Non-Binding Sequential Exchange between Discounting Agents

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Abstract

When exchange is sequential, and no binding agreements can be written, the agent acting first is exposed to the possibility that, even if he honors the agreement, his trading partner may subsequently choose not to do so. The primary focus of the current analysis is whether trade can successfully occur in such environments. Exchange will successfully occur so long as there are sufficiently large gains from trade for the agent acting second. As a result, the agent acting first may be better off with less relative bargaining power.

The possibility of facilitating exchange through the use of an escrow service is considered. Conditions are determined under which the agent acting first will employ such a service in order to ensure successful exchange (as opposed to ensuring successful exchange through the disposal of his own relative bargaining advantage).

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1 Introduction

For most transactions exchange occurs simultaneously, in that each party to the transaction parts with the item which they are giving up at the same time. For example, if an individual goes to a fast food restaurant for lunch: he decides what he wants, places an order, and then trade occurs simultaneously in that the customer pays the cashier at essentially the same time at which the goods are delivered. Since all aspects of the transaction occur simultaneously, the transaction itself cannot be "split" into separate parts. That is, the transaction cannot be divided into discrete phases of: customer delivery of payment, merchant receipt of payment, merchant delivery of goods, and customer receipt of goods. Borrowing terminology from the computer science literature, such transactions will be referred to as "atomic."[1] As Camp (2000) points out, such atomic transactions either fail or succeed completely.

Clearly not all transactions are atomic. In some instances, different phases of a transaction occur at different times. For example, it is often customary for one party to part with their item first. Such instances of "non-simultaneous" exchange will be referred to as "non-atomic" transactions. While non-atomic transactions could either fail or succeed completely, there is also the possibility of partial success or failure (in which one party satisfies the terms of the agreement, while the other does not).

When a consumer purchases an item by mail order, over the telephone, or over the internet, the purchase is almost always an non-atomic transaction, in which the buyer must pay for the item before receiving the item. However, not all non-atomic transactions differ fundamentally from atomic transactions, since in many instances neither party is exposed to the possibility that the other party might not "hold up his end of the bargain." This is due to the fact that if one party does not satisfy the terms of the agreement, the other party is often able to take legal action in order to have the transaction either enforced or voided in its entirety.

[1]See Tygar (1996) for a discussion of atomicity of data processing in regards to electronic commerce.

With the rapid growth of the internet, such non-atomic trade is becoming more common. Further, many examples exist in which a transaction is not only non-simultaneous, but also one party is exposed to the possibility that his trading partner will unilaterally not honor the agreement. This could be the case for at least two different reasons. First, it may be that the transaction which is agreed upon is not clearly a legally binding agreement.[2] Second, this could effectively be the case even if there is a legally binding contract between the buyer and seller. If the costs of enforcing the contract are extremely high relative to the gains from trade, it would not be worthwhile for an agent to attempt to have the contract enforced if his trading partner does not "hold up his end of the bargain."

By its very nature, the internet often facilitates transactions between parties that are geographically separated by great distances. In many instances, these are mutually beneficial transactions that would not otherwise occur. As such, economists typically view this matching of trading partners favorably. However, it is precisely this feature of internet transactions (matching parties that are geographically separated from each other) that often makes the enforcement of a bargain between the two parties more difficult.[3] It is much easier for parties to successfully commit fraud in such non-atomic environments.

Of the 16,775 complaints of fraud registered with the Internet Fraud Complaint Center (IFCC) during 2001, 20.3% were specifically categorized as instances of "non-delivery of merchandise and payment." Only one other cate-

[2] It may be that the agreement is illegal. For example, in many jurisdictions, it is illegal to sell tickets to concerts or sporting events at prices considerably above "face value," however, such agreements are often reached online. Further, even if the agreement is legal, it may not be clear when a legally binding contract has been reached. As Winn (2000) notes, if two parties are negotiating via e-mail, it may not be precisely clear (even to the courts) when a legal agreement has been reached.

[3] "One of the components of fraud committed via the Internet that makes investigation and prosecution difficult is that the offender and victim may be located thousands of miles apart...a unique characteristic not found with many other types of 'traditional' crime." (*IFCC 2001 Internet Fraud Report*, page 15.)

gory, “auction fraud,” received more complaints (42.8% of all complaints). It should be noted that “auction fraud” consists of either “non-delivery of merchandise” or “misrepresentation” (which occurs when the seller intentionally misleads the bidder about the value of the item being sold). Further, since only one in ten incidents of fraud are ever brought to the attention of regulatory or enforcement agencies,[4] such occurrences are more common than these figures initially suggest.

Consider the transactions occurring through the internet site WebTix (www.tixs.com). This site lists classified advertisements for tickets to concerts, theatre, and sporting events. WebTix does not sell the items listed on their site. They merely act as an intermediary, matching sellers and buyers. Since they are not a party to the transaction, WebTix cannot be held responsible if a party to the transaction does not hold up his end of the bargain. Further, many of the transactions agreed upon through WebTix are likely to be “consumer to consumer” transactions between buyers and sellers with no previous interaction with each other. According to the IFCC these are precisely the types of internet transactions that are most likely to result in unsuccessful outcomes.[5]

The issue of whether or not trade can be sustained in such environments is addressed. Specifically, non-simultaneous transactions between a single buyer and a single seller are modelled. When exchange is sequential and no binding contracts can be written, the agent acting first is exposed to the possibility that even if he honors the agreement his rival may choose not to.

One way in which agents have attempted to circumvent the problems arising from such non-simultaneous interaction is through the use of third party escrow services. For example, *Escrow.com* specializes in providing

[4]This figure is from the *National Public Survey on White Collar Crime*, as reported in the IFCC 2001 Internet Fraud Report.

[5]“Nearly 76% of alleged fraud perpetrators tend to be individuals (as opposed to businesses)...” (*IFCC 2001 Internet Fraud Report*, page 3); “...most complaints probably involve complainants and perpetrators that did not have a relationship prior to the incident.” (*IFCC 2001 Internet Fraud Report*, page 15.)

online escrow services for parties engaged in sequential exchange. In essence the third party escrow service will eliminate (for a fee) the possibility of partial success or failure.[6] The role of such services in facilitating successful exchange in markets of this nature is examined.

2 Basic Framework

Consider a situation in which gains from trade exist between a buyer (denoted B) and a seller (denoted S). Specifically, suppose there is a commodity for which B has a constant valuation of v_b for every unit and S has a constant valuation of v_s for every unit. Assuming $0 \leq v_s < v_b$, gains from trade exist on every unit.

B and S will attempt to exchange one unit at a time over a discrete number of periods. At the start of each such period n, B and S negotiate the terms of trade. Specifically, it is assumed that bargaining between B and S leads to an agreed upon price $p = \alpha v_b + (1 - \alpha)v_s$, with $0 < \alpha < 1$.[7] α should be thought of as measuring the "inherent bargaining skill" of the seller relative to the buyer.

After negotiating the terms of trade in this manner, each agent must choose whether or not to honor the agreement reached at the start of the period. When the subsequent exchange is sequential and no binding contracts can be written, the decision of each agent regarding whether or not to honor

[6] In the model developed here the value to each party of the item being exchanged is known by both parties. As such, the only benefit of an escrow service is the elimination of the possibility of partial success or failure. In practice, escrow services are also useful when the actual quality of the item is unknown to the buyer before he physically inspects the item. While important, such issues are beyond the scope of the present analysis.

[7] This price results from the *weighted Nash Bargaining Solution* (Harsanyi and Selten (1972)) for the problem in which the utility of S is $p - v_s$, the utility of B is $v_b - p$, and S and B have relative bargaining powers of α and $1 - \alpha$ respectively (with $0 < \alpha < 1$). It also results from the *weighted Kalai-Smorodinsky Bargaining Solution* (Thomson (1994)) for the problem in which the utility of S is $p - v_s$, the utility of B is $v_b - p$, and S and B have relative bargaining powers of $\lambda = \frac{\alpha}{1-\alpha}$ and 1 respectively.

the agreement will depend critically upon the order in which the agents must act. Two distinct situations of this nature are considered: exchange in which B must deliver payment before S decides whether or not to deliver the item ("buyer moves first"), and exchange in which S must deliver the item before B decides whether or not to deliver payment ("seller moves first"). The outcome in each of these two cases will be compared to the outcome which would result if a binding contract could be written between the two parties ("enforceable exchange"). Such interaction is analyzed supposing that each agent discounts future payoffs. Specifically, it is assumed that a payoff of x realized t periods from now is valued at $x\delta^t$. The discount factor of B is $\delta_b \in [0, 1]$; the discount factor of S is $\delta_s \in [0, 1]$.

Conditions under which exchange will successfully occur are identified. It is argued that the agent moving first may have an incentive to freely dispose of this own relative bargaining advantage (that is: if the buyer must act first he may have an incentive to offer to pay a higher price than he could otherwise bargain for; if the seller must act first he may have an incentive to offer to accept a lower price than he could otherwise bargain for). When an agent chooses to dispose of a portion of his own relative bargaining advantage, exchange will successfully occur when it otherwise would not have successfully occurred.

Finally, the possibility of supporting exchange through the use of a third party escrow service is considered. It will be supposed that the agent who must move first has the option of paying a fee in order to make the agreement binding. Conditions under which such a service would be used are specified.

3 Equilibrium Outcome

Interaction between these two agents is modelled as a dynamic game of complete information. A subgame perfect Nash equilibrium is identified in each of the two cases of sequential exchange under consideration. The equilibrium is characterized by specifying conditions under which each agent would optimally choose to honor the agreement in each period. In each case, the identified equilibrium is a pair of Nash reversion strategies, which calls for the agreement not to be honored by each party during any period for which some previous agreement was not honored by either party.

3.1 Buyer Moves First

Begin by considering a situation in which the buyer must send payment to the seller before the seller decides whether or not to deliver the item to the buyer. After negotiating a price $p = \alpha v_b + (1-\alpha)v_s$, B must choose between sending this agreed upon payment to S (denoted H for "honor") or sending no payment to S (denoted F for "fink"). After observing the choice of B, S must choose between delivering the item to B (denoted H for "honor") or not delivering the item to B (denoted F for "fink"). Consider the interaction between B and S in any arbitrary period n for which no agent has chosen F during any previous period.

Begin by considering the choice of S after B has chosen H.[8] At this point, if S chooses F he will realize a payoff of p this period, but no future exchange will occur (due to the fact that B will choose F during all future periods). Thus, the payoff to S from such a choice is

$$\pi_{SF}^{(BS)} = p.$$

If instead S chooses H he will realize $(p - v_s)$ this period and the relationship will continue to the next period. Thus, his payoff from this choice is

$$\pi_{SH}^{(BS)} = (p - v_s) + \delta_s \pi_{SH}^{(BS)},$$

implying

$$\pi_{SH}^{(BS)} = \frac{(p - v_s)}{1 - \delta_s}.$$

[8] If B had chosen F, then S should clearly choose F (since each player will revert to a strategy of choosing F during every future period, along with the fact that choosing F in the current period results in a higher payoff than choosing H in the current period).

S will optimally choose H so long as $\pi_{SH}^{(BS)} \geq \pi_{SF}^{(BS)}$, which corresponds to $p \geq \frac{v_s}{\delta_s}$.

From here it is clear that if $p < \frac{v_s}{\delta_s}$ then B will choose F, since S would not honor the agreement even if B chose H. If instead $p \geq \frac{v_s}{\delta_s}$, then: S will choose H following a choice of H by B (and the relationship will continue to the next period) and S will choose F following a choice of F by B (and each agent will choose F during every future period). As a result, the expected payoff for B from choosing F is

$$\pi_{BF}^{(BS)} = 0,$$

whereas the expected payoff for B from choosing H is

$$\pi_{BH}^{(BS)} = (v_b - p) + \delta_b \pi_{BH}^{(BS)},$$

which implies

$$\pi_{BH}^{(BS)} = \frac{v_b - p}{1 - \delta_b}.$$

For any $p \geq \frac{v_s}{\delta_s}$, B will want to choose H so long as $\pi_{BH}^{(BS)} \geq \pi_{BF}^{(BS)}$ which corresponds to $p \leq v_b$. Clearly $p = \alpha v_b + (1 - \alpha) v_s < v_b$ for any $0 < \alpha < 1$.

As a result, when B must deliver payment before S delivers the item, an equilibrium of the following form exists. If $p < \frac{v_s}{\delta_s}$: each agent chooses F in every period. If $p \geq \frac{v_s}{\delta_s}$: each agent chooses H so long as his rival has never chosen F and each agent chooses F if either agent has ever previously chosen F. Note that exchange will be successful only if the negotiated price results in sufficiently large gains from trade for the seller.

When this pair of equilibrium strategies is followed, one of two outcomes will result. If $p < \frac{v_s}{\delta_s}$: exchange is completely unsuccessful during every period (that is, B and S will both choose F during every period), B realizes a payoff of $\Pi_B^{(BS)} = 0$, and S realizes a payoff of $\Pi_S^{(BS)} = 0$. If $p \geq \frac{v_s}{\delta_s}$: exchange is completely successful during every period (that is, B and S will both choose H during every period), B realizes a payoff of $\Pi_B^{(BS)} = \frac{1}{1-\delta_b}(v_b - p)$, and S realizes a payoff of $\Pi_S^{(BS)} = \frac{1}{1-\delta_s}(p - v_s)$, with $p = \alpha v_b + (1 - \alpha) v_s$. $\Pi_B^{(BS)}$ and $\Pi_S^{(BS)}$ are each illustrated in Figure 1 as a function of α.

Let $\underline{\alpha}$ denote the value of α for which $p = \frac{v_s}{\delta_s}$. Since $p = \alpha v_b + (1-\alpha)v_s$, it follows that $\underline{\alpha} = \left(\frac{1-\delta_s}{\delta_s}\right)\frac{v_s}{v_b - v_s}$. Exchange will successfully occur in this case if and only if $\alpha \geq \underline{\alpha}$. Clearly $\underline{\alpha} > 0$. Further, $\underline{\alpha} \leq 1$ so long as $\delta_s \geq \frac{v_s}{v_b}$.

3.2 Seller Moves First

Now suppose that after negotiating a price $p = \alpha v_b + (1-\alpha)v_s$, S must "move first." That is, S must choose between delivering the item to B (denoted H) or not delivering the item to B (denoted F). After observing the choice of S, B must choose to either send a payment of p to S (denoted H) or not send any payment to S (denoted F). Again, consider the interaction between B and S in any arbitrary period n for which no agent has chosen F during any previous period.

Begin by focusing on the choice of B after S has chosen H.[9] When faced with this decision, if B chooses F he will realize a payoff of v_b this period, but no future exchange will occur (due to the fact that S will choose F during all future periods). Thus, the payoff for B from such a choice is

$$\pi_{BF}^{(SB)} = v_b.$$

If instead B chooses H he will realize $(v_b - p)$ this period and the relationship will continue to the next period. Thus, his payoff from this choice is

$$\pi_{BH}^{(SB)} = (v_b - p) + \delta_b \pi_{BH}^{(BS)},$$

implying

$$\pi_{BH}^{(SB)} = \frac{v_b - p}{1 - \delta_b}.$$

B will optimally choose H so long as $\pi_{BH}^{(SB)} \geq \pi_{BF}^{(SB)}$, which is equivalent to $p \leq \delta_b v_b$.

From here it is clear that if $p > \delta_b v_b$ then S should clearly choose F, since B would not honor the agreement even if S were to choose H. If instead

[9] If S had chosen F, then B should clearly choose F (since each player will revert to a strategy of choosing F during every future period, along with the fact that choosing F in the current period results in a higher payoff than choosing H in the current period).

$p \le \delta_b v_b$, then: B will choose H following a choice of H by S (and the relationship will continue to the next period) and B will choose F following a choice of F by S (and each agent will choose F during every future period). As a result, the expected payoff for S from choosing F is

$$\pi_{SF}^{(SB)} = 0,$$

while the expected payoff for S from choosing H is

$$\pi_{SH}^{(SB)} = (p - v_s) + \delta_s \pi_{SH}^{(SB)},$$

so that

$$\pi_{SH}^{(SB)} = \frac{p - v_s}{1 - \delta_s}.$$

For any $p \le \delta_b v_b$, S will want to choose H so long as $\pi_{SH}^{(SB)} \ge \pi_{SF}^{(SB)}$ or equivalently $p \ge v_s$. It is clear that $p = \alpha v_b + (1 - \alpha) v_s > v_s$ for any $0 < \alpha < 1$.

As a result, when the seller must deliver the item before the buyer delivers payment, an equilibrium of the following form exists. If $p > \delta_b v_b$: each agent chooses F in every period. If $p \le \delta_b v_b$: each agent chooses H so long as his rival has never chosen F and each agent chooses F if either agent has ever previously chosen F. Thus, exchange will successfully occur so long as the negotiated price leads to sufficiently large gains from trade for the buyer.

When this pair of equilibrium strategies is followed, one of two outcomes will again result. If $p > \delta_b v_b$: exchange is completely unsuccessful during each period (that is, B and S will both choose F during each period), B realizes a payoff of $\Pi_B^{(SB)} = 0$, and S realizes a payoff of $\Pi_S^{(SB)} = 0$. On the other hand, if $p \le \delta_b v_b$: exchange is completely successful during each period (that is, B and S will both choose H during each period), B realizes a payoff of $\Pi_B^{(SB)} = \frac{1}{1-\delta_b}(v_b - p)$, and S realizes a payoff of $\Pi_S^{(SB)} = \frac{1}{1-\delta_s}(p - v_s)$, again with $p = \alpha v_b + (1 - \alpha) v_s$. $\Pi_B^{(SB)}$ and $\Pi_S^{(SB)}$ are illustrated in Figure 2 each as a function of α.

Let $\overline{\alpha}$ denote the value of α which results in $p = \delta_b v_b$. With $p = \alpha v_b + (1 - \alpha) v_s$, we have $\overline{\alpha} = \frac{\delta_b v_b - v_s}{v_b - v_s}$. Exchange will successfully occur in this case if and only if $\alpha \leq \overline{\alpha}$. It is clear that $\overline{\alpha} < 1$ for any $\delta_b < 1$, and $\overline{\alpha} \geq 0$ so long as $\delta_b \geq \frac{v_s}{v_b}$.

3.3 Enforceable Exchange

For a common frame of reference, consider a traditional situation in which exchange is enforceable. Each agent must again choose either H or F. However, if either agent chooses F exchange does not take place, in that the item is not transferred from S to B and no payment is transferred from B to S. This results in each agent realizing a payoff of zero in the current period. If each agent chooses H the item is exchanged from S to B and a payment of p is transferred from B to S. Thus, in the current period S realizes a payoff of $p - v_s$ and B realizes a payoff of $v_b - p$. Each agent has a weakly dominant strategy of choosing H in every period. When agents play according to this strategy pair: exchange is completely successful during each period, B realizes a payoff of $\Pi_B^{(EE)} = \frac{1}{1-\delta_b}(v_b - p)$, and S realizes a payoff of $\Pi_S^{(EE)} = \frac{1}{1-\delta_s}(p - v_s)$, where $p = \alpha v_b + (1-\alpha)\, v_s$.

4 Free Disposal of Bargaining Advantage

From the results thus far: when B must move first exchange will be successful if and only if $\alpha \geq \underline{\alpha}$; when S must move first exchange will be successful if and only if $\alpha \leq \overline{\alpha}$.

In this section, the possibility of allowing agents to freely dispose of their own relative bargaining advantage is considered. It is argued that if agents have this option: when B must move first exchange will be successful whenever $\underline{\alpha} \leq 1$ (or equivalently whenever $\delta_s \geq \frac{v_s}{v_b}$); when S must move first exchange will be successful whenever $\overline{\alpha} \geq 0$ (or equivalently whenever $\delta_b \geq \frac{v_s}{v_b}$).

Recall that α is a measure of the relative bargaining advantage of the seller and $p = \alpha v_b + (1-\alpha)v_s$ is monotonically increasing in α. Suppose that there exists some "true" value of $\alpha \in (0,1)$, denoted α_T. α_T can be thought of representing the relative bargaining advantage of S when each agent "bargains to the best of his own ability." It would be reasonable to suppose that an individual would be able to bargain at a level less than his full potential. When such action is undertaken by a single agent, the relative bargaining powers of each party will change (supposing the other agent does not decrease his own bargaining effort as well). If the seller chooses to bargain at less than his full potential (while the buyer bargains at his full potential), α would decrease; if the buyer chooses to bargain at less than his full potential (while the seller bargains at his full potential), α would increase.

An agent should be willing to reduce his own relative bargaining advantage if doing so does not decrease his own payoff; an agent should not be willing to sacrifice his relative advantage if doing so does decrease his own payoff. If an agent can benefit from relinquishing a portion of his relative bargaining advantage, it is reasonable to expect that he would want to do so. An agent should be able to act in this manner, so long as his rival does not object to such a change.

Let α^* denote the value of α which B and S mutually "choose" when each agent is given the option of surrendering a portion of his own relative bargaining advantage. Following this choice of α^* by the agents, exchange will either occur or not occur according to the conditions previously determined.

In general, let $\Pi_B(\alpha)$ denote the payoff of B as a function of α and let $\Pi_S(\alpha)$ denote the payoff of S as a function of α. In every case under consideration, either $\Pi_S(\alpha)$ is non-decreasing in α over the entire range from zero up to one or $\Pi_B(\alpha)$ is non-increasing in α over the entire range from zero up to one.[10]

If $\Pi_S(\alpha)$ is non-decreasing in α, then S would never object to an increase in α (but may potentially object to a decrease in α). As such, B is essentially free to choose any value of α above α_T. It is reasonable to suppose that in this case

$$\alpha^* = \arg\max_{\alpha \geq \alpha_T} \Pi_B(\alpha). \tag{1}$$

If instead $\Pi_B(\alpha)$ is non-increasing in α, B would never object to a decrease

[10]This can easily be seen from Figures 1 and 2.

in α (but may potentially object to an increase in α). Thus, S may essentially choose any α less than α_T. In this case it is reasonable to suppose

$$\alpha^* = \arg\max_{\alpha \leq \alpha_T} \Pi_S(\alpha). \tag{2}$$

4.1 Choice of α^* when Buyer Acts First

Figure 1 illustrates the payoff of each agent when B acts first during each period. In this case, the payoff of S is non-decreasing in α. Upon inspection of Figure 1, it is clear that by Condition (1): if $\alpha_T \geq \underline{\alpha}$ then $\alpha^* = \alpha_T$, and if $\alpha_T < \underline{\alpha}$ then $\alpha^* = \underline{\alpha}$. As a result, when B must move first, it may be beneficial for B to relinquish a portion of his own relative bargaining advantage. When the buyer does this, he is essentially agreeing to pay a higher price than he otherwise could bargain for. Specifically, if $\alpha_T < \underline{\alpha}$ the buyer will agree to pay a price of $\frac{v_s}{\delta_s}$, the minimum price for which the payoff of the seller from honoring the agreement (and delivering the item after receiving payment) is at least as large as the payoff of the seller from not honoring the agreement (and not delivering the item after receiving payment).

An implication of the above is that when B must act first (and agents may freely dispose of their own relative bargaining advantage), exchange will always successfully occur so long as $\delta_s \geq \frac{v_s}{v_b}$. Thus, exchange can be sustained as long as S does not discount future transactions too much.

4.2 Choice of α^* when Seller Acts First

Similarly, Figure 2 shows the payoff of each agent when S acts first in each period. In this case, the payoff of B is non-increasing in α. Upon examination of Figure 2, it is clear that by Condition (2): if $\alpha_T \leq \overline{\alpha}$ then $\alpha^* = \alpha_T$, and if $\alpha_T > \overline{\alpha}$ then $\alpha^* = \overline{\alpha}$. Thus, when S must act first, it may be beneficial for S to dispose of a portion of his own relative bargaining advantage. When the seller chooses to do so, he is essentially agreeing to accept a lower price for each unit than he otherwise could bargain for. Specifically, if $\alpha_T > \overline{\alpha}$ the seller will agree to accept a price of $\delta_b v_b$, the maximum price for which the payoff of the buyer from honoring the agreement (and delivering payment after the item is received) is at least as large as the payoff of the buyer from not honoring the agreement (and not delivering payment after the item is received).

These insights imply that when S must act first (and agents may freely dispose of their own relative bargaining advantage), exchange will always successfully occur so long as $\delta_b \geq \frac{v_s}{v_b}$. That is, exchange is sustainable so long as B does not discount future transactions too much.

4.3 Choice of α^* when Exchange is Enforceable

When exchange is enforceable, exchange will successfully occur at $p = \alpha v_b + (1-\alpha) v_s$ for any value of $\alpha \in (0,1)$. B realizes a payoff of $\Pi_B^{(EE)} = \frac{1}{1-\delta_b}(v_b - p)$, and S realizes a payoff of $\Pi_S^{(EE)} = \frac{1}{1-\delta_s}(p - v_s)$, where $p = \alpha v_b + (1-\alpha) v_s$. Note that $\Pi_B^{(EE)}$ is strictly increasing in α and Π_S^{EE} is strictly decreasing in α. Thus, by either Condition (1) or Condition (2) we arrive at the conclusion that $\alpha^* = \alpha_T$. That is, neither agent will ever wish to dispose of any portion of his own relative bargaining advantage. This is because when exchange is enforceable, there is never any benefit from doing so (only a direct cost in the form of a smaller gain on each unit exchanged). Equivalently, in a traditional (enforceable) transaction, the buyer never has any incentive to offer to pay a higher price than he could bargain for and the seller never has any incentive to accept a lower price than he could bargain for.

5 Role of Escrow Service

The distinguishing characteristic of sequential, non-binding exchange was that the agent acting first is exposed to the possibility that even if he honors the agreement his rival may choose not to. One observable way in which agents have clearly attempted to circumvent this problem is through the use of escrow services. For instance, *Escrow.com* provides online escrow services aimed at facilitating transactions negotiated over the internet.

Suppose that after agents negotiate a price p, the agent called upon to act first has the opportunity to hire such an escrow service. If the escrow service is used, this agent is no longer exposed to the possibility that he must honor the agreement even if his rival subsequently chooses not to. Suppose the fee for using the escrow service is τp, with $\tau \in [0, 1]$. This fee must be paid regardless of the final outcome of the exchange process.[11]

5.1 Use of Escrow Service when Buyer Acts First

Consider the case in which B must act first. If B chooses to hire such an escrow service he incurs a cost of τp. The benefit of hiring the service is that B is no longer exposed to the possibility of having to make a payment of p even when S chooses not to deliver the item. If B has chosen to hire the escrow service, then following a payment of p by B: if S chooses to honor the agreement (by delivering the item), S will realize a payoff of $p - v_s$ and B will realize a payoff of $(v_b - p) - \tau p$ during the current period; whereas if S chooses not to honor the agreement (by not delivering the item), S will realize a payoff of 0 and B will realize a payoff of $-\tau p$ during the current period.

Thus, if B chooses to use such a service, each agent will optimally choose to honor the agreement, for any price $v_s \leq p \leq v_b$. As a result, if B chooses to use the escrow service in each period: S would realize a payoff of $\frac{1}{1-\delta_s}(p - v_s)$ and B would realize a payoff of $\frac{1}{1-\delta_b}[v_b - (1+\tau)p]$.

B will base his decision of whether or not to employ the escrow service on a comparison of $\frac{1}{1-\delta_b}[v_b - (1+\tau)p]$ to $\Pi_B^{(BS)}$. So long as $\tau < \frac{v_b}{v_s}\delta_s - 1$, the buyer would realize a higher payoff by using the escrow service if and

[11] The fee structure considered here is modelled after the structure on *Escrow.com* in that: the fee is a percentage of the selling price and the fee must be paid even if exchange is ultimately unsuccessful. The results of this section would not differ qualitatively if instead: the fee was some constant $K > 0$ or if the fee is only incurred if exchange is successful.

only if the negotiated price results from $\alpha \in (0, \underline{\alpha})$.[12] Once this is noted, we observe that when the option of hiring the escrow service is available, B will realize a payoff of $\Pi_B^{(BS-E)} = \frac{1}{1-\delta_b}\left[v_b - (1+\tau)p\right]$ for a price resulting from $\alpha \in (0, \underline{\alpha})$ and a payoff of $\Pi_B^{(BS-E)} = \frac{1}{1-\delta_b}\left[v_b - p\right]$ for a price resulting from $\alpha \in [\underline{\alpha}, 1)$. Further, S will realize a payoff of $\Pi_S^{(BS-E)} = \frac{1}{1-\delta_s}\left[p - v_s\right]$ for any price between v_s and v_b. These payoffs are illustrated in Figure 3.

From Figure 3, note that $\Pi_S^{(BS-E)}$ is increasing in α. Thus, if agents may freely dispose of their own relative bargaining advantage, α^* will be determined according to Condition (1).

Let $\underline{\alpha}_E$ denote the unique value of α for which $\frac{1}{1-\delta_b}\left[v_b - (1+\tau)p\right]$ is equal to $\Pi_B^{(BS)}\Big|_{\alpha=\underline{\alpha}}$. That is,

$$\underline{\alpha}_E = \left(\frac{1}{1+\tau}\right)\left(\frac{1-\delta_s}{\delta_s} - \tau\right)\left(\frac{v_s}{v_b - v_s}\right).$$

So long as $\tau < \frac{1-\delta_s}{\delta_s}$, it follows that $\underline{\alpha}_E \in (0, \underline{\alpha})$.

From here Condition (1) implies: if $\alpha_T \in (0, \underline{\alpha}_E]$ then $\alpha^* = \alpha_T$, if $\alpha_T \in (\underline{\alpha}_E, \underline{\alpha})$ then $\alpha^* = \underline{\alpha}$, and if $\alpha_T \in [\underline{\alpha}, 1)$ then $\alpha^* = \alpha_T$. That is, if $\alpha_T \in (0, \underline{\alpha}_E]$, the buyer will choose to use the escrow service in order to guarantee that the transaction occurs successfully. If instead $\alpha_T \in (\underline{\alpha}_E, \underline{\alpha})$, the buyer will not use the escrow service, but rather will ensure that exchange will successfully occur by agreeing to pay a higher price. Finally, if $\alpha_T \in [\underline{\alpha}, 1)$, exchange will successfully occur without the buyer having to either use the escrow service or pay a higher price.

Thus, the escrow service is only useful to B when $\alpha_T \in (0, \underline{\alpha}_E]$. In this case, α_T leads to a relatively low price. This price is low enough so that the payoff for the buyer from hiring the escrow service (and having exchange successfully occur at this relatively low price) is greater than the payoff from successful exchange at the minimum price for which exchange could successfully occur without employing the escrow service.

[12] For exchange to ever be successful when B acts first, it must be that $\delta_s \geq \frac{v_s}{v_b}$. When this is the case, $\frac{v_b}{v_s}\delta_s - 1 \geq 0$. Thus, when $\delta_s \geq \frac{v_s}{v_b}$, $\tau < \frac{v_b}{v_s}\delta_s - 1$ will be satisfied for τ close enough to zero.

Note that
$$\frac{\partial \underline{\alpha}_E}{\partial \tau} = -\left(\frac{1}{1+\tau}\right)^2 \left(\frac{1}{\delta_s}\right)\left(\frac{v_s}{v_b - v_s}\right) < 0.$$
From here we arrive at the intuitive result that a higher value of τ (that is, a higher fee for using the escrow service) would make it less likely that the buyer would wish to use the escrow service.

5.2 Use of Escrow Service when Seller Acts First

Now suppose S must act first. If S chooses to use an escrow service he incurs a cost of τp. Again, the benefit of hiring the service is that S is not exposed to the possibility of having to deliver the item which B chooses not to pay for. Specifically, if S uses the escrow service, then following delivery of the item by S: if B chooses to honor the agreement (by delivering the agreed upon payment), S will realize a payoff of $(1-\tau)p - v_s$ and B will realize a payoff of $v_b - p$ during the current period; whereas if B chooses not to honor the agreement (by not delivering the agreed upon payment p), S will realize a payoff of $-\tau p$ and B will realize a payoff of 0 during the current period.

Thus, if S chooses to use such a service, it is optimal for each agent to honor the agreement at any price $v_s \leq p \leq v_b$. It follows that, if S chooses to use the escrow service in each period: S would realize a payoff of $\frac{1}{1-\delta_s}\left[(1-\tau)p - v_s\right]$ and B would realize a payoff of $\frac{1}{1-\delta_b}\left[v_b - p\right]$.

S will base his decision of whether or not to use the escrow service on a comparison of $\frac{1}{1-\delta_s}\left[(1-\tau)p - v_s\right]$ to $\Pi_S^{(SB)}$. So long as $\tau < 1 - \frac{v_s}{\delta_b v_b}$, the seller would realize a higher payoff by using the escrow service if and only if the negotiated price results from $\alpha \in (\overline{\alpha}, 1)$.[13] Thus, when the option of using an escrow service is available, S will realize a payoff of $\Pi_S^{(SB-E)} = \frac{1}{1-\delta_s}\left[(1-\tau)p - v_s\right]$ for a price resulting from $\alpha \in (\overline{\alpha}, 1)$ and a payoff of $\Pi_S^{(SB-E)} = \frac{1}{1-\delta_b}\left[p - v_s\right]$ for a price resulting from $\alpha \in (0, \overline{\alpha}]$. Further, B will realize a payoff of $\Pi_B^{(SB-E)} = \frac{1}{1-\delta_s}\left[v_b - p\right]$ for any price between

[13] For exchange to ever be successful when S must act first, it must be that $\delta_b \geq \frac{v_s}{v_b}$. When this is the case, $1 - \frac{v_s}{\delta_b v_s}$. As s result, if $\delta_b \geq \frac{v_s}{v_b}$, then $\tau < 1 - \frac{v_s}{\delta_b v_b}$ is satisfied for τ close enough to zero.

v_s and v_b. These functions are illustrated in Figure 4.

From Figure 4, we see that $\Pi_B^{(SB-E)}$ is decreasing in α. Thus, if agents are able to freely dispose of their own relative bargaining advantage, α^* will be determined by Condition (2).

Let $\overline{\alpha}_E$ denote the unique value of α for which $\frac{1}{1-\delta_s}\left[(1-\tau)p - v_s\right]$ is equal to $\Pi_S^{(SB)}\Big|_{\alpha=\overline{\alpha}}$. Thus,

$$\overline{\alpha}_E = \frac{\delta_b v_b - (1-\tau)v_s}{(1-\tau)(v_b - v_s)}.$$

Assuming $\tau < 1 - \delta_b$, it follows that $\overline{\alpha}_E \in (\overline{\alpha}, 1)$.

From here Condition (2) implies: if $\alpha_T \in [\overline{\alpha}_E, 1)$ then $\alpha^* = \alpha_T$, if $\alpha_T \in (\overline{\alpha}, \overline{\alpha}_E)$ then $\alpha^* = \overline{\alpha}$, and if $\alpha_T \in (0, \overline{\alpha})$ then $\alpha^* = \alpha_T$. That is, if $\alpha_T \in [\overline{\alpha}_E, 1)$, the seller will choose to use the escrow service in order to facilitate successful exchange. If instead $\alpha_T \in (\overline{\alpha}, \overline{\alpha}_E)$, the seller will not employ the escrow service, but rather will agree to accept a lower price in order to ensure that exchange will successfully occur. Finally, if $\alpha_T \in (0, \overline{\alpha})$, exchange will successfully occur without the seller having to either hire the escrow service or pay a higher price.

Thus, the escrow service is only useful to S when $\alpha_T \in [\overline{\alpha}_E, 1)$. In this case, α_T results in a relatively high price. This price is high enough so that the payoff for the seller from hiring the escrow service (and having exchange successfully occur at this relatively high price) is greater than the payoff from successful exchange at the maximum price for which exchange could successfully occur without employing the escrow service.

Note that

$$\frac{\partial \overline{\alpha}_E}{\partial \tau} = \left(\frac{1}{1-\tau}\right)^2 \left(\frac{\delta_b v_b}{v_b - v_s}\right) > 0,$$

which leads to the intuitive insight that a higher value of τ (that is, a higher fee for using the escrow service) would make it less likely that the seller would wish to employ the escrow service.

6 Conclusion

When exchange is sequential, and no binding agreements can be written, the party called upon to act first is exposed to the possibility that, even if he honors the agreement, his trading partner may subsequently choose not to honor the agreement. Transactions of this nature are likely becoming more common as a greater volume of consumer-to-consumer exchange is negotiated over the internet. The primary focus of the current analysis is whether or not trade can successfully occur in such instances. In order to address this issue, repeated interaction of this nature between a single seller and single buyer is modelled.

When attempting to exchange any single unit, the buyer and seller begin by negotiating the terms of trade. This negotiation results in a mutually beneficial price p, strictly between the valuation of the seller and the valuation of the buyer. Exchange will successfully occur so long as this agreed upon price results in sufficiently large gains from trade for the agent called upon to act second. Since each agent individually prefers any successful, mutually beneficial exchange (in comparison to completely unsuccessful exchange), the agent called upon to act first may benefit by relinquishing a portion of his own relative bargaining advantage. That is, if the buyer must deliver payment before the seller delivers the item, the buyer may have an incentive to pay a higher price than he could otherwise bargain for. Similarly, if the seller must deliver the item before the buyer delivers payment, the seller may be willing to accept a lower price than he could otherwise bargain for.

Finally, the possibility of facilitating sequential exchange through the use of an escrow service is considered. Conditions are determined under which the agent acting first will employ an escrow service in order to ensure that exchange occurs successfully (as opposed to ensuring successful exchange through the disposal of his own relative bargaining advantage).

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FIGURE 1

Payoffs when Buyer Moves First

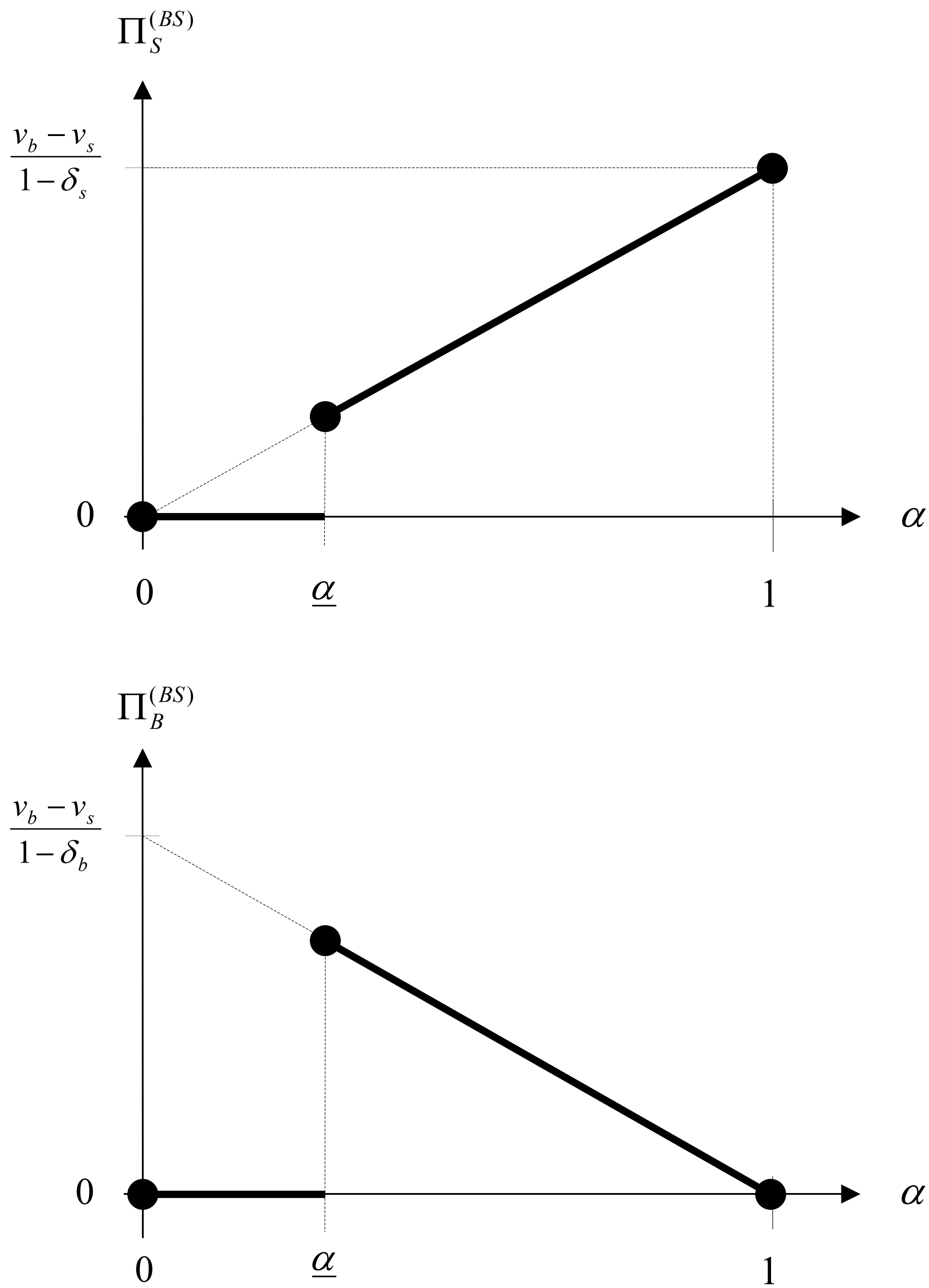

FIGURE 2

Payoffs when Seller Moves First

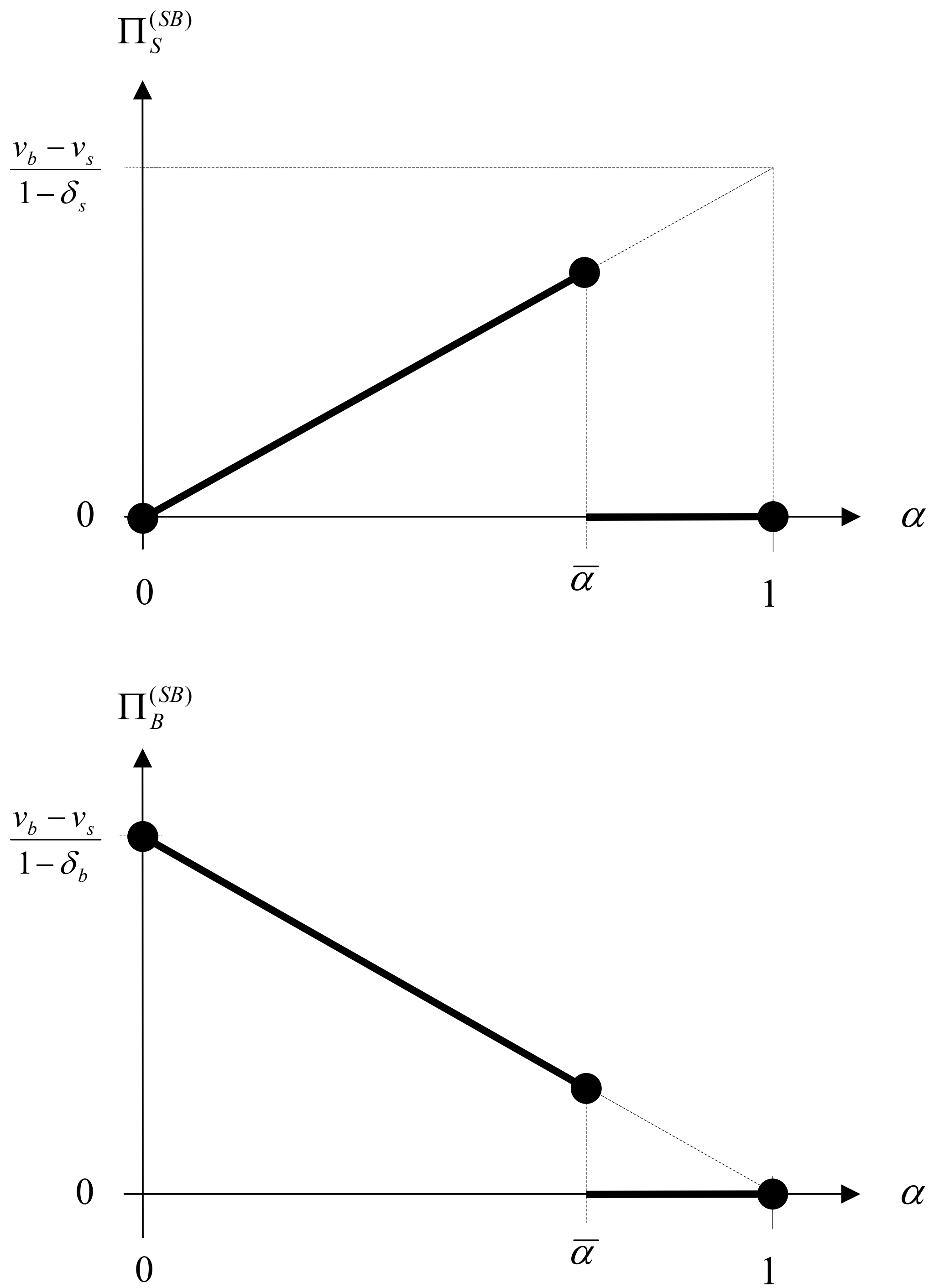

FIGURE 3

Payoffs when Buyer Moves First and Escrow Option is Available

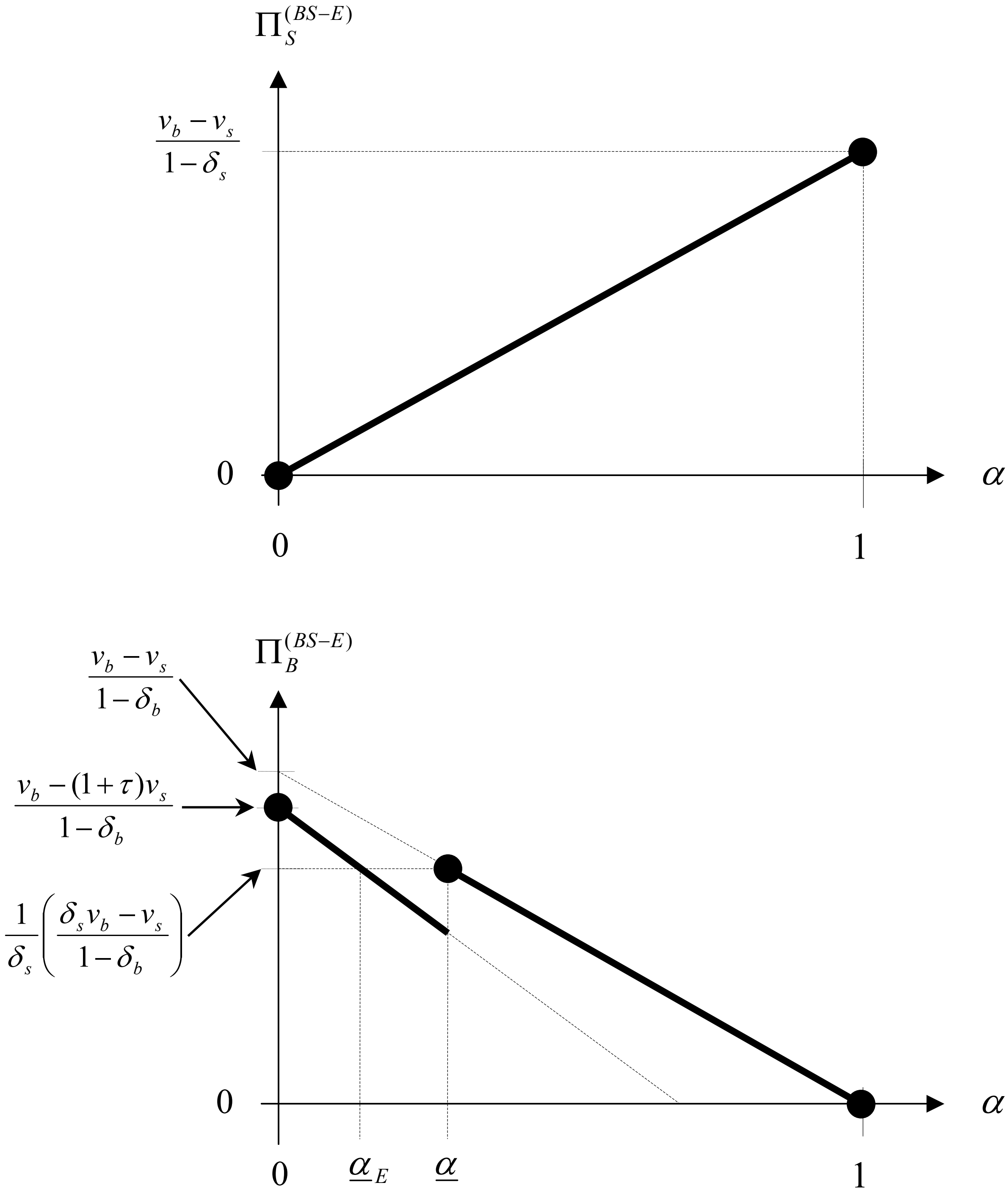

FIGURE 4

Payoffs when Seller Moves First and Escrow Option is Available