

The Unit Structure Analysis of Energy Price Shock in Japan

Topic: Input-Output Analysis: Energy Policies - IV

Author: Aoi Tsukioka

Co-Authors: Shigemi KAGAWA, Sora Matsushima

Japan is poor in natural resources and relies on imported natural resources for domestic primary energy needs by over 95%, implying that Japan is seriously vulnerable to an increase in prices of imported energy resources. Primary energy prices of crude oil, coal, and natural gas have increased by 80 to 90% in Japan during the period between 2015 and 2022. Thus, the Japanese economy has clearly experienced a rapid increase in energy prices due to the global energy supply insecurity caused by the Russian aggression against Ukraine. It is important to note that the rapid energy price increase has a significant impact on the production cost of a wide variety of industries because they directly and indirectly use primary energy via product supply chains. An important research question is what are the most vulnerable industries or supply chains that have suffered from the recent energy price shock in Japan? In addressing this research question, we focused on cost pass-through describing that a business entity changes the price of goods and services in response to a change in the energy cost of producing them. To model the cost pass-through via product supply chains, we developed a novel cost-pushed unit structure approach that is capable of describing an adjacency matrix by weighting the energy cost increases embedded in transactions between sectors. We then applied a cluster analysis to the adjacency matrix to find supply chains (i.e., industry groups) with overconcentrated energy cost increases in the supply chain network. In Addition, we quantitatively clarified the effect of a surge in primary energy prices of crude oil, coal, and natural gas in 2022 using the Leontief input-output price model. Regarding the data for this study, we used the 2005, 2011, and 2015-linked input-output tables (IOTs) for Japan and estimated the IOTs in constant 2015 prices using the GRAS method. We also used the time series dataset for energy prices of imported crude oil, coal, and natural gas. From the results based on those data, we found that petroleum products contributed to over 50% of the increased cost pressure on the whole industry in Japan. We also found that more than 20% of the cost pressure from petroleum products was concentrated in the following three industries, namely, Chemical industry, Agriculture and fishery industry, and Transportation industry. Therefore, the supply chain paths from the Petroleum product industry to the three industries (i.e., Chemical industry, Agriculture and fishery industry, and Transportation industry) are vulnerable to higher energy prices and thus they should be the highest priority sectors to mitigate energy-related cost pressure on the whole Japanese industry. Furthermore, the industry cluster analysis clarified that a chemical-related cluster including "basic petrochemicals", "petrochemical aromatics", "thermoplastic resin", and "aliphatic intermediates" received the highest cost pressure via the supply chains. We suggest that industry clusters (i.e., stakeholders) with higher energy-related cost pressure identified in this study should improve energy efficiency as a group through supply chain engagement to ease the cost pressure. Policymakers should define priority on them and financially support higher priority clusters in energy efficiency improvements.