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Abstract

Corsetti, Dasgupta, Morris, and Shin (2004, RES) demonstrate that the presence of the large speculator can cause the remaining traders to be more aggressive in speculative attacks in the foreign exchange market. We conduct an experimental analysis designed to test theoretical findings of Corsetti, Dasgupta, Morris, and Shin (2004, RES); in fact the results support their theoretical predictions. Moreover, the results also suggest an asymmetric effect in regulating and deregulating the size of the large speculator.

Key words: Currency Crises; Global Game; Experimental Economics
JEL classification: F31; E58; D82; C72; C91

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1 Introduction

In the last 15 years, we have witnessed many financial crises all over the world: the ERM crisis in 1992, the Mexican Peso crisis in 1994, the Asian financial crisis in 1997, the Russian crisis in 1998, the Brazilian crisis in 1999, the Argentine crisis in 2001, and so on. In these episodes, large speculators, like George Soros and Julian Robertson, have often been accused for not only destabilizing the market unnecessarily during a crisis, but also for triggering the crisis. This is because they are considered to be able to influence to some degree the whole market. As opposed to small traders, large speculators are regarded as capable of exercising a disproportionate influence on the likelihood and severity of a financial crisis. For instance, it is well known that George Soros was named "the man who broke the Bank of England" in the ERM crisis of 1992. As well, during the Asian financial crisis of 1997, the then Prime Minister of Malaysia, Mahathir Mohamad, accused George Soros and others of being "the anarchists, self-serving rogues and international brigandage".[1]

Corsetti, Dasgupta, Morris, and Shin (2004) show theoretically that the presence of a large speculator does indeed cause all the remaining speculators to be more aggressive than the case where there is no large speculator, as small speculators attack the currency when fundamentals are stronger. Meanwhile, empirical evidence on the role of large speculators is mixed.[2] One reason for the mixed empirical results might be due to data constraint. Their personal funds are typically registered in the so-called tax havens and they do not have to disclose data as regulations in tax havens are far less stringent. As a result, it is hard to obtain sufficiently detailed data to decisively determine the role of the large speculator in financial crises.

This paper aims to complement the literature by using experimental analysis. As Roth (1995) argued, an experimental approach gives us a controlled environment that "allows observations to be unambiguously interpreted in relationship to the theory." This paper reports the results of experiments designed to test the predictions of Corsetti, Dasgupta,

[1] Financial Times, July 25, 1997.

[2] See Brown, Goetzmann, and Park (1998), Fung and Hsieh (2000), Fung, Hsieh, and Tsatsaronis (2000), and Corsetti, Pesenti, and Roubini (2002) among others.

Morris, and Shin (2004). In particular, the experiments test (a) whether the large speculator makes small speculators more aggressive in attacking the peg, and (b) whether the large speculator is more aggressive in attacking the peg than small speculators. Moreover, we also test (c) whether the effect of the recognition that "Soros appears" is symmetric to the effect of the recognition that "Soros disappears" even though Corsetti, Dasgupta, Morris, and Shin (2004) do not deal with this issue. This investigation would provide some possible clues to construct a dynamic theoretical model in the future. The results of the experiments not only support the predictions of Corsetti, Dasgupta, Morris, and Shin (2004) but also suggest that the effect of "Soros appears" is not symmetric to the effect of "Soros disappears". Therefore, the results indicate how we could extend the model of Corsetti, Dasgupta, Morris, and Shin (2004) to explain the asymmetric effect.

This paper is organized as follows. Section 2 reviews the literature. Section 3 explains the speculative-attack model used in our experiments. Section 4 describes the experimental design. In Section 5 we present the results. Section 6 concludes the paper.

2 Literature

The motivation for this paper is related to two experimental papers: Heinemann, Nagel, and Ockenfels (2004) and Cheung and Friedman (2005). Heinemann, Nagel, and Ockenfels (2004) conduct experiments to test the predictions of the theory of global games. Their experiments imitate the speculative-attack model by Morris and Shin (1998). They concluded that the global game solution (the so-called threshold strategy) is an important reference point and provides correct predictions for comparative statics with respect to the parameters of the payoff function. Their experiments, however, are not designed to test the implications of the existence of the large speculator, which is the central goal of our experiment. Cheung and Friedman (2005) incorporate a large speculator in their experiments. They concluded that while the presence of a larger speculator increases the likelihood of a successful attack, giving the large speculator a larger size does not significantly strengthen his impact. Nevertheless, in a dynamic framework the increase in the likelihood of a successful attack due to the presence of a large speculator is not necessarily equal to the decrease in the likelihood of a successful attack due to the absence of the large speculator. In other words, the effect of the presence of a large speculator due to deregulation of position holdings limitation is not necessarily equal with the effect of the absence of a large speculator due to regulation of position holdings limitation. We test this possible asymmetric effect in our experiments, while they do not. In addition, their experiment design is closer to the first generation models pioneered by Krugman (1979) and Flood and Garber (1984), rather than the global game model of Corsetti, Dasgupta, Morris, and Shin (2004), as the economic fundamentals are deteriorating in the experiments to determine the timing of speculative attacks. It is possible that the experimental design of deteriorating economic fundamentals could induce the global game solutions (threshold strategies). Morris and Shin (1998) and Corsetti, Dasgupta, Morris, and Shin (2004) demonstrate that threshold strategies are the only equilibrium strategies even in the absence of deteriorating economic fundamentals. Therefore, care should be taken when we interpret the result of their experiments as supportive (or not supportive) of the global game solutions established by Corsetti, Dasgupta, Morris, and Shin (2004). This is because their experiment does not imitate the model by Corsetti, Dasgupta, Morris, and Shin (2004) very closely. In contrast, this paper conducts experiments designed to imitate the Corsetti, Dasgupta, Morris, and Shin (2004) model as closely as possible, in order to test the global game solutions.

3 The Model

In our experiment, we employ a reduced game form based on Corsetti, Dasgupta, Morris, and Shin (2004) with a finite number of speculators who decide simultaneously whether to attack the pegged currency or not.

Consider an economy where the central bank pegs the exchange rate. The economy is characterized by a state of underlying economic fundamentals, Y. A high value of Y refers to good fundamentals while a low value refers to bad fundamentals. We assume that Y is randomly drawn from the interval $[\underline{Y}, \bar{Y}]$, with each realization equally likely.

Now assume that there are two kinds of speculators: a single large speculator ("Soros") and m small speculators (m is some positive integer). Each small speculator can short-sell one unit of the domestic currency. The distinguishing feature of the large speculator is his or her access to a larger line of credit in the domestic currency to take up a short position to the limit of λ (≥ 1). Just for simplicity, we assume λ is an integer. We name it the "Soros case". Later we will consider the "No-Soros case" where there are $m + \lambda$ small speculators and there is no large speculator.

By receiving the noisy private signal about economic fundamentals, a speculator decides whether or not to short sell the currency, i.e. to attack the pegged currency. An attack is associated with opportunity costs c. If the currency devalues, each attacking speculator earns an amount D. To make the model more interesting, we assume that a successful attack is profitable: $D - c > 0$.

Whether the current exchange rate parity is viable depends on the strength of the economic fundamentals and the incidence of speculative attacks against the peg. The incidence of speculative attacks is measured by the mass of speculators attacking the peg as follows:

$$N = k + \lambda \cdot I[\text{Soros attacks}], \tag{1}$$

where k is the number of small speculators who attack the peg and $I[\text{Soros attacks}]$ is the indicator function, which takes the value of unity if Soros attacks and zero otherwise. Therefore, the possible maximum number of N is $m+\lambda$. An attack is successful if and only if a sufficient number of speculators decide to attack. The better the state of the economy, the higher the hurdle to success: the hurdle to success is modeled as a nonincreasing function of Y. Let $a(Y)$ be the size of speculative attacks that are required to enforce a devaluation and assume $a' \leq 0$ and $a(\bar{Y}) < 0 < m + \lambda < a(\underline{\mathrm{Y}})$. The currency peg fails if and only if:

$$N \geq a(Y). \tag{2}$$

When the economic fundamentals are sufficiently strong (i.e., Y satisfies $a(Y) > m + \lambda$), the pegged currency is maintained irrespective of the actions of the speculators. When the economic fundamentals are sufficiently weak (i.e., Y satisfies $a(Y) \leq 0$), the peg is abandoned even in the absence of a speculative attack. The most interesting range is the intermediate case when $0 < a(Y) \leq m + \lambda$. In this case, the government is forced to abandon the peg if a sufficient proportion of speculators attack the currency, whereas the peg will be maintained if a sufficient proportion of speculators choose not to attack. This tripartite classification of fundamentals follows Obstfeld (1996). In what follows, a crisis is defined when the government abandons the peg and no crisis if the government defends the peg.

Although speculators do not observe the value of Y, they receive informative private signals about it. When the true state is Y, a speculator i observes a signal $x_i = Y + \varepsilon_i$ that is drawn uniformly from the interval $[Y - \varepsilon, Y + \varepsilon]$ $(\varepsilon \geq 0)$. Conditional on Y, the signals are i.i.d. across individuals. Note that there is no difference, at least in terms of precision, between Soros' private signal and small speculators' private signals. In the model, the only difference between Soros and the small speculators is their size. We exclude the possibility that Soros has better information about economic fundamentals than the small speculators, in order to focus as clearly as possible on the size effect.

With regard to speculators' preferences, the expected utility from attacking the currency conditional on his or her private signal is the following.

$$U = \text{Prob}\left[N \geq a(Y) \middle| \, x_i\right] D - c$$

$\text{Prob}\left[N \geq a(Y) \middle| \, x_i\right]$ is the probability that his or her attack is successful conditional on their private signal.

The timing of the game is structured as follows.

- Nature chooses the value of Y.
- Each speculator receives a *private* signal $x_i = Y + \varepsilon_i$.
- Each speculator decides whether or not to attack the currency peg.
- The central bank abandons the peg if $N \geq a(Y)$ otherwise defends the peg.
- If the attack is successful, those who attacked get $D - c$. If the attack is not successful,

their payoff is $-c$. The payoff of those who did not attack is zero.

3.1 Common Knowledge Case

Before investigating the case $\varepsilon > 0$, consider the case where there is no noise in the signal: $\varepsilon = 0$. Hence, the realization of Y is common knowledge among the speculators.

In this case, there are multiple equilibria when $\lambda < a(Y) \leq m + \lambda$: the crisis is the equilibrium if all the speculators coordinate an attack, while no crisis is the equilibrium if no speculator attacks. In the multiple equilibria, there is no clear implications of the presence of Soros. To establish this argument, suppose that there are $m + \lambda$ small speculators and there is no Soros in the market. We have named this case the No-Soros case. Note that in this case the possible maximum number of N, which is $m + \lambda$, is the same as in the Soros case. Notice also that there are multiple equilibria, the crisis and no crisis, in the No-Soros case as in the Soros case. Within multiple equilibria framework, there is no significant difference in terms of equilibrium selection between the Soros case and the No-Soros case when $\lambda < a(Y) \leq m + \lambda$: it is not very clear how and whether or not the presence of Soros affects equilibrium selection when $\lambda < a(Y) \leq m + \lambda$. In order to consider the implications of the existence of Soros, it would be useful to refine the multiple equilibria to clarify how one particular equilibrium is selected over another.

3.2 Noncommon Knowledge Case

A familiar feature in the literature from the discussion of global games is that when $\varepsilon > 0$, the realization of Y will not be common knowledge among the speculators. Applying the global game approach, Corsetti, Dasgupta, Morris, and Shin (2004) have demonstrated that in this case there is a unique equilibrium. In this unique equilibrium the small speculators use the switching strategy around X^* while Soros uses the switching strategy around X^{**}. X^* is a threshold signal, as such small speculators attack if and only if they receive a signal above this threshold. X^{**} is a threshold signal for Soros, as such Soros attacks if and only if he receives a signal above this threshold. Moreover, Corsetti, Dasgupta, Morris, and Shin (2004) have demonstrated that the presence of Soros does indeed make all other speculators more aggressive in their attack.

A risk neutral speculator receiving the threshold signal is indifferent between attacking and not attacking provided that all other speculators attack, if and only if, they receive signals above their threshold signal. At state Y the probability that Soros' attack is successful is given by the probability that at least $a(Y)-\lambda$ out of m small speculators get signals above X^* and attack. This can be demonstrated by a binomial distribution. The probability that a single speculator gets a signal above X^* at state Y is $(Y-X^*+\varepsilon)/(2\varepsilon)$. Denoting the round-up of $a(Y)$ by $\hat{a}(Y)$, the expected payoff of attacking Soros conditional on the threshold signal is:

$$
\begin{aligned}
& EU(X^{**}) \\
= \; & \frac{1}{2\varepsilon}\int_{X^{**}-\varepsilon}^{X^{**}+\varepsilon} D\cdot \mathrm{Prob}\left[k \geq \hat{a}(Y)-\lambda\right] dY \\
= \; & \frac{1}{2\varepsilon}\int_{X^{**}-\varepsilon}^{X^{**}+\varepsilon} D\cdot \Big(1-\mathrm{Prob}\left[k \leq \hat{a}(Y)-\lambda-1\right]\Big) dY \\
= \; & \frac{1}{2\varepsilon}\int_{X^{**}-\varepsilon}^{X^{**}+\varepsilon} D\cdot \left(1-\sum_{k=0}^{\hat{a}(Y)-\lambda-1}\binom{m}{k}\left(\frac{Y-X^*+\varepsilon}{2\varepsilon}\right)^{k}\left(1-\frac{Y-X^*+\varepsilon}{2\varepsilon}\right)^{m-k}\right) dY \\
= \; & \frac{1}{2\varepsilon}\int_{X^{**}-\varepsilon}^{X^{**}+\varepsilon} D\cdot \left(1-\mathrm{Bin}\left[\hat{a}(Y)-\lambda-1, m, \frac{Y-X^*+\varepsilon}{2\varepsilon}\right]\right) dY, \qquad (3)
\end{aligned}
$$

where Bin is the cumulative binomial distribution. The equilibrium threshold signal X^{**} is defined by:

$$EU(X^{**}) = c. \qquad (4)$$

At state Y the probability that a small speculator's attack is successful is given by the sum of the following: (1) the probability that at least $a(Y)-\lambda-1$ out of $m-1$ small speculators receive private signals above X^* and Soros receives a private signal above X^{**} and then they all attack, and (2) the probability that at least $a(Y)-1$ out of $m-1$ small speculators receive private signals above X^* and attack but Soros receives a private signal below X^{**} so Soros does not attack. Let the former be $P_1(Y)$ and the latter be $P_2(Y)$. Notice that private signals are independent across speculators (and hence between Soros and small speculators) conditional on Y. Therefore, these two probabilities can be written as follows:

$$
\begin{aligned}
P_1(Y) &= \text{Prob}\,[\text{Soros attacks at state } Y] \cdot \text{Prob}\,[k \geq \hat{a}(Y) - \lambda - 1] \\
&= \text{Prob}\,[x_i \geq X^{**}] \cdot \Big(1 - \text{Prob}\,[k \leq \hat{a}(Y) - \lambda - 2]\Big) \\
&= \frac{Y - X^{**} + \varepsilon}{2\varepsilon} \cdot \left(1 - \text{Bin}\left[\hat{a}(Y) - \lambda - 2, m-1, \frac{Y - X^{*} + \varepsilon}{2\varepsilon}\right]\right), \qquad (5)
\end{aligned}
$$

$$
\begin{aligned}
P_2(Y) &= \text{Prob}\,[\text{Soros does not attack at state } Y] \cdot \text{Prob}\,[k \geq \hat{a}(Y) - 1] \\
&= \text{Prob}\,[x_i < X^{**}] \cdot \Big(1 - \text{Prob}\,[k \leq \hat{a}(Y) - 2]\Big) \\
&= \left(1 - \frac{Y - X^{**} + \varepsilon}{2\varepsilon}\right) \cdot \left(1 - \text{Bin}\left[\hat{a}(Y) - 2, m-1, \frac{Y - X^{*} + \varepsilon}{2\varepsilon}\right]\right). \qquad (6)
\end{aligned}
$$

The expected payoff of an attacking small speculator with the threshold signal is:

$$
EU(X^*) = \frac{1}{2\varepsilon} \int_{X^*-\varepsilon}^{X^*+\varepsilon} D \cdot \Big(P_1(Y) + P_2(Y)\Big)\, dY. \qquad (7)
$$

The equilibrium threshold signal X^* is defined by:

$$
EU(X^*) = c. \qquad (8)
$$

4 Experimental Design

Sessions were administered at a PC pool in the School of Political Science and Economics at Waseda University, Tokyo on October 17, 19, November 21, and 24, 2005 with 138 participants. Most of the participants were undergraduates of Waseda University. To recruit participants, we advertised on the notice board and the web page of Waseda University and interested students applied for the experiment. About half the participants were economics or commercial science undergraduates, the remaining were majors in various fields such as law, science and engineering, literature, and so on. The experiment was programmed and conducted with the software z-Tree (Fischbacher (1999))and instructions were read to the participants. Throughout the sessions participants were not allowed to communicate or see others' computer screens. We conducted a benchmark case of the experiment on October 17 and 19. There were 70 participants in the benchmark case. On November 21 and 21, we conducted the experiment with some modification of the experimental design in terms of payoff, precision of private signal, and the size of Soros. We named it a comparative statistics case. There were 68 participants in the comparative statistics case.

4.1 Benchmark case

We divided the sample of the benchmark case into two subsamples, subsample 1 and subsample 2. In subsample 1, we firstly ran one session for the No-Soros case and then proceeded to another session for the Soros case. In subsample 2, we firstly ran one session for the Soros case and then proceeded to another session for the No-Soros case.[3]

In the No-Soros case, there are 10 "small" subjects and no "large" subject (i.e., the no Soros) in the same group. In this case, the possible maximum number of N is 10 in the No-Soros case.

In the Soros case, subjects are further split evenly into two groups. The session for the Soros case was conducted in each group separately. Out of five subjects in each group, four subjects were "small" and one subject was "large" (Soros). We set $\lambda = 6$. Therefore, the possible maximum number of N in each group is again 10 ($m + \lambda = 4 + 6 = 10$ in each group) in the Soros case.

Each session consisted of 10 independent rounds. In each round all subjects had to decide between alternatives A and B for five independent situations. In the Soros case, one subject was randomly chosen as Soros in each round. Thus, the subject who was chosen as Soros could be different across 10 rounds.

For each situation, a state Y, the same for all subjects, was randomly selected from a uniform distribution in the interval [30, 90]. Instead of being informed about Y, each subject received a private noisy signal, independently and randomly drawn from a uniform distribution in the interval [Y-10, Y+10]. These numbers were displayed with two decimal digits. We did not order the signals so as not to induce so-called threshold strategies. We

[3]We investigate if there was any difference between the two subsamples in subsection 5.2.3.

did not conduct sessions with common information where subjects were informed about Y.

The payoff for alternative A was 1,000 Experimental Currency Units (ECU) with certainty. The payoff for B was 3,000 ECU, if $N \geq a(Y) = 20 - Y/4$ held, zero otherwise. One ECU is ¥0.01 and subjects were informed about it.[4] All parameters of the game and the rules were common knowledge except for drawn states Y and private signals.

Once all players had completed their decisions in one round, they were provided—for each situation—the value of Y, how many people had chosen A, how many people had chosen B, payoff of A, payoff of B (which automatically informed them whether action B was successful or not), and their individual payoffs. After all players had read the information on the screen a new round started and information of previous rounds could not be revisited. Subjects were allowed to take notes and many of them actually did take notes.

4.2 Comparative Statistics Case

On November 21, there were 40 participants and we conducted a experiment where there was no noise in the signal: every participant was informed about the value of Y. The payoffs for A and B were the same as in the benchmark case. We divided the sample into two subsamples, subsample 3 and subsample 4. In subsample 3, we firstly ran one session for the No-Soros case and then proceeded to the other session for the Soros case. In subsample 4, we firstly ran one session for the Soros case and then proceeded to another session for the No-Soros case.

On November 24, there were 28 participants. We divided the sample into two subsamples, subsample 5 (10 participants) and subsample 6 (18 participants). In subsample 5, the payoff for A was 300 ECU, rather than 1,000 ECU. The payoff for B was the same as the benchmark case, 3,000 ECU. We ran one session for the No-Soros case and then proceeded to the next session for the Soros case. In subsample 6, there were nine small participants in the same group of the No-Soros case so that the maximum number of N

[4]The experimental design is such that Soros has larger market power in terms of speculative pressure ($\lambda = 6$) than small speculators while the payoff of B for Soros is the same as for small speculators. This is more parsimonious design than the design where the payoff of B for Soros is larger than other speculators.

is 9. In the Soros case, nine participants were divided into three groups, each of which consisted of three participants. We set the size of Soros to be 7 (i.e., $\lambda = 7$) so that the maximum number of N is 9 ($m + \lambda = 2 + 7 = 9$). We ran one session for the No-Soros case and then proceeded to the next session for the Soros case.

The experimental design in each subsample is summarized in Table 2. We name subsample 1, 2, 3, and 4 private information subsamples (PI subsamples), while we name subsample 3 and 4 common information subsamples (CI subsamples).

4.3 Payments

After two sessions (the No-Soros case and the Soros case) were completed, participants had to respond to questions in a questionnaire about their behavior and were free to give additional comments regarding the experiment. Once the questionnaire was completed, each participant was paid their reward in private.[5]

The experiment length was about 100 minutes. The descriptive statistics about the payment to each subject is shown in Table 3.

5 Results

Our main question is whether or not speculators attacked the peg (i.e., subjects choose B) more aggressively in the Soros case than in the No-Soros case. In order to answer this question, we estimated the probability with which a subject i chooses B by fitting a logistic distribution function to observed choices.[6]

[5] In addition to the performance fee earned in the experiment, each participant received ¥1000 as a fixed show-up fee. In Table 3 we report the sum of the performance fee and the fixed show-up fee.

[6] The logistic distribution is more appropriate than the normal distribution, because we observe 'fat tails' due to irrational behavior of a few subjects who did not play threshold strategies. Moreover, estimation results of the probit model are qualitatively similar to those of the logit model. The results are available upon request.

5.1 Results of Private Information Subsample

First of all, we estimate the following specification:

$$\text{Prob[Subject } i \text{ chooses B]} = \frac{\exp(\beta_0 + \beta_1 x_i + \beta_2 I[\text{Soros case}] + \beta_3 I[\text{Large}])}{1 + \exp(\beta_0 + \beta_1 x_i + \beta_2 I[\text{Soros case}] + \beta_3 I[\text{Large}]),} \tag{9}$$

where I[Soros case] is a dummy variable that takes the value of unity in the Soros case and zero in the No-Soros case, and I[Large] is a dummy variable that takes the value of unity if a subject i is chosen as Soros and zero otherwise. The hypotheses consistent with the global game solutions are the following.[7]

- A subject is more likely to choose B when he receives a larger signal ($\beta_1 > 0$).
- A subject is more likely to choose B in the Soros case than in the No-Soros case ($\beta_2 > 0$).
- A subject is more likely to choose B when he is chosen as Soros than otherwise ($\beta_3 > 0$).

Since the global game solutions predict the above in the case where the private signals are noisy, we estimate (9) by excluding CI subsamples (subsample 3 and 4 in which there is no noise in the signal) from the sample. The results are summarized in Table 4. The three theoretical predictions of the global game solutions stated above are supported. β_0, β_1, β_2 and β_3 are all highly significant at the 0.1% level. Moreover, the signs of β_1, β_2 and β_3 are all positive as the theory predicts.

Predicted probabilities of choosing B are depicted in Figure 1. The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case (the curve marked with the triangle symbol "▲") is positioned to the most left. The curve of the predicted probabilities of choosing B when the subject is *not* chosen as Soros in the Soros case is in the middle (the curve marked with the square symbol "■"). The curve

[7]Notice that it is not possible to derive closed form solutions of the equilibrium values in the reduced-game form presented in Section 3 or in the original model of Corsetti, Dasgupta, Morris, and Shin (2004). We present the reduced-form model that is as close as to the experimental design. But if we assume there is a continuum of small speculators whose mass is equal to m, rather than m small speculators, then it is possible to derive the closed form solutions under the assumption that Y and ε_i distribute uniformly. The solutions are consistent with these hypothesis.

of the predicted probabilities of choosing B in the No-Soros case is positioned to the most right (the curve marked with the lozenge symbol "⧫").

Next, we estimate the following specification to determine whether or not the change in payoff and/or the change in the size of Soros matters. As before we estimate (10) by excluding subsample 3 and subsample 4 (in which there is no noise in the signal) from the sample.

$$\text{Prob[Subject } i \text{ chooses B]} = \frac{\exp(\Upsilon_i)}{1 + \exp(\Upsilon_i),} \tag{10}$$

where Υ_i is defined as follows:

$$\begin{aligned} \Upsilon_i &= \beta_0 + \beta_1 x_i + \beta_2 I[\text{Soros case}] + \beta_3 I[\text{Large}] + \beta_4 I[5] + \beta_5 I[5] \cdot I[\text{Soros case}] \\ &\quad + \beta_6 I[5] \cdot I[\text{Large}] + \beta_7 I[6] + \beta_8 I[6] \cdot I[\text{Soros case}] + \beta_9 I[6] \cdot I[\text{Large}], \end{aligned}$$

where I[j] is a dummy variable that takes the value of unity if a subject is in subsample j and zero otherwise.

The results are summarized in Table 5. The qualitative results for β_0, β_1, β_2 and β_3 are similar as before. They are all highly significant at the 0.1% level. β_4 is significantly positive, meaning that subjects are more likely to choose B when A is less attractive due to smaller payoff of A. β_7 is significantly negative. When the maximum number of N is smaller (which is 9 rather than 10 in subsample 6), subjects are less likely to choose B. β_8 is significantly positive. Once Soros appears in the market when the maximum number of N is smaller, subjects become more aggressive than they would become when the maximum number is 10.

Predicted probabilities of choosing B are depicted in Figure 2.

The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case in subsample 5 (the case where the payoff for A is smaller) is positioned to the most left (the curve marked with the symbol "×"). If the subject is chosen as Soros in the subsample 5, he/she is the most aggressive in choosing B. The curve of the predicted probabilities of choosing B when the subject is not chosen as Soros in the Soros case in subsample 5 is positioned to the second left (the curve marked with the symbol "•"). The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case in subsample 6 is positioned to the third left (the curve marked with the symbol "▲"). The curve of the predicted probabilities of choosing B when the subject is not chosen as Soros in the Soros case in subsample 6 is positioned to the fourth left (the curve marked with the symbol "■"). The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case in benchmark case is positioned in the middle (the curve marked with the symbol "△"). The curve of the predicted probabilities of choosing B of the subject in the No-Soros case in subsample 5 is positioned to the fourth right (the curve marked with the symbol "+"). The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case in benchmark case is positioned to the third right (the curve marked with the symbol "□"). The curve of the predicted probabilities of choosing B in the No-Soros case in benchmark case is positioned to the second right (the curve marked with the symbol "◊"). The curve of the predicted probabilities of choosing B in the No-Soros case in subsample 6 is positioned to the most right (the curve marked with the symbol "♦").

5.2 Results of Benchmark Case

5.2.1 Two Subsamples

Estimation results obtained from both subsample 1 and subsample 2 in benchmark case are summarized in Table 6, and predicted probabilities of choosing B are depicted in Figure 3. The three theoretical predictions of the global game solutions stated above are supported. β_0, β_1, β_2 and β_3 are all highly significant at the 0.1% level.

5.2.2 Each Subsample

The sample of the benchmark case can be divided into two subsamples, subsample 1 and subsample 2, according to the order of the experiment of the No-Soros case and that of the Soros case. In subsample 1, we firstly conducted the experiment of the No-Soros case and then proceed to the experiment of the Soros case. There are 40 subjects in the subsample

1. In subsample 2, we firstly conducted the experiment of the Soros case and then proceed to the experiment of the No-Soros case. There are 30 subjects in the subsample 2.

It is likely that only one of two subsamples drives the estimation results of the benchmark case. To investigate this issue, we estimate the equation (9) for each of these subsamples separately. In each subsample, the estimation results are qualitatively similar to those of benchmark case, as it is revealed in Table 7, Table 8, Figure 4 and Figure 5. In each subsample, the theoretical predictions are supported as in all sample. Therefore, irrespective of the order of the experiment of the No-Soros case and that of the Soros case, the theoretical predictions of the global game are supported.

5.2.3 Results: Two Subsamples Revisited

Notice that we can interpret subsample 1 as the situation where "Soros appears" due to deregulation of position holdings limitation, while subsample 2 as the situation where "Soros disappears" due to regulation of position holdings limitation. We investigate whether or not there are any significant differences between subsample 1 and subsample 2.

We are concerned in a possibility that the effect that "Soros appears" may not be symmetric to the effect that "Soros disappears". In subsample 1, we conducted the experiment of the No-Soros case firstly and then proceed to the experiment of the Soros case. In subsample 2, we conduct the experiment of the Soros case firstly and then proceed to the experiment of the No-Soros case. If the effect that "Soros appears" (subsample 1) is indeed symmetric to the effect that "Soros disappears" (subsample 2), there must be no significant differences between the Soros case (the No-Soros case) in subsample 1 and the Soros case (the No-Soros case) in subsample 2.

Corsetti, Dasgupta, Morris, and Shin (2004) did not provide an answer to this question. Since Corsetti, Dasgupta, Morris, and Shin (2004) considered a one-shot game of the No-Soros case and a one-shot game of the Soros case *independently* and then compare the resulting equilibrium of the No-Soros case with that of the Soros case, the order between the No-Soros case and the Soros case was not taken into account. We investigated this question in the following to derive some possible clues as to construct a dynamic theoretical model in the future.

To investigate this issue, we estimate the following:

$$\text{Prob[Subject } i \text{ chooses B]} = \frac{\exp(\Psi_i)}{1+\exp(\Psi_i),} \tag{11}$$

where Ψ_i is defined as follows:

$$\begin{aligned} \Psi_i &= \beta_0 + \beta_1 x_i + \beta_2 I[\text{Soros case}] + \beta_3 I[\text{Large}] + \beta_4 \cdot I[1] \\ &\quad + \beta_5 I[1] \cdot I[\text{Soros case}] + \beta_6 I[1] \cdot I[\text{Large}], \end{aligned} \tag{12}$$

where $I[1]$ is a dummy variable that takes the value of unity if a subject is in subsample 1 and zero otherwise. It must be the case that $\beta_4 = \beta_5 = \beta_6 = 0$ if there is no difference between the Soros case (No-Soros case) in subsample 1 and the Soros case (No-Soros case) in subsample 2.

The estimation results are presented in the following. Firstly, the three theoretical predictions of the global game solutions stated above are supported, as β_0, β_1, β_2 and β_3 are all highly significant at the 0.1% level. Moreover, the signs of β_1, β_2 and β_3 are all positive as the theory predicts.

The null hypothesis ($\beta_4 = \beta_5 = \beta_6 = 0$) that there is no difference between the Soros case (No-Soros case) in subsample 1 and the Soros case (No-Soros case) in subsample 2 is rejected at 0.01% level. Moreover, subjects are significantly more aggressive in the Soros case in subsample 1 than in the Soros case in subsample 2, as β_5 is significantly positive.

Predicted probabilities of choosing B are depicted in Figure 6. The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case in the subsample 1 is positioned to the most left (the curve marked with the symbol "▲"). If the subject is chosen as Soros in the subsample 1, he/she is the most aggressive in choosing B. The curve of the predicted probabilities of choosing B when the subject is chosen as Soros in the Soros case in the subsample 2 (the curve marked with the symbol "■") is almost overlapped by the curve of the predicted probabilities of choosing B when the subject is *not* chosen as Soros in the Soros case in subsample 1 (the curve marked with the symbol "♦"). These two curves are positioned to the second left. The subject chosen as Soros in the subsample 2 and the subject *not* chosen as Soros in the Soros case in the subsample 1 are similarly aggressive in choosing B. The curve of the predicted probabilities of choosing B when the subject is *not* chosen as Soros is the Soros case in subsample 2 is positioned in the middle (the curve marked with the symbol "$\times$"). The curve of the predicted probabilities of choosing B when the subject in the No-Soros case in subsample 2 is positioned to the second right (the curve marked with the symbol "+"). The curve of the predicted probabilities of choosing B when the subject in the No-Soros case in subsample 1 is positioned to the most right (the curve marked with the symbol "$\bullet$"). Thus, the subject in the No-Soros case in subsample 1 is the least aggressive in choosing B.

We summarize the order of aggressiveness (from the most aggressive to the least aggressive) in Table 10. Notice that the subjects in the No-Soros case in subsample 1 are less aggressive in choosing B than the subjects in the No-Soros case in subsample 2. Moreover the subjects not chosen as Soros in the Soros case in subsample 1 are more aggressive in choosing B than the subjects not chosen as Soros in the Soros case in subsample 2. This suggests that the effect of "Soros appears" is not symmetric to the effect of "Soros disappears". Indeed, subjects are significantly more aggressive in the Soros case in subsample 1 than in the Soros case in subsample 2: β_5 is significantly positive.

An important question is why the subjects are significantly more aggressive in the Soros case in subsample 1 than the Soros case in subsample 2. One possible answer for the subsample 1's aggressiveness in the Soros case is the house money effect (Thaler and J.Johnson (1990)). The house money effect means that prior losses can reduce risk-taking behavior, while prior gains make people more risk-seeking. In our case, the income subjects receive from the first session of each experiment possibly causes subjects to be more risk-taking. As shown in Table 11, the subject in subsample 1 has already received 1,840.75 JPY on average at the start of the Soros case, and received 2,011 JPY at the start of the No-Soros case in subsample 2.[8] Afterwards, the subjects who received a windfall of

[8]These payoffs included the fixed show-up fee.

income at the start of the second session (the Soros-case in subsample 1, and the No-Soros case in subsample 2) become more aggressive in choosing B.

It is natural to use the house money effect as a potential explanation, when the decision-making process by the subject is sequential in nature. If players derive utility from consumption and changes in wealth, Barberis, Huang, and Santos (2001) demonstrate theoretically that people are less risk averse after stock prices increase and people become more risk averse after stock prices fall. Furthermore, Ackert, Charupat, Church, and Deaves (2003) examined the house money effect on asset pricing in a dynamic setting by using experimental methods. They demonstrated that participants are willing to pay more for the stock with a larger initial endowment. Hence, our result is consistent with the literature that the subjects with greater windfall of income are more aggressive in the decision making.

5.3 Results of All Sample

We estimate (9) using all sample (both private and common information subsamples). The results are summarized in Table 12 and predicted probabilities of choosing B are depicted in Figure 7.

The results are qualitatively the same as before. β_0, β_1, β_2 and β_3 are all highly significant at the 0.1% level. Moreover, the signs of β_1, β_2 and β_3 are all positive as the theory predicts.

Next, we investigate whether there is any difference between private information subsamples and common information subsamples. To determine this, we estimate the following:

$$\text{Prob[Subject } i \text{ chooses B]} = \frac{\exp(\Phi_i)}{1 + \exp(\Phi_i),} \tag{13}$$

where Φ_i is defined as follows:

$$\begin{aligned} \Phi_i &= \beta_0 + \beta_1 x_i + \beta_2 I[\text{Soros case}] + \beta_3 I[\text{Large}] + \beta_4 \cdot I[\text{CI}] \\ &\quad + \beta_5 I[\text{CI}] \cdot I[\text{Soros case}] + \beta_6 I[\text{CI}] \cdot I[\text{Large}], \end{aligned} \tag{14}$$

where $I[\text{CI}]$ is a dummy variable that takes the value of unity if a subject is in CI subsample and zero otherwise. It must be the case that $\beta_4 = \beta_5 = \beta_6 = 0$ if there is no difference between PI subsamples and CI subsamples.

The results are summarized in Table 13 and predicted probabilities of choosing B are depicted in Figure 8.

There are two significant differences between PI subsamples and CI subsamples. Firstly, subjects are significantly more aggressive in choosing B in CI subsamples than in PI subsamples: β_4 is significantly positive. Secondly, in both PI and CI subsamples subjects become significantly more aggressive in the Soros case than in the No-Soros case, while they do so more in PI subsamples than in CI subsamples: β_2 is significantly positive and β_5 is significantly negative. How can we interpret these results? One possible interpretation is the following: in PI subsamples subjects do not know the value of Y or hint numbers other subjects receive, while in CI subsamples they know the value of Y and they know everyone's value of Y. Therefore, there is more uncertainty in PI subsamples than in CI subsamples, which may cause subjects to be less aggressive in choosing B since there is more uncertainty regarding other subjects' behavior in PI subsamples. This may explain the positive β_4. When there is Soros in the market, it may reduce uncertainty regarding other subjects' behavior to some degree, since everyone becomes more aggressive in choosing B. The "decrease" in uncertainty may be larger in PI subsamples than in CI subsamples. This may explain the negative β_5.

6 Conclusion and Future Research

This paper reported the results of an experiment designed to test the predictions of Corsetti, Dasgupta, Morris, and Shin (2004). The results of the experiment support the theoretical predictions of Corsetti, Dasgupta, Morris, and Shin (2004). In particular, the results suggest that the large speculator makes other small speculators more aggressive in attacking the peg and the large speculator is more aggressive in attacking the peg than small speculators. Moreover, the results suggest an asymmetric effect between regulating and deregulating the size of the large speculator, which was not a concern by Corsetti, Dasgupta, Morris, and Shin (2004). This may provide us suggestions as to construct a dynamic model by extending the original model.

For future research, we are planning to conduct experiments to test related theoretical papers. Bannier (2005) highlights the role that the market sentiment has on the impact of a large trader on a currency crisis. Corsetti, Guimarães, and Roubini (2005) investigate the role of the official creditor (the IMF or an international lender of last resort) as a large player in the world economy. It is very likely that it would be challenging to estimate these models due to data constraint, experimental analysis would be able to provide some useful information to accompany the literature.

Appendix

In the following, we describe how we provided instructions regarding the rules of the game to the participants.[9] We provided the following instructions through a power point presentation. Table 14 and table 15 were printed and distributed to every participants.

A Experiment Instruction

From now on please do not speak without permission. Please raise your hand if you have a question and one of the instructors would attend to your request. Please turn off your cell phone. Please do not talk to yourself.

Thank you for participating in the experiment. This is the experiment conducted by 21COE-GLOPE (Constructing Open Political-Economic Systems) Vision Team. Firstly we would provide an outline of the experiment.

A.1 Outline of Experiment

The following two kinds of experiments will be conducted: (1) Experiment 1, and (2) Experiment 2. There are 10 rounds in each experiment. The experiments will be conducted using computers. Please do not look at the computer of other participants. After the completion of the experiments, you will be paid a cash amount as a reward for participating in the experiments. The amount of reward depends on the results of the experiments, so please make decisions carefully. Please do not leave your seat after the experiments, unless the instructors request you to do so. After the experiments are completed, we will calculate the amount you receive according to the results of the experiments. During this time please complete the questionnaire. There would be a practice session before the actual experiments. The practice session would not count toward your reward, although the rules of the game of the practice session are the same with the actual experiments. Please follow our instructions during the practice session. If you see an error message on the screen, please raise your hand.

[9] The following descriptions are the instructions for subsample 1 and subsample 3. The descriptions for the remaining subsamples are very similar.

The reward is calculated as follows: 1,000 JPY + Performance fee = Your reward. Performance fee is denominated in terms of ECU (experimental currency unit). The exchange rate between ECU and JPY is 1 ECU = 0.01 JPY.

A.2 Experiment 1

You are one of 10 participants. Five independent situations will be presented on your computer screen (i.e., per round). There will be 10 independent rounds. In each situation, you have to choose A or B. Firstly the following message will be displayed. "You are given the power of one person. Each of 10 participants in the same group has the power of one person respectively".

In each of five situations, a number Y is drawn randomly from the interval [30, 90] respectively. The number Y is common to every participant. The probability that any number in the interval [30, 90] is drawn is the same for all numbers in the interval. Before you choose A or B, you will NOT be informed of Y. You will be given a hint about the number Y. The hint number is drawn from the interval [Y-10, Y+10] randomly for each participant. These hints numbers may be the same or different across participants. You will NOT be informed of any hint number that is given to other participants. The probability that any hint number in the interval [Y-10, Y+10] is drawn is the same for all numbers in the interval. Given your hint number, you have to choose A or B.

If you choose A, you are given 1000 ECU with certainty. If you choose B, two factors would determine whether or not you can obtain a positive payoff: 1) how many participants choose B, and 2) how large is Y. Suppose N participants out of 10 participants choose B. If N $\geq$ 20-Y/4, as a result each of those N participants receives 3000 ECU. If N $<$ 20-Y/4, as a result each of those N participants receives 0 ECU. Once you make decisions for each of all five independent situations, the round is terminated.

Let us state an example. There are 10 participants. From the interval [30, 90], Y=68.65 is drawn. Hint numbers are given to each participant as follows: 58.59, 65.24, 62.67, 76.40, 72.92, 62.25, 71.12, 73.21, 65.52, 69.23. Three participants choose A, while seven participants choose B. Those who have chosen A receive 1,000 ECU. To be able to obtain

3,000 ECU by choosing B, at least 20-Y/4 = 20 - (68.65)/4 = 2.8375 participants (i.e., three or more participant) have to choose B. Since seven participants chose B, each of these seven participants receives 3,000 ECU.

Every time the round is terminated, you are informed of the following: 1) The value of Y in each situation, 2) how many participants chose A or B in each situation, and 3) your payoff in each situation and the sum of your payoff in five situations. The relation between the value of Y and the size of N necessary for successful B is summarized in Table 14.

Do you understand so far the experiment? Please raise your hand if you have any questions. If you see an error message on your computer screen, please raise your hand.

A.3 Experiment 2

In experiment 2, 10 participants are divided evenly into two groups, each of which consists of five participants. Experiment 2 is conducted within each group. You are one of five participants. Among the five participants, there is a powerful participant. (The meaning of this will be explained in detail later.) You will be informed of whether you are powerful or not by the message on your computer.

Five independent situations will be presented on your computer screen (i.e., per round). There will be 10 independent rounds. In each situation, you have to choose A or B. In each of the five situations, a number Y is drawn randomly from the interval [30, 90] respectively. The number Y is common to every participant. The probability that any number in the interval [30, 90] is drawn is the same for all numbers in the interval. Before you choose A or B, you will NOT be informed of Y. You will be given a hint number about Y. The hint number is drawn from the interval [Y-10, Y+10] randomly for each participant. These hint numbers may be the same or different across participants. You are NOT informed of any hint number that is given to other participants. The probability that any hint number in the interval [Y-10, Y+10] is drawn is the same for all numbers in the interval. Given your hint number, you have to choose A or B.

If you choose A, you are given 1000 ECU with certainty. If you choose B, the following three factors determine whether or not you can obtain a positive payoff from choosing B: 1) how many participants choose B, 2) whether or not the powerful participant chooses B, and 3) how large is Y.

How many participants choose B and whether or not the powerful participant chooses B are converted into a number N. If N $\geq$ 20-Y/4, then each of those N participants receives 3000 ECU. If N $<$ 20-Y/4, then each of those N participants receives 0 ECU.

How many participants choose B and whether or not the powerful participant chooses B are converted into a number N. The conversion takes place as follows. 1) Every time one participant who is NOT powerful chooses B, N increases by 1. If one participant chooses B, N increases by 1. If two participants choose B, N increases by 2. If three participants choose B, N increases by 3. If four participants chooses B, N increases by 4. 2) If the powerful participant chooses B, N increases by 6, as the powerful participant has the power of six people. For instance, if two participants who are NOT powerful and the powerful participant choose B, as a result N = 2 + 6 = 8.

Once you make decisions for each of all five independent situations, the round is terminated.

Let us state an example. There are five participants. From the interval [30, 90] Y=58.62 is drawn. Hint numbers are given to each participant as follows: 58.89, 65.24, 62.67, 62.25, and 68.50. The powerful participant and one participant who is not powerful choose B, while remaining three participants choose A. Those who chose A receive 1,000 ECU. To obtain 3,000 ECU by choosing B, N has to be greater than or equal to at least 20-Y/4 = 20-58.62/4 = 5.345. Since the powerful participant and one participant who is not powerful choose B, N = 6 + 1 = 7. Therefore, those who chose B receive 3,000 ECU.

Every time the round is terminated, you are informed of the following. 1) The value of Y in each situation, 2) how many participants chose A or B in each situation, and 3) your payoff in each situation and the sum of your payoff in the five situations. The relationship between the value of Y and the size of N necessary for successful B is summarized in Table 15.

The meaning of figures in parentheses of the table is as follows: (Whether the powerful participant chooses B or not, How many other participants who are not powerful choose B). (1, 2) means that the powerful participant and two other participants choose B. (0, 3) means that the powerful participant chooses A and three other participants choose B.

Do you understand the experiment so far? Please raise your hand if you have any questions. If you see an error message on the screen of your computer, please raise your hand.

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Table 1: Payoff Matrix

	Success	Failure
Attack	$D - c$	$-c$
Not Attack	0	0

Table 2: Experimental Design

Subsample	1	2	3	4	5	6
# of participants	40	30	20	20	10	18
Payoff for A (ECU)	1,000	1,000	1,000	1,000	300	1,000
Payoff for B (ECU)	3,000	3,000	3,000	3,000	3,000	3,000
1st Session	No-Soros	Soros	No-Soros	Soros	No-Soros	No-Soros
Maximum N	10	10	10	10	10	9
Noise in Signal	PI	PI	CI	CI	PI	PI
Size of Soros	6	6	6	6	6	7

Table 3: Descriptive Statistics about the Payment to Each Subject

	Average (JPY)	Std. Dev.	Max (JPY)	Min (JPY)
Subsample 1	2874.750	103.392	3080	2580
Subsample 2	2922.667	172.123	3100	2310
Subsample 3	3247.000	39.636	3290	3150
Subsample 4	3100.500	149.682	3260	2630
Subsample 5	2937.100	120.890	3055	2686
Subsample 6	2950.556	56.517	3070	2870

Table 4: Estimation Results: Subsample 1, 2, 5, and 6 (Obs. Number is 9,800.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-10.468	0.217	0.000
x_i	0.182	0.004	0.000
I[Soros case]	1.352	0.075	0.000
I[Large]	0.542	0.115	0.000

Table 5: Estimation Results: Subsample 1, 2, 5, and 6 (Obs. Number is 9,800.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-10.952	0.230	0.000
x_i	0.190	0.004	0.000
I[Soros case]	1.186	0.086	0.000
I[Large]	0.597	0.144	0.000
I[5]	1.628	0.179	0.000
$I[5] \cdot I$[Soros case]	-0.115	0.261	0.661
$I[5] \cdot I$[Large]	0.152	0.435	0.727
I[6]	-0.567	0.123	0.000
$I[6] \cdot I$[Soros case]	1.260	0.196	0.000
$I[6] \cdot I$[Large]	-0.386	0.276	0.163

Table 6: Estimation Results: Subsample 1 and 2 (Obs. Number is 7,000.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-10.365	0.251	0.000
x_i	0.180	0.004	0.000
I[Soros case]	1.128	0.085	0.000
I[Large]	0.570	0.141	0.000

Table 7: Estimation Results: Subsample 1 (Obs. Number is 4,000.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-12.416	0.410	0.000
x_i	0.214	0.007	0.000
I[Soros case]	1.728	0.126	0.000
I[Large]	0.591	0.197	0.003

Table 8: Estimation Results: Subsample 2 (Obs. Number is 3,000.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-8.701	0.317	0.000
x_i	0.152	0.005	0.000
I[Soros case]	0.533	0.119	0.000
I[Large]	0.592	0.206	0.004

Table 9: Estimation Results: Subsample 1 and 2 (Obs. Number is 7,000.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-10.361	0.259	0.000
x_i	0.182	0.004	0.000
I[Soros case]	0.613	0.128	0.000
I[Large]	0.690	0.222	0.002
I[1]	-0.185	0.106	0.081
$I[1] \cdot I$[Soros case]	0.874	0.168	0.000
$I[1] \cdot I$[Large]	-0.171	0.287	0.553

Table 10: Aggressiveness Order

Most Aggressive	Subject chosen as Soros in subsample 1
	Subject chosen as Soros in subsample 2
	Subject *not* chosen as Soros in subsample 1
	Subject *not* chosen as Soros in subsample 2
	Subject in No-Soros case in subsample 2
Least Aggressive	Subject in No-Soros case in subsample 1

Table 11: Payoff at the Beginning of 2nd Session

Subsample 1	1840.75
Subsample 2	2011.00

Table 12: Estimation Results: All Sample (Obs. Number is 13,800.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-10.467	0.184	0.000
x_i	0.186	0.003	0.000
I[Soros case]	1.156	0.064	0.000
I[Large]	0.464	0.098	0.000

Table 13: Estimation Results: All Sample (Obs. Number is 13,800.)

Variable	**Coefficient**	**Std. Err.**	**P value**
Constant	-10.764	0.191	0.000
x_i	0.187	0.003	0.000
I[Soros case]	1.389	0.075	0.000
I[Large]	0.556	0.117	0.000
I[CI]	0.821	0.092	0.000
I[CI] $\cdot$ I[Soros case]	-0.856	0.135	0.000
I[CI] $\cdot$ I[Large]	-0.322	0.219	0.140

Table 14: Y and N

Range of Y	To obtain the positive payoff from choosing B, Y has to be greater than or equal to:
30.00 $\sim$ 39.99	Y is too small for B to yield the positive payoff.
40.00 $\sim$ 43.99	10
44.00 $\sim$ 47.99	9
48.00 $\sim$ 51.99	8
52.00 $\sim$ 55.99	7
56.00 $\sim$ 59.99	6
60.00 $\sim$ 63.99	5
64.00 $\sim$ 67.99	4
68.00 $\sim$ 71.99	3
72.00 $\sim$ 75.99	2
76.00 $\sim$ 79.99	1
80.00 $\sim$ 90.00	0

Table 15: Y and N

Range of Y	To obtain the positive payoff from choosing B, Y has to be greater than or equal to:	The minimum necessary combination of the powerful participant and other participants in order to attain N
30.00 $\sim$ 39.99	Y is too small for B to yield the positive payoff.	
40.00 $\sim$ 43.99	10	(1, 4)
44.00 $\sim$ 47.99	9	(1, 3)
48.00 $\sim$ 51.99	8	(1, 2)
52.00 $\sim$ 55.99	7	(1, 1)
56.00 $\sim$ 59.99	6	(1, 0)
60.00 $\sim$ 63.99	5	(1, 0)
64.00 $\sim$ 67.99	4	(1, 0) or (0, 4)
68.00 $\sim$ 71.99	3	(1, 0) or (0, 3)
72.00 $\sim$ 75.99	2	(1, 0) or (0, 2)
76.00 $\sim$ 79.99	1	(1, 0) or (0, 1)
80.00 $\sim$ 90.00	0	(0, 0)

Figure 1: Estimation Results : Subsample 1, 2, 5, and 6 (Obs. Number is 9,800.)

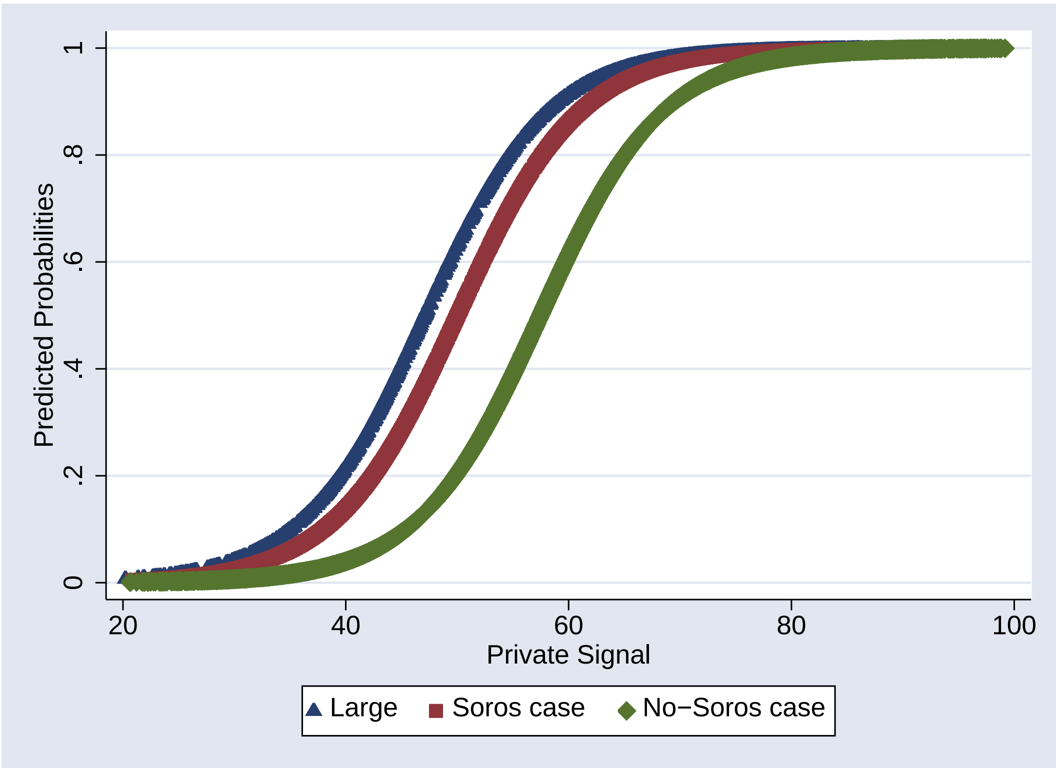

Figure 2: Estimation Results : Subsample 1, 2, 5, and 6 (Obs. Number is 9,800.)

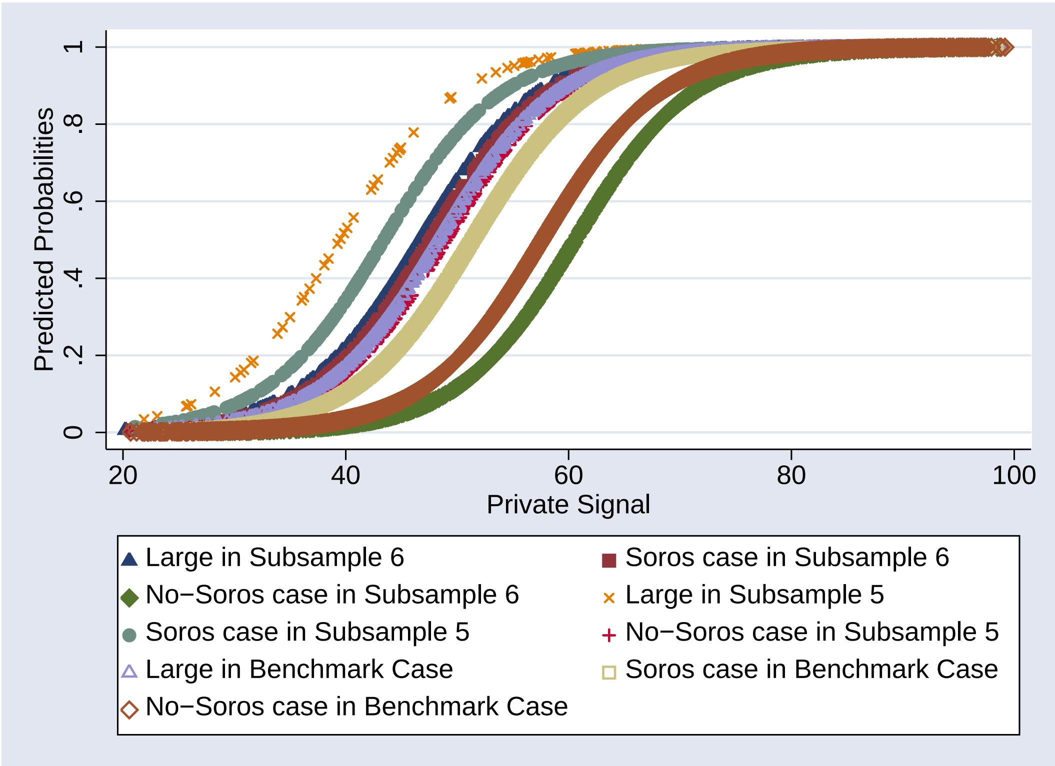

Figure 3: Estimation Results : Subsample 1 and 2 (Obs. Number is 7,000.)

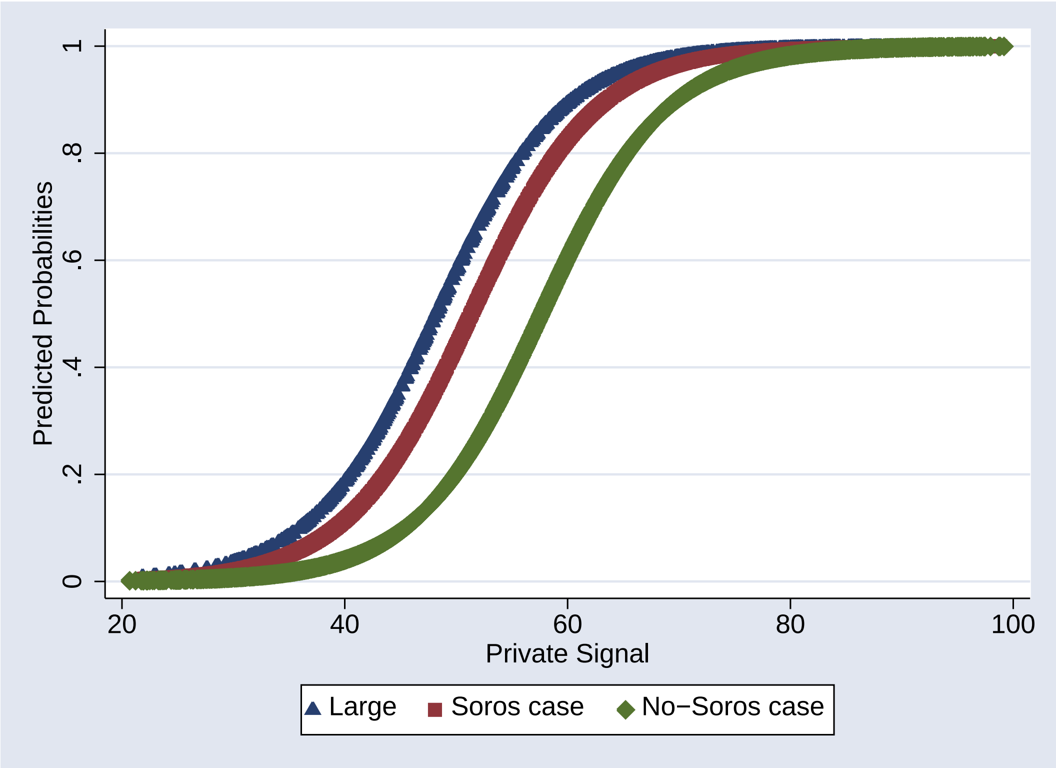

Figure 4: Estimation Results : Subsample 1 (Obs. Number is 4,000.)

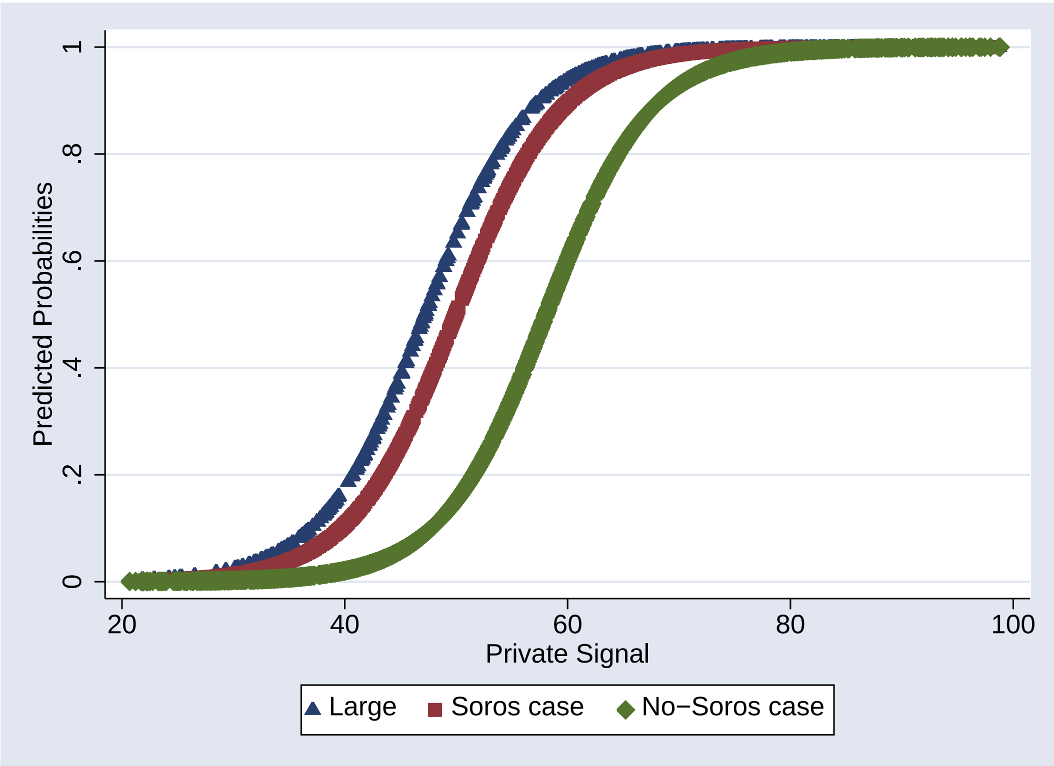

Figure 5: Estimation Results : Subsample 2 (Obs. Number is 3,000.)

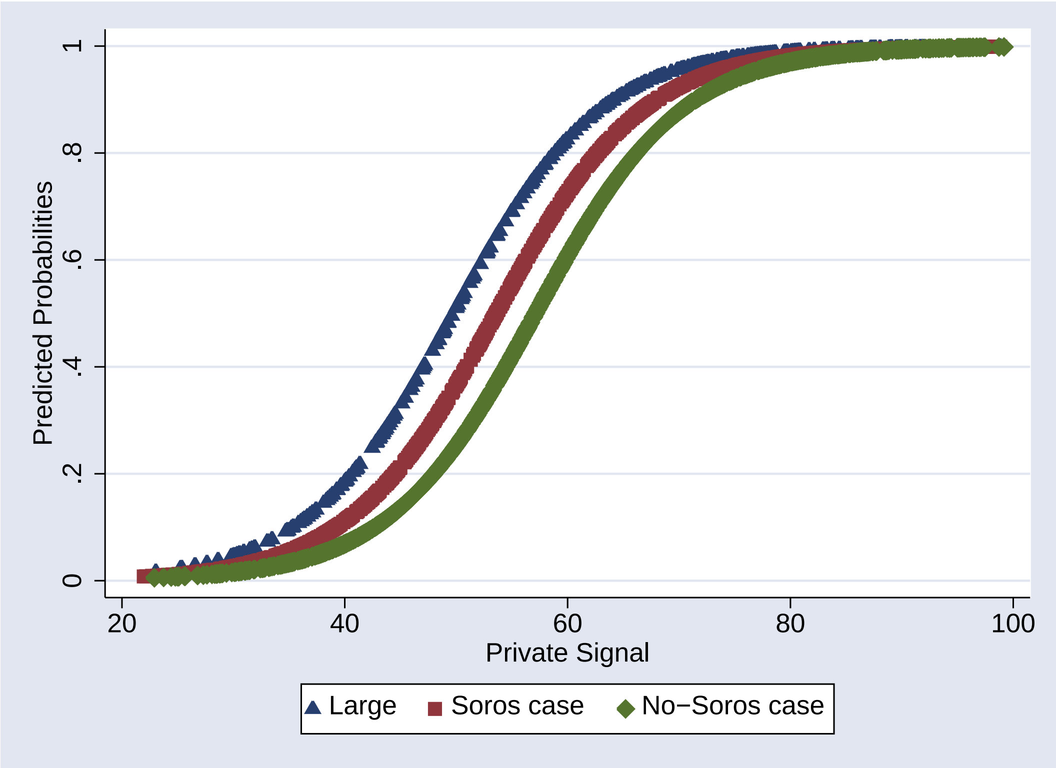

Figure 6: Estimation Results: Subsample 1 and 2 (Obs. Number is 7,000.)

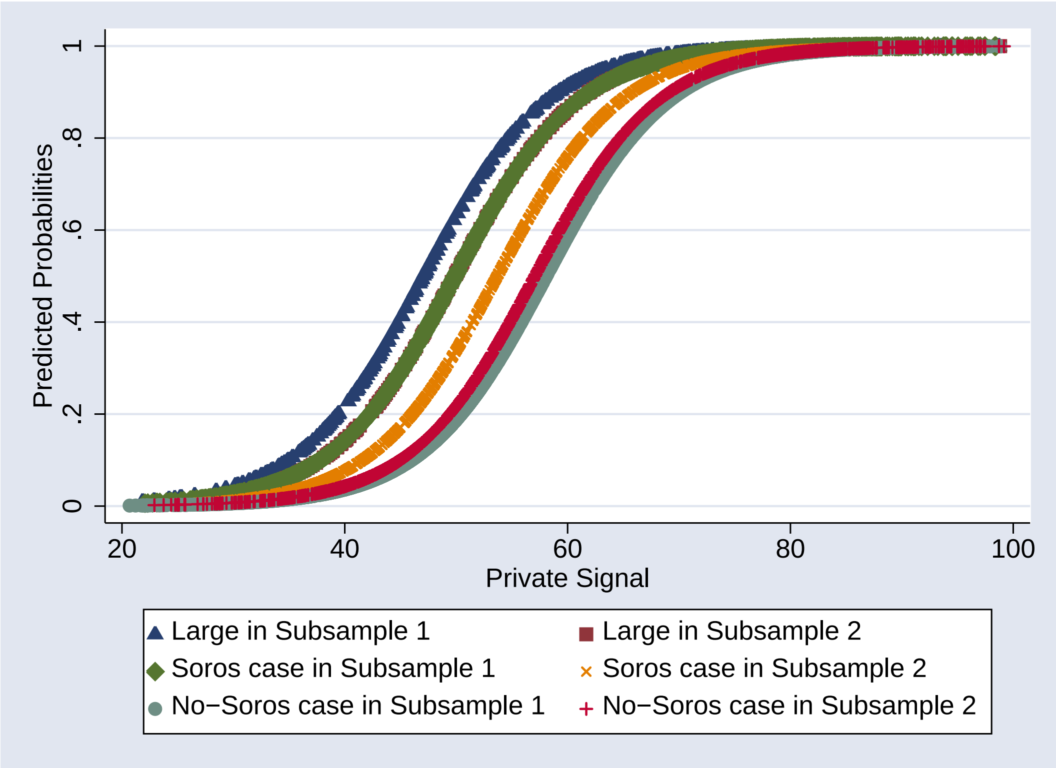

Figure 7: Estimation Results : All Sample (Obs. Number is 13,800.)

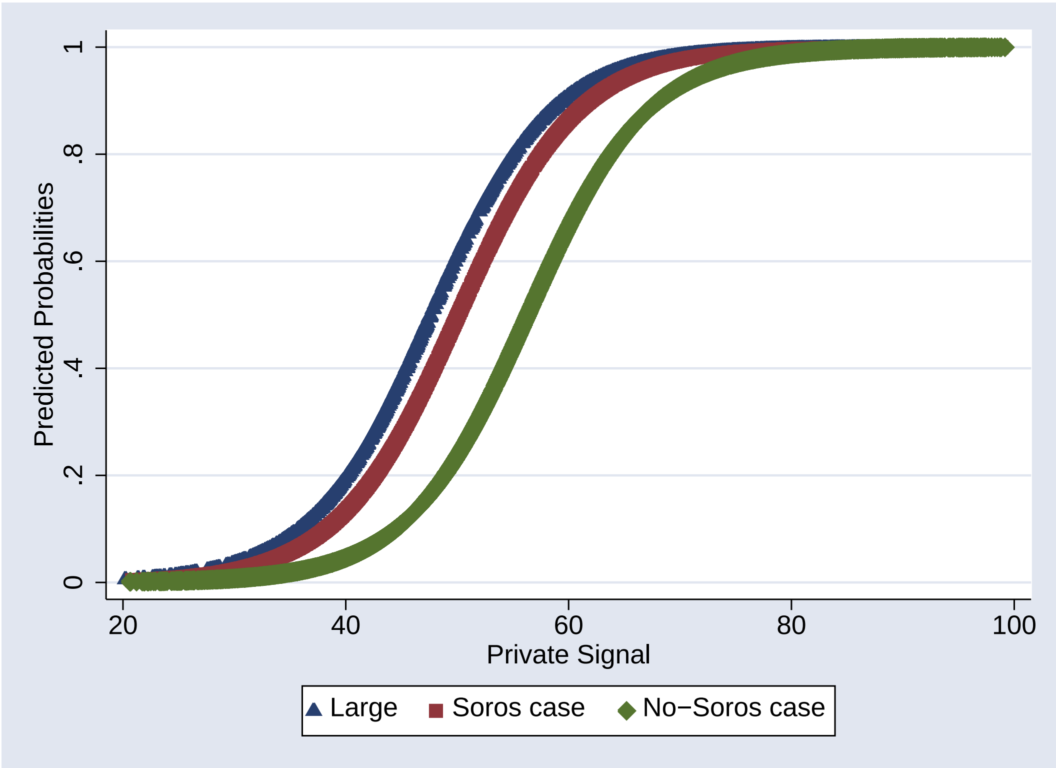

Figure 8: Estimation Results : All Sample (Obs. Number is 13,800.)