Structural Decomposition Analysis of the Global CO2 Emissions

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論 文 内 容 の 要 旨

Global greenhouse gas emissions have increased continuously as nations have pursued economic growth. The average annual increase in greenhouse gas (GHG) emissions for the decade 2000 through 2010 is 2.2%. According to Assessment Report 5 of the Intergovernmental Panel for Climate Change (IPCC), CO_2 remains the major GHG, accounting for 76% of total GHG emissions. Changes in human population, per-capita gross domestic product (GDP), energy intensity of production, and CO_2 emission intensities of energy production have affected fossil fuel-related CO_2 emissions by +87, +103, −35, and −15%, respectively, over the 40-year period from 1970 to 2010. In addition to the empirical finding on the aggregated global CO_2 emissions, this thesis provides empirically examines the extent to which changes in the industrial structure of a specific country as well as changes in import structure and export structure have contributed to changes in production-based CO_2 emissions at industry level (i.e., territorial CO_2 emissions). This thesis further analyzes the contribution of the supply chain segments between material sector and service sector to consumption-based CO_2 emissions of a specific country. Based on the empirical results, this thesis finally argues how the structural changes of countries have contributed to the changes in the global CO_2 emissions. This thesis comprises five chapters.

Chapter 1 briefly provides research background, research objectives, and contributions of this thesis. This chapter illustrates the rapid increase in the global CO_2 emissions over time and points out an importance of reducing CO_2 that occupies a large portion of greenhouse gas emissions. This chapter also points out an urgent international cooperation to reduce CO_2 under the Paris agreement.

Chapter 2 conducts a review of relevant existing articles, identifies the contributions and problems of the existing research, and describes the significance and objectives of the present study.

Chapter 3 proposes a comprehensive decomposition method to estimate how changes in domestic economic scale, industrial composition, domestic technology, export scale of intermediate products, export composition of intermediate products, export scale of final products, export composition of final products, import scale of intermediate products, import composition of intermediate products, import scale of final products, import composition of final products, and foreign technology affect the volumes of both territorial CO_2 emissions (including emissions induced by producing exports) and extraterritorial CO_2 emissions induced by imports. Specifically, the sources of the territorial CO_2 emissions of each of 40 nations from

1995 to 2009 were examined using the Environmentally Extended World Input–Output Tables in 2009 prices. The results on industrial composition effects of countries show that, in contrast to the high-income nations, the middle-income nations heavily industrialized, and the resulting increase in emissions (+111 Mt CO_2) due to industrialization in the middle-income nations exceeded the reduction in emissions (−47 Mt CO_2) due to deindustrialization of the high-income nations. Ultimately, the combined effect in the industrial compositions in both income groups was positive and the structural changes contributed to increasing CO_2 emissions. The results also show that the export composition effect was negligibly small in both the high-income and middle-income group of countries during 1995–2008 and it has not played an important role in climate change.

Chapter 4 focuses on the effects of changes in material and energy input structure on the consumption-based CO_2 emissions. Previous studies demonstrated the connection between domestic structural changes including the shift toward a service economy and the increase in greenhouse gas (GHG) emissions embodied in final demand of a specific country. This chapter is an important follow-up research that examines the environmental effects across countries and evaluates whether or not the development levels of countries can explain those environmental effects. Specifically, this chapter employed a multiplicative structural decomposition analysis based on the World Input-Output Database (WIOD) during 1995 to 2008 and decomposed consumption-based CO_2 emissions of 40 nations into the following four inducement sources: (i) inputs from material goods (including energy) to material goods, (ii) inputs from material goods to services, (iii) inputs from services to material goods, and (iv) inputs from services to services. The results show that the global average of the CO_2 multiplier effect regarding material goods input to material goods fell from 1.44 to 1.35 between 1995 and 2008. In other words, the average production structure related to this input segment has steadily contributed to suppressing CO_2 emissions. On the other hand, from the global average of another CO_2 multiplier effect, the segment related to inputs from material goods to services did not change toward decreasing CO_2 emissions during the study period and it still had a higher contribution to the CO_2 emissions. The results is helpful for policymakers to identify the target segment of supply chain to reduce the domestic CO_2 emissions without lowering the level of the country's production activities

Chapter 5 summarizes the analysis results obtained from Chapters 3 and 4, and presents the conclusions of this dissertation.