Economic Growth and Energy Efficiency

Yunchang Jeffrey Bor*

Overview

The relationship between economic growth and energy efficiency is a big but vague question in energy economics. For global study, it concerns the divide between rich and poor countries, the trade-off between raising human living standards and undermining the environment, the tensions associated with energy security and national defense. Above all, it is one of the key issues driving the global warming problem. The present paper builds up a global panel database and uses multi-level decomposition methodology as well as panel-data regression to discover the fundamental relationship between economic growth and energy efficiency.

Methods

The present paper builds up a global panel database and uses multi-level decomposition methodology[1] as well as panel-data regression to discover the fundamental relationship between economic growth and energy efficiency.

Results

Based on the Global Economic Energy Efficiency Index (EEEI), the global economic energy efficiency in 2009 has improved 6.03% in total compared to the base year of 2005. There are 85 countries that have made a positive contribution to the world's economic energy efficiency and 44 countries that have had a negative effect on the world's economic energy efficiency.

The present EEEI ranking contains 129 of the world's countries. The final energy consumption comes from Energy Balance, published by the International Energy Agency (IEA). The real gross domestic product is derived from the Value-added Statistics of the United Nations Statistics Division (UNSD). The top ten countries contributing to the recent world energy efficiency improvement are: the United States, China, Russia, Germany, Ukraine, Spain, the Republic of Korea, the United Kingdom, France, and Uzbekistan. The main contribution to the improvement in EEEI in the United States and Russia comes from the transportation sector. Although the energy demand in China is very strong due to economic development, the growth rate of real GDP is even more rapid than the growth rate of energy consumption. This leads to the positive result for EEEI in China. As for Taiwan, it is ranked in 16th position (down 4 places compared to 2008).

India has a huge population and its economic development is surging. However, the growth of energy consumption is too fast (especially the use of coal) to be outpaced by economic growth. The EEEI for India is the worst in the world in 2009 and the major cause is the inefficiency of energy use in the agricultural and service sectors. Another bad example is the United Arab Emirates. Although the United Arab Emirates enjoys a huge oil-dollar benefit by exporting crude oil, the wastage and poor performance of energy use in the manufacturing sector makes its EEEI the second worst in the world.

According to the International Monetary Fund (IMF), there are 34 countries that are in the category of Advanced Economies (AE). Therefore, the remaining 95 countries in the present report all belong to the category of Emerging and Developing Economies (EDE). However, due to the global shortage of fossil energy, most of the countries are highly focused on improving energy efficiency. Based on the multi-level decomposition methodology in EEEI (Bor 2008), the AEs have made considerable efforts in

* Head and professor, Department of Economics, Chinese Culture University, Taipei, Taiwan; email：byc2@faculty.pccu.edu.tw；Tel: +886-955-120228

[1] Please refer to Bor, Y.J. (2008). "Consistent Multi-level Energy Efficiency Indicators and their Policy Implications." Energy Economics 30: 2401-2419 for the notation. The base year of the EEEI is 2005 and the latest global updated data is 2009.

improving energy efficiency by 3.37% since the Kyoto Protocol came into effect on February 16, 2005. On the other hand, energy efficiency also improved up by 2.65% for EDEs, which is also a remarkable outcome in 2009.

Parallel with the classification of IMF, there are six regions for EDE which are: the Commonwealth of Independent States, Developing Asia, Central and Eastern Europe, Sub-Saharan Africa, Latin America and the Caribbean, and the Middle East and North Africa. By EEEI in 2009, the performances in terms of economic energy efficiency were: 1.22% for the Commonwealth of Independent States, 1.14% for Developing Asia, 0.29% for Central and Eastern Europe, 0.16% for Sub-Saharan Africa, 0.04% for Latin America and the Caribbean, and -0.20% for the Middle East and North Africa.

Among the regions in terms of EDE, the most notable countries are China, Russia, and the Ukraine. The energy resources, especially for coal, natural gas, and oil resources, are abundant in these countries. The populations of China (about 1.35 billion) and Russia (about 0.14 billion) are also very large in the world. However, the performances in terms of economic energy efficiency of these countries are unique and impressive. The contribution of EEEI for China is 1.33%, ranking it second in the world in 2009. The improvement of economic energy efficiency in China is mostly from the industrial sector. The contribution of EEEI for Russia is 0.53%, ranking it third in 2009. The services sector is the main reason for Russia's improvement. The contribution of EEEI for the Ukraine is 0.27%, ranking it fifth in the world. Both the industrial and service sectors account for the contribution. The world center of gravity for recent progress on energy efficiency has gradually moved to Developing Asia and the Commonwealth of Independent States regions.

Conclusions

By using the global panel database of 129 countries from 1996-2009, a panel-data regression model has been assembled to discover the relationship between the change rates of energy efficiency and change rates of real economic growth. Before carrying out the regression analysis, the data was divided into two groups, AE and EDE, by assigning a dummy variable. The dummy variable D = 0, is the AE, and D = 1 is the EDE. Outlier data has been ruled out if either the dependent variable (change rate of energy efficiency) or the independent variable (change rate of real economic growth) is out of range of four standard errors. It is shown that the best regression model is:

$$EIR = -0.5906GDPR + 1.3082D + 0.1311GDPR * D \quad (1)$$

$$\begin{cases} D = 0 : Y_A = -0.5906GDPR \\ D = 1 : Y_D = 1.3082 - 0.4595GDPR \end{cases} \quad (2)$$

From the above panel-data regression model, the major findings are: the relationship between economic growth and energy efficiency is negative. Economic growth does, basically, drive the improvement of energy efficiency, which is an optimistic sign for matters related to control of global greenhouse gases. The negative relationship is stronger for the AE group than the negative relationship in EDE group. The AE model shows that the regression model is an original model, which means that the intercept is zero. It may be interpreted that AE must pursue economic growth and energy efficiency in tandem. This result of "no economic growth, then no energy efficiency," and vice versa, shows that the energy conservation policy is a no-regrets policy. On the other hand, the intercept of EDE is a positive number of 1.3082. This result may represent that there exists a survival threshold in EDEs. They definitely need aid from AEs to help them to go through the basic process of economic development.