Supply Chain Network Analysis of Carbon Tax in Japan

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The Japanese government is focusing on carbon pricing to achieve carbon neutrality. A carbon tax, one method of carbon pricing, puts a price on CO2 emissions, providing an incentive to reduce emissions. The Japanese government plans to introduce a carbon tax in 2028, targeting five domestic industries: Petroleum refinery products (i.e., crude oil wholesaler), Coal products (i.e., coal wholesaler), Electricity (i.e., power supply industry), Gas supply (i.e., city gas), and trading companies.

The tax amount is determined based on the CO2 emissions from fossil fuels imported by these industries. The carbon tax payment imposed on upstream industries will be passed on to downstream industries through supply chain networks, affecting middle and downstream industries that utilize products from upstream industries. Therefore, it is crucial to focus on the impact of the ripple effect on the economy and the environment. This study aims to identify how a carbon tax would influence the Japanese economy and the environment.

In this study, the effects of a carbon tax imposed on four industries: petroleum refinery products, coal products, electricity, and gas supply were analyzed. Firstly, we estimated the monetary and physical amounts of fossil fuels imported by each of the four industries using the detailed physical input-output table of 2015. Secondly, we calculated the amount of carbon dioxide potential directly emitted by the four industries using the carbon dioxide emission factor provided by the Ministry of the Environment of Japan. From the CO2 emission potential, the amount of carbon tax payment that would be imposed on the four industries was estimated.

As the carbon tax rate has not been determined in Japan, we assumed a carbon tax rate following the rates introduced in EU countries. To consider the ripple effect, we quantified the increase rate of 373 domestic products using both the input-output price model and the supply-chain network model based on the price model. Additionally, we identified the cost pathway of the ripple effect using Structural Path Analysis. Finally, we identified the potential reduction in CO2 emissions due to changes in final demand for each domestic product, considering the relationship between the price of the product and the demand for the product.

While many studies describe the advantages and disadvantages of carbon taxes, few of them identify the economic and environmental effects of a carbon tax in the complex supply chain. From a result based on the 2015 input-output tables of Japan, we found that the total Carbon Footprint of fossil fuels imported by the four industries including Petroleum refinery products, Coal products, Electricity, and Gas supply was about 926 Mt-CO2e. If a carbon tax of 2,890 JPY per ton of CO2 emissions (i.e., the least carbon tax rate in the EU countries) is applied to the four industries, a total carbon tax payment of 2,678 billion JPY would be imposed in Japan.

Furthermore, it is estimated that the average price in Japan would increase by 1.9% through supply chain networks, with â€œpig ironâ€• experiencing the highest price increase at 17%. In addition, we found that price increase rates in the supply chain groups would be particularly high around iron and steel industries including â€œpig iron,â€• â€œcrude steel (converter),â€• and chemical product industries including â€œbasic petrochemicals,â€• and â€œpetrochemical aromaticsâ€•. It is important for these industries to reduce CO2 emissions so that they can mitigate their own carbon tax burdens. Based on the results of this study, we suggest that the government should provide

financial support to improve energy efficiency within the supply chain groups identified in this study and determine the best way to operate a carbon tax.