A LABORATORY EXPERIMENT ON BILATERAL OLIGOPOLY IN EMISSIONS TRADING MARKETS

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Overview

Market power in emissions trading markets has been extensively investigated as emerging markets for tradable emissions permits such as EU ETS could be sufficiently dominated by a number of large sellers or buyers. Previous studies on market power in emissions trading assume the existence of a subset of competitive players. A key feature of emissions trading markets, however, is that emissions permits are often traded by a limited number of large sellers and buyers. Thus, both sellers and buyers can influence the market price in their favor, and emissions trading markets could be well described by a model of bilateral oligopoly where every trader can exercise market power. The aim of our study is to examine whether a model of bilateral oligopoly is more appropriate for predicting market outcomes of emissions trading than traditional models of imperfect competition that assume the existence of competitive traders.

Method

We conducted a computerized laboratory experiment at Tohoku University on March 10, 2011, using a so-called 'z-tree' program. The experiment included 4 sessions and each session lasted for approximately 90 minutes. Sixteen subjects were randomly assigned to each session. In each session, four subjects traded emissions permits in a computerized single unit double auction. The number of trading periods was ten and this number of trading periods had not been informed to the subjects until the end of the session. Most of the subjects were either undergraduate students or vocational school students. Each subject participated in one of the four sessions and received an average of $30 (1 US dollar = 80 yen) as a reward, which depended on how much the subject earned by trading permits in the experiment. Prior to each session, we explained to subjects about details of the trading rules, and the subjects were asked to carefully read instructions of trading. In the description about the trading rules of the experiment, we avoided using the terminology that suggested emissions trading.

Table 1 summarizes the experimental design. Holding total emissions (40) constant, we assumed two treatments that differed in the initial endowment of permits. Each subject faced a marginal abatement cost function, $C'(x) = \alpha - \beta x$, where x is the amount of emissions and α and β are parameters. The same amount of permits was initially assigned to each subject in Treatment 1 while the initial allocation of permits differed across subjects in Treatment 2. For both treatments, Subjects A and B would be buyers while Subjects C and D would be sellers, as indicated by their marginal abatement cost functions. For both treatments, the benchmark of perfect competition indicates that the equilibrium price of emissions permits would be 130 and that the competitive distribution of emissions would place 20 with Subjects A and B and 0 with Subjects C and D. We conducted 2 sessions for each treatment.

Table 1. Experimental design

Subject		A	B	C	D
β		1	1	5	5
α		150	150	130	130
Initial endowment	Treatment 1	10	10	10	10
	Treatment 2	6	6	14	14

Results

First, we compare allocative efficiency between two treatments. If the initial allocation does not affect allocative efficiency, there would be no difference in an efficiency measure between two treatments. Figure 1 shows allocative efficiency in each period, which is measured by the ratio of a reduction in total abatement costs of all subjects due to emissions trading under each treatment to that reduction under the competitive benchmark (Ledyard and Szakaly-Moore, 1994). At first glance, the efficiency measure in Treatment 1 is higher than that in Treatment 2 over the entire periods. However, a Mann-Whitney test failed to reject the null hypothesis that the probability distributions of allocative efficiency under two treatments were identical. Thus, there was no statistical difference in allocative efficiency between two treatments.

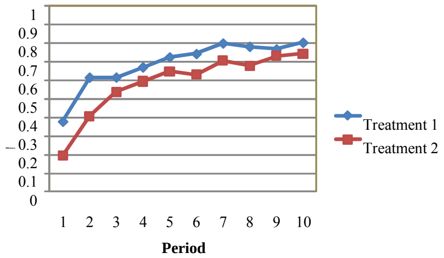

Figure 1. Allocative efficiency in each period

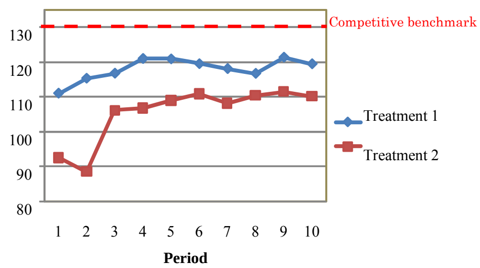

Figure 2. Average permit price in each period

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Next, we compare the equilibrium permit prices between two treatments. Previous studies indicate the initial allocation of permits along with the size of traders as a determinant of market power while the theoretical literature on bilateral oligopoly (Carvajal and Weretka, 2011) argues that the curvature of traders' cost function associated with their production technology, parameter β, also affects market power. Figure 2 shows the average equilibrium price for two treatments in each period. If the market is perfectly competitive, the equilibrium price would be 130, regardless of the initial allocation of permits. For both treatments, however, buyers' market power was relatively larger than sellers' market power, thereby lowering the equilibrium prices. This divergence in the equilibrium price from the competitive level is consistent with the literature on bilateral oligopoly; the smaller β becomes, the more market power emerges.

Conclusion

Our results suggest that a model of bilateral oligopoly could well describe market outcomes of emissions trading. Persistent divergence in the equilibrium price of emissions permits from the competitive level is in line with the literature on laboratory experiments of emissions trading (Sturm, 2008). Also our results imply that initial endowment of emissions permits does not significantly affect allocative efficiency.

Acknowledgment

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