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日本における二酸化炭素排出の構造分析

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論 文 名　：Structural Analysis of Carbon Dioxide Emissions in Japan
（日本における二酸化炭素排出の構造分析）

区　　分　：甲

論　文　内　容　の　要　旨

Worldwide CO_2 emissions reached 49.5 Gt per year in 2010. CO_2 emissions have continued to increase since 1970, and the rate of increase has been especially rapid during the past decade, which has seen a mean annual increase of 2.2%. Comparing the Fourth Assessment Report published in 2007 and the Fifth Assessment Report published in 2014, there has been little change in the emission levels of developed countries such as Japan over the past ten years. Important questions are twofold: why the developed countries have not significantly contributed to increasing CO_2 emissions during the past decade and how they have tried to reduce the emissions. This thesis sheds light on a shift in the industrial structure in Japan towards the service sector and argues how the structural changes in Japan have contributed to climate mitigation. This thesis further focuses on the second question and demonstrates that Life Cycle Assessment (LCA) based on industry cluster techniques is useful in monitoring life-cycle CO_2 emissions associated with product supply-chains of a specific industry. This thesis comprises six chapters.

Chapter 1 briefly provides research background, research objectives, and contributions of this dissertation. This chapter illustrates that global warming is a major problem for society that requires urgent solution, following recently-published IPCC report and relevant articles. Subsequently, this chapter also points out that environmental management systems such as Life Cycle Assessment (LCA) at industry level is crucial in reducing industrial CO_2 emissions.

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 focuses on the Japanese economy during three time periods, from 1990 to 1995, from 1995 to 2000, and from 2000 to 2005, and decomposed changes in CO_2 emissions associated with detailed industrial activities into five contributing factors, technical effects, industrial composition effects, economic scale effects, import scale effects, and import composition effects. The major findings of this chapter are the following: (1) During the 15-year period from 1990 to 2005, technical effects in the ocean and road cargo transport sectors helped to ensure an overall technical effect of −29 Mt CO_2 for tertiary industries as a whole, thus contributing significantly to a reduction in CO_2 emissions, (2) The industrial composition changes during the period from 2000 to 2005 contributed to a decrease in CO_2 emissions, while those changes during the 10-year period from 1990 to 2000 led to an increase in CO_2 emissions. (3) During the 15-year period from 1990 to 2005, structural change effects under the domestic technology assumption totaled −35 Mt CO_2,

or 3% of total CO_2 emissions in 1990 and these effects were instrumental in allowing Japan to attain its emissions-reduction target under the Kyoto Protocol, which was a 6% reduction from 1990 emissions levels, (4) the domestic environmental benefit arising from the transition to a service economy would amount to ¥18.7 billion.

Chapter 4 focuses on LCAs in industry, and proposes a method for determining objective system boundaries using industrial cluster analysis to resolve problems concerning the arbitrariness of system boundary determination in conventional LCAs. This chapter also objectively determines critical system boundaries for LCA in five major industries that have acquired large numbers of ISO 14001 certifications (non-residential construction (non-wooden), residential construction (wooden), bolts/nuts/rivets and springs, wholesale, and consumer electrical appliances (excluding air conditioners)), by analyzing the supply chains and detecting CO_2 emission-intensive industry systems (industry clusters). This chapter finally concludes that industry clusters identified in this study should be considered in critical LCA system boundaries.

Chapter 5 develops a method for statistically evaluating the instability of system boundary setting based on multiple cluster analyses, and conducts an empirical analysis with a focus on the automobile LCA. This chapter concludes that the process LCA practitioners should consider the CO_2 intensive industrial clusters identified by using the clustering method and evaluate the bias of life-cycle CO_2 emissions resulting from the stability analysis developed in this study.

Chapter 6 summarizes the analysis results obtained from Chapters 3 to 5, and presents the conclusions of this dissertation.