Effects of Economic Replacement Incentives for Consumers on Life-cycle CO2 Emissions

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Author: Daisuke NISHIJIMA
Co-Authors: Masahiro Oguchi, Shigemi KAGAWA

In evaluating environmental burdens from consumer durables, product lifetime is a key factor and most of the previous studies used average lifetime or lifetime distribution with a focus of engineering durability (MÃ¼ller 2006; Kagawa et al., 2011; Nishijima, 2016). These product lifetime modelling techniques did not consider consumerâ€™s behavior. Whereas, the product replacement modelling techniques based on the economic maximum utility theory have been developed in economics and marketing fields (Schiraldi, 2011; Melnikov, 2013). It is beneficial to apply the economic product replacement models to environmental research. This study attempts to integrate the product replacement model with environmental input-output analysis (Nansai et al., 2009; Shigetomi et al., 2015). As a case study, we focused on air conditioners and analyzed the impacts of economic incentives such as subsidies on the life-cycle CO2 emissions of the product in Japan. We firstly constructed the product replacement model following the proceeding studies (Rust, 1987; Gordon, 2009;). By reconciling the Bellman equation for discounted utility flow with the hazard function of products, we expressed the value functions of replacing old products with new products or keeping old products. We applied those value functions to the dynamic logit model and estimated the logit parameters by the maximum likelihood estimation. We used the annual sales and replacement data of air conditioners during 1993 to 2015 (The Japan Refrigeration and Air Conditioning Industry Association; The Japan Electrical Manufacturesâ€™ Association) and maintenance cost data during the same period (Agency for Natural Resources and Energy of Japan). We integrated the dynamic replacement model into the final demand of environmental input-output framework. Finally, we estimated the life-cycle CO2 emissions of subsidies for replacing old air conditioners with new ones or for maintenance of older air conditioners and discussed how we can mitigate global warming through the economic policies of durable products.