[*ENERGY MIX AND SOCIAL WELFARE: EVIDENCE FROM SOUTH KOREA*]

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Overview

This article examines the effects of the energy mix on social welfare under a dynamic general equilibrium framework in South Korea. To assess the social welfare effects, we focus on the energy mix as an energy policy target and incorporate two factors, energy price and nuclear disaster, into the model. The results suggest that the increase in the proportion of nuclear energy in the energy mix promotes social welfare in the long run because the positive effect of the cost-efficiency from nuclear energy use outweighs the negative effect of a higher risk of nuclear disaster on social welfare. We also find that the rise in energy policy uncertainty decreases output and consumption through delaying investment.

Methods

Our model builds on a series of energy augmented real business cycle models which include a single type of energy into the utility and production function. The baseline model economy consists of a representative economic agent that makes every decision related to energy and non-energy consumption, savings and leisure subject to technical and budget constraints. In addition, the price of energy is modeled as an exogenous random process. Energy is explicitly modeled in the household's utility function.

The representative household's utility consists of three resources: non-energy consumption (c_t), energy consumption (e_t), and leisure ($1 - l_t$), $u(t) = \phi \log[\theta c_t^{\rho} + (1 - \theta)e_t^{\rho}]^{1/\rho} + (1 - \phi) \log(1 - l_t)$ where ϕ represents the share of consumption in the household's utility; θ is the share of non-energy consumption in the aggregate consumption; and $1/(1 - \rho)$ indicates the elasticity of substitution between energy and non-energy consumption.

we extend the baseline economy as follows: 1) We consider various sources such as nuclear power, renewable energy, LNG and coal as components of the energy mix. The price of multiple energy sources are converted to a composite price weighted by energy mix; 2) As the proxy for energy policy, the proportion of each energy source in the energy mix is modeled as an exogenous process, allowing for a time-varying volatility which indicates the policy uncertainty; and 3) Damage caused by disaster is also included as the potentialcosts of nuclear energy.

Results

Energy policy: To evaluate the impacts of energy policy on economic activities, we exploit the dynamic impulse response of key economic variables to energy policy shock. Since each administration emphasizes different energy sources, we compare the macroeconomic impact of the energy policy under two administrations. We determine the magnitude of energy policy shock according to the difference between each administration's energy mix target and current energy mix in 2017. The impulse response functions (IRFs) of key economic variables in Figure 1 explain the transmission channel through which phasing out nuclear energy negatively affects economic activities. The Moon's energy policy places an emphasis on the replacement of nuclear energy with renewable energy. Generally, the cost of renewable energy is higher compared to nuclear energy. Therefore, the Moon's policy will increase the composite energy price (E). Due to the substitution effect, increased composite energy prices reduce household's and firm's energy consumption (F, G). A lower energy input for production decreases the optimal level of capital and labor, thus investment decreases (H, I). Reduction in production factors (such as capital, labor and energy) decreases output (J), and consumption is also decreased due to the income effect (K). Consequently, lower expected consumption decreases the real interest rate (L). The Park's policy, emphasizing an increase in the proportion of nuclear energy in the energy mix, decreases the composite energy price, consequently having the opposite impact on each variable. Therefore, in the short to medium run a higher proportion of nuclear energy has a positive impact on output and consumption due to a decrease in the energy price, which in turn affects social welfare positively.

Disaster probability: To figure out the transmission mechanism of nuclear disaster on economic activities, we refer to the IRFs of key economic variables to disaster probability shock. Conservatively, we set the magnitude of disaster probability shock as equal to the steady-state disaster probability, i.e., we examine the reaction of the economy when doubling the disaster probability. Figure 2 shows that disaster disrupts productivity, accumulated capital stocks, and energy consumption and production, which is in line with the literature. The positive shock on disaster probability negatively affects productivity (A, B). For precautionary purposes, households consume less, work harder and delay their investment (C, D, E). Due to a decrease in investment and expected consumption, the capital and real interest rate decrease, respectively (F, G). The proportion of nuclear energy in the energy mix decreases, and, thus, the composite price increases (H, I). Therefore, households and firms consume less energy because of the substitution effect (J, K). Due to these lower production factors, the aggregate output levels decreases (L). Therefore, the nuclear disaster channel implies that in the short to the medium run a rise in the proportion of nuclear energy in the energy mix increases nuclear disaster damage to output and consumption, which in turn affects social welfare in a negative way.

Conclusions

We investigate the impacts of the energy mix on economic activities and social welfare within the DSGE framework in South Korea. A higher proportion of nuclear energy in the energy mix, while leading to an economy more efficient in terms of electricity generation, will also render the economic system more vulnerable to nuclear disaster. To evaluate the effects of the energy mix comprehensively, we consider two competing factors: cost-efficiency and disaster damage. The main finding is that the positive price channel clouds out the negative disaster damage channel: an increase in the proportion of nuclear energy increases consumption and output. When energy prices are at the 2015 level, a higher proportion of nuclear energy results in social welfare gain in the long run. We have shown that increasing the proportion of nuclear energy in the energy mix will fail to increase social welfare, if the price of renewable energy decreases by 66.7% or more. Should the price of renewable energy continue to decrease at the current trend, nuclear energy would lose its economic comparative advantage over renewable energy in 2052. Our research suggests that adhering to the Moon's energy mix target quadrupling the portion of renewable energy to 20% by 2030 and making the country nuclear-free by 2060 would bring about social welfare costs to society. Other than the case that a nuclear disaster happens at a probability of 33.7% or causes 28.7% damage to the capital accumulation, maintaining or increasing the proportion of nuclear energy still benefits society in terms of social welfare. Our findings underscore the importance of reducing legislative uncertainty. This in turn requires designing and implementing policy incentives that investors perceive as providing greater stability for promoting long-term investment. Beside cost-effectiveness and safety that are usually considered in the choice of the energy policy target, the stability of the policy itself should be added to the list to be explicitly considered. If policies lack long-term credibility or are surrounded by uncertainty, there is a risk that producers and investors will refrain from undertaking the necessary investments, so that the policy aims cannot be met at the lowest possible cost.

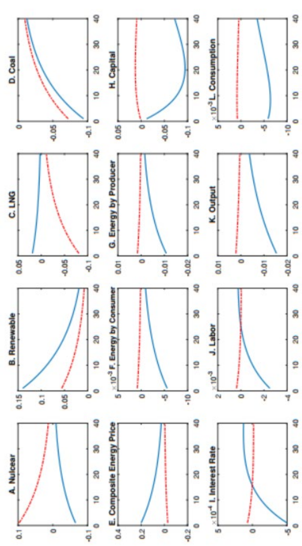

Figure 1: Impulse response to energy policy shock under different administrations. The dashed line denotes the Park administration, and the solid line denotes the Moon administration. The magnitude of policy shock is determined by the difference between each administration's energy mix target and the current energy mix.

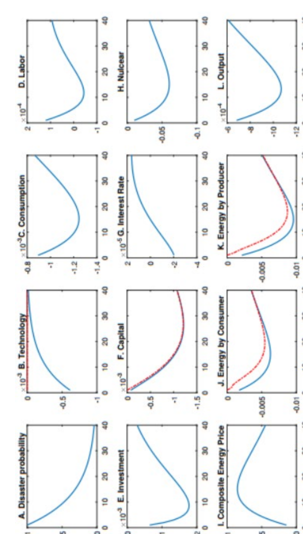

Figure 2: Impulse response to disaster probability shock: Solid lines indicate the remaining factors after a disaster. The dashed lines indicate the factors optimally chosen by an agent. Conservatively, we set the magnitude of disaster probability shock equal to the steady-state disaster probability ($\sigma_z = \bar{z}$ =1.70%), i.e., double the disaster probability.