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論 文 の 要 旨

The author analyzes the impact of environmental policy on the development of technological innovation in Japan, the European Union (EU) and USA by using the End of Life Vehicles (ELV) innovations as case study. The author also evaluates the environmental benefits of such innovation through the use of Life Cycle Assessment (LCA). The research outcomes and experience gained in developed countries is used to make hybrid ELV model in China to solve the upcoming ELV problems via an efficient ELV management system. The Thesis is divided into 6 chapters. Chapter 1 makes a literature review of the previous studies related to the impact of environmental policies on technological innovation. This chapter stresses that while market-based instruments are usually more effective in inducing innovations, Command and Control Approaches could also be effective if applied correctly. The chapter also outlines the objectives of the research. Chapter 2 introduces the use of patent data as a proxy to measure environmental innovations. The chapter explains the advantages and disadvantages of using patent data, the patent classification system as well as other related indicators such as Revealed Technological Advantage Index (RTA). These indicators are important proxies to analyze the impact of policies on innovation. Chapter 3 introduces the case of ELV in Japan. The chapter first explains the evolution of environmental policies in Japan and highlights the drivers for the introduction of ELV regulations. The chapter also explains the model specification and conducts a statistical analysis to determine whether there is any statistical significant difference between the periods before and after ELV regulations were enacted. In this step the research identified the patents related to Automobile Shredder Residue (ASR) since their illegal disposal and difficulty to recycle were areas of concern when the law was enacted. The results show that ELV technological patents were

higher during regulation period. Chapter 4 compares the policy-innovation linkage in Japan, EU and USA by using statistical analysis. The results show that ELV patent counts were higher during the ELV regulation in the case of Japan compared to the EU and the USA. This indicates that the Japanese regulation was very effective and it pushed Japanese firms to innovate more in ELV sector unlike the EU and the USA. The chapter also conducted a regression analysis comparing the cases of Japan and EU (due to the absence of specific regulations in the USA) using R&D investment and lagged patent count as variables. This also further signifies that ELV regulations in Japan had a positive impact, which further support that more ELV technological innovation took place after the ELV regulation in Japan compared to the EU. This chapter also analyzed the RTA for ELV patents in the case studies and found that Japan has relative advantage in ELV technology compared to world patenting trend. Chapter 5 introduces ELV regulations and management in China. The chapter addresses the current problems including the lack of a clear legal framework, the informal and illegal recycling of ELV especially metals and the lack of technological know-how to address this issue properly. The chapter also introduces measures that should be taken in order to overcome the current situation including: clear regulations and enforcement path, recycling fund for scrap automobiles, voluntary agreement with automakers and importers, and promoting manual dismantling. Therefore, proper ELV recycling system should be established in rapidly developing countries like China by discouraging the black market prevailed in the current recycling sector. Further, the results show that China has higher technological spillover of ELV technologies, which indicates that there is more technology, transfer from developed countries to China as they see more potential market in China. Finally chapter 6 summarizes the conclusion of the research.

審 査 の 要 旨

The author analyzed the impact of environmental regulations on technological innovations by using ELV as case study. Through statistical analysis the research compared the changes in patent activity related to ELV in Japan, EU and USA and found that while in the three cases there was an increase in patent activity the trends in Japan were higher. The study also found that the RTA analysis for ELV patents was higher in Japan compared to the other cases suggesting a stronger impact of the environmental regulations in Japan. The study then explores the potential of the dissemination of the experience of developed nations in China, the largest producer and consumer of cars. The study suggests that proper ELV recycling system should be established in China by discouraging the black market that prevails in the current recycling sector. Further, the analysis of absorptive and innovative capacities shows that the gap with developed countries has reduced significantly in the last years. China has also higher technological spillover of ELV technologies, which indicate that there is more technology transfer activity from developed countries to China as they see more potential market in this country. The improvement in both absorptive and innovative capabilities will accelerate the adoption and design of innovations in this area. Finally the author suggests that China should implement a proper regulation and monitoring system in order to address the current and future rapid increase in ELV waste generation. The author also states that the recycling targets should be implemented combined with an incentive or penalty system for effective application. This will trigger innovation in ELV sector similar to the experience of developed nations.

On January 13, 2017 the thesis review committee gathered to revise and finalize the examination of the Thesis. The candidate explained the outcomes of his research and addressed the questions and comments raised by the Committee. As a result, the review committee decided to pass the candidate and grant him the degree of Doctor in Environmental Sciences.