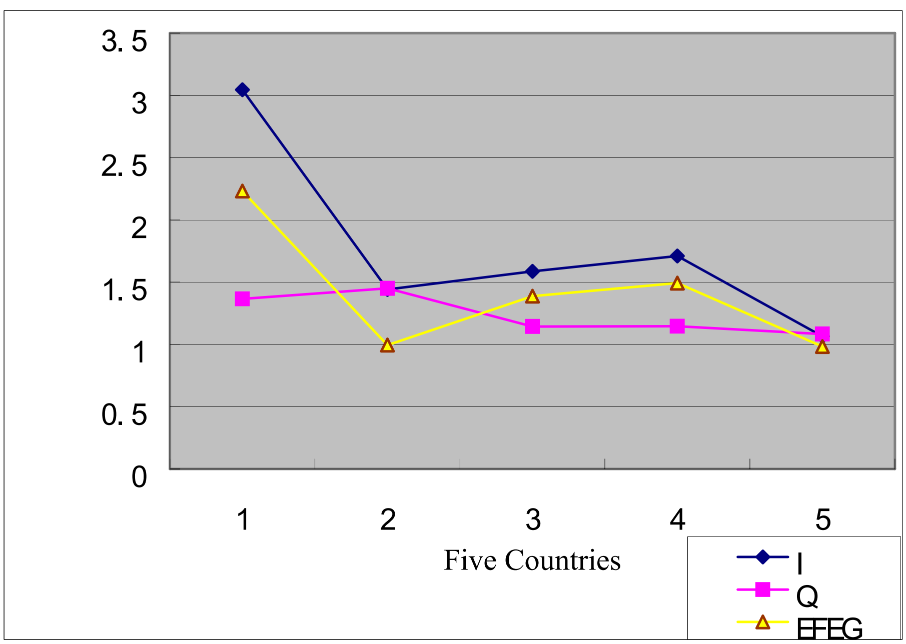


Fig.5 Five Cities' Q-I Figure

3) The Analysis to Five Countries from 1990 to 2000

Fig.6 and Fig.7 are plotted as follows after the calculation using basic data from reference [14]-[16]:



1—China, 2—India, 3—Japan, 4—US, 5—France

Fig.6 Five Countries' Q, I and EFEG Comparison (resource excluded)

From Fig.6, of all the countries, China has the biggest I and a comparatively low Q. As a result, its EFEG is the highest, which means that in 1990-2000 China’s growth trend is the best of the five countries; On the contrary, India has a small I and the biggest Q, which means in this same period, India’s growth trend is the worst of the five.

Now taking resource into account, each country’ EFEG change is reflected by arrows in Fig.7:

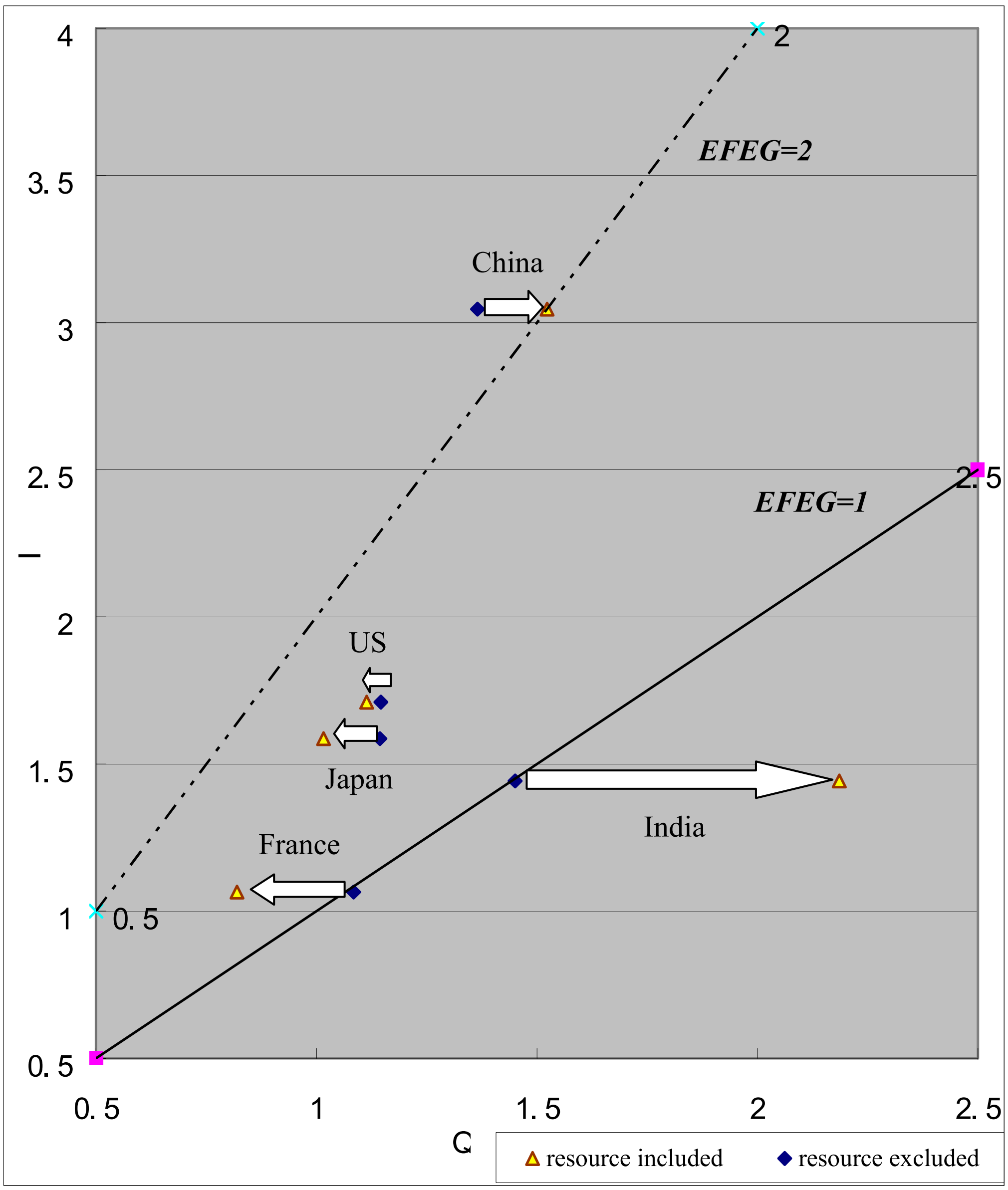


Fig.7 Five Countries’ EFEG Change

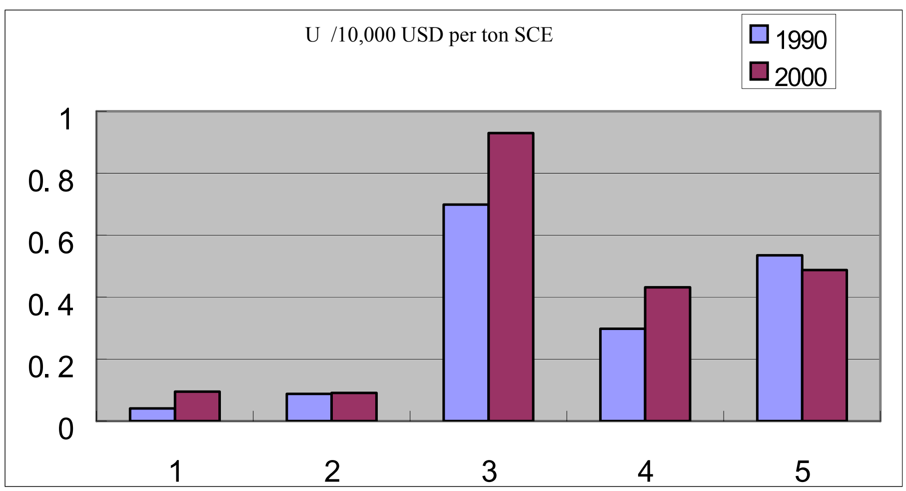
Taking resources into account, the Q of each developing country is becoming bigger while that of the developed country is becoming smaller. This hints that developed countries are better in its resource protection than developing countries.

Besides the Health Line (EFEG=1) that mentioned before, there is an additional line in Fig.7. Its slope equals 2 (EFEG =2). China satisfies this new requirement but India does not even satisfy the EFEG=1 requirement, whether resources are included or not. Japan and US is between EFEG=1 and EFEG=2. France satisfies EFEG=1 requirement only when resources are included.

We must point out that EFEG=1 is not a suitable requirement for China, as its GDP per unit energy consumption U is rather small (Fig.8). For instance, if EFEG equals 1, when I reaches 3.05 as in 1990-2000, Q would also reach 3.05. This Q is too much for the environment to bear. A more reasonable requirement would be EFEG=2 in ten years or EFEG=1.07 each year (dashed line in Fig.2 and Fig.5). In Fig.2, only period 1999-2000 satisfies this new requirement and in Fig.5 only Tianjin does not satisfy this.

As can be seen, Health Line could be different according to individual cases. And each region could use individual Health Line to make its own estimation.

As has already been mentioned before, EFEG would only reflect the healthy degree of economy growth trend. To measure absolute degree, energy or resources consumption per GDP unit or GDP per energy or resources unit consumption could be used. Fig.8 shows the analysis using GDP per energy unit consumption U:



1—China, 2—India, 3—Japan, 4—US, 5—France

Fig.8 Five Countries' U

From Fig.8, conclusions could be drawn as follows:

a) There is still a considerable gap between the developed countries and developing ones. Japan, US and France could produce more GDP using the same energy than China and India;

b) Except for France, all the other countries' U is increasing from 1990 to 2000;

c) China's growth of U is fastest, which again, validates that it has the biggest EFEG.

4. Conclusions and Prospect

EFEG could well reflect the health degree of one region's economy growth trend and it is easy to be calculated. However, it is only a relative measurement because a high EFEG only means that the trend of development is healthy. Energy or resources consumption per GDP unit or GDP per energy or resources unit cost could be used to measure absolute degree. Using the multiple indicators system containing I, Q, EFEG and U, we could evaluate different region's sustainable development degree.

In the above case studies, all weight coefficients are 1. In fact, it could be decided by various ways, for instance, according to the quantity and importance of the data. And suggestions by experts could also be considered. The more data we have and the more factors we consider, the more reliable the result is. This system could also be applied in a variety of other domains, like industries, enterprises and regions.

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