A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS OF CO_2 REGULATION AND NUCLEAR PHASE-OUT POLICY IN JAPAN

Shiro Takeda, Kyoto Sangyo University, Phone: +81-(0)75-705-1599+, email: shiro.takeda@gmail.com
Toshi H. Arimura, Waseda University, email: toshi.arimura@gmail.com
Masato Yamazaki, Nagoya Univeristy, email: yamazaki.masato@nagoya-u.jp

Overview

After the Great East Japan earthquake in 2011, energy has been a very important policy issue in Japan and it is often discussed in terms of 3E+S (energy security, economic efficiency, environment and safety). Japan imports almost all fossil fuels and this threatens energy security in Japan. However, the shift from fossil fuels to renewable energy, which is self-sufficient, raises energy costs and generates additional burden on households and firms. In addition, Japan as a developed country must take the initiative to reduce GHG emissions and the nuclear power was an important option for GHG reduction. However, the nuclear accident in Fukushima makes it difficult to depend on nuclear power.

The current Japanese government plans to use a certain amount of nuclear energy in the future. However, many people in Japan oppose use of nuclear power, for example, 60% of Japanese oppose restart of nuclear power plants (Nikkei, Feb. 29, 2016). Reflecting this, the Japanese gov. has promoted renewable energy since 2011 and started feed-in tariff policy for renewable energy in 2012.

In Japan, there is an on-going debate over GHG reduction target, the use of nuclear power and the renewable energy policy promotion. To discuss the desirable policies, we need information about their impacts on economic activity. So the purpose of this study is to quantitatively examine the impacts of CO2 regulation, nuclear reduction and renewable energy promotion on Japanese economy. In particular, we analyze their impacts on macroeconomic variables (GDP, income etc.), electricity sector and various production sectors.

Methods

To evaluate the impacts of CO2 regulation, nuclear reduction and renewable energy promotion on Japanese economy, we use a computable general equilibrium model. Our model is a recursive dynamic model with the time span from 2010 to 2030. The model includes 48 goods and 42 sectors. We highly disaggregate energy goods and sectors. For example, our model considers 15 energy goods and 5 electricity sectors (fossil fuel, hydro, nuclear, solar and wind). When we consider renewable energy, its cost is likely to play an important role. To incorporate renewable energy into our model, we use cost information estimated by the Power Generation Cost Analysis Working Group organized under the government.

We first derive the reference equilibrium (BAU) and then solve nuclear phase-out (NPO) scenario, CO2 reduction scenario, and the combination of NPO and CO2 reduction and compare equilibria with the reference scenario. Scenarios are listed in the following table.

Table 1: Scenarios

Scenario	Explanation
BAU	Reference scenario
NPO_A	Nuclear phase out (50% reduction)
NPO_B	Nuclear phase out (90% reduction)
CO2R	CO2 reduction (25% reduction from 2005 level)
CO2R_L	CO2 reduction (10% reduction)
CO2R_S	CO2 reduction (40% reduction)
NPO_A_CO2R	NPO_A+ CO2R
NPO_B_CO2R	NPO_B+ CO2R
FIT_LOW	Low subsidy rates for renewable energy
FIT_HIGH	High subsidy rates for renewable energy

Results

Macroeconomic impacts are summarized in Table 2. In NPO scenarios, there is no change in CO2 emissions. This is because NPO makes fossil fuel power increase but there is a cap on CO2 emissions. In NPO_B, GDP decreases by 1.0%. In scenarios with CO2 regulation (CO2R), we have high permit price and CO2 emissions decrease significantly. The size of the decrease in GDP and income is larger than NPO scenarios. In scenario NPO + CO2R, the decrease in GDP and real income is amplified.

NPO and CO2 regulations have similar impacts on individual sectors. That is, both of them lead to the large decrease in output of energy intensive manufacturing sectors and transport sectors and the small decrease in output of low CO2 intensity sectors. But they have different impacts on energy sectors.

Table 2: Macroeconomic variables (% change from BAU value, 2030)

	NPO_A	NPO_B	CO2R	CO2R_L	CO2R_S	NPO_A_ CO2R	NPO_B_ CO2R
CO2 emissions	0	0	-25	-10	-40	-25	-25
Permit price (1000yen/ton)	5.1	8.7	24.6	7.6	65.5	34.6	45.4
Real income	-0.7	-1.5	-2.8	-0.7	-7.0	-4.2	-5.9
GDP	-0.5	-1.0	-1.9	-0.5	-4.6	-2.8	-3.8
Consumption	-0.7	-1.5	-2.8	-0.7	-7.0	-4.2	-5.9
Investment	-0.3	-0.8	-1.7	-0.4	-5.0	-2.8	-4.1
Export	-1.4	-2.8	-6.6	-2.6	-10.7	-8	-9.2
Import	-1.5	-2.9	-7	-2.8	-11.4	-8.5	-9.8
Labor supply	-0.4	-0.9	-1.7	-0.4	-4.5	-2.6	-3.7
Leisure	0.6	1.3	2.6	0.7	6.9	4	5.7

Conclusions

Japan is facing the need to reduce both CO2 emissions and nuclear power generation but our analysis shows that pursuing NPO and CO2 regulation simultaneously is likely to generate large loss for the economy. To reduce the burden on the economy, we need to design efficient CO2 regulations.

References

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