

Environmental policy and consumer behavior under monetary budget and time constraint

Topic: Sustainable production and consumption I

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The economic growth during the last several decades has made consumers' living very convenient. This substantial change can be viewed primarily as the results of substitution of time with energy (Binswanger, 2001 *Ecol. Econ.*). For example, a lot of days can be saved by taking an express train instead of traveling hundreds kilometers on foot; one can reduce the number of times of grocery shopping if he or she has a refrigerator. It should thus be noticed that time-use aspects of consumer behavior should be properly taken into account, particularly for analyzing energy and environmental issues. Jalas (2002 *JIE*, 2005 *Ecol. Econ.*) and Druckman et al. (2012, *Ecol. Econ.*) are a few exceptional examples that have studied the consumers' time-use and its effects on the environment. However, they did not explicitly considered consumers' monetary budget.

With this background, we propose a consumer model in which monetary budget and time constraints are simultaneously considered as in Becker (1965, *Econ. J.*). The model consists of consumption "technologies," each of which is expressed as a set of goods and time necessary to achieve its purpose. We utilized the Japanese Time-Use Survey and Household Survey to develop our model that includes multiple consumption "technologies" to achieve particular purposes; for example, laundry modes (home washing and laundry shop) and transportation modes (private car and public transportation). Combining this consumer model with an environmentally extended input-output model, we constructed a linear program (LP) to minimize environmental emission. An optimal solution to the LP can be interpreted as a social outlook in terms of consumer behavior. Moreover, the shadow prices, or dual variables, for constraints representing environmental regulation can be used as indicators for evaluating the effectiveness of these regulations.