

Net emission transfer of toxic chemical substances: Empirical study for U.S. manufacturing industries

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The U.S. toxic release inventory (TRI) database has been prepared as an information to properly manage toxic chemicals since 1986. In Europe, a strict environmental regulation for toxic chemicals emission, -Restriction of Hazardous Substances Directive- has been started as since 2006 and the manufacturing sectors which export to Europe has been obligated to produce their products that do not contain toxic chemicals exceeding the environmental regulations. Thus the manufacturing sectors have tried to reduce the toxic chemicals technologically in the U.S., especially manufacturing firm exporting to European country.

Previous studies focused on how the strict chemicals regulation has affected productions of manufacturing sectors in the exporting countries (Fujii et al., 2011). The above studies are important in evaluating the role of the environmental regulation on trade and toxic chemicals emission, however it should be noted that the toxic chemicals emission is a result generated through the product supply-chains connecting consumers to producers and the emission sources are also wide. This study focuses on the U.S. toxic chemicals emission during 1998 to 2010. Our research question is how the toxic chemical emission has been affected by the changes in (1) scale of final demand, (2) production technologies in U.S. manufacturing sector, and (3) structure change of international trade patterns.

To clarify this question, we apply following two methods. Firstly, we estimated the U.S. toxic chemical substances emission and emission transfer from other countries to the U.S. by using environmentally-extended multi-regional input-output analysis model (Kagawa et al., 2015). Second method is log mean Divisia index (LMDI) approach to clarify the determinants factor of production technology change in U.S. manufacturing sectors (Fujii and Managi, 2013). We propose new decomposition research framework of production technology change using LMDI focusing on the four factors which are (1) cleaner production, (2) end of pipe, (3) transfer for offsite management, and (4) toxicity of emitted chemical substances.

This is the first study focusing on the induced effect of toxicity by chemical substances emission in production process. The induced effects of toxicity represent how manufacturing process is clean and low toxicity. Therefore, we can understand the effect of international chemical regulation into U.S. manufacturing process by change of induced toxicity. Additionally, we believe the research framework focusing both demand and supply side using multiple factor decomposition is unique. Therefore, the concept of induced toxicity effect and developed research framework are the novelty points of this study.

Toxic chemical emission data in U.S. manufacturing sector is observed from the TRI database published by U.S. EPA. We use about 600 chemical substances emission and each toxic chemical substances has different toxicity. To integrate their toxicity, we apply the risk-screening environmental indicators published by U.S. EPA. Additionally, international trade data is observed from world input output database (Timmer et al., 2015).

The major results are summarized as follows. Mining industry and paper and pulp industry increased induced toxicity due to production scale expansion. Surprisingly, wood, electric product, and transportation equipment industries had decreased induced toxicity more than 90% from 1998 to

2011. The main determinants factor of this rapid decline is decreasing of toxicity per production. From the production technology decomposition results, this factor decreased due to toxicity per emission amount, which imply three industries successfully reduced their induced toxicity by substitution of chemical substances. Additional, we found the China, India, and Brazil increased induced toxicity from 1998 to 2011. Meanwhile, many European countries decreased their induced toxicity. Further discussion related with international chemical regulation will be available at the conference.