Evaluating Inter-Fuel Substitution in Reducing Carbon Dioxide Emissions of Asian Countries

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Overview

Interfuel substitution refers to the replacement of inefficient and polluting fuel with a cleaner fuel. The three fossil fuels commonly used are oil, gas and coal. Due to its low extraction cost, coal is the most widely used fossil fuel but emits higher levels of GHG compared to oil or natural gas.

Interfuel substitution as a climate change mitigation strategy has been proven in the literature to be a feasible approach. In general the estimated elasticities of substitution shows that coal can be replaced with oil or gas. However, there is a gap in the literature looking at energy demand and interfuel substitution in developing countries. Most of the research are concentrated in China while in other Asian countries interfuel substitution has not been studied adequately. Aside from China this paper will study interfuel substitution in Japan, Korea, Indonesia, Singapore, Malaysia, Thailand and the Philippines. Moreover, even though most of the empirical results point to possible interfuel substitution the literature stop short of examinng its potential to reduce carbon dioxide emissions. In this paper the estimated elasticities of substitution are used to compute for the reduction of carbon dioxide as a dirty fuel is substituted with a clean fuel.

It is hypothesized that interfuel substitution can reduce carbon dioxide emissions in Asia. Energy demand in Asia is set to increase due to rising population, income and changing lifestyles. By switching from coal which is a dirty fuel to oil or gas which have lower carbon emissions the environment will not be sacrificed for development.

Methods

A translog production function was adopted to analyze the relationships between capital, labor, oil consumption, gas consumption and coal consumption among the selected Asian countries. It has the following general functional form:

$$lnY_t = ln\alpha_0 + \sum_i \alpha_i \, lnX_{it} + \frac{1}{2}\sum_i \sum_j \alpha_{ij} \, lnX_{it} lnX_{jt}$$

Where Y_t refers to output at time t, α_0 denotes technical knowledge, X_{it} and X_{jt} denote the levels of inputs *i* and *j* at time *t*, and α_i and α_{ij} are the parameters.

The estimation technique was a ridge regression which gives more robust results compared to OLS regression in light of multicollinearity problems in the model. In order to estimate the environmental effects of switching from one fuel to another the quantity of carbon dioxide emitted by each fuel is determined. Using the substitution elasticities a scenario analysis of fuel switching is established in which the change in the fuel price is determined to trigger interfuel substitution and the corresponding reduction or increase in carbon emissions.

Results

In general, the output elasticity of the energy sources in the selected Asian countries are low. This shows that the output responsiveness to changes in fossil fuels is inelastic. A change in the amount of fuel used will not translate into a substantial change in output. The substitution elasticity between all factors were found to be positive and high. Thus, all the factors are substitutes.

The results of the environmental impact analysis show that substituting oil or gas for coal does not always result in reduction of carbon dioxide emissions. In Indonesia and Thailand, for instance, increasing oil consumption at the expense of coal actually worsens pollution. Similarly, the switch from coal to gas in Malaysia exacerbates carbon dioxide emissions. The reason for this is that switching from coal to a country's dominant energy source contributes to the latter's propensity to pollute. The dominant fuel in the energy mix of Thailand and Indonesia is oil while in Malaysia, it is gas.

Conclusions

The heavy reliance on imported fuel combined with inefficient energy regulations such as subsidies have encouraged the inefficient usage of fossil fuels in ASEAN. The countries which subsidise fossil fuel use are Indonesia, Malaysia, Thailand, Vietnam, Brunei Darussalam and Myanmar. The low energy prices provided by subsidies discouraged consumers and industry to use appliances and equipment which are more energy efficient. Moreover, the bias toward fossil fuels dampened investments in energy efficient technologies and the deployment of renewable energy.

For an interfuel substitution strategy to contribute to mitigating emissions of carbon dioxide it is important to chose carefully what fuel to substitute with. If the wrong fuel is used then it will exacerbate emissions and leave the environment worse off than before the fuel substitution policy.

Climate change is caused by the accumulation of carbon emissions in the atmosphere over time. Government energy subsidies distort prices and encourage excessive use of energy leading to greater emissions. Therefore, to reduce emissions subsidies must be removed so prices can reflect the true demand for energy and promote the right usage of fossil fuel.

References:

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