



Method for Evaluation of the Eco-Factor of Economic Growth in China

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- Framework of the Eco-factor of Economic Growth
- Case study in China during its reform and opening-up period
- Comparison of *EFEG* in China and USA
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Sustainable development indicators

Sustainable development (SD), i.e. “development that meets the needs of the present without compromising the ability of future generations to meet the own needs” (WCED, 1987)

- Human Development Index (<http://hdr.undp.org/en/>)
- Genuine Saving
- Wellbeing Index
- Green GDP accounting system (ISEW, GPI, etc.)
- Ecological Footprint (<http://www.footprintnetwork.org/en/index.php/GFN/>)
- Eco-efficiency
- Factor X ($4 < X < 50$)
 - Factor 4 (<http://www.wupperinst.org/FactorFour/>)
 - Factor 10 (<http://www.factor10-institute.org/>)
- ...



Green GDP in China

- The National Environmental Protection Agency together with the National Bureau of Statistics of China launched a Green GDP accounting project in march 2004.
- Experimental work was carried out in 10 provinces and municipalities in 2005
- China Green National Accounting Study Report 2004 was published as the initial result in September 2006
- Green GDP accounting results for China have not been published by the government since 2006
- Two major difficulties
- ...



The Model of EFEG

Factor X of Eco-consumption $EFEG = \frac{I}{Q}$

$$I = \frac{GDP_t}{GDP_{t-1}} \quad Q = \sqrt{R^{W_R + W_E + W_P}} \times E^{W_E} \times P^{W_P}$$

$$R = \frac{\sum_{i=1}^m w_{1i} R_i}{w_1} \quad E = \frac{\sum_{j=1}^n w_{2j} E_j}{w_2} \quad P = \frac{\sum_{k=1}^p w_{3k} P_k}{w_3} \quad w_1 = \sum_{i=1}^m w_{1i} \quad w_2 = \sum_{j=1}^n w_{2j} \quad w_3 = \sum_{k=1}^p w_{3k}$$

Factor X of Resource $EFEG_R = \frac{I}{Q_R} = \frac{I}{R}$

Factor X of Energy $EFEG_E = \frac{I}{Q_E} = \frac{I}{E}$

Factor X of Environment $EFEG_P = \frac{I}{Q_P} = \frac{I}{P}$

Factor X of Material $EFEG_{R,E} = \frac{I}{\sqrt{Q_R^{W_R} \times Q_E^{W_E}}}$



The Model of EFEG

Equations

$$EFEG_{R,E} = \sqrt{W_R + W_E} \sqrt{EFEG_R^{W_R} \times EFEG_E^{W_E}}$$

$$EFEG = \sqrt{W_R + W_E + W_P} \sqrt{EFEG_R^{W_R} \times EFEG_E^{W_E} \times EFEG_P^{W_P}}$$

The accumulation of $EFEG$ in l years

$$(EFEG)_l = \frac{\text{The variation multiple of economic growth in } l \text{ years}}{\text{The variation multiple of eco-consumption in } l \text{ years}}$$

$$(EFEG)_l \approx \prod_{h=1}^l EFEG_h$$

The average of $EFEG$ in l years

$$\overline{(EFEG)}_l = \sqrt[l]{\prod_{h=1}^l EFEG_h} \approx \sqrt[l]{(EFEG)_l}$$



The Model of EFEG

The Relationship among *EFEG*, Factor X and Eco-efficiency

- *EFEG* derives from the concept of Factor X and Eco-efficiency
- *EFEG* expands the scope of Factor X, for it compromises not only resource aspect as Factor X, but also includes energy and environmental aspect in part of eco-consumption
- *EFEG* is virtually a relative form of Eco-efficiency, and more aspects are combined together in the denominator



Parameters and standard of EFEG

- Based on Material Flow Accounts, used domestic extraction resource (non-energy use resource, minerals and biomass) is selected for the aspect of resource
- Total primary energy consumption is chosen for the aspect of energy
- Waste water, SO₂, dust discharge and untreated industrial solid are environment aspects



Parameters and standard of EFEG

■ The Alarm Value

- $I = Q, EFEG = 1$
- $I < Q, EFEG < 1$

■ The National Standard Value

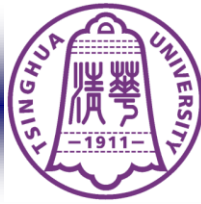
$$EFEG_P = \frac{1 + 7.5\%}{\sqrt[5]{1 - 10\%}} = 1.0979$$

$$EFEG_E = \sqrt[5]{\frac{1}{1 - 20\%}} = 1.0456$$

$$EFEG_R = \sqrt{EFEG_E \times EFEG_P}$$

$$EFEG = \sqrt[3]{EFEG_R \times EFEG_E \times EFEG_P} = 1.0714$$

Total emission of major pollutants (SO₂, COD, etc.) must be reduced by 10%; GDP unit energy consumption must be reduced by 20%; and GDP should increase by an annual average of approximately 7.5% (PRC, 2006)



*EFE*G performance in China during its reform and opening-up period

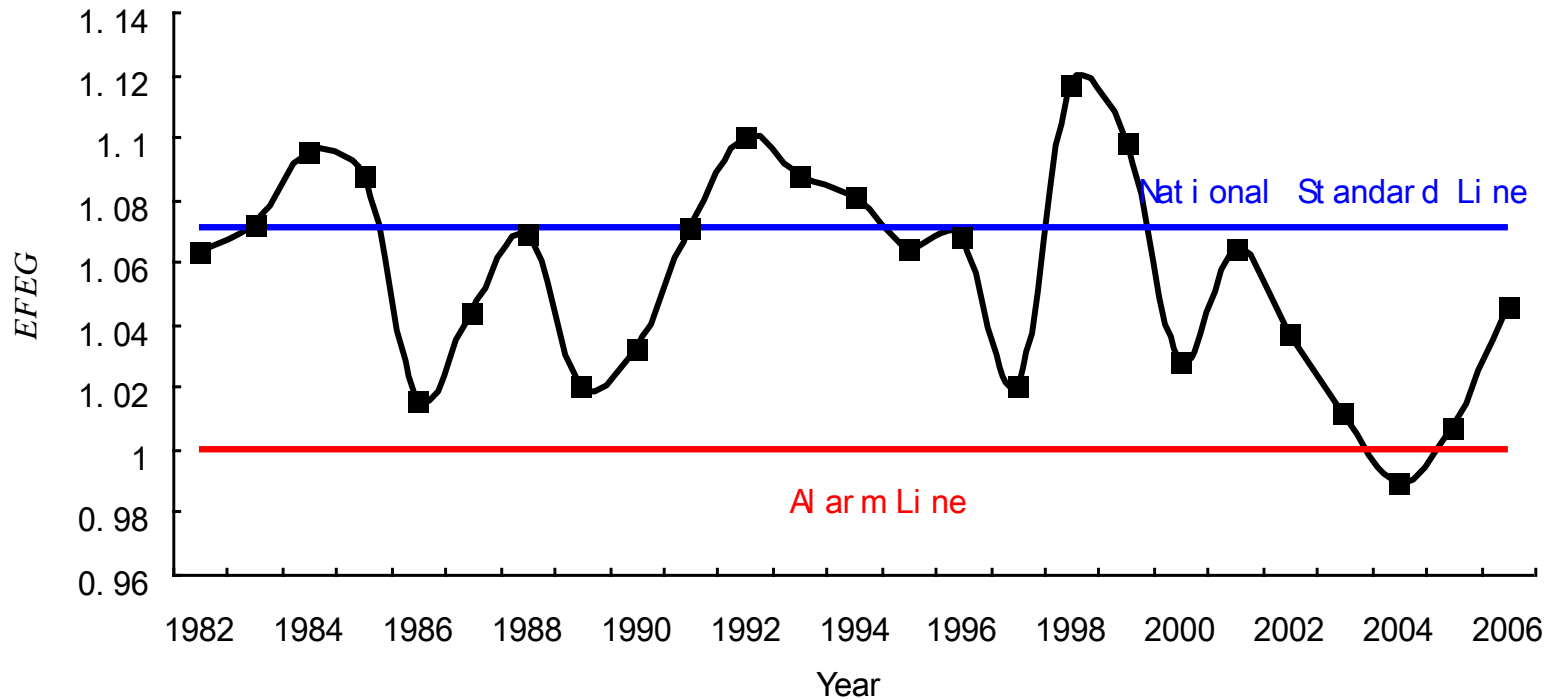


Figure 1. *EFE*G in China 1982–2006

Max=1.1168; Min=0.9892; Average=1.0550;
Factor X of Eco-consumption (Accumulation)=3.8127



Decoupling of economy from eco-consumption

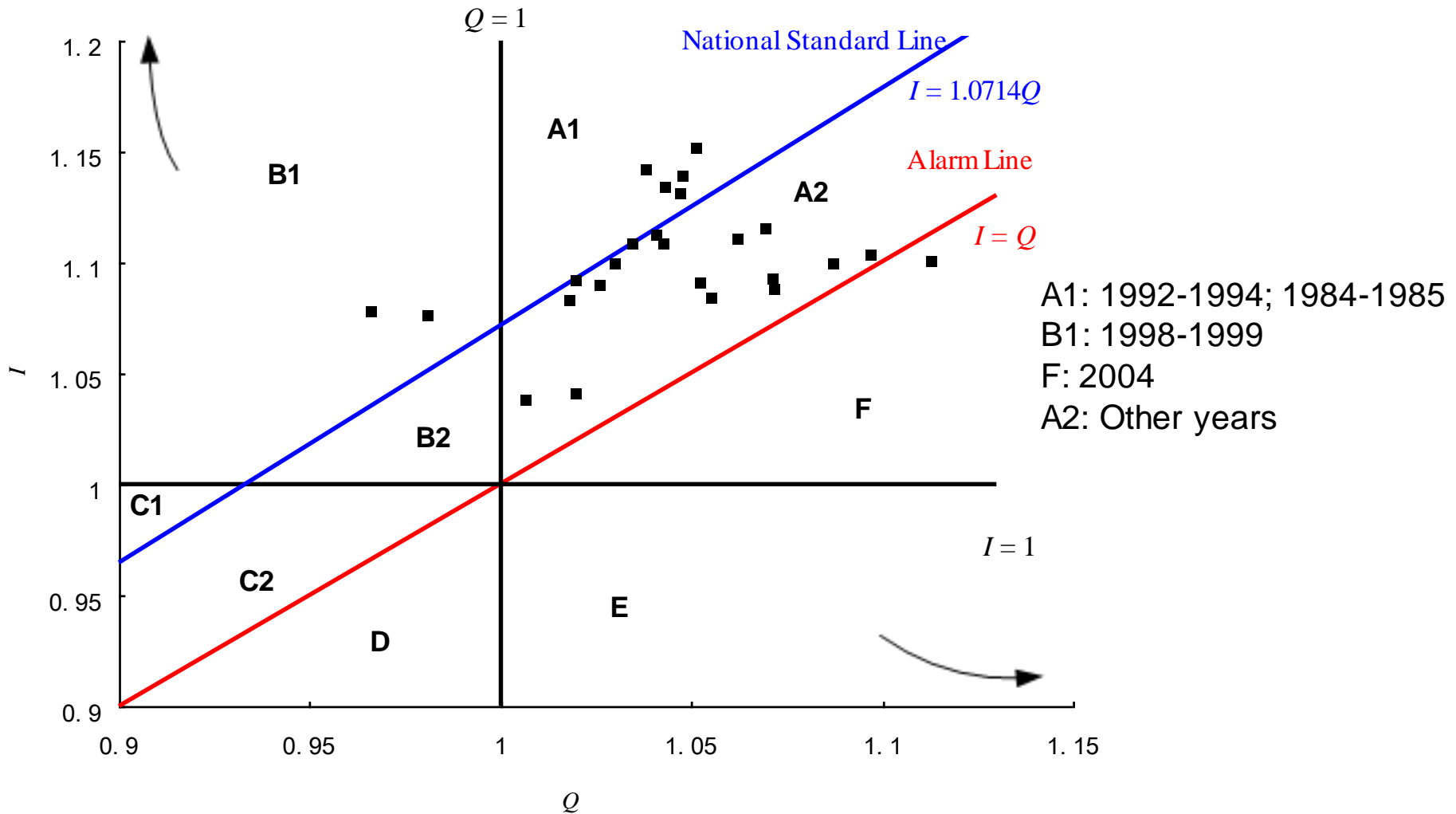


Figure 2. The relationship of economy and eco-consumption in China 1982-2006



Decoupling of economy from eco-consumption

- From the view point of *EFEG*, they are divided into 3 groups:
 - {A1, B1, C1}: *EFEG* are above the National Standard Line
 - {A2, B2, C2}: *EFEG* are between the Alarm Line and National Standard Line
 - {D, E, F}: *EFEG* are below the Alarm Line
- From the view point of decoupling, they are divided into 4 groups:
 - {A1, A2, F}: Increasing eco-consumption ($Q > 1$) and improving economy ($I > 1$), so economy is coupling with eco-consumption. This mode is the general situation in the world. $A1 > A2 > F$
 - {B1, B2}: Reducing eco-consumption ($Q < 1$) and improving economy ($I > 1$), so economy is decoupling with eco-consumption. $B1 > B2$
 - {C1, C2, D}: Reducing eco-consumption ($Q < 1$) and reducing economy ($I < 1$), so economy is coupling with eco-consumption. $C1 > C2 > D$
 - {E}: Increasing eco-consumption ($Q > 1$) and reducing economy ($I < 1$), so economy is coupling with eco-consumption. It happens only in the war time or great depression period of economy.



Decoupling of economy from eco-consumption

- Better situation are greater I , smaller Q , and greater $EFEG$
- B1 is the best situation among the 9 categories, and the closer B1 being to y axis, the better situation of SD is
- E is the worst of all the 9 categories and the closer E being to x axis, the worse situation of SD is
- If the current state of SD is E, measures should be taken to transform it to B1. And there are mainly 2 routes:
 - E-D-C-B1, reducing eco-consumption before improving economy
 - E-F-A-B1, improving economy before reducing eco-consumption

Comparison of $EFEG_R$ in China and the USA

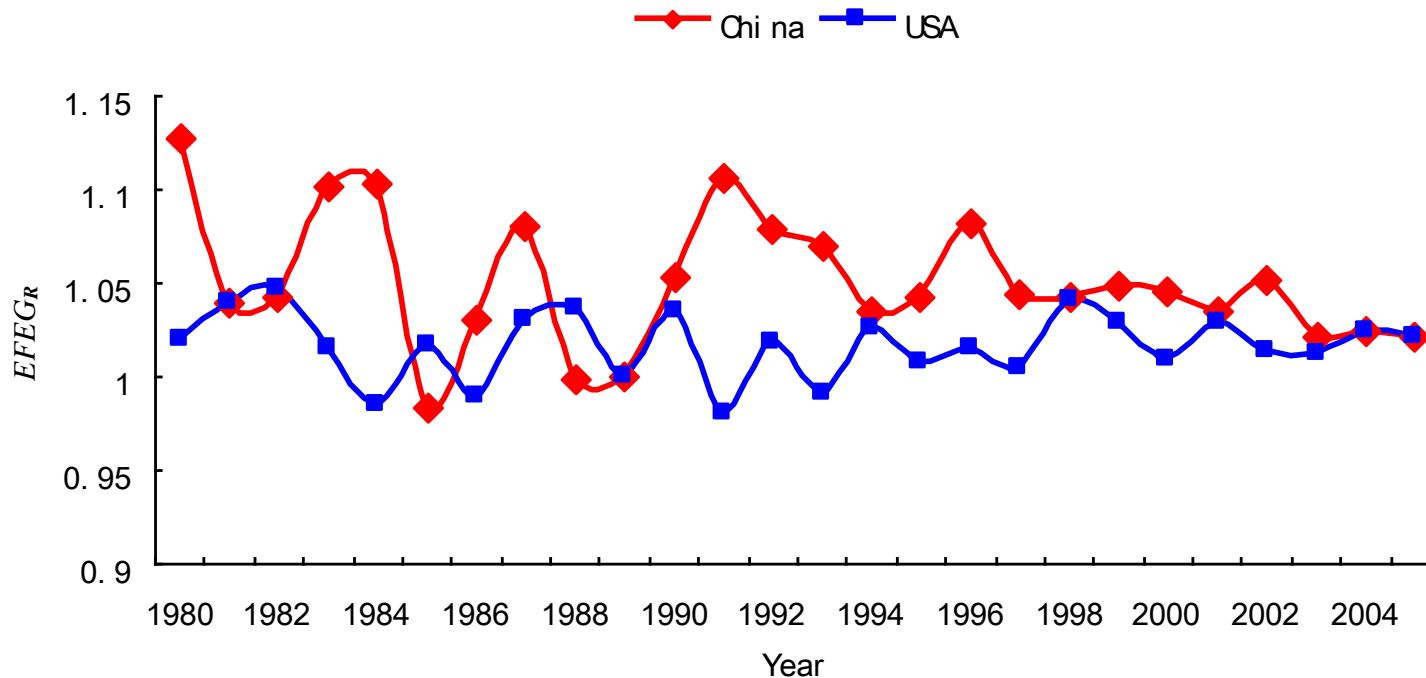


Figure 3. $EFEG_R$ in China and the USA in 1981-2006

1981–2006

China $EFEG_R$ average: 1.0496; Factor X of Resource: 3.5208

USA $EFEG_R$ average: 1.0166; Factor X of Resource: 1.5356

Comparison of $EFEG_E$ in China and the USA

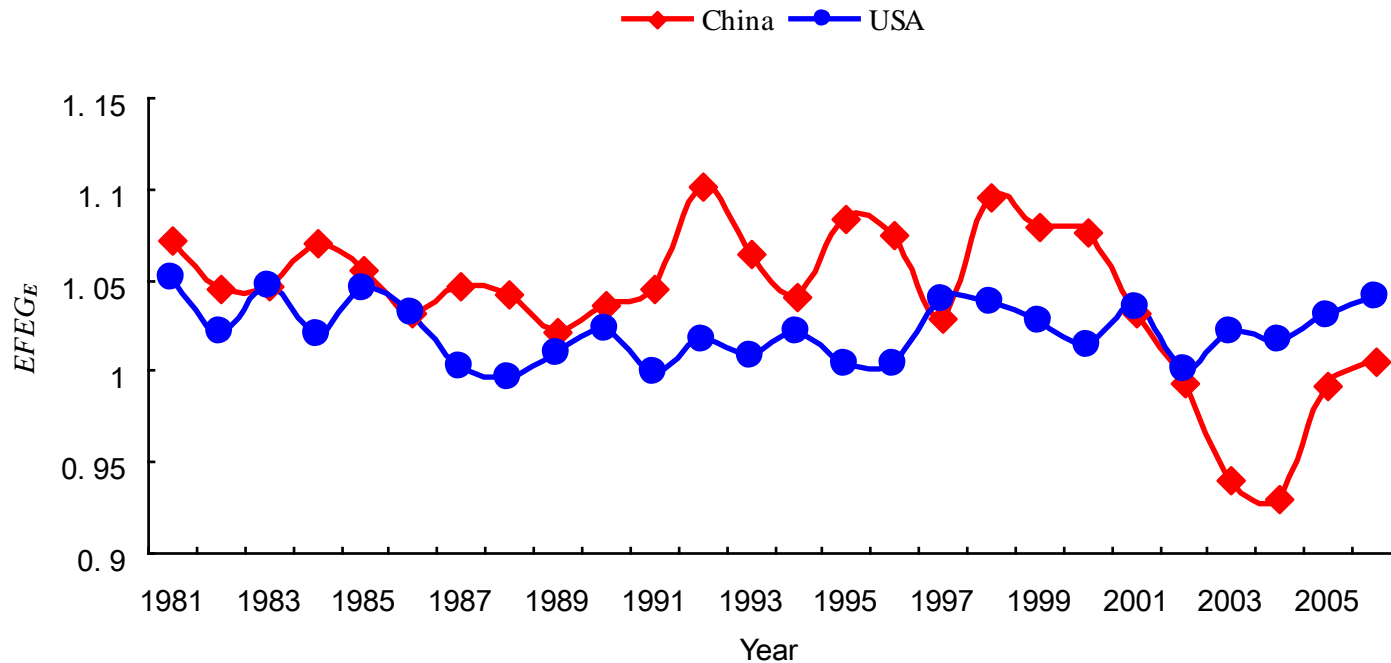


Figure 3. $EFEG_E$ in China and the USA in 1981-2006

1981–2006

China $EFEG_E$ average: 1.0393; Factor X of Energy: 2.7271

USA $EFEG_E$ average: 1.0213; Factor X of Energy: 1.7302



- It is regular that *EFEG* Performance in China was better than that of the USA because:
 - *EFEG* is a relative indicator of SD and reflects only the change trend between economy and eco-consumption
 - China is a developing country which had stepped into the period of fast development since 1978, its economic growth rate was much greater than the USA, and the *EFEG* performance in China deserves greater on advantage of later comers, such as utilizing cheap labor costs at home and the modern technology and management abroad
- When it comes to the absolute indicators (GDP, per capital GDP, energy consumption per unit of GDP, etc.), the USA was much better
- China should employ much stricter constraints on economic development in the future and so the *EFEG* would be greater to achieve a desirable level of economic growth under the tremendous pressure of resources, energy and environment



- *EFEG* is easy to operate for monitoring the trend of National SD
- *EFEG* is simple but useful for decision making by government
- China *EFEG* performance is between the Alarm Line and the National Standard Line during the reform and opening-up period
- *EFEG* in China was declining recently due to the acceleration of heavy chemical industry
- The economy was coupling with eco-consumption in China during the reform and opening-up period
- China *EFEG* performance is better than that of the USA



Thanks for your attention!