Exclusion with Committed Prices And Its Experimental Study*

Xiaomin Bian†

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Abstract

Vertical contracts prohibiting a seller's customers from dealing with rival sellers have been controversial in antitrust economics. In our settings, when the exclusive contract is a bundle of a committed price and a transfer, the incumbent could deter entry successfully by committing a price lower than its cost and charging money from buyers. The incumbent prefers to offer contracts for longer periods since the longer the contract, the harder the potential entrant to enter the market in early periods. Furthermore, we check whether exclusion could be successful in a laboratory experiment and find that successful exclusion is achieved even if participants do not behave on the equilibrium path. When contracts on the equilibrium path are offered, the likelihood of exclusion increases as the robustness of strategic uncertainty increases. Though incumbents do not design contracts on the equilibrium path, they offer contracts to accomplish exclusion. Thus, policies to prohibit exclusion are essential since exclusion is successful both theoretically and experimentally.

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†Department of Economics, The Ohio State University. Email: bian.94@osu.edu.

1 Introduction

Vertical contracts that prohibit a seller's customers from dealing with rival sellers have long been controversial in antitrust economics. Real examples include *United States v. United Shoe Machinery*[1], *Standard Fashion v. Magrane Houston*[2], *EU Commission v. British Airways*[3], and *AMD v. Intel*[4].

The Chicago-school view (Posner, 1976[18]; Bork, 1993[3]) holds that exclusive contracts will not generate profits for an incumbent seller. They argued that the compensation to the buyer is higher than the incumbent seller's monopolist profit, which would incur a loss for the incumbent. Rasmusen, Ramseyer, and Wiley (1991)[19], and Segal and Whinston (2000)[20] (*RRW-SW*) have shown that exclusive contracts can be profitable for the incumbent when there are externalities across buyers. In their settings of scale economies, when a buyer signs an exclusive contract, it imposes a negative externality on all other buyers by reducing the profitability of entry.

Following their papers, many other papers have checked the possibility and cost of exclusion in different settings. When downstream buyers are competitors, the inefficient exclusion is successful when the exclusive contract is a compensation (Fumagalli and Motta, 2006[8]; Simpson and Wichelgren, 2007[21]; Wright, 2008[23]; Abito and Wright, 2008[1]; Wright, 2009[24]; Miklós-Thal and Shaffer, 2016[17]). Other vertical contracts can also result in exclusion, including resale price maintenance (Asker and Bar-Isaac, 2014[2]), loyalty discounts (Fumagalli and Motta 2016[9]; Calzolari and Denicolò, 2020[4]), lump-sum rebates (Ide et al., 2016[12], Chao et al., 2018[5]).

In this paper, we follow the market setting as Fumagalli and Motta (2006)[8] where buyers are Bertrand competitors in the downstream market. The incumbent seller proposes contracts in the form of a committed price and a transfer to downstream buyers. When the game lasts for one period, we have proved that exclusion is always successful and guarantees the incumbent a monopolist profit. In this case, the more efficient seller stays out of the market, and downstream buyers get zero profit. When

1 United States v. United Shoe Machinery Corporation, 89 F. Supp. 357 (D. Mass. 1950).
2 Standard Fashion Co. v. Magrane-Houston Co., 258 U.S. 346, 42 S. Ct. 360, 66 L. Ed. 653 (1922).
3 British Airways plc v. Commission, Case T-219/99, [2003] ECR II-5917.
4 Intel Corp. v. Advanced Micro Devices, Inc., 542 U.S. 241, 124 S. Ct. 2466, 159 L. Ed. 2d 355 (2004).

the game has infinitely many periods, and the incumbent can choose the effective length of the contracts, the incumbent would prefer to offer contracts for longer periods since it becomes more difficult for the potential entrant to enter the market. The incumbent would commit a price lower than his marginal cost to exclude the potential seller and then transfer money from buyers to guarantee his profit. Thus, a policy implication is that the incumbent should be restricted from offering contracts for a long length of contracts. Transfers from buyers to the incumbent before any real transaction should be restricted or prohibited.

Theoretical works have shown that exclusion is successful in many settings. However, participants in the real market may not behave as the equilibrium prediction. A reasonable question is whether real subjects could achieve exclusion successfully. Assuming the incumbent is rational, are buyers able to achieve the exclusion equilibrium the incumbent prefers? When incumbents can design contracts by themselves, what kind of contracts will they design? Are those contracts the equilibrium contracts? Is exclusion still achievable?

In order to check the exclusion behaviors, we designed an experiment to apply the simultaneous one-period game with two buyers in the lab. There are three treatments: *Safe Equilibrium Contract*, *Coordination Equilibrium Contract*, *Incumbent-Design Contract*.

In *Safe Equilibrium Contract* and *Coordination Equilibrium Contract* treatments, the computer acts as the incumbent and offers contracts on the equilibrium path to buyers. In the subgame faced by buyers in *Safe Equilibrium Contract* treatment, there exists only one equilibrium: (Accept, Reject) by Row and Column buyer, respectively. The incumbent excludes successfully and earns the monopolist profit. *Reject* is the dominant strategy for the Column buyer. By knowing this, the Row buyer should choose *Accept*. However, the Row buyer faces the risk of earning a very negative payoff if the Column player trembles hands. In the subgame faced by buyers in *Coordination Equilibrium Contract* treatment, there are two equilibria: (Accept, Reject) and (Reject, Accept). The incumbent prefers (Accept, Reject), which results in the monopolist profit. Nonetheless, (Reject, Accept) is risk dominant for buyers, leading to a negative profit for the incumbent. In *Incumbent-Design Contract* treatment, subjects act as incumbents and propose contracts to buyers.

Our main findings are as follows. First, when buyers are offered safe equilibrium contracts, the likelihood of exclusion increases as the robustness of strategic uncertainty (measured by basins of attraction of *Accept*) of the Row player increases. The rate of accommodating entry is also high. Second, when buyers are offered coordination equilibrium contracts, the incumbent's successful exclusion is rarely achieved. Instead, buyers coordinate on the risk dominant equilibrium (Reject, Accept). Third, when incumbents can propose contracts, the exclusion is successfully achieved but not on the equilibrium path. The incumbent shares profit with buyers to sign both buyers. Risk dominance (Kandori et al., 1993[13]; Young, 1993[25]) and strategic uncertainty (Dal Bó et al., 2021[7]) help to explain participants' choices. Therefore, the exclusion is highly achievable in the lab. Theoretical predictions and experimental results both suggest that restrictions on exclusion are necessary.

Previous experimental literature on exclusive contracts are mainly based on *RRW-SW* and consider coordination game, the impact of an active entrant, and the influence of communication (Landeo and Spier, 2009[15], 2012[16]; Smith, 2011[22]; Kitamura et al., 2018[14]). Our experiment is different from the previous papers. First, the contract in our paper consists of a committed price and a transfer which is more realistic than a mere transfer. Second, buyers in our game are downstream Bertrand competitors rather than final consumers in previous experimental papers. As a result, buyers' risk of making choices increase which leads them to make various decisions. Third, besides successful exclusion and entry, the incumbent in our experiment could achieve unsuccessful exclusion which gives him a negative profit. Therefore, the incumbent designs contracts more cautiously. In addition, there are more options to achieve exclusion, not on the equilibrium path, which makes the question more interesting.

2 Model

In this paper, we follow the market setting as Fumagalli and Motta (2006). The demand for the final product is $Q = 1 - P$. There are two upstream producers of a homogeneous input, an incumbent (I) and a potential entrant (E), and two downstream buyers. Downstream buyers are Bertrand competitors using the input to produce a final good in the downstream market. I can produce the input at a constant marginal cost of c_I. E has a marginal cost of c_E ($c_E = 0 < c_I < \frac{1}{2}$) but need to pay a sunk cost of $F > 0$ to enter the market. We assume $F < \frac{c_I(1-c_I)}{2}$; otherwise E will not enter the market even if there is one free buyer in the market.

The timeline of the game within a given period is summarized below:

1.1. I simultaneously offers buyer 1 (B_1) and buyer 2 (B_2) exclusive contracts: (w_1, x_1) and (w_2, x_2). w_i is the committed price from I to B_i if B_i signs the exclusive contract. x_i is a transfer from I to B_i in exchange for the buyer's promise not to buy from any other input supplier. $i \in \{1, 2\}$.

1.2. B_1 and B_2 simultaneously decide whether to accept or reject the contracts.

2. The potential entrant E decides whether to enter or not.

3. The active upstream firms set prices for downstream buyers. E offers a price of w_E^f to free buyers. I offers a price of w_I^f to free buyers and follows the exclusive contracts for signed buyers.

4. Buyers decide the amount of input to order and compete in the downstream market. It is free for buyers to enter the downstream market.

We assume that if buyers are indifferent between whether to sign the exclusive contract or not, then they will sign it. The equilibrium price for free buyer(s) will be identified adopting the tie-break rule that at equal prices it is the lower-cost firm that takes all the market. In addition, contracts and decisions are observable by all participants in the game. The timeline is also shown in Figure 1.

Proposition 1. *When exclusive contracts are in the form of (w_i, x_i) and the incumbent makes simultaneous offers, in the equilibrium, I proposes the following contracts:*

(1) $(w_i, x_i) = (w_i, -(\frac{1+c_I}{2} - w_i)\frac{1-c_I}{2})$ *where* $w_i \leq \hat{w}$ *to* B_i*;*

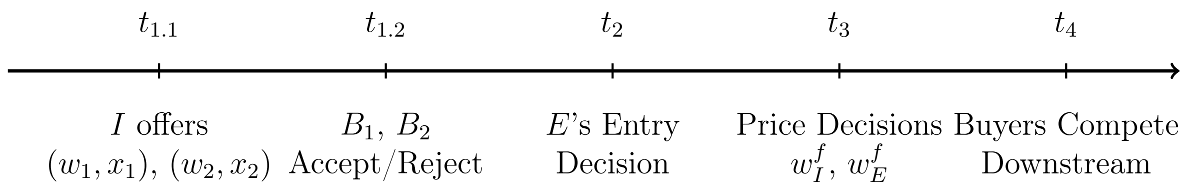


Figure 1: Timeline for 1 Period Simultaneous Game

(2) (w_{-i}, x_{-i}) *where* $w_{-i} \geq w_i$ *and* $x_{-i} \leq 0$,

or (w_{-i}, x_{-i}) *where* $w_{-i} < w_i$ *and* $x_{-i} \leq -(w_i - w_{-i})(1 - w_i)$ *to* B_{-i}*;*

$i \in \{1, 2\}$*.* $\hat{w}$ *satisfies* $\hat{w}\frac{1-\hat{w}}{2} - F = 0$.

B_i *accepts the contract and* B_{-i} *rejects the contract.* E *will not enter the upstream market.* I *earns the monopolist profit* $\frac{(1-c_I)^2}{4}$*.*

Proof. Let us denote $\hat{w}$ the price such that if one buyer signs the contract committing to $\hat{w}$ and the other buyer rejects, it is unprofitable for E to undercut $\hat{w}$ and serves the free buyer. Thus $\hat{w}\frac{1-\hat{w}}{2} - F = 0$, otherwise I will not receive any demand if E drops the price a bit. By assumption, $\hat{w} \in (0, c_I)$.

At $t_{1.2}$, B_1 and B_2 decide simultaneously whether to accept or reject the contracts. Let S denote the number of buyers who sign contracts.

Case 1: B_i rejects (w_i, x_i).

If B_{-i} rejects (w_{-i}, x_{-i}), $\pi^f_{-i} = 0$.

If B_{-i} accepts (w_{-i}, x_{-i}),

$$\pi^s_{-i} = \begin{cases} (w_I^f - w_{-i})(1 - w_I^f) + x_{-i} & if \quad w_{-i} < \hat{w} \\ 0 + x_{-i} & otherwise \end{cases}$$

To make B_{-i} accept the contract,

$$x_{-i} = \begin{cases} -(w_I^f - w_{-i})(1 - w_I^f) & if \quad w_{-i} < \hat{w} \\ 0 & otherwise \end{cases}$$

Case 2: B_i accept (w_i, x_i).

(1) $w_{-i} < w_i$,

If B_{-i} accepts the contract, $\pi^s_{-i} = (w_i - w_{-i})(1 - w_i) + x_{-i}$.

If B_{-i} rejects the contract,

$$\pi^f_{-i} = \begin{cases} (w_i - c_I)(1 - w_i) & if \quad w_i > c_I \\ 0 & otherwise \end{cases}$$

To make B_{-i} accept the contract,

$$x_{-i} = \begin{cases} (1 - w_i)(w_{-i} - c_I) & if \quad w_i > c_I \\ -(w_i - w_{-i})(1 - w_i) & otherwise \end{cases}$$

(2) $w_{-i} \geq w_i$,

If B_{-i} accepts the contract, $\pi^s_{-i} = 0 + x_{-i}$.

To make B_{-i} accept the contract,

$$x_{-i} = \begin{cases} (w_i - c_I)(1 - w_i) & if \quad w_i > c_I \\ 0 & otherwise \end{cases}$$

At $t_{1.1}$, I offers simultaneous contracts to B_1 and B_2.

(1) $S = 0$,

If neither buyer accepts the contract, I's profit is $\pi_{I|S=0} = 0$.

(2) $S = 2$,

If $w_i < w_{-i}$, $\pi_{I|S=2} = (w_i - c_I)(1 - w_{-i}) - x_i - x_{-i}$. $\pi^s_i = (w_{-i} - w_i)(1 - w_{-i}) + x_i$, $\pi^s_{-i} = 0 + x_{-i}$.

To make B_i accept the contract,

$$x_i = \begin{cases} (1 - w_{-i})(w_i - c_I) & if \quad w_{-i} > c_I \\ -(w_{-i} - w_i)(1 - w_{-i}) & otherwise \end{cases}$$

To make B_{-i} accept the contract,

$$x_{-i} = \begin{cases} (w_i - c_I)(1-w_i) & if \quad w_i > c_I \\ 0 & otherwise \end{cases}$$

Thus, the highest possible profit for I is 0.

If $w_i = w_{-i}$, to sign both buyers,

$$x_i = \begin{cases} (w_{-i} - c_I)(1-w_{-i}) & if \quad w_{-i} > c_I \\ 0 & otherwise \end{cases}$$

Thus, the highest possible profit for I is 0 when both buyers sign the contracts.

(3) $S = 1$, If B_i accepts the contract and B_{-i} rejects the contract,

$$\pi_i^s = \begin{cases} (w_I^f - w_i)(1-w_I^f) + x_i & if \quad w_i < \hat{w} \\ 0 + x_i & otherwise \end{cases}$$

$$x_i = \begin{cases} -(w_I^f - w_i)(1-w_I^f) & if \quad w_i < \hat{w} \\ 0 & otherwise \end{cases}$$

$$\pi_{-i}^f = \begin{cases} (w_i - c_I)(1-w_i) & if \quad w_i > c_I \\ 0 & if \quad otherwise \end{cases}$$

The profit for I is

$$\pi_{I|S=1} = \begin{cases} 0 & if \quad w_i > c_I \\ (w_i - c_I)\frac{1-w_i}{2} & if \quad \hat{w} \le w_i \le c_I \\ (1-w_I^f)(w_I^f - c_I) & if \quad w_i < \hat{w} \end{cases}$$

The highest possible profit for I is $\pi_{I|S=1} = \frac{(1-c_I)^2}{4}$ with $w_I^f = \frac{1+c_I}{2}$. Thus, I always prefers one buyer to sign the contract and the other buyer to reject the contract. In equilibrium, I will offer B_i a contract $(w_i, x_i) = (w_i, -(\frac{1+c_I)}{2} - w_i)\frac{1-c_I}{2})$ where $w_i \le \hat{w}$ to accept. B_{-i} will be offered two types of contracts: (w_{-i}, x_{-i}) where $w_{-i} \ge w_i$ and

$x_{-i} \leq 0$; (w_{-i}, x_{-i}) where $w_{-i} < w_i$ and $x_{-i} \leq -(w_i - w_{-i})(1 - w_i)$. B_{-i} rejects the contract. The potential entrant will not enter the market and the incumbent earns the monopolist profit.

$\square$

As long as I commits a price $w_i \leq \hat{w}$ and B_i accepts it, I deters the entry of E. Since B_1 and B_2 are Bertrand competitors in the downstream market, I designs transfers that make one buyer accept the contract and the other buyer reject the contract. The buyer who accepts the contract earns the monopolist profit in the downstream market $\pi_B^M = -(\frac{1+c_I}{2} - \hat{w})\frac{1-c_I}{2}$ where $w_I^f = \frac{1+c_I}{2}$ is I's price to the free buyer in the upstream market. I will transfer π_B^M from the signed buyer and earn the monopolist profit $\frac{(1-c_I)^2}{4}$.

3 Experimental Design

In the previous section, we have seen that exclusion is successful, and the incumbent can earn the monopolist profit when exclusive contracts are offered simultaneously[5]. However, one may argue that participants in the real market do not behave as the equilibrium prediction. As a result, exclusion might be hard to achieve, and efficient entry is still possible. On the one hand, buyers may safer choices to accommodate entry. On the other hand, the incumbent could offer contracts different from the equilibrium contracts which result in entry. Successful exclusion is achieved only if the incumbent deters entry and earns a positive profit. Thus, we design an experiment to check whether exclusion is successful and who can make profits from it. Are contracts offered on the equilibrium path? If exclusion fails, what are the possible reasons?

Following our settings in the model, the final market has a demand function $Q = 100 - P$. The incumbent can produce the input at a constant marginal cost of $c_I = 40$. The potential entrant has a marginal cost of $c_E = 0$ and needs to pay an entry cost $F = 1050$ to enter the market. In this case, the price $\hat{w}$ that can make the entrant just willing to enter the market and serve one buyer is $\hat{w} = 30$. In the equilibrium, I proposes the following contracts:

[5] More results on sequential games are shown in Appendix A.

(1) $(w_i, x_i) = (w_i, -(70 - w_i) * 30)$ where $w_i \leq 30$ to B_i;

(2) (w_{-i}, x_{-i}) where $w_{-i} \geq w_i$ and $x_{-i} \leq 0$,

or (w_{-i}, x_{-i}) where $w_{-i} < w_i$, and $x_{-i} \leq -(w_i - w_{-i})(100 - w_i)$ to B_{-i};

B_i accepts the contract and B_{-i} rejects the contract.

Since there are many possible equilibria in this game, we would only choose one set of equilibria to run the experiment[6]. The set of equilibria we chose was:

(1) I proposes $(w_R, x_R) = (30, -1200)$ to B_R, the Row Player;

(2) I proposes $(w_C, x_C) = (30, x_C)$ where $x_C \leq 0$ to B_C, the Column Player;

B_R accepts the contract and B_C rejects the contract. E will not enter the market. I earns the monopolist profit $\frac{(100-c_I)^2}{4} = 900$. The index for Row and Column players could be switched.

There are two types of equilibria in this game. One type of equilibrium (*Safe Equilibrium*) has $(w_R, x_R) = (30, -1200)$ and $(w_C, x_C) = (30, x_C)$ where $x_C \leq -1200$. One example of the subgame faced by buyers is shown in Table 1[7]. In this equilibrium, the Row Player accepts (w_R, x_R) and the Column Player rejects (w_C, x_C). (Accept, Reject) is the only equilibrium of the whole game[8].

Table 1: Payoffs for *Safe Equilibrium* ($x_C = -1200$)

	Accept	Reject
Accept	$(-1200 + \epsilon, -1200 - \epsilon)$	$(\epsilon, 0)$
Reject	$(0, -\epsilon)$	$(0, 0)$

$\epsilon > 0$, $\epsilon \to 0$.

The other type of equilibrium (*Coordination Equilibrium*) has $(w_R, x_R) = (30, -1200)$ and $(w_C, x_C) = (30, x_C)$ where $-1200 < x_C \leq 0$. In the equilibrium of the whole game, the Row Player accepts (w_R, x_R) and the Column Player rejects (w_C, x_C), i.e., (Accept, Reject). However, in the subgame faced by buyers, there are two equilibria: (Accept, Reject) and (Reject, Accept). Both equilibria result in exclusion. However, (Accept,

[6] This is mainly for Treatment 1 and Treatment 2.

[7] In the experiment, subjects have 200 points to start which is not shown in the table.

[8] In theory, (Accept, Reject) is the only equilibrium. In Table 1, $\epsilon \to 0$ is used to implement the only equilibrium.

Reject) grants the incumbent a monopolist profit while (Reject, Accept) results in a negative profit for the incumbent. One example of the subgame faced by buyers is shown in Table 2.

Table 2: Payoffs for *Coordination Equilibrium* ($x_C = 0$)

	Accept	Reject
Accept	$(-1200 + \epsilon, -\epsilon)$	$(\epsilon, 0)$
Reject	$(0, 1200 - \epsilon)$	$(0, 0)$

$\epsilon > 0$, $\epsilon \to 0$.

In the experiment, the computer acts as the potential entrant whose entry depends on the decisions made by the incumbent and buyers. It is a successful exclusion when the entry is deterred, and the incumbent earns a positive profit. When the entry is deterred, and the incumbent earns a negative profit, it is a failed exclusion. Each subject has 200 points (1 U.S. cent/point) to start[9]. There are three treatments. Instructions can be found in Appendix B.

In Treatment 1, the computer acts as the rational incumbent and offers only *Safe Equilibrium* contracts. $w_R = w_C = 30$. The Row Buyer's transfer is randomly drawn from the set $S_R = \{-1200, -1100, -1000, -900\}$ and the Column Buyer's transfer is randomly drawn from the set $S_C = \{-1200, -1300, -1400, -1500\}$. In this case, only one equilibrium exists in the subgame of buyers, i.e., (Accept, Reject), for most transfer combinations. The exclusion is successful, and the incumbent achieves the monopolist profit. In the case when either $x_R = -1200$ or $x_C = -1200$, there exist other equilibria. Two subjects are randomly paired in each period and act as either Row or Column buyers. Buyers decide whether to accept or reject their contracts simultaneously after seeing their contracts. There are 30 rounds. In the first 15 rounds, buyers could see both their contracts and the contract to the paired buyer. In the second 15 rounds, buyers can only see their own contracts. However, subjects know that if their transfers come from $S_R(S_C)$, their paired subjects' transfers must come from $S_C(S_R)$.

[9] This amount is the reservation payment. We will include this reservation payment in following data analysis.

In Treatment 2, the computer still acts as the rational incumbent and offers *Coordination Equilibrium* contracts to buyers. $w_R = w_C = 30$. The Row Buyer's transfer is randomly drawn from the set $S_R = \{-1200, -1100, -1000, -900\}$ and the Column Buyer's transfer is randomly drawn from the set $S_C = \{0, -100, -200, -300\}$. In this case, the only equilibrium of the whole game is (Accept, Reject), which achieves successful exclusion and a monopolist profit for the incumbent. However, there are two equilibria in buyers' subgame: (Accept, Reject) and (Reject, Accept). Though both equilibria of the subgame result in exclusion, exclusion achieved by (Accept, Reject) is preferred by the incumbent since the incumbent can achieve the monopolist profit. However, the exclusion achieved by (Reject, Accept) results in the incumbent a negative profit: $-300 - x_C \leq 0$. There are 30 rounds. In the first 15 rounds, buyers could see both their contracts and the contract to the paired buyer. In the second 15 rounds, buyers can only see their own contracts. However, subjects know that if their transfers come from $S_R(S_C)$, their paired subjects' transfers must come from $S_C(S_R)$.

In Treatment 3, one subject acts as the incumbent, and two subjects act as buyers. The roles are fixed throughout the experiment. The incumbent is asked to design contracts for the two buyers. There are 20 rounds. In each round, one incumbent is randomly grouped with two buyers. The incumbent is given the possible choice sets of prices and transfers. $w_R, w_C \in \{0, 10, 20, 30, 40, 50, 60, 70\}$. $x_R, x_C \in \{-1400, -1300, \ldots, 1100, 1200\}$. For each possible pair of contracts proposed, the incumbent will be given the payoff information for him and the two buyers based on the acceptance and rejection decisions of the two buyers. After seeing both contracts, the two buyers decide whether to accept or reject the contracts simultaneously. The payoffs for participants are shown in Table 3.

The online experiment was programmed and conducted using oTree (Chen et al., 2016[6]). Subjects were primarily from the undergraduate student population at The Ohio State University, recruited through ORSEE (Greiner, 2004[10]). There were three sessions for each treatment. There were 58 subjects in Treatment 1, 60 subjects in Treatment 2, and 60 subjects (20 subjects acted as incumbents) in Treatment 3. Each session lasted for around 40 minutes, averaging \$11.4 per subject, including a \$5 show-

Table 3: Payoffs in Treatment 3

R and C both *Accept*	$w_R \geq w_C$	$\pi_I = (w_C - 40)(100 - w_R) - x_R - x_C$ $\pi_R = x_R$ $\pi_C = (w_R - w_C)(100 - w_R) + x_C$
	$w_R < w_C$	$\pi_I = (w_R - 40)(100 - w_C) - x_R - x_C$ $\pi_R = (w_C - w_R)(100 - w_C) + x_R$ $\pi_C = x_C$
R *Accept*, C *Reject*	$w_R \leq 30$	$\pi_I = (w_R - 40) * 30 - x_R$ $\pi_R = (70 - w_R) * 30 + x_R$ $\pi_C = 0$
	$30 < w_R < 40$	$\pi_I = (w_R - 40)\frac{100-w_R}{2} - x_R$ $\pi_R = x_R$ $\pi_C = 0$
	$w_R \geq 40$	$\pi_I = -x_R$ $\pi_R = x_R$ $\pi_C = (w_R - 40)(100 - w_R)$
R and C both *Reject*	w_R, w_C	$\pi_I = 0$ $\pi_R = 0$ $\pi_C = 0$

up fee.

4 Results

4.1 Buyers' Choices with Safe Equilibrium

In Treatment 1, buyers are offered safe equilibrium contracts on the equilibrium path. $w_R = w_C = 30$, $x_R \in \{-1200, -1100, -1000, -900\}$, $x_C = \{-1200, -1300, -1400, -1500\}$. The only equilibrium is (Accept, Reject) for most transfer combinations.

The robustness to strategic uncertainty of the equilibrium (Accept, Reject) can be measured by the maximum probability of the other buyer choosing *Accept* that makes *Accept* a best response. Let p be the maximum probability of Row Player choosing *Accept* which makes Column Player *Accept* as a best response. Let q be the maximum probability of Column Player choosing *Accept* which makes Row Player *Accept* a best response. The probability combination (p, q) measures the basin of attraction of *Accept* for both buyers. The basins of attraction of Treatment 1 are shown in Table 4 [10][11][12]. A higher q (p) means *Accept* is more attractive for the Row (Column) buyer.

Table 4: Basins of Attraction in Treatment 1

		Column Offer			
		-1200	-1300	-1400	-1500
Row Offer	-1200	(0, 0)	$(-\frac{1}{12}, 0)$	$(-\frac{1}{6}, 0)$	$(-\frac{1}{4}, 0)$
	-1100	$(0, \frac{1}{12})$	$(-\frac{1}{12}, \frac{1}{12})$	$(-\frac{1}{6}, \frac{1}{12})$	$(-\frac{1}{4}, \frac{1}{12})$
	-1000	$(0, \frac{1}{6})$	$(-\frac{1}{12}, \frac{1}{6})$	$(-\frac{1}{6}, \frac{1}{6})$	$(-\frac{1}{4}, \frac{1}{6})$
	-900	$(0, \frac{1}{4})$	$(-\frac{1}{12}, \frac{1}{4})$	$(-\frac{1}{6}, \frac{1}{4})$	$(-\frac{1}{4}, \frac{1}{4})$

(Accept, Reject) is the only equilibrium when $p \neq 0$ and $q \neq 0$. When either $p = 0$ or $q = 0$, there exists more than one equilibrium. When $q = 0$, the other equilibrium is (Reject, Reject). When $p = 0$, the other equilibrium is (Reject, Accept). The rates of choosing (Accept, Reject) are shown in Table 5.[13] Although (Accept, Reject) is the only equilibrium for most basins of attraction, the rate of choosing it is still low, from 50% to 80%. For given p, the rate of choosing (Accept, Reject) increases as q increases. Table 6 shows the rate of choosing (Reject, Reject), from 20% to 50%. For given p, the rate of choosing (Reject, Reject) increases as q decreases.

Result 1. *Exclusion is not always achieved when the incumbent offers safe contracts*

[10] The rates of Row Offers been drawn are: $P(-1200) = 23.68\%$, $P(-1100) = 25.06\%$, $P(-1000) = 26.43\%$, $P(-900) = 24.83\%$. There is no difference in the frequencies of Row Offers.

[11] The rates of Column Offers been drawn are: $P(-1200) = 24.37\%$, $P(-1300) = 25.63\%$, $P(-1400) = 25.40\%$, $P(-1500) = 24.60\%$. There is no difference in the frequencies of Column Offers.

[12] Two-Tailed Wilcoxon tests will be used unless indicated otherwise.

[13] In Round 1 to Round 15, buyers could see the other buyer's contract. In Round 16 to Round 30, buyers could only see their contracts. There is no difference between public contracts rounds and private contracts rounds ($p = 0.8923$). So we combine the data.

Table 5: Rate of Choosing $(Accept, Reject)$ in Treatment 1

		q			
		0	$\frac{1}{12}$	$\frac{1}{6}$	$\frac{1}{4}$
p	0	50.2%	56.2%	70.1%	72.7%
	$-\frac{1}{4}$	52.3%	58.4%	67.8%	76.4%
	$-\frac{1}{6}$	51.4%	60.1%	71.3%	79.5%
	$-\frac{1}{12}$	53.2%	58.2%	69.5%	78%

Table 6: Rate of Choosing $(Reject, Reject)$ in Treatment 1

		q			
		0	$\frac{1}{12}$	$\frac{1}{6}$	$\frac{1}{4}$
p	0	45.3%	42.3%	33.2%	23.5%
	$-\frac{1}{4}$	43.9%	40.1%	31.4%	21.5%
	$-\frac{1}{6}$	44.1%	36.9%	26.9%	19.2%
	$-\frac{1}{12}$	42.5%	40.4%	29.3%	21.2%

on the equilibrium path. The rate of entry is high. The rate of successful exclusion increases as the basin of attraction of Accept increases for Row buyers.

Since $p \leq 0$, *Reject* is the dominant strategy for Column Player. Column Players in this treatment almost always choose *Reject*, with a rate of 98.7%. By knowing this, the Row Player should choose to *Accept* the contract. However, we have seen a large rate of choosing *Reject* by Row Players. Risk dominance cannot explain the choice of *Reject* by Row Players since (Accept, Reject) is risk dominant.

We run a Probit regression to check the impact of basins of attraction on choosing $(Accept, Reject)$. The dependent variable is 1 if (Accept, Reject) is chosen and 0 otherwise. The independent variables are p, q, and their cross effect. The results are reported in Table 7. The Probit regression result on $(Reject, Reject)$ is also shown in Table 7. There is no impact of p. There are strong marginal effects for choosing (Accept, Reject) and (Reject, Reject) following the increase of the basin of attraction of *Accept* for Row players (q) and the cross effect $p*q$. As a result, strategy uncertainty of the Row player explains the high rate of accommodating entry.

Table 7: Marginal Effect of Exclusion and Entry in Treatment 1

	$(Accept, Reject)$	$(Reject, Reject)$
p	0.0243	0.0154
	(1.11)	(0.95)
q	0.6711***	-0.4329***
	(4.77)	(3.65)
$p * q$	-0.06235***	-0.7812***
	(3.29)	(2.19)
Observations	870	870

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 2. *The basin of attraction for Column buyers choosing Accept does not influence the high rate of accommodating entry. Nevertheless, strategic uncertainty (measured by the size of the basin of attraction of Accept) of the Row player has a strong effect on Row player's choosing Accept. Exclusion is more likely to achieve as the basin of attraction of Row player increases.*

4.2 Buyers' Choices with Coordination Equilibria

In Treatment 2, buyers are offered coordination equilibria contracts on the equilibrium path. $w_R = w_C = 30$, $x_R \in \{-1200, -1100, -1000, -900\}$, $x_C \in \{0, -100, -200, -300\}$. There are two equilibria in the subgame faced by buyers: (Accept, Reject) and (Reject, Accept). (Accept, Reject) is a part of the equilibrium of the whole game since it leads to successful exclusion. (Reject, Accept) results in failed exclusion since the incumbent earns a negative profit $-300 - x_C \leq 0$. The basins of attraction (p, q) of this treatment are shown in Table 8[14][15].

[14] The rates of Row Offers been drawn are: $P(-1200) = 22.22\%$, $P(-1100) = 26.22\%$, $P(-1000) = 24.11\%$, $P(-900) = 27.45\%$. There is no difference in the frequencies of Row Offers.

[15] The rates of Column Offers been drawn are: $P(0) = 23.34\%$, $P(-100) = 26.44\%$, $P(-200) = 25.22\%$, $P(-300) = 25\%$. There is no difference in the frequencies of Column Offers.

Table 8: Basins of Attraction in Treatment 2

		Column Offer			
		0	-100	-200	-300
Row Offer	-1200	(1, 0)	$(\frac{11}{12},0)$	$(\frac{5}{6},0)$	$(\frac{3}{4}, 0)$
	-1100	$(1,\frac{1}{12})$	$(\frac{11}{12}, \frac{1}{12})$	$(\frac{5}{6}, \frac{1}{12})$	$(\frac{3}{4}, \frac{1}{12})$
	-1000	$(1, \frac{1}{6})$	$(\frac{11}{12}, \frac{1}{6})$	$(\frac{5}{6}, \frac{1}{6})$	$(\frac{3}{4}, \frac{1}{6})$
	-900	$(1, \frac{1}{4})$	$(\frac{11}{12}, \frac{1}{4})$	$(\frac{5}{6}, \frac{1}{4})$	$(\frac{3}{4}, \frac{1}{4})$

Following Harsanyi and Selten (1988)[11], (Reject, Accept) is always risk dominant for buyers than (Accept, Reject). In other words, (Reject, Accept) is more robust to strategic uncertainty than (Accept, Reject). The average rate of successful exclusion, i.e., choosing (Accept, Reject), is shown in Table 9. The rate of choosing (Accept, Reject) is meager, from 3% to 7%, and is not influenced by p or q. The rate of failed exclusion, i.e., choosing (Reject, Accept), is shown in Table 10. Most buyers coordinate on this risk dominant equilibrium. For a given p, the rate of choosing (Accept, Reject) decreases as q increases.

Table 9: Rate of Choosing (Accept, Reject) in Treatment 2

		q			
		0	$\frac{1}{12}$	$\frac{1}{6}$	$\frac{1}{4}$
p	$\frac{3}{4}$	3.42%	5.67%	5.82%	6.08%
	$\frac{5}{6}$	4.04%	4.91%	5.85%	5.76%
	$\frac{11}{12}$	3.78%	5.43%	6.12%	5.98%
	1	4.79%	5.81%	6.23%	6.46%

The Probit regressions of choosing the two equilibria are shown in Table 11. The incumbent's preferred equilibrium, i.e., choosing (Accept, Reject), is not influenced by basins of attraction (p, q). However, the unsuccessful exclusion is significantly impacted by basins of attraction (p, q). There are strong marginal effects for choosing (Reject, Accept) following the increase of the basin of attraction of *Accept* for Row players (q) and the cross effect $p * q$. Since (Reject, Accept) is always risk dominant compared with

Table 10: Rate of Choosing (Reject, Accept) in Treatment 2

		q			
		0	$\frac{1}{12}$	$\frac{1}{6}$	$\frac{1}{4}$
p	$\frac{3}{4}$	85.7%	79.3%	76.5%	73.2%
	$\frac{5}{6}$	88.9%	78.6%	75.3%	72.3%
	$\frac{11}{12}$	86.3%	79.2%	78.2%	74.1%
	1	84.6%	80.1%	77.8%	72%

(Accept, Reject), risk dominance cannot explain the less choices of (Reject, Accept) as q increases. Thus, strategic uncertainty explains the choices of unsuccessful exclusion.

Table 11: Marginal Effect of Exclusion in Treatment 2

	Successful Exclusion ($Accept, Reject$)	Unsuccessful Exclusion ($Reject, Accept$)
p	0.0047	0.0262
	(0.88)	(1.24)
q	0.0023	0.8922***
	(1.03)	(3.82)
$p * q$	0.00018	-0.1428***
	(0.89)	(2.84)
Observations	900	900

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 3. *Exclusion is achieved with a high probability when the incumbent offers coordination equilibrium contracts. However, an unsuccessful exclusion that the incumbent earns a negative profit occurs much more frequently. Strategic uncertainty can explain the high rate of choosing (Reject, Accept).*

4.3 Incumbents' Choices

Our results in Treatment 1 and Treatment 2 show that successful exclusion is not easy to realize when contracts on the equilibrium path are offered. Buyers' strategic uncertainty accommodates entry or results in unsuccessful exclusion. Another possible reason for the low rate of exclusion is that we assume a rational incumbent whose contracts are designed to maximize his profit. In this case, one buyer's transfer is always -1200, making it risky for the buyer to accept the contract as long as he is strategically uncertain about the other buyer's choice. Though incumbents are more experienced than buyers in real life, they may still design different contracts rather than contracts on the equilibrium path. We want to check what kind of contracts will be proposed by the incumbent and how exclusion is achieved.

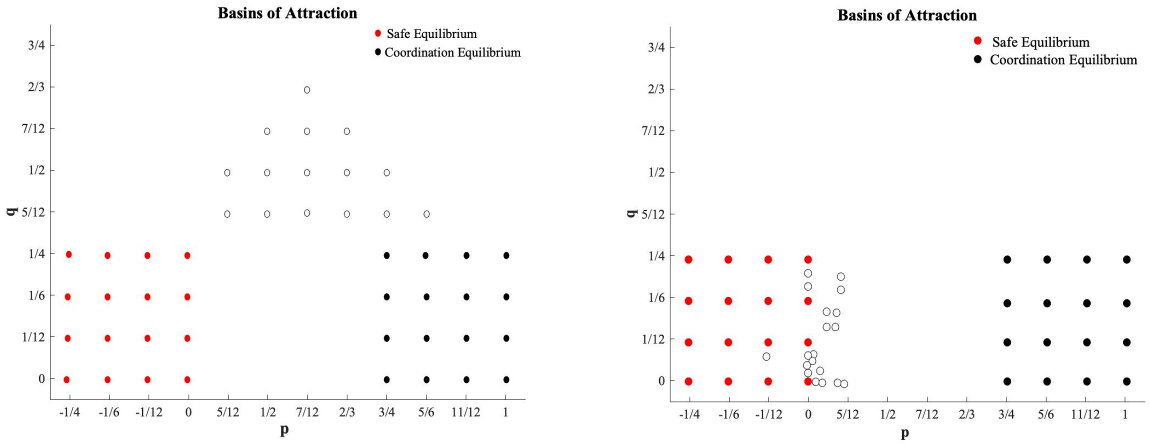
In Treatment 3, the incumbent can propose (w_R, x_R) and (w_C, x_C) to the two buyers. $w_R, w_C \in \{0, 10, 20, \ldots, 60, 70\}$ where 70 is the monopoly price. $x_R, x_C \in \{-1400, -1300, \ldots, 0, 100, \ldots, 1200\}$. The payoff table is shown in Table 3.

Since the incumbent can design any contract bundles, we first check whether incumbents propose contracts on the equilibrium path. The equilibrium contracts contain at least one committed price $w_R \leq 30$ (or $w_C \leq 30$) and one transfer $x_R = -1200$ (or $x_C = -1200$). However, no incumbent in our experiment proposes equilibrium contracts. Figure 2 shows basins of attraction when the incumbent proposes at least one committed price no more than 30 compared to Safe Equilibrium in Treatment 1 and Coordination Equilibrium in Treatment 2.

To understand what kinds of contracts are proposed by incumbents, we categorize all contracts designed by incumbents based on the committed prices. The rate of proposing $w_R \leq 30$ and $w_C \leq 30$ is 20.25%. The rate of proposing $w_R > 30$ and $w_C \geq 30$ is 31.5%. The rate of proposing $w_R > 30$ and $w_C > 30$ is 48.25% which is significantly more than the other two types of price commitments[16]. The price commitments proposed by incumbents are shown in Table 12. As shown in Table 12, exclusion is most successful when $w_R > 30$ and $w_C > 30$ with a rate of 84.45%[17]. In this case, the committed prices

[16] 20.25% v.s. 48.25%, $p = 0.043$. 31.5% v.s. 48.25%, $p = 0.051$.

[17] 84.45% v.s. 22.22%, $p = 0.000$. 84.45% v.s. 56.35%, $p = 0.013$.



(a) $w_R \leq 30$, $w_C \leq 30$

(b) $w_R > 30$, $w_C \leq 30$

Figure 2: Basins of Attraction for $w_i \leq 30$

are from the set $\{50, 60, 70\}$, transfers are from the set $\{0, 100, 200, 300, 400\}$, and both buyers accept the contracts. Basins of attraction are shown in Figure 3. However, when $w_R \leq 30$ and $w_C \leq 30$, buyers mostly reject the contracts and accommodate entry.

Table 12: Exclusion and Entry on Price Commitments in Treatment 3

	$w_R \leq 30$, $w_C \leq 30$ (20.25%) $x_R < 0$, $x_C < 0$	$w_R > 30$, $w_C \leq 30$ (31.5%) $x_C < 0$	$w_R > 30$, $w_C > 30$ (48.25%) $x_R > 0$, $x_C > 0$
Successful Exclusion	22.22%	56.35%	84.45%
Failed Exclusion	4.94%	3.17%	11.4%
Entry	72.84%	40.48%	4.15%
Diff. (Success-Failed)	17.28%**	53.18%***	73.05%***
Diff. (Success-Entry)	50.61%***	15.87%**	80.3%***
Diff. (Failed-Entry)	67.9%***	37.31%***	6.9%*

*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Result 4. *When incumbents can design contracts, they frequently propose contracts with committed prices higher than marginal cost and positive transfers. Buyers are willing to both accept the contracts, and successful exclusion is achieved. Nevertheless, price*

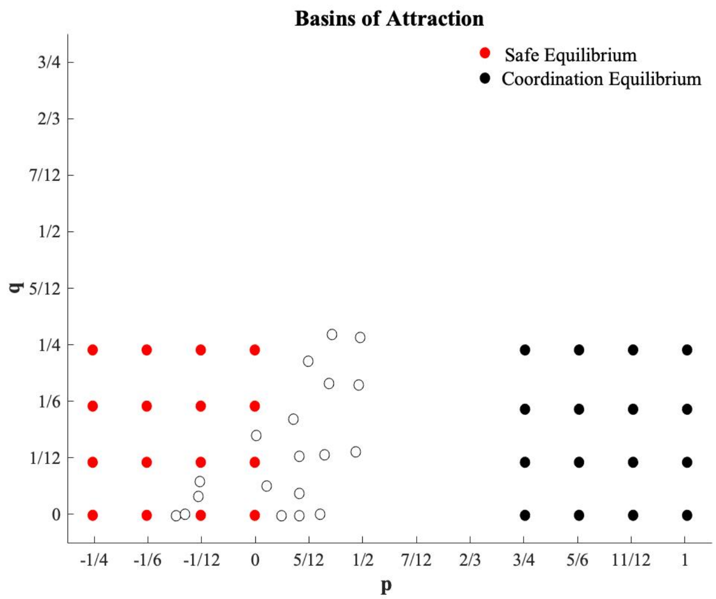


Figure 3: Basins of Attraction for $w_R > 30$, $w_C > 30$

commitments and transfers on the equilibrium path results in low rates of successful exclusion.

On the equilibrium path, the incumbent earns the monopolist profit $\pi_I^M = 900$, and both buyers earn 0. In Table 13, we summarize price commitments and transfers offered by incumbents and the average payoffs of participants. When incumbents can propose contracts, the average payoffs for incumbents decrease while the average payoffs for buyers increase compared with the equilibrium. When $w_R > 30$ and $w_C > 30$, a high rate of successful exclusion leads to the highest average profit for incumbents and buyers.

Result 5. *When incumbents can design contracts, contracts with committed prices higher than marginal cost and positive transfers result in the highest profits for incumbents and buyers.*

When $w_R > 30$ and $w_C > 30$, we have seen a high rate of successful exclusion and the highest average profits for incumbents and buyers. However, incumbents and buyers are both making "mistakes." On the one hand, to earn the monopolist profit $\pi_I^M = 900$, the incumbent should propose contracts on the equilibrium path. On the

Table 13: Price Commitments and Transfers in Treatment 3

w_R, w_C	x_R, x_C	Average Payoff
$w_R \leq 30$, $w_R \leq 30$	$x_R \in \{-700, -600, -500, -400, -300, -200\}$ $x_C \in \{-700, -600, -500, -400, -300, -200\}$	$\pi_I = 99.54$ $\pi_R = \pi_C = 56.29$
$w_R > 30$, $w_R \leq 30$	$x_R \in \{-500, -400, \ldots, 300, 400\}$ $x_C \in \{-700, -600, \ldots, -200, -100\}$	$\pi_I = 132.2$ $\pi_R = 23.19$, $\pi_C = 36.42$
$w_R > 30$, $w_C > 30$	$x_R \in \{0, 100, 200, 300, 400\}$ $x_C \in \{0, 100, 200, 300, 400\}$	$\pi_I = 219.56$ $\pi_R = \pi_C = 67.83$

other hand, a buyer B_i who rejects the contract will earn $(w_{-i} - 40)(100 - w_{-i}) > x_i$. The results chosen by incumbents and buyers come from their strategic uncertainty.

Result 6. *Strategic uncertainty restrains incumbents from proposing contracts on the equilibrium path and buyers from rejecting the contracts to earn higher profits.*

5 Summary and Conclusion

This paper has shown the exclusion results when the contracts are in a committed price and a transfer, both theoretically and experimentally. The main takeaway is that exclusion is highly likely to be successful in both theoretical and experimental settings. When participants are assumed to be rational in the theoretical setting, the incumbent earns the monopolist profit while buyers and the potential entrant earn nothing. Although participants do not behave as theoretical predictions in experimental settings, the exclusion is still achieved at a high rate where the incumbent and buyers share the profit. As a result, policies to detect and restrain exclusive contracts are necessary to accommodate the more efficient seller and benefit final consumers.

Note that there is no active potential entrant in our experiment, resulting in subjects sharing profits in Treatment 3. It is interesting to check the impact of an active potential entrant. Also, the behaviors of incumbents and buyers in Treatment 3 are worth analyzing. Why could they achieve exclusion successfully though deviation leads to higher profit?

Appendix

A Sequential Contracts

In this appendix, we consider the model in Section 2 where contracts to the two buyers are offered sequentially.

A.1 One-Period Case

The timeline of the game within a given period is summarized below:

1.

1.1. I offers buyer 1 (B_1) an exclusive contract (w_1, x_1), where w_1 is the committed price from I to B_1 if B_1 signs the exclusive contract, x_1 is a transfer from I to B_1 in exchange for the buyer's promise not to buy from any other input supplier.

1.2. B_1 decides whether to accept or reject the contract.

1.3. I offers buyer 2 (B_2) an exclusive contract (w_2, x_2).

1.4. B_2 decides whether to accept or reject the contract.

2. The potential entrant E decides whether to enter or not.

3. The active upstream firms set prices for downstream buyers. E offers a price of w_E^f to free buyers. I offers a price of w_I^f to free buyers and follows the exclusive contracts for signed buyers.

4. Buyers decide the amount of input to order and compete in the downstream market. It is free for buyers to enter the downstream market.

The other assumptions are the same as in Section 2. The timeline is also shown in Figure 4.

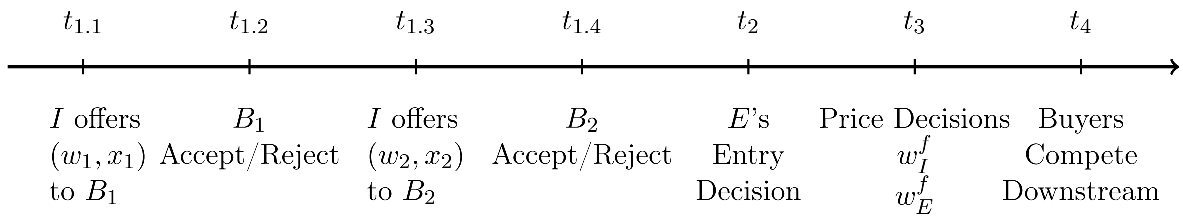


Figure 4: Timeline for 1 Period Sequential Game

Proposition 2. *When exclusive contracts are in the form of* (w_i, x_i) *and the incumbent makes sequential offers, equilibria are as follows:*

(1) I proposes $(w_1, x_1) = (w_1, -(\frac{1+c_I}{2} - w_1)\frac{1-c_I}{2})$ *where* $w_1 \leq \hat{w}$ *to* B_1*;* (w_2, x_2) *where* $w_2 \geq w_1$ *and* $x_2 \leq 0$*.* B_1 *accepts the contract and* B_2 *rejects the contract.*

(2) I proposes $(w_1, x_1) = (w_1, x_1)$ *where* $w_1 \geq w_2$ *and* $x_1 \leq -(\frac{1+c_I}{2} - w_1)\frac{1-c_I}{2})$*;* $(w_2, x_2) = (w_2, -(\frac{1+c_I}{2} - w_2)\frac{1-c_I}{2})$ *where* $w_2 \leq \hat{w}$*.* B_1 *rejects the contract and* B_2 *accepts the contract.*

E will not enter the upstream market. I earns the monopolist profit $\frac{(1-c_I)^2}{4}$*.*

Proof. Let us denote $\hat{w}$ such that $\hat{w}\frac{1-\hat{w}}{2} - F = 0$. By assumption, $\hat{w} \in (0, c_I)$.

At t_4, the buyer who can buy the input at a lower price will serve the downstream market. If they buy the input at the same price, they share the downstream market.

At t_3, I will set $w_I^f \geq c_I$ regardless of E's entry decision at t_2. Let S denote the number of buyers who sign contracts at t_1. If $S = 0$, E enters and sets $w_E^f = c_I$. If $S = 2$, E will not enter and $w_E^f \in [0, \infty)$. When $S = 1$, B_i signs the contract (w_i, x_i). E's entry decision depends on w_i. If $w_i < \hat{w}$, E will not enter, $w_E^f \in [0, \infty)$. If $w_i = \hat{w}$, E enters and $w_E^f = \hat{w}$. If $w_i > \hat{w}$, E enters and $w_E^f = \min\{c_I, w_i\}$.

At $t_{1.4}$, B_2 decides whether to accept or reject the contract.

Case 1: B_1 rejects (w_1, x_1).

In this case, B_2's payoff is $\pi_2^f = 0$ if B_2 also rejects. If B_2 accepts the contract,

$$\pi_2^s = \begin{cases} (w_I^f - w_2)(1 - w_I^f) + x_2 & if \quad w_2 < \hat{w} \\ 0 + x_2 & otherwise \end{cases}$$

To make B_2 accept the contract,

$$x_2 = \begin{cases} -(w_I^f - w_2)(1 - w_I^f) & if \quad w_2 < \hat{w} \\ 0 & otherwise \end{cases}$$

Case 2: B_1 accepts (w_1, x_1).

(1) $w_2 < w_1$

If B_2 accepts (w_2, x_2), B_2 will control the downstream market and set the price at w_1. The profit of B_2 is $\pi_2^s = (w_1 - w_2)(1 - w_1) + x_2$.

If B_2 rejects (w_2, x_2),

$$\pi_2^f = \begin{cases} (w_1 - c_I)(1 - w_1) & if \quad w_1 > c_I \\ 0 & otherwise \end{cases}$$

To make B_2 accept the contract,

$$x_2 = \begin{cases} (1 - w_1)(w_2 - c_I) & if \quad w_1 > c_I \\ -(w_1 - w_2)(1 - w_1) & otherwise \end{cases}$$

(2) $w_2 \geq w_1$

If B_2 accepts the contract, two buyers will share the downstream market. $\pi_2^s = 0 + x_2$.

If B_2 rejects (w_2, x_2),

$$\pi_2^f = \begin{cases} (w_1 - c_I)(1 - w_1) & if \quad w_1 > c_I \\ 0 & otherwise \end{cases}$$

To make B_2 accept the contract,

$$x_2 = \begin{cases} (w_1 - c_I)(1 - w_1) & if \quad w_1 > c_I \\ 0 & otherwise \end{cases}$$

At $t_{1.3}$, I decides the contract (w_2, x_2) offered to B_2.

Case 1: B_1 rejects (w_1, x_1).

I's profit if B_2 rejects the contract is $\pi_I^r = 0$.

I's profit if B_2 accepts (w_2, x_2),

$$\pi_I^s = \begin{cases} 0 = \pi_I^r & if \quad w_2 > c_I \\ (w_2 - c_I)\frac{1-w_2}{2} \leq \pi_I^r & if \quad \hat{w} \leq w_2 \leq c_I \\ (1 - w_I^f)(w_I^f - c_I) \geq \pi_I^r & if \quad w_2 < \hat{w} \end{cases}$$

Case 2: B_1 accepts (w_1, x_1).

I's profit if B_2 rejects (w_2, x_2) is

$$\pi_I^r = \begin{cases} 0 - x_1 & if \quad w_1 > c_I \\ (w_1 - c_I)\frac{1-w_1}{2} - x_1 & if \quad \hat{w} \leq w_1 \leq c_I \\ (w_1 - c_I)(1 - w_I^f) - x_1 & if \quad w_1 < \hat{w} \end{cases}$$

I's profit if B_2 accepts the contract,

(1) $w_2 \leq w_1$,

$$\pi_I^s = \begin{cases} -x_1 = \pi_I^r & if \quad w_1 > c_I \\ (1 - w_1)(w_1 - c_I) - x_1 \leq \pi_I^r & if \quad w_1 \leq c_I \end{cases}$$

(2) $w_2 > w_1$,

$$\pi_I^s = \begin{cases} (w_1 - c_I)(w_1 - w_2) - x_1 < \pi_I^r & if \quad w_1 > c_I \\ (w_1 - c_I)(1 - w_2) - x_1 = \pi_I^r & if \quad w_1 = c_I \\ (w_1 - c_I)(1 - w_2) - x_1 & if \quad w_1 < c_I \end{cases}$$

Thus, I is always willing to sign one buyer with the committed price of $w_i < \hat{w}$ to exclude E and earn the monopolist profit.

At $t_{1.2}$, B_1 decides whether to accept or reject (w_1, x_1). If B_1 rejects the contract, the payoff for B_1 is 0 since I will offer $w_2 < \hat{w}$ to exclude E. If B_1 accepts the contract,

I will always design a contract that B_2 rejects. B_1 is willing to accept the contract only if the payoff $(w_I^f - w_1)(1 - w_I^f) + x_1 \geq 0$.

At $t_{1.1}$, I decides the contract offered to B_1. In one equilibrium, $(w_1, x_1) = (w_1, -(\frac{1+c_I}{2} - w_1)\frac{1-c_I}{2})$ where $w_1 \leq \hat{w}$, (w_2, x_2) where $w_2 \geq w_1$ and $x_2 \leq 0$. B_1 accepts the contract and B_2 rejects the contract. In another equilibrium, $(w_2, x_2) = (w_2, -(\frac{1+c_I}{2} - w_2)\frac{1-c_I}{2})$ where $w_2 \leq \hat{w}$, and (w_1, x_1) where $w_1 \geq w_2$ and $x_1 \leq -(\frac{1+c_I}{2} - w_1)\frac{1-c_I}{2}$. B_1 rejects the contract and B_2 accepts the contract. In both equilibria, E will not enter the upstream market. I's profit is $\pi_I = \frac{(1-c_I)^2}{4}$, which is the monopolist profit.

□

A.2 Infinite Periods

We now consider a game with infinite many periods in which there are two types of states, which we denote M (monopolist) and C (competition). The game starts in state M at the first period. In this period, only the incumbent is active in the market initially, and the potential entrant has to decide whether to enter the market or not. The timing within a period starting in state M is the same as A.2.

When the state changes to C, i.e., E is in the market, the incumbent and the potential entrant simultaneously set w_I^f and w_E^f. Two buyers decide the amount of input to order and compete in the downstream market. As long as the state changes to C, E will stay in the market in all later periods. The discount factor is $\delta \in (0, 1)$.

Proposition 3. *When the incumbent can offer exclusive contacts in each period, and the game lasts for infinitely many periods, entry occurs in Period 1 for* $\delta \geq \frac{F}{c_I(1-c_I)+F}$. *When* $\delta < \frac{F}{c_I(1-c_I)+F}$, *entry is deterred forever.*

Proof. When the state changes to C, $w_E^f = w_I^f = c_I$. E will serve both buyers. The profit of E in each period is $\pi_E^C = c_I(1 - c_I)$. The state will stay in C for later periods. The total profit for the entrant when the state changes to C is $\frac{1}{1-\delta}\pi_E^C$.

I's profit of exclusion is $\frac{(1-c_I)^2}{4}$ regardless of its committed prices. Thus, to guarantee the profit, I could offer the contracts $(w_1, x_1) = (0, -\frac{(1-c_I)^2}{4})$ and $(w_2, x_2) = (0, 0)$.

If E enters in Period 1, the profit of E is $-F$. If $-F + \frac{\delta}{1-\delta}c_I(1 - c_I) \geq 0$, i.e.

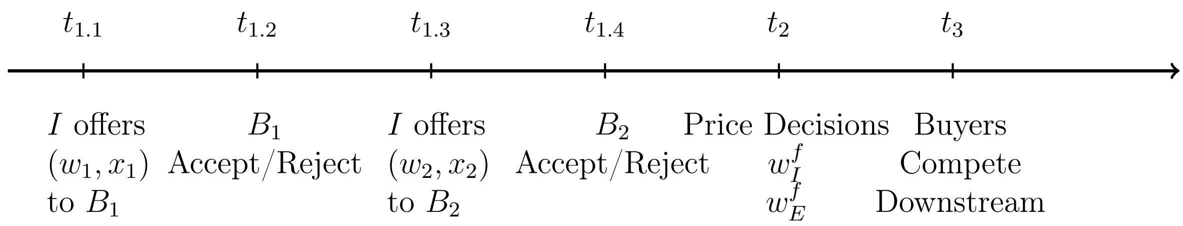


Figure 5: Timeline when E enters the market

$\delta \geq \frac{F}{c_I(1-c_I)+F}$, E will enter the market in Period 1. If $\delta < \frac{F}{c_I(1-c_I)+F}$, E will not enter the market and I monopolizes the upstream market. The profit of I is $\frac{1}{1-\delta}\frac{(1-c_I)^2}{4}$.

If $\delta \geq \frac{F}{c_I(1-c_I)+F}$, E is willing to enter in Period 1 and charge $w_E^f = 0$. The timeline in the first period is shown in Figure 5.

At t_2,

(1) If $S = 0$, $w_E^f = w_I^f = c_I$, $\pi_E^f = c_I(1-c_I) - F$. $\pi_1 = \pi_2 = 0$.

(2) If $S = 2$, $w_E^f \in [0, \infty)$, $w_I^f \in [0, \infty)$.

(3) If $S = 1$, B_i signs (w_i, x_i).

If $w_i > c_I$, $w_E^f = c_I$, $\pi_E = c_I(1-w_i) - F$. $\pi_i = 0 + x_i$, $\pi_{-i} = (w_i - c_I)(1-w_i)$.

If $w_i = c_I$, $w_E^f = c_I$, $\pi_E = \frac{c_I(1-c_I)}{2} - F$. $\pi_i = 0 + x_i$, $\pi_{-i} = 0$.

If $w_i < c_I$, $w_E^f = w_i$, $\pi_E = w_i\frac{1-w_i}{2} - F$. $\pi_i = 0 + x_i$, $\pi_{-i} = 0$.

At $t_{1.4}$, B_2 decides whether to accept or reject the contract.

Case 1: B_1 rejects (w_1, x_1).

If B_2 rejects the contract, $\pi_2^f = 0$. If B_2 accepts the contract, $\pi_2^s = 0 + x_2$. To make B_2 accept the contract, $x_2 = 0$.

Case 2: B_1 accepts (w_1, x_1).

(1) $w_2 < w_1$

If B_2 accepts (w_2, x_2), $\pi_2^s = (w_1 - w_2)(1-w_1) + x_2$.

If B_2 rejects (w_2, x_2),

$$\pi_2^f = \begin{cases} (w_1 - c_I)(1-w_1) & if \quad w_1 > c_I \\ 0 & if \quad w_1 \leq c_I \end{cases}$$

To make B_2 accept the contract,

$$x_2 = \begin{cases} (1-w_1)(w_2-c_I) & if \quad w_1 > c_I \\ -(w_1-w_2)(1-w_1) & if \quad w_1 \le c_I \end{cases}$$

(2) $w_2 \ge w_1$

If B_2 accepts the contract, $\pi_2^s = 0 + x_2$.

If B_2 rejects (w_2, x_2),

$$\pi_2^f = \begin{cases} (w_1-c_I)(1-w_1) & \quad w_1 > c_I \\ 0 & if \quad w_1 \le c_I \end{cases}$$

To make B_2 accept the contract,

$$x_2 = \begin{cases} (w_1-c_I)(1-w_1) & if \quad w_1 > c_I \\ 0 & if \quad w_1 \le c_I \end{cases}$$

At $t_{1.3}$, I decides the contract (w_2, x_2) offered to B_2.

Case 1: B_1 rejects (w_1, x_1).

I's profit if B_2 rejects the contract is $\pi_I^r = 0$.

I's profit if B_2 accepts the contract is

$$\pi_I^s = \begin{cases} 0 = \pi_I^r & if \quad w_2 > c_I \\ (w_2-c_I)\frac{1-w_2}{2} \le \pi_I^r & if \quad w_2 \le c_I \end{cases}$$

Case 2: B_1 accepts (w_1, x_1).

I's profit if B_2 rejects (w_2, x_2) is

$$\pi_I^r = \begin{cases} 0 - x_1 & if \quad w_1 \ge c_I \\ (w_1-c_I)\frac{1-w_1}{2} - x_1 & if \quad w_1 < c_I \end{cases}$$

I's profit if B_2 accepts (w_2, x_2),

(1) $w_2 \leq w_1$,

$$\pi_I^s = \begin{cases} -x_1 = \pi_I^r & if \quad w_1 > c_I \\ (1-w_1)(w_1-c_I) - x_1 \leq \pi_I^r & if \quad w_1 \leq c_I \end{cases}$$

(2) $w_2 > w_1$,

$$\pi_I^s = \begin{cases} (w_1-c_I)(w_1-w_2) - x_1 < \pi_I^r & if \quad w_1 > c_I \\ (w_1-c_I)(1-w_2) - x_1 & if \quad w_1 \leq c_I \end{cases}$$

At $t_{1.2}$, B_1 decides whether to accept or reject (w_1, x_1).

Case 1: B_1 rejects (w_1, x_1)

If B_2 also rejects the contract, $\pi_1^f = 0$.

If B_2 accepts (w_2, x_2),

$$\pi_1^f = \begin{cases} (w_2-c_I)(1-w_2) & if \quad w_2 > c_I \\ 0 & if \quad w_2 \leq c_I \end{cases}$$

Case 2: B_1 accepts (w_1, x_1)

(1) $w_2 \leq w_1$

If B_2 also accepts the contract, $\pi_1^s = 0 + x_1$. To make B_1 accept the contract,

$$x_1 = \begin{cases} (w_2-c_I)(1-w_2) & if \quad w_2 > c_I \\ 0 & if \quad w_2 \leq c_I \end{cases}$$

If B_2 rejects the contract, $\pi_1^s = 0 + x_1$. To make B_1 accept the contract, $x_1 = 0$.

(2) $w_2 > w_1$

If B_2 accepts the contract, $\pi_1^s = (w_2 - w_1)(1 - w_2) + x_1$. To make B_1 accept the contract,

$$x_1 = \begin{cases} (1-w_2)(w_1-c_I) & if \quad w_1 > c_I \\ -(w_2-w_1)(1-w_2) & if \quad w_1 \leq c_I \end{cases}$$

If B_2 rejects the contract, $\pi_1^s = 0 + x_1$. To make B_1 accept the contract, $x_1 = 0$.

At $t_{1.1}$, I decides the contract offered to B_1. In the case B_1 rejects the contract, $\pi_I^r = 0$ if B_2 also rejects. If B_2 accepts the contract, the highest possible profit for I is also 0.

At $t_{1.1}$, in the case when B_1 accepts (w_1, x_1). If B_2 rejects (w_2, x_2),

$$\pi_I^r = \begin{cases} 0 & if \quad w_1 \geq c_I \\ (w_1 - c_I)\frac{1-w_1}{2} < 0 & if \quad w_1 < c_I \end{cases}$$

If B_2 accepts (w_2, x_2),

(1) $w_2 < w_1$

$$\pi_I^s = \begin{cases} (1 - w_1)(w_1 - c_I) < 0 & if \quad w_1 < c_I \\ -(w_2 - c_I)(1 - w_2) < 0 & if \quad c_I < w_2 < w_1 \\ 0 & otherwise \end{cases}$$

(2) $w_2 = w_1$

$$\pi_I^s = \begin{cases} (w_1 - c_I)(1 - w_1) \leq 0 & if \quad w_1 \leq c_I \\ -(w_1 - c_I)(1 - w_1) < 0 & if \quad w_1 > c_I \end{cases}$$

(3) $w_2 > w_1$

$$\pi_I^s = \begin{cases} (w_1 - c_I)(w_1 - 1) < 0 & if \quad w_1 > c_I \\ (1 - w_2)(w_2 - c_I) \leq 0 & if \quad w_1 \leq c_I \end{cases}$$

'Thus, the highest possible profit can be earned by I is 0. Thus, when $\delta \geq \frac{F}{c_I(1-c_I)+F}$, E enters the market in the first period. The total profit for E is

$$\pi_E = \begin{cases} -F + \frac{\delta}{1-\delta}c_I(1 - c_I) & if \quad \text{both buyers accept } I\text{'s contracts} \\ -F + \frac{1}{1-\delta}c_I(1 - c_I) & if \quad \text{both buyers reject } I\text{'s contracts} \\ -F + \frac{c_I(1-c_I)}{2} + \frac{\delta}{1-\delta}c_I(1 - c_I) & if \quad \text{one buyer accepts } I\text{'s contracts} \end{cases}$$

The total profit for I is 0. $\square$

Since I can always offer the contracts with a committed price of 0, E will only enter if E can bear $w_E^f = 0$. When E enters the market, $\pi_E^C = c_I(1-c_I)$ for each later period. Thus, E can bear zero profit in Period 1 when the discount factor is large, i.e. $\delta \geq \frac{F}{c_I(1-c_I)+F}$. As a result, the exclusion is hard to achieve when the game lasts for infinitely many periods, and exclusive contracts are offered in each period.

Now we extend this infinite game and require the incumbent to offer effective contracts every two periods. In this case, the potential entrant can either enter in the first or second periods. The state is C when both buyers can buy from either I or E in the market.

Proposition 4. *When exclusive contracts can be offered by the incumbent every two periods and the game lasts for infinitely many periods, entry occurs in the first period if $\frac{\delta^2}{1-\delta}c_I(1-c_I) \geq F$ and entry occurs in the second period if $\frac{\delta^2}{1-\delta}c_I(1-c_I) < F < \frac{\delta}{1-\delta}c_I(1-c_I)$. When $\delta \leq \frac{F}{c_I(1-c_I)+F}$, entry is deterred forever.*

Proof. When the state changes to C, i.e. both buyers are free in the market, $w_I^f = w_E^f = c_I$. The total profit for E when the state changes to C is $\frac{1}{1-\delta}c_I(1-c_I)$.

If $\delta < \frac{F}{c_I(1-c_I)+F}$, i.e. $\delta(-F + \frac{\delta}{1-\delta}c_I(1-c_I)) < 0$, E will not enter the market since I will offer $(w_1, x_1) = (0, -\frac{(1-c_I)^2}{4})$ and $(w_2, x_2) = (0, 0)$ to monopolize the upstream market. The profit for I is $\frac{1}{1-\delta}\frac{(1-c_I)^2}{4}$.

If $\frac{\delta^2}{1-\delta}c_I(1-c_I) \geq F$, E is willing to enter in the first period and bears two periods' zero profit. The results would be similar to Proposition 3. I's profit is always 0. In the equilibrium, the two buyers could both accept the contracts, both reject the contracts or only one accept the contract. E earns positive profit.

If $-F + \frac{\delta}{1-\delta}c_I(1-c_I) \geq 0$, i.e. $\delta \geq \frac{F}{c_I(1-c_I)+F}$, E is willing to enter the market and bears one period's zero profit. In this case, I will set $w_I^f = \frac{1+c_I}{2}$, i.e. the monopolist price in the first period since there is no competitor in the upstream market.

B_2 decides whether to accept (w_2, x_2) or not in the first period.

Case 1: B_1 rejects (w_1, x_1).

If B_2 also rejects (w_2, x_2), $\pi_2^f = 0$. If B_2 accepts (w_2, x_2), $\pi_2^s = (\frac{1+c_I}{2} - w_2)\frac{1-c_I}{2} + (1+\delta)x_2$. Thus, $x_2 = \frac{1}{1+\delta}(w_2 - \frac{1+c_I}{2})\frac{1-c_I}{2}$ to sign B_2.

Case 2: B_1 accepts (w_1, x_1).

(1) If $w_2 < w_1$,

If B_2 accepts the contract, $\pi_2^s = (1+\delta)((w_1 - w_2)(1-w_1) + x_2)$. If B_2 rejects the contract,

$$\pi_2^f = \begin{cases} \delta(w_1 - c_I)(1-w_1) & if \quad w_1 > c_I \\ 0 & if \quad w_1 \leq c_I \end{cases}$$

$$x_2 = \begin{cases} (1-w_1)(\frac{\delta}{1+\delta}(w_1 - c_I) - (w_1 - w_2)) & if \quad w_1 > c_I \\ -(w_1 - w_2)(1-w_1) & if \quad w_1 \leq c_I \end{cases}$$

(2) If $w_2 \geq w_1$,

If B_2 accepts the contract, $\pi_2^s = (1+\delta)x_2$. If B_2 rejects the contract,

$$\pi_2^f = \begin{cases} \delta(w_1 - c_I)(1-w_1) & if \quad w_1 > c_I \\ 0 & if \quad w_1 \leq c_I \end{cases}$$

$$x_2 = \begin{cases} \frac{\delta}{1+\delta}(w_1 - c_I)(1-w_1) & if \quad w_1 > c_I \\ 0 & if \quad w_1 \leq c_I \end{cases}$$

I decides (w_2, x_2) to B_2.

Case 1: B_1 rejects (w_1, x_1).

If B_2 rejects the contract, I's profit is $\pi_I^r = \frac{(1-c_I)^2}{4}$.

If B_2 accepts the contract, I's profit is

$$\pi_I^s = \begin{cases} \frac{(1-c_I)^2}{4} & if \quad w_2 \geq c_I \\ \frac{(1-c_I)^2}{4} + \delta(w_2 - c_I)\frac{1-w_2}{2} < \pi_I^r & if \quad w_2 < c_I \end{cases}$$

Case 2: B_1 accepts (w_1, x_1). If B_2 rejects the contract, I's profit is

$$\pi_I^r = \begin{cases} \frac{1-c_I}{2}(w_1 - c_I) - (1+\delta)x_1 & if \quad w_1 \geq c_I \\ \frac{1-c_I}{2}(w_1 - c_I) + \delta(w_1 - c_I)\frac{1-w_1}{2} - (1+\delta)x_1 & if \quad w_1 < c_I \end{cases}$$

(1) If $w_2 < w_1$ and B_2 accepts the contract,

$$\pi_I^s = \begin{cases} (1-w_1)(w_1 - c_I) - (1+\delta)x_1 & if \quad w_1 > c_I \\ (1+\delta)(1-w_1)(w_1 - c_I) - (1+\delta)x_1 & if \quad w_1 \leq c_I \end{cases}$$

(2) If $w_2 = w_1$ and B_2 accepts the contract,

$$\pi_I^s = \begin{cases} (w_1 - c_I)(1-w_1) - (1+\delta)x_1 & if \quad w_1 > c_I \\ (1+\delta)(w_1 - c_I)(1-w_1) - (1+\delta)x_1 & if \quad w_1 \leq c_I \end{cases}$$

(3) If $w_2 > w_1$ and B_2 accepts the contract,

$$\pi_I^s = \begin{cases} (w_1 - c_I)(1-w_2)(1+\delta) - \delta(w_1 - c_I) - (1+\delta)x_1 & if \quad w_1 > c_I \\ (1+\delta)(w_1 - c_I)(1-w_2) - (1+\delta)x_1 & if \quad w_1 \leq c_I \end{cases}$$

B_1 decides whether to accept or reject (w_1, x_1).

Case 1: B_1 rejects the contract.

If B_2 rejects (w_2, x_2), $\pi_1^f = 0$.

If B_2 accepts (w_2, x_2), B_1's profit is

$$\pi_1^f = \begin{cases} \delta(w_2 - c_I)(1-w_2) & if \quad w_2 > c_I \\ 0 & if \quad w_2 \leq c_I \end{cases}$$

Case 2: B_1 accepts the contract.

(1) $w_2 \leq w_1$.

If B_2 also accepts the contract, $\pi_1^s = (1+\delta)x_1$.

$$x_1 = \begin{cases} \frac{\delta}{1+\delta}(w_2 - c_I)(1-w_2) & if \quad w_2 > c_I \\ 0 & if \quad w_2 \leq c_I \end{cases}$$

If B_2 rejects the contract, $\pi_1^s = (\frac{1+c_I}{2} - w_1)\frac{1-c_I}{2} + (1+\delta)x_1$. To sign B_1, $x_1 = \frac{\delta}{1+\delta}\frac{1-c_I}{2}(w_1 - \frac{1+c_I}{2})$.

(2) If $w_2 > w_1$, If B_2 accepts the contract, $\pi_1^s = (1+\delta)((w_2 - w_1)(1-w_2) + x_1)$.

$$x_1 = \begin{cases} \frac{\delta}{1+\delta}(w_2 - c_I)(1-w_2) - (w_2 - w_1)(1-w_2) & if \quad w_2 > c_I \\ -(w_2 - w_1)(1-w_2) & if \quad w_2 \leq c_I \end{cases}$$

If B_2 rejects the contract, $x_1 = \frac{\delta}{1+\delta}\frac{1-c_I}{2}(w_1 - \frac{1+c_I}{2})$ to sign B_1.

If B_1, B_2 both rejects the contracts, I's profit is $\frac{(1-c_I)^2}{4}$. If B_1 rejects the contract and B_2 accepts the contract, $\pi_I \leq \frac{(1-c_I)^2}{4}$. If B_1 accepts the contract and B_2 rejects the contract,

$$\pi_I = \begin{cases} \frac{1-c_I}{2}(w_1 - c_I) - \delta\frac{1-c_I}{2}(w_1 - \frac{1+c_I}{2}) & if \quad w_1 > c_I \\ -\delta\frac{1-c_I}{2}(w_1 - \frac{1+c_I}{2}) & if \quad w_1 = c_I \\ \frac{1-c_I}{2}(w_1 - c_I) - \delta\frac{1-c_I}{2}(w_1 - \frac{1+c_I}{2}) + \delta(w_1 - c_I)\frac{1-w_1}{2} & if \quad w_1 < c_I \end{cases}$$

The highest possible profit in this case is $\frac{(1-c_I)^2}{4}$ when $w_1 > c_I$. If both B_1 and B_2 accept the contracts,

(1) $w_2 \leq w_1$

$$\pi_I = \begin{cases} (1-w_1)(w_1 - c_I) & if \quad w_2 \leq c_I < w_1 \\ (1-w_1)(w_1 - c_I) - \delta(w_2 - c_I)(1-w_2) & if \quad c_I < w_2 < w_1 \\ 0 & if \quad w_1 = c_I \\ (1+\delta)(1-w_1)(w_1 - c_I) & if \quad w_1 < c_I \end{cases}$$

The highest possible profit is also $\frac{(1-c_I)^2}{4}$.

(2) $w_2 > w_1$.

The highest possible profit is also $\frac{(1-c_I)^2}{4}$. $\square$

When contracts are offered every two periods, a higher discount rate for E is required to enter in Period 1. Entry in Period 1 leads to zero profit for I and possibly higher profit for E.

We can easily extend the case to T-period contracts.

Proposition 5. *When exclusive contracts can be offered by the incumbent every T periods and the game lasts for infinitely many periods, entry is deterred forever if $\delta < \frac{F}{c_I(1-c_I)+F}$. For δ satisfying $\frac{\delta^{T+2-t}}{1-\delta}c_I(1-c_I) < F \leq \frac{\delta^{T+1-t}}{1-\delta}c_I(1-c_I)$, E enters in Period t.*

The longer the contracts offered by I, the more challenging for E to enter in early periods. When T goes to infinity, the result will be the same as the one-period game, E will be deterred forever. When contracts are in the form of a committed price and a transfer, the incumbent should be restricted from offering long-period contracts. Since c_I is impossible to observe in the real market, another policy restriction on contracts is that any transfer from buyers to the incumbent should be prohibited before any actual transaction.

B Instructions

B.1 Instructions for Treatment 1 and 2

Please DON'T close the web page throughout the experiment.

This study will take approximately 30 minutes. You will receive \$5 for showing up on time. You may also receive additional money, depending on the decisions made (as described below). Upon completion of the session, this additional amount will be paid to you individually and privately.

There are 30 rounds. One round will be randomly selected for payment at the end of the experiment. Your earnings will be \$5 + the earnings of the round selected.

In each round, you will be randomly paired with another person. You will not know who you are paired with. The computer acts as Role 1. You and your paired player are both Role 2. Role 1 is selling her items to Role 2s. The game of each round is described as below.

1. You have 200 points to start. Each point is worth 1 cent.

2. The computer (Role 1) makes proposals to you.

In Round 1 to Round 15, you could see the proposal to you and the proposal to your paired player.

In Round 16 to Round 30, you could only see the proposal to you.

Each proposal is composed of two parts: Price and Offer in the form of (Price, Offer).

Price is the price you can buy the item from Role 1 if you accept the proposal.

Offer is the amount of points you get from Role 1 if you accept the proposal (negative points mean the amount you pay to Role 1).

The Price for you is always 30.

There are two Offer Boxes: Box 1 and Box 2.

Box 1 has possible offers of -1200 points, -1100 points, -1000 points, -900 points.

Box 2 has possible offers of 0 points, -100 points, -200 points, -300 points.

The computer will randomly pick one offer from Box 1 and one offer from Box 2. These two offers will be randomly assigned to you and your paired player.

For example, Proposal to You = (30, -1100 points), Proposal to Your Paired Player = (30, -100 points).

3. You decide whether to accept or reject the proposal to you.

Your payoff is determined as follows. You don't need to remember the numbers below. You will be given the information in each round.

If you and your paired player both accept the proposals:

Your payoff = 200 points + Offer to you

Your paired player's payoff = 200 points + Offer to your paired player

If you and your paired player both reject the proposals:

Your payoff = 200 points

Your paired player's payoff = 200 points

If only you accept your proposal:

Your payoff = 200 points + 1200 points + Offer to you

Your paired player's payoff = 200 points

If only your paired player accepts his or her proposal:

Your payoff = 200 points

Your paired player's payoff = 200 points + 1200 points + Offer to your paired player

For example, Proposal to You = (30, -1100 points), Proposal to Your Paired Player = (30, -100 points). You accept your proposal and your paired player rejects his or her proposal. Your payoff is 200 + 1200 + (-1100) = 600 points, your paired player's payoff is 200 points.

After that, you will be randomly paired again and move to the next round. You will not know your payment till the end of the experiment.

B.2 Instructions for Treatment 3

Please DON'T close the web page throughout the experiment.

This study will take approximately 60 minutes. You will receive $5 for showing up on time. You may also receive additional money, depending on the decisions made (as described below). Upon completion of the session, this additional amount will be paid to you individually and privately.

There are 20 rounds. One round will be randomly selected for payment at the end of the experiment. Your earnings will be $5 + the earnings of the round selected.

You will be assigned the roles A, B1 or B2 at the beginning of the session. Your role will be fixed throughout the experiment.

In each round, you will be randomly grouped with two other players. You will not know who the two other players are. Role A is selling the items to Role Bs. The game of each round is described as below.

1. You have 200 points to start. Each point is worth 1 cent.

2. Role A makes proposals to Role Bs. Each proposal is composed of two parts: Price and Offer in the form of (Price1, Offer1) and (Price2, Offer2).

Price is the price that Role B can buy the item from Role A if Role B accepts the proposal.

Offer is the amount of points Role A transfers to Role B if Role B accepts the proposal (negative points mean the amount Role B pays to Role A).

The Price Box has possible prices of 0, 10, 20, 30, 40, 50, 60, 70.

The Offer Box has possible offers of -1400 points, -1300 points, -1200 points, -1100 points, -1000 points, -900 points, -800 points, -700 points, -600 points, -500 points, -400 points, -300 points, -200 points, -100 points, 0 points, 100 points, 200 points, 300 points, 400 points, 500 points, 600 points, 700 points, 800 points, 900 points, 1000 points, 1100 points, 1200 points.

Role A makes proposals to Role Bs by choosing prices and offers.

Role Bs will see both proposals. Role Bs decide whether to accept or reject the proposals.

Your payoffs are determined as follows. You don't need to remember the numbers below. You will be given the information in each round.

If B1 and B2 both reject the proposals:

A's Payoff = 200 points

B1's Payoff = 200 points

B2's Payoff = 200 points

If B1 and B2 both accept the proposals:

If Price1 > Price2:

A's Payoff = (Price2 - 40) * (100 - Price1) - Offer1 - Offer2 + 200 points

B1's Payoff = Offer1 + 200 points

B2's Payoff = (Price1 - Price2) * (100 - Price1) + Offer2 + 200 points

If Price2 > Price1:

A's Payoff = (Price1 - 40) * (100 - Price2) - Offer1 - Offer2 + 200 points

B1's Payoff = (Price2 - Price1) * (100 - Price2) + Offer1 + 200 points

B2's Payoff = Offer2 + 200 points

If Price2 = Price1:

A's Payoff = (Price1 - 40) * (100 - Price1) - Offer1 - Offer2 + 200 points

B1's Payoff = Offer1 + 200 points

B2's Payoff = Offer2 + 200 points

If B1 accepts the proposal and B2 rejects the proposal:

If Price1 $\geq$ 40:

A's Payoff = 200 points - Offer1

B1's Payoff = 200 points + Offer1

B2's Payoff = 200 points + (Price1 - 40) * (100 - Price1)

If 40 $>$ Price1 $\geq$ 30:

A's Payoff = (Price1 - 40) * (100 - Price1)/2 - Offer1 + 200 points

B1's Payoff = Offer1 + 200 points

B2's Payoff = 200 points

If Price1 $\leq$ 30:

A's Payoff = (Price1 - 40) * 30 - Offer1 + 200 points

B1's Payoff = (70 - Price1) * 30 + Offer1 + 200 points

B2's Payoff = 200 points

If B2 accepts the proposal and B1 rejects the proposal:

If Price2 $\geq$ 40:

A's Payoff = 200 points - Offer2

B1's Payoff = 200 points + (Price2 - 40) * (100 - Price2)

B2's Payoff = 200 points + Offer2

If 40 $>$ Price2 $\geq$ 30:

A's Payoff = (Price2 - 40) * (100 - Price2)/2 - Offer2 + 200 points

B1's Payoff = 200 points

B2's Payoff = 200 points+Offer2

If Price2 $\leq$ 30:

A's Payoff = (Price2 - 40) * 30 - Offer2 + 200 points

B1's Payoff = 200 points

B2's Payoff = (70 - Price2) * 30 + Offer2 +200 points

Again, you don't need to remember all these numbers. You will be given the numbers in each round of the game.

After that, you will be randomly paired again and move to the next round. You will not know your payment till the end of the experiment.

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