EVALUATING IMPACTS OF CARBON TAX ON ENERGY SELECTION FOCUSING ON PERCEPTION OF RISK BY CONSUMERS

[Yuta NAKADEGAWA, University of Tsukuba, +81-90-6492-9950, s2220534@s.tsukuba.ac.jp]
[Kengo SUZUKI, University of Tsukuba, +81-29-853-6194, kengo@risk.tsukuba.ac.jp]

Overview

The large part of studies evaluating the impacts of carbon tax assumes that economic agents act in a reasonable manner for their own profit under perfect information. However, such assumptions are not suitable to consider the dynamics of liberalised market in which multiple economic agents change their perception and acts corresponding to market condition and acts of other agents. This study evaluates the impacts of carbon tax considering the perception of risk by market players by adopting gaming experiments. We designed a browser game in which participants play a role of energy consumers based on the Hotelling type two resources models in the field of resource economics. The game was played five times for each of two conditions: without and with taxation rules. The record of gameplays and answers to questionnaire survey were obtained. The results show that the fewer amount of backstop energy (non-fossil energy) is consumed in the condition with tax mainly in the first half of the game. Further, the level of anxiety about energy price was relatively higher in first half of games in the condition with tax. These results suggest that carbon tax may weaken the intentions to voluntary increase backstop energy inherent to the market.

Methods

Figure 1 is the conceptual figure of the browser game used in this study. The participants of the game, four persons per game, play a role of energy consumers who obtain personal benefit by consuming either fossil fuels or backstop energy. The objective of participants is to maximize their total benefit at the end of the game (after 50th round). In each round, participants decide the consumption of fossil fuels and backstop energy. The benefit of a participant is calculated as the difference between the benefit of energy consumption and the cost of energy purchases. The unit price of fossil fuels rises every round regardless of players' actions while that of backstop energy decreases in correlation with the total consumption of backstop energy.

This study assumes the following scenario. When there is no tax, the benefit of each participant is maximized by consuming only fossil fuels while the benefit of whole society is maximized by substantially switching to backstop energy. When taxing to fossil fuels, both the benefits of each participant and whole society are maximized by the energy transition. The benefit of whole society is defined as the difference between the total benefits of participants and environmental damage which increases in correlation with the total consumption of fossil fuels. Parameters of the game model were set so that the optimal strategy of game matches the above scenario.

The 40 students of University of Tsukuba were participated in the experiments; 5 games were played under the without and with tax conditions, respectively. The rewards for them were in correlation with their personal benefits.

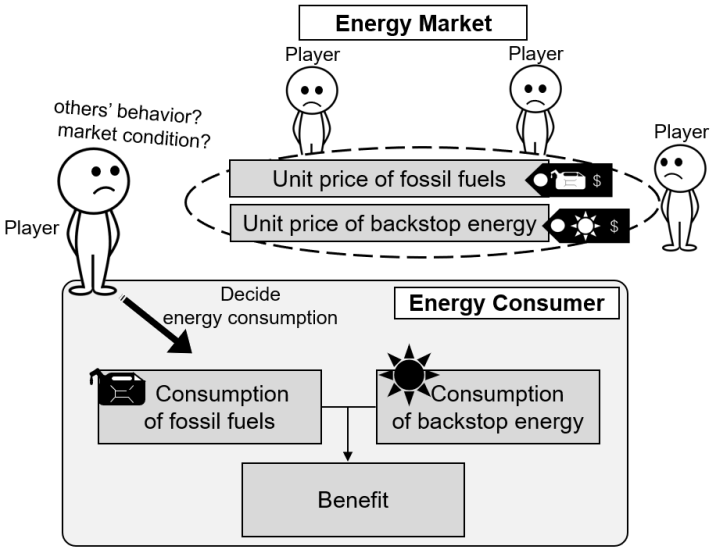


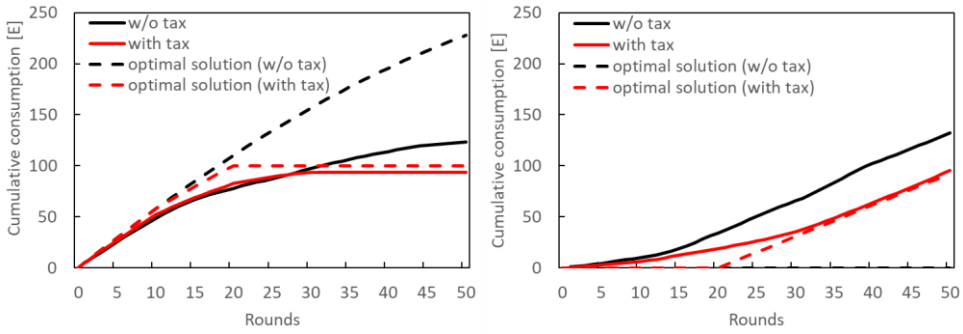
Figure 1: Conceptual figure of the game

Results

Figure 2(a) and (b) show the time-series changes in cumulative consumption of fossil fuels and backstop energy. Black and red lines indicate the without and with tax conditions, and solid and dashed lines indicate the experimental results and optimal solutions. Figure 3(a) and (b) show the time-series changes in the level of anxiety about the prices of backstop energy and fossil fuels.

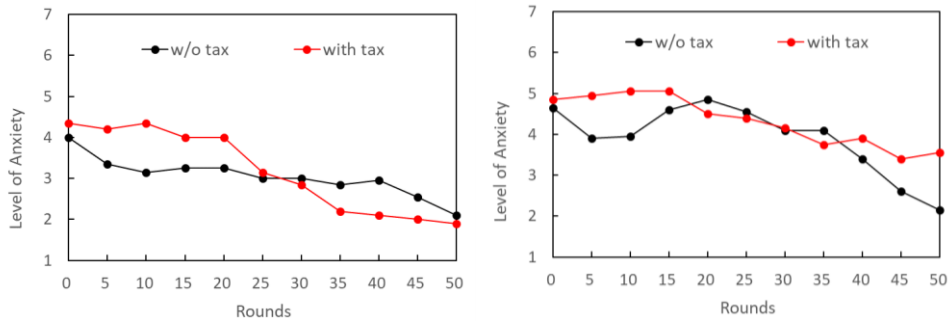
During the early stage (the 1st to 15th rounds), the level of anxiety about the prices of each energy was relatively high in the with tax conditions, but the difference in energy selection did not occur. During the middle stage (the 16th to 30th rounds), the consumption of backstop energy was relatively high in the without tax condition. During the late stage (the 30th to 50th rounds), the energy transition completed in only the with tax condition.

Pillutla and Chen (1999) demonstrated that behaviour in the social dilemma can be strongly affected by the gap between the positive expectation and negative observation. In this study, explanation for the tax appeared to form the expectation of players that others aggressively introduce backstop energy. However, players seldom installed relatively expensive backstop energy during the early stage. Thus, relatively high anxiety about energy price during the early and middle stage in the with tax condition can be interpreted as conflict between intension to energy transition and economic thinking that prefers cheap fossil fuels. This gap between expectation and observation appeared to decrease the introduction of backstop energy in the middle stage.



(a) fossil fuel (b) backstop energy

Figure 2: The time-series change in the consumption of energy



(a) Fossil fuel (b) Backstop energy

Figure 3: The time-series change in anxiety about uncertainty in energy price.

Conclusions

The results of this study suggest that the tax may undermine the spontaneous intention to transition to backstop energy and postpone the spread of backstop energy.

References

Pillutla MM, Chen XP (1999). Social Norms and Cooperation in Social Dilemmas: The Effects of Context and Feedback, *Organizational Behavior and Human Decision Processes*, 78(2): 81-103. https://doi.org/10.1006/obhd.1999.2825