AN EXPERIMENTAL ANALYSIS OF BILATERAL OLIGOPOLY IN EMISSIONS TRADING MARKETS

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(1)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 (Sturm, 2008). 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 appropriate for predicting market outcomes of emissions trading.

(2)Methods

We conducted a series of computerized laboratory experiments at Tohoku University in 2011, using a so-called 'z-tree' program. Each experiment included 8 sessions and each session lasted for approximately 90 minutes. Thirty-two 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 10 and this number of trading periods had not been informed to the subjects until the end of the session.

Holding total emissions constant, we assumed 5 treatments that differed in the initial endowment of emissions permits and the marginal abatement cost functions. We conducted 8 sessions for each treatment. For each treatment, we assumed linear marginal abatement cost functions and initial allocation of emissions permits so that subjects A and B would be symmetric buyers and subjects C and D would be symmetric sellers. To see the effect of the convexity of the marginal abatement cost function on market power, the slope of the marginal abatement cost function for subjects A and B (buyers) was assumed to be smaller than that for subjects C and D (sellers) in Treatments 1 and 2, while in Treatments 4 and 5 the slope of the marginal abatement cost function for subjects C and D (sellers) was assumed to be smaller than that for subjects A and B (buyers). Theoretical models of bilateral oligopoly (Wirl, 2009; Lange, 2012) indicate that the buyers' market power exceeds that of sellers in Treatments 1 and 2 while the sellers' market power dominates in Treatments 4 and 5. All subjects were assumed to have the identical slope of the marginal abatement cost function in Treatment 3, thereby exerting identical market power. To see the effect of the initial allocation of emissions permits on market power, the initial allocation of emissions permits differed across subjects in Treatments 2 and 5 while the same amount of permits was initially assigned to each subject in Treatments 1, 3 and 4.

(3)Results

First, we compare the price of emissions permits among all treatments. Figure 1 shows the average permit price in each period for each treatment. During all periods of the experiment, the observed prices of permits in Treatments 1 and 2 were persistently lower than the competitive price (130), and the observed prices of permits in Treatments 4 and 5 were persistently higher than the competitive price. In Treatment 3, the observed price of permits was close to that of the competitive equilibrium in most of the trading periods. These observations are consistent with theoretical models of bilateral oligopoly. Moreover, the price of permits in Treatment 2 was persistently lower than that in Treatment 1 while the price of permits in Treatment 5 exceeded that in Treatment 4. These findings about the effects of the initial allocation of permits on the price are consistent with

theoretical predictions.

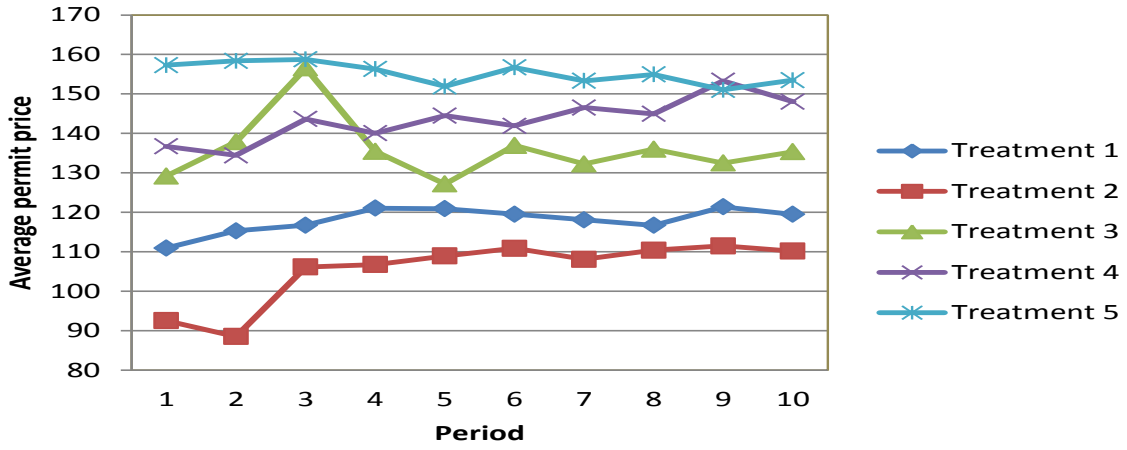

Fig 1. Average permit price in each period

Second, the convergence process of the permit price of each treatment is investigated by estimating an econometric model. For the closing price at convergence, we cannot reject the null hypothesis that indicates the equality of the observed price with the price predicted by a theoretical model of bilateral oligopoly in all treatments. This implies that in all treatments, the observed price exhibits convergence to the price predicted by a theoretical model of bilateral oligopoly. The estimated value of the permit price at convergence varies across treatments. When buyer's market power is larger than seller's market power, the estimated value of the converged price was found to be lower than the price at competitive equilibrium in Treatments 1 and 2. In contrast, for Treatments 4 and 5, the converged price of emissions permits was found to be higher than the price at competitive equilibrium.

Finally, we compare the adverse effects of market power on allocative efficiency across all treatments, using the ratio of an increase in aggregate profits due to emissions trading under bilateral oligopoly to that under the competitive equilibrium. This ratio in the last period of trading was close to that predicted by a "share auction" model of bilateral oligopoly (Wirl, 2009) in all treatments but Treatment 5. Thus, market power of all traders reduced allocative efficiency in emissions permit trading as indicated by a model of bilateral oligopoly.

(4)Conclusions

Our results suggest that a model of bilateral oligopoly, which assumes market power of all traders, could well describe market outcomes of emissions trading. The effects of the slope of the marginal abatement cost function on market power in laboratory experiments are found to be consistent with those predicted by a theoretical model of bilateral oligopoly. Persistent divergence in the equilibrium price of emissions permits from the competitive level is in line with the literature on experiments of emissions trading (Sturm, 2008).

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