INTERFUEL RELATIONSHIPS OF A DEVELOPING AND DEVELOPED COUNTRY: KOREA VS. JAPAN

Jihyo Kim, Seoul National University, +82-2-880-8284, frogpri1@snu.ac.kr
Eunnyeong Heo, Seoul National University, +82-2-880-8284, heoe@snu.ac.kr

Overview

The issue of reducing carbon emission while maintaining the economic growth has been important because of the climate change. Interfuel substitution can contribute to reduce carbon emission by increasing use of low-carbon fuel while decreasing use of the opposite one. It is likely that a developed country has established more appropriate interfuel relationships than a developing country because the share of expensive low-carbon energy such as natural gas or electricity is relatively high in a developed country. Also, a developing country which has experienced a sudden industrialization accompanied by rapid increase in energy consumption may alter the structure of domestic energy markets, which eventually induces the change in the interfuel relationships (Cho et al., 2004). Thus, there is a chance that interfuel relationships more fluctuate in a developing country than a developed country. This paper investigates interfuel substitution in the industrial sector using the time series data of South Korea and Japan in the last three decades. South Korea and Japan is a representative developing and developed country in Asia, respectively. It allows us to test whether interfuel relationship in a developed country is more carbon-reducible and stable than in a developing country.

In general, an energy cost function of which independent variables consist of the prices of oil, coal, natural gas, and electricity is analyzed to examine interfuel relationships. Considering relatively high volatility of fuel prices, a dynamic model adjusting fuel demand to price change is more frequently used rather than a static model. Thus, we adopt the dynamic linear logit model suggested by Considine and Mount (1984). Also, previous studies (Considine and Mount, 1984; Jones, 1995; Urga and Walters, 2003; Serletis et al., 2010) analyzed interfuel relationships using a specification of an energy cost function. However, Considine and Mount (1984), Jones (1995), and Urga and Walters (2003) analyzed only U. S. industrial energy demand. Meanwhile, Serletis et al. (2010) tried to conduct international comparison but they did not focus on the issue of developing/developed country. Our study is differentiated from them viewed from that we are focused on the issue of developing/developed country in Asia. Also, the comparison of interfuel relationships in Korea and that of Japan can carry significance because they are not only similar in their industrial structures and but also role models of other developing countries.

The remainder of this paper is organized as follows: the second section introduces the data, model, and econometric methodology used in this study; the third section discusses the answers of two research topics, followed by the fourth section deriving policy implications.

Methods

The dynamic linear logit models (Considine and Mount, 1984; Urga and Walters, 2003) applied to estimate interfuel substitution for the industrial sectors in Korea and Japan from 1988 to 2009(T=32). The data including price and quantity indices of oil (o), coal (c), natural gas (g), and electricity (e) are needed to estimate this model. The aggregate quantity index of individual fuels are calculated from the data in *Extended Energy Balances* series (IEA, 2011a). Individual fuel prices indices come from the Energy Prices and Taxes (IEA, 1999, 2011b). The logistic approximation of a set of n non-homothetic cost shares (S_{it}) with non-neutral technical change is given by:

$$S_{it} = \exp(f_{it}) / \sum_{j=1}^{n} \exp(f_{jt}), \qquad i = o, c, g, e$$

$$\text{where } f_{it} = \beta_i + \sum_{j=1}^{n} \beta_{ij} \ln w_{jt} + \beta_{iy} \ln y_t + \beta_{it} t + \lambda \ln x_{it-1} + \varepsilon_{it} .$$

w_{it}, y_t, and x_{it} denote the price for the *i*-th input factor, output level, and input quantity in period t. Also, a time trend t reflects non-neutral technical change and the partial adjustment parameter λ does the dynamic optimization process.

The above logarithmic share equations yield a set of well-behaved neoclassical demand equations if the following parameter restrictions are imposed: symmetry, adding-up and homogeneity in prices (Diewert, 1971). The estimation is performed in TSP 5.1/OxMetrics using the SUR procedure implementing the iterative Zellner estimation. Based on the coefficient estimates, the Allen-Uzawa elasticities of substitution (AES) are calculated for identification of the interfuel substitution.

Results

First, the AES calculation results show that Japan has established more carbon-reducible interfuel relationships than Korea but the differences in absolute values of AES are quite small. In particular, the substitution from fossil fuel to electricity has been observed in Korea as well as Japan.

Second, from the time series of AES, interfuel relationships of Korea have been experienced frequent changes comparing those of Japan. This result supports our hypothesis that a developed country has more stable interfuel relationships than a developing country.

Conclusions

This study firstly conducts a comparison of Japan and Korea, focusing on the interfuel relationships of industrial sector. This approach enables us to analyze the two hypotheses mentioned in the first section on energy use in a developed and developing countries. Our results clearly suggest that a developed country is more stable than a developed country in interfuel relationships. However, when it comes to carbon-reducible interfuel relationships, the results are ambiguous to analyze. Because the Korean government have tried to maintain relatively low price of electricity, it is supposed that Both Korea and Japan have shown the same tendency that substitution between electricity and other fossil fuels.

Acknowledgement

This work was supported by the New and Renewable Energy Program of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government Ministry of Knowledge Economy (No. 20093021020020).

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