Productivity Analysis of Resource Accumulation in the Prefectures of Japan

江口, 昌伍

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氏　　名　：江口 昌伍

論 文 名　：Productivity Analysis of Resource Accumulation in the Prefectures of Japan
（日本の都道府県における資源蓄積量に基づく生産性分析）

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論 文 内 容 の 要 旨

In 2013, the Japanese Ministry of the Environment issued the ‘Third Fundamental Plan for Establishing a Sound Material-Cycle Society. The plan explains that, in order to create a sound material-cycle society, it will be necessary not only to focus on societal material flow and improve resource productivity, but also to focus on societal material stock, to utilize stock more efficiently, and to accumulate stock that will increase social welfare. On the other hand, in order to address the growing global greenhouse gas (GHG) emissions, Paris Agreement was adopted at the COP 21 in December of 2015 and all the membership countries of United Nations Framework Convention on Climate Change (UNFCCC) are obligated to cooperate to mitigate global warming through reducing GHG emissions. Thus, Japan needs to achieve the economic growth by improving utilization efficiency of the resources accumulated in the prefectures, while Japan is obligated to reduce CO_2 emissions by 26% relative to 2013 levels by 2030 following Paris Agreement. With this background, this thesis extends the conventional efficiency and productivity analysis framework which considers labor and private and social capital stock in monetary term as factor inputs for production activities to the framework considering private and social capital stock in physical term as a factor input in addition to labor and monetary-based capital stock. By using the provided analysis framework, this thesis conducts the productivity and environmental efficiency analyses considering CO_2 emissions in the 46 prefectures of Japan and discusses the possible ways of sustainable development in relation to resource accumulation. This thesis comprises five chapters.

Chapter 1 briefly provides research background, research objectives, and contributions of this thesis. This chapter illustrates why Japan needs to achieve the transition from a “flow-based society” to “stock-based society” following the Third Fundamental Plan for Establishing a Sound Material-Cycle Society. Subsequently, this chapter also shows the relationship between economic activities and CO_2 emissions based on the IPCC report published in 2014 and explains the important factors in order to achieve the decoupling of economic growth and CO_2 emissions.

Chapter 2 provides a comprehensive 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 employs a Data Envelopment Analysis (DEA) framework using long-term panel data of the physical stocks of buildings and infrastructure (roadways and railways), labor force and gross regional

product of 46 Japanese prefectures during the period of 1970 to 2010. This chapter analyzed the change in the productivity resulting from the labor force and resource accumulation in Japan's prefectures for the study period in order to evaluate how the productivity changed over the years. The results show that productivity increased in almost all of the prefectures between 1970 and 1990. On the other hand, between 1990 and 2010, productivity declined in approximately 80% of Japan's prefectures including big prefectures such as Tokyo and Osaka. I find that the productivity in some medium-ranking prefectures in terms of population continued to increase even after 1990 due to the fact that in such prefectures there was catch-up to the efficient production frontier.

Chapter 4 analyzed the environmental efficiency of production activities based on the accumulated resources (i.e., buildings and roadways), factor inputs (i.e., labor and private capital stock), and CO_2 emissions of 46 Japanese prefectures during the period ranging from 1992–2008. This chapter compared a "conventional" environmental efficiency indicator (i.e., production per unit of environmental impact) with a "DEA-based" environmental efficiency indicator that could simultaneously consider inputs, desirable outputs, and undesirable outputs to evaluate environmental performance and examines how the efficiency indicators obtained by the "simplified" efficiency analysis differ from those endogenously determined by the DEA analysis based on economic theory. This chapter further estimated the change in the DEA-based environmental efficiency during the study period and analyzed how social-economic factors affected the efficiency. The major findings were as follows: (1) A ranking gap is apparent between the "conventional" and "DEA-based" indicators in a lot of prefectures. The reason for this ranking gap is that the conventional indicator ignores input factors used by production activities, whereas the DEA-based indicator does not. (2) a decline in environmental efficiency was observed in many prefectures from 1992–1999, whereas a rapid increase in environmental efficiency was observed from 2000–2008 as a result of technical change (14%), (3) although the increase in population has positively impacts the environmental efficiency, the expansion of tertiary industries reduces the environmental efficiency due to the lower per worker GDP for the retail, and transportation industries compared with the manufacturing industries.

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