Price Elasticity of Energy Demand in Energy-intensive Sector -Comparative Study of Japan, Korea and China

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Overview

At the Pittsburgh G20 Summit in 2009, the Energy subsidy was one of the main topics. Energy price is highly subsidized especially in developing countries, and this is the reason why the domestic energy price in developing countries is much lower than developed countries. The low energy cost can be negative incentive for energy conservation, and the impacts of subsidy reform highly depend on price elasticity.

Although a large body of research on the price elasticity already exists, the elasticity estimates have wide range of results. And there is no consensus about the price elasticity value especially for developing countries. The two problems which most commonly noted in connection with estimating the price elasticity of energy demand are the asymmetry of price elasticity and the non-linearity of energy demand trend (Adeyami (2010)).

The main object of this study is to get more robust estimates of price elasticity of energy demand in energy intensive sector of developing nations. In the following, we analyse for energy intensive industrial sectors in Japan, Korea and China taking into account of the above mentioned problems. And we will get some implications about the effectiveness of price reform on the energy conservation in developing nations.

Methods

Coping with the asymmetry of price elasticity, we use a price variable which is divided into two parts (upturn and downturn) suggested by Haas(1998). In order to capture the non-linear energy demand trend, we employ state-space model with Kalman-filter proposed by Hunt et al. (2003) in which the underlying energy demand trend is estimated as an unknown parameter.

Our estimation model is comprised of an observation equation that specifies an energy demand function with income, price, and trend as explanatory variables, and transition equations which specify the trend and the parameter changes over time. In the following, e is energy demand, X is real output, p is aggregated energy price of each sector, p^{inc} is cumulative rate of price increase and p^{dec} is cumulative rate of price decrease, μ is the unknown trend and ε is disturbance. Both prices are deflated by GDP deflator, and satisfying the following equation

$$p_t = p_t^{inc} \times p_t^{dec} \quad (1)$$

Observation equation: Energy demand

$$\ln e_t = \mu_t + \alpha_t \ln X_t + \beta_t \ln p_t^{inc} + \gamma_t \ln p_t^{dec} + \varphi_t \ln e_{t-1} + \varepsilon_t \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \quad (2)$$

Transition equation

Trend level $\mu_t = \mu_{t-1} + \lambda_t + \eta_t \quad \eta_t \sim N(0, \sigma_\eta^2)$ (3)

Trend slope $\lambda_t = \lambda_{t-1} + \rho_t \quad \rho_t \sim N(0, \sigma_\rho^2)$ (4)

In the following equation (5), α is modeled as a time-varying parameter. β , γ and φ are also modeled as the same specification.

$$\alpha_t = \alpha_{t-1} + \tau_t \quad \tau_t \sim N(0, \sigma_\tau^2) \quad (5)$$

We use IEA energy balance data, IEA Energy Prices and Taxes data, and each country's statistics of energy and economics.

Results

Table 1. shows the estimation results of long-term price and income elasticity in the view of countries and industry sectors. The price elasticity in the period of price rise (upturn price elasticity) is greater than that in the period of price fall (downturn price elasticity) in most of countries/sectors. This result is consistent with the previous studies such as Haas et al.(1998) and Hoshino(2013). Two exceptions are Korean iron and steel industry and chemical industry. Except for the paper and pulp industry, the price elasticity of China is the highest among these

three countries. In iron and steel, chemical and non-metallic mineral industries, the long-term upturn price elasticities of China are almost three to ten times larger than those of Japan.

Figure 1. shows long-term income elasticity in each countriy and sector. Except for Chinese iron & steel and Korean non-metallic mineral industry, the long-term income elasticities of both countries are about one-third of those in Japan. The smaller income elasticity of energy demand means that there is a large scale effect of production size regarding to the energy input.

Table1. Long-term price elasticity of four energy-intensive industry sectors

Price Elasticities (Long-term)				
	Iron and steel		Chemical	
	Upturn	Downturn	Upturn	Downturn
Japan	−0.10	−0.04	−0.51	−0.19
Korea		−0.10	−0.06	−0.44
China	−1.18	−0.14	−1.67	−1.51
	Paper and Pulp		Non-metallic minerals	
	Upturn	Downturn	Upturn	Downturn
Japan	−0.44	−0.39	−0.16	−0.09
Korea	−0.28	−0.01	−0.47	−0.05
China	−0.31	−0.09	−0.62	−0.11

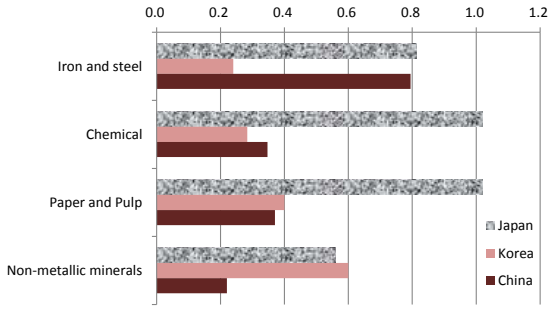

Figure 1. Long-term income elasticity of four energy-intensive industry sectors

Conclusions

The aim of this study is to get more reliable estimates of price elasticity of energy demand in energy intensive sector of developing nations and to get some implications about the effectiveness of price reform for the energy conservation in developing nations.

We found that the estimated price elasticity is asymmetric between the period of price rise and fall, and price elasticity in the period of price rise (upturn price elasticity) is larger than that in the period of price fall (downturn price elasticity) with a few exceptions. This result is consistent with the previous study such as Haas (1998) and Hoshino (2013) which targeted to developed nations.

The Chinese upturn price elasticity is the largest among the three countries. This means that the energy price will play an important role for energy conservation purposes, and price adjustment through a subsidy reform can be one of the effective policies in Chinese industrial sector.

As for the income elasticity, the long-term income elasticities of Korea and China are much smaller than Japan with two exceptions such as Chinese iron and steel industry and Korean non-metallic mineral industry. This implies that in the energy intensive sector of China and Korea, they have a large potential of decreasing the energy intensity along with the industry's production expansions

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