

REGULATING PURCHASING ALLIANCES: AN EXPERIMENTAL INVESTIGATION

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Abstract

In this paper, we study purchasing alliances using posted-offer markets inspired by the experimental economics tradition. The paper is motivated by the concerns expressed over the formation of purchasing alliances: suppliers fear that purchasing alliances will adversely impact their profits; antitrust authorities like the FTC are concerned that such alliances could be anti-competitive due to buyer collusion. Studying collusion with industry data is extremely difficult, hence we demonstrate the laboratory inquiry method of experimental economics to study purchasing alliances. In particular, we study an intriguing characteristic which can ameliorate collusion among buying partners – the fact that alliances are formed between companies that are rivals in the marketplace. We find that contrary to FTC’s fears, purchasing alliances can in fact harm buyers while benefiting sellers.

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1. Introduction

Recent years have seen a phenomenal growth in the formation of purchasing alliances. Advances in computer technology have enabled firms to set up complex electronic exchange systems that promise to streamline purchasing transactions and transform the operation of markets (Kaplan and Sawhney, 2000). Many such collaborative buying alliances have also been set up between companies that compete with each other in the marketplace.

The sharing of information that is possible in such purchasing alliances, and the potential for collusive collaboration amongst competitors, has raised red flags with antitrust authorities (DeSanti, 2000). In a bid to provide more power to the antitrust authorities, the U.S. Senate in October 2005 passed the Antitrust Criminal Investigative Improvements Act. This Act empowers antitrust authorities to use wire-taps in suspected cases of collusion, cartels and horizontal price-fixing.

Buyer collusion and horizontal price-fixing can indeed be facilitated by the formation of a purchasing alliance, to the detriment of sellers. On the other hand, purchasing alliances are often formed between firms that normally compete with each other in the marketplace. In this paper, we study whether collusion between buyers to the detriment of sellers is in fact facilitated by the formation of a purchasing alliance. Given that the study of collusion using field data is extremely difficult due to the legal issues involved, we use a laboratory inquiry method from the field of experimental economics to investigate this intriguing aspect of purchasing alliances. We study buying alliances using laboratory posted-offer markets (Davis and Holt, 1993), and find that ironically, the formation of a buying alliance can be detrimental, not to the sellers, but to the buyers.

1.1 Buying Alliances

The earliest horizontal alliances were probably the “farmer co-ops” in which individual farmers banded together to increase their bargaining and market power. Independent retail grocers have also used purchasing cooperatives for many decades to obtain lower prices from suppliers, the most well-known being IGA or the Independent Grocers’ Association.

Broadly defined, a purchasing alliance consists of two or more entities that join together either formally or informally, or through an independent third party, in order to combine their individual purchasing requirements for materials, services, and capital goods (Hendrick 1997).

A form of purchasing alliance organized through an independent third party is a group purchasing organization or GPO. These buying alliances are common in the healthcare industry, with over 700 GPOs collectively contracting for almost 50% of the supplies and equipment purchased by health care institutions (Hovenkamp 2002).

In recent years, advances in information technology have spurred the formation of electronic purchasing alliances. Probably the most well-known is Covisint, the online joint venture between General Motors, Ford, DaimlerChrysler, Renault and Nissan formed to streamline purchases of over \$1,100 billion in auto supplies each year¹. Another venture, DSS World Sourcing AG, which is a buying alliance of Delta, SwissAir and Singapore Airlines, is an attempt to consolidate the purchasing power of the airlines to reduce the cost of procuring products ranging from peanuts to airplane parts. Other airlines have formed buying alliances for the purchase of actual aircraft – Air Canada,

¹ Our sources for examples in this paragraph are publications like *The Economist*, Associated Press reports and other popular business periodicals and news items.

Lufthansa, SAS, and Australian Airlines joined forces to purchase 100 airplanes of a single model aircraft for a total order of more than \$4.5 billion. Dow Chemical, Royal Dutch/Shell and 12 other firms in the energy and petrochemical business pooled their buying power to form the Trade-Ranger.

The evolution of purchasing alliances into massive electronic marketplaces such as the examples above has been spurred by advances in technology, and billions of dollars in purchases are estimated to be handled by such business-to-business e-marketplaces (FTC 2000). These electronic marketplaces utilize the Internet and Web-based information systems to provide a platform for firms to buy and/or sell their products. With their speed of handling transactions and utilization of real-time business communications, such purchasing alliances promise to significantly increase transactional efficiencies and savings. The collaboration that exists among the participants of such a purchasing alliance can foster reduction in administrative and search costs and result in overall efficiencies. Such efficiencies have been recognized as being advantageous by antitrust authorities; the Guidelines for Collaborations Amongst Competitors released by the US Department of Justice and the FTC in 2000, for instance, specify that “it would be a rare case in which setting up a B2B e-marketplace itself would be viewed as per se illegal” (DeSanti, 2000).

At the same time, however, when the purchasing alliance brings together as collaborators companies that are rivals in the marketplace, certain aspects of buying alliances start to have antitrust authorities concerned. These relate to the sharing of information that is possible between competitors, and the potential for monopsonistic conduct that exists when competitors come together in a buying alliance.

Antitrust concerns are raised when close competitors in the same industry can potentially use their buying power to depress prices paid to suppliers. Antitrust authorities are concerned about the possible monopsonistic effects of buying alliances. Monopsony, the market structure with a single buyer and multiple sellers, is the conceptual opposite of a monopoly which has a single seller and multiple buyers. Just like a monopolist can use his power to force buyers to accept higher prices, a monopsonist raises concerns because he can exploit sellers by forcing them to accept lower prices. Buying alliances have the potential of functioning like a monopsony if buyers band together and work like a single giant buyer. Hence, alliances in which competitors can make collusive arrangements on price or output using the mechanism of a buying consortium are likely to attract legal scrutiny under the Competitor Collaboration Guidelines (DeSanti, 2000).

However, the essential requirement for a buying alliance to work as a monopsony and thereby harm sellers, is that the buying partners in the alliance band together cooperatively. This may be hard to achieve when the alliance is formed between companies that are rivals in the marketplace. Competitive rivalries between the participants in a buying alliance can keep their collusive tendencies in check; the competitive spirit can dull the potential for collaborative outcomes. As Hamel, Doz and Prahalad (1989) point out in an article written years before the “alliance fever” of the current era, “successful companies never forget that their partners may be out to disarm them.” They also warn that when companies form alliances with their competitors, they must “defend against competitive compromise” with respect to the skills, technologies, and information that gets traded. Similarly, Bucklin and Sengupta (1993) note that, “The

potential for serious conflict is always present as partners often compete with each other” (p. 33). It is therefore interesting to study whether collusion in a buying consortium can be sustained amongst companies that are close rivals outside the consortium.

This is the issue that we study in this paper. Given that the formation of buying alliances on such a large scale is a fairly recent phenomenon, buyer alliances have only recently started receiving attention from academic researchers, and this particular aspect of buyer consortiums has not been studied previously, perhaps due to the difficulty in obtaining industry data. Prior research has dealt with issues in new product alliances (e.g. Sivadas and Dwyer, 2000, Rindfleisch and Moorman, 2001), selling partnerships (e.g. Barclay and Smith, 1997), and horizontal alliances (e.g. Nygaard and Dahlstrom, 2002). Simonin and Ruth (1998) and Park et al (1996) focus on cooperative brand marketing activities and their effects on attitudes of consumers towards the brands in the brand alliance.

In this paper, we study the effect of buyer alliances on market outcomes, specifically with a view to determining whether the formation of an alliance tips the balance in favor of the buyers at the expense of their suppliers. The questions we examine in this paper are: in what way does the performance of markets change when buyers are allowed to form a buying alliance? Does the formation of buying alliances adversely impact sellers’ profits? To what extent do buyer alliances facilitate collusion amongst competitors? To answer these questions, we study key parameters such as prices, profits and efficiencies, in laboratory posted-offer markets implemented in the experimental economics tradition.

1.2 Experimental Economics Methodology

Laboratory markets conducted using the posted-offer method can be fruitfully used to catalog the behavior of buyers and sellers in many common strategic situations; yet this research methodology has remained largely unexplored in the study of alliances. We view this paper as an exploratory step aimed at understanding the impact of buying alliances, and concurrently introducing the reader to the posted-offer method of experimental economics. To our knowledge, this is the first time that the posted-offer methodology has been used in the study of alliances.

The posted-offer method allows a researcher to implement markets with repeated interactions among players, and is one of the methods used to study market outcomes in experimental economics. Experimental economics, as the term suggests, is a sub-field in economics research that treats economics as an observational science and relies on controlled experimentation to learn about economic behavior (Kagel and Roth 1995, Davis and Holt 1993). As with any laboratory experimentation, studies conducted in the experimental economics tradition give the researcher greater control over a number of variables that are likely to confound the results obtained using alternative research methods such as surveys or econometric analysis of historical data.

In addition, there are some distinguishing characteristics of the experiments conducted by experimental economists. One distinguishing feature is the use of financial incentives. While psychologists believe that subjects' intrinsic motivation alone is sufficient to induce performance in experimental tasks, economists believe that monetary reward is absolutely essential to motivate participants in experiments. Hence it is a tradition in experimental economics that subjects get paid for their participation. Also, as

Camerer and Hogarth (1999) note, in contrast to most experimental tasks undertaken in psychology or marketing studies, the decision-making tasks in economics experiments are usually complex, and participants are required to make repeated decisions over a number of trading periods. Thus in order to maintain participant interest and motivation, the use of monetary incentives becomes unavoidable. Participants in experimental economics studies are rewarded in direct proportion to the profits that they make during the study. This ensures that subjects pay attention to the complex experimental task. It also mirrors conditions in the real world where economic decisions always have monetary consequences. Thus experimental economics studies have the advantage of bringing together controlled experimental conditions in the presence of real-world reward structures.

In this study, we are interested in investigating the effect of buying alliances where competitors have an opportunity to collude. Although the purchasing alliances may not be formed with the intention of colluding, they do facilitate the exchange of information amongst competing companies should they desire to collude. The experimental economics approach is well-suited for this investigation since it allows us to simulate this very situation in our experimental markets; in the “buying alliance” markets, we provided the buyers in our posted-offer markets an opportunity to collude, without binding them in a specific contract and without imposing collusive actions on them. Also, since players in an experimental market get rewarded based on the profits they earn, each buyer is trying to maximize his/her own earnings, thereby fiercely competing with the other buyer. Thus posted-offer markets allowed us to parsimoniously replicate the real-world relations between companies in a purchasing alliance.

Would survey data be adequate to study the impact of such buying alliances? While surveys may be able to flesh out issues related to the perceived usefulness of buying alliances in bringing about cost savings or transactional benefits, our objective in this study is to investigate whether competing companies seize the opportunities for collusion that buying alliances provide. It would be extremely difficult to get forthright answers to questions on collusion or collusive intent using questionnaire surveys. For example, Hendrick (1997) reports the results of a survey of purchasing consortiums but explicitly specifies that a purchasing consortium is assumed to avoid all “real, potential, and perceived violations of anti-trust laws.” Thus, rather than surveys, the experimental methodology is better suited to studying the issue at hand.

Would econometric analysis of empirical data on prices and volumes help us ascertain the effect of buying alliances? While such data could conceivably be available, it would be exceedingly difficult to tease out the impact of buyer collusion opportunities provided by buyer consortiums. Moreover, as with any field data, it would be near-impossible to disentangle the effects of changes in market characteristics, and the effect of the buying alliance itself. By maintaining control over the market demand and supply curves in the experimental posted-offer markets, we are able to unambiguously attribute the changes in profits to the presence of an opportunity to collude.

Also, theoretical Nash equilibrium prices are never known in real-world interactions between companies since cost data and demand figures are not known with any degree of certainty. By using a market-power design in our experimental markets, we are able to theoretically calculate the Nash equilibrium pricing distribution and then

compare it with prices observed in the experimental markets. This would not be possible using any method other than the posted-offer method of experimental economics.

Finally, we are interested in evaluating the effect of buyer alliances over the long term rather than just at a point in time. As mentioned before, posted-offer markets are implemented with repeated interactions among players, and thus are ideally suited for a study where long-run effects are important. Using posted-offer markets also allows us to theoretically predict equilibrium behavior, which is derived using game theory under assumptions of individual rationality. Since the focus of this paper is on the interplay of individual rationality versus inter-firm cooperation, these theoretical predictions are important because we are able to compare experimental results with equilibrium predictions for the posted-offer market.

2. Posted-Offer Markets

A number of purchasing alliances have been characterized as web-based mega-catalogs (Kaplan and Sawhney, 2000) where sellers list their products at posted prices. This setup is parsimoniously replicated in the posted-offer market methodology.

Posted-offer (PO) markets are so called because prices are “posted” by sellers and buyers shop around deciding which product and how much they want to purchase.

The posted-offer² mechanism captures the basic structural features of retail markets as well as the operation of markets for various professional services, markets for mail-order

² Some of the other market trading institutions used in market experiments in experimental economics are the Walrasian auction, the posted-bid auction, the English auction, the posted-offer auction, the double auction, the clearinghouse auction, the discriminative auction, the bid auction, the competitive auction, the offer auction and the Dutch auction.

products, the intermediate goods markets, and markets where firms undertake to sell products only at posted list prices (Ketcham, Smith and Williams 1984). Firms in selected industries like brewery or shipping also operate using the posted-offer mechanism since regulations mandate that such firms post prices with a government, quasi-government or regulatory agency (Davis and Holt 1993). The PO-institution has been extensively analyzed by Smith (1976), Plott and Smith (1978) and Ketcham, Smith and Williams (1984). Today, the posted-offer market is the most common market in operation in the United States, and indeed all over the world. It is therefore interesting to note that the economics literature of the 1930s hurled strong anti-competitive accusations³ against this very market mechanism that is so mainstream today.

In a laboratory posted-offer market, players are assigned the roles of sellers and buyers. The sellers are given information on their production costs, and the buyers are given their reservation values for the product. Sellers decide on the price they want to charge for their product and buyers decide on the quantity they wish to buy based on the sellers' posted prices. This process is conducted over a number of trading periods, thus allowing researchers to study repeated interactions between buyers and sellers in a market in a controlled setting.

We studied purchasing alliances using posted-offer markets by following standard experimental economics protocol. In the next section, we describe the experimental setup we used, while at the same time providing a description of the posted-offer method.

³ Market and experimental data reveal that prices tend to be higher and efficiencies tend to be lower in posted-offer markets compared to the double auction.

3. Experimental Implementation of the Posted-Offer Markets

In our experimental setup, two sellers and two buyers interacted with each other in a posted-offer market in which sellers had market power, i.e. the Nash equilibrium prices were designed to be higher than competitive equilibrium prices. Theoretically, therefore, it is a Nash equilibrium strategy in this design for sellers to set prices higher than competitive equilibrium prices. This ability to set higher prices was incorporated in the experimental market design in order to provide a sharper test of the effect of buyer alliances. We implemented each posted-offer market with players interacting in a non-computerized face-to-face setting. In each market, sellers were told their cost structure and they decided on the price they would charge. They were not given any information about the demand in the market.

Since we were studying the effect of buyer alliances on market outcomes, we had two experimental conditions: in the “buyer-alliance” markets, buyers were given an opportunity to discuss buying strategies before the start of each trading period. In the “passive-buyer” markets, play progressed as in a conventional posted-offer market wherein each buyer played independently of the other and did not have any opportunity for any kind of discussion.

It is important to note that the buyer-alliance markets did not have a formal contractual implementation of an alliance; buyers were merely afforded an “opportunity to collude” in their buying actions if they desired. This was done deliberately, since in the corporate world, markets are characterized by intense competitive rivalries and even when companies come together in buying alliances, these rivalries do not diminish. There are strong tensions between the instinct to act selfishly and the need to behave

cooperatively (see for example Hamel 1991). We wanted to preserve this sense of tension in our experimental “buyer-alliance” markets.

In the buyer-alliance condition, buyers were allowed to discuss their buying strategies at the start of each period but were also instructed that those discussions were not binding on them. In other words, after their discussions, each buyer was free to act in his/her own selfish interest in reaction to the prices posted by sellers, without having to abide by the strategies they may have decided on earlier. This mirrors the conditions in a real-world buying alliance that the FTC is wary about. The social psychology literature has many instances in which “bonds” are formed between subjects in an experiment as a result of something as trivial as the color of the ribbon the subjects receive – an effect we wanted to guard against. Hence we deliberately kept the level of alliance-formation cues to a minimum, merely providing buyers the opportunity for pre-period discussion in the buyer-alliance condition. In the “passive buyer” markets, buyers proceeded as in a conventional posted-offer market, that is, each buyer played independently. Buyers were not allowed to communicate with each other.

In both experimental conditions, buyers were given information on how much they valued the commodity being sold, and each buyer independently decided on the quantity s/he wanted to buy, with the objective of achieving as high an individual surplus as possible. Buyers had no knowledge of the sellers’ costs. Similarly, sellers did not know the buyers’ reservation values or the total demand in the market; they merely knew their own costs and the number of units they could produce. In addition, although the markets were designed to be symmetric with both sellers having the same cost structure

and both buyers having the same valuation structure, the sellers and buyers did not know the costs and reservation values of the other seller and buyer in the market.

In order to assess the effect of buyer collusion, we compared the pattern of play under the two conditions on a number of parameters, the most important being the prices posted by the sellers, the profits that they made, the surplus enjoyed by the buyers, and the overall efficiency of the market. If the buyers are strictly rational agents, the dominant strategy for them would be to follow a myopically optimal strategy of purchasing all profitable units in any given trading period. Refusing to buy would be irrational since it would mean forgoing profits. However, when accorded communication opportunities with other buyers, buyers could well engage in strategic withholding by refusing to purchase even profitable units, in a strategic attempt to punish sellers for setting high prices. Hence if buyers are willing to ignore rational self-interest in favor of the alliance, sellers will be forced to offer lower prices, which will have the effect of depressing mean posted prices and mean contract prices in the buyer alliance condition. In the next section, we provide a detailed description of the market parameters employed in both experimental conditions.

3.1. Market Design Parameters

Figure 1 diagrammatically shows the parameters of the game in terms of the aggregate supply and demand in the market. In keeping with the experimental economics tradition, the markets were conducted with an undefined product and the game sessions were devoid of any cover stories. Each market had two buyers and two sellers. As depicted in Figure 1, buyers ($B_i, i=1,2$) faced a symmetric number of sellers ($S_i, i=1,2$)

with a total market capacity of six units, the capacity being arrayed in a two-step supply configuration where each seller could produce one low-cost unit and two high-cost units. In keeping with the experimental protocol in posted-offer markets, sellers had to decide on one common “posted” price for all the units even though the units did not have the same production cost.

Also, as per standard posted-offer trading procedures, the inventory carrying costs were zero and there were no penalties for unsold units. Each seller had one low-cost unit produced at a per unit-cost of c_1 and two higher-cost units at a per-unit cost of c_2 , giving them a total capacity of three units each. In our markets, these costs were set at \$4 and \$5 respectively. The demand function for the markets is arrayed as a two-step function. Each buyer can buy three units each, two of which are valued higher than the third unit, thereby inducing a downward sloping demand curve. Each buyer values the two high-reservation units at r (set at \$26) and the per-unit marginal valuation of the lower-value unit is denoted by p_c (which was set at \$10). We chose these parameters r , p_c and c_2 such that both sellers have the ability to profitably raise prices above competitive levels⁴.

In each experimental market, two sellers and two buyers played face-to-face in a non-computerized setting. The players in our markets were 72 undergraduate students at a major research university who participated in 18 experimental markets involving over 1508 market decisions. We used standard manual⁵ posted-offer design procedures, which included trained and supervised research assistants, the reading of instructions, a short quiz to test comprehension of these instructions, trial periods with no rewards as practice

⁴ $r > 3p_c - 2c_2$ is the condition for the sellers to profitably raise prices above competitive levels, as explained in the Appendix.

⁵ Computerization has no effect on PO-market performance (Davis and Holt 1993).

sessions, and a debriefing at the end of the game. Following the tradition among experimental game theorists, we stayed away from any intentional deception of players. The players' earnings were converted into tickets for winning cash prizes in lotteries such that their probability of winning the cash prizes was directly proportional to their performance during the experiment⁶. To control for end-game effects, a die was tossed after 19 periods and the game was terminated if a 1 or 2 was rolled.

In each "buyer-alliance" market, the sequence of moves was as follows: At the start of each trading period, the two buyers were given an opportunity to discuss their buying strategies. They could discuss strategies ranging from strategically withholding purchases, punishing any one or both sellers, to deciding on threshold buying levels, favoring one seller over another, or could come to any other strategic agreement. In order to maintain the analog to corporate buying alliances, they were also instructed that those pre-play discussions were not binding on them and that they were free to play in any manner they desired once the sellers announced their prices for that period⁷.

The sellers in the buying alliance markets could see that these discussions between the buyers were taking place, but could not hear them. Each seller independently decided on the number of units s/he wanted to sell during the period and the one common selling price for all the units. The experimenter announced these "posted prices" to the buyers. Each buyer then independently decided on the number of units s/he wanted to buy and from which seller. The buyers could decide to withhold

⁶ Unlike psychologists, experimental game theorists believe in relying on financial incentives when behavior in laboratory settings is studied. The lottery method tends to be used when there are budget constraints; research has shown that lottery results are not significantly different from outcomes obtained with the use of smaller continuous payoffs (e.g. Bolle 1990).

⁷ We took the usual precautions to guard against demand effects.

purchases in an effort to force the sellers to post a lower price in future periods, even if the price posted by the sellers for the current period was lower than their reservation values. Alternatively, they could disregard the discussions they had at the start of the trading period and buy at any price posted by the sellers.

Conventional posted-offer procedures mandate that buyers first purchase units that are valued higher in order to ensure that individual demand functions are downward-sloping, and likewise sellers sell lower-cost units first to induce upward-sloping individual supply functions. Keeping this in mind, sellers as well as buyers calculated their earnings for the period after the buying decisions were completed, and the same procedure was repeated for the next trading period.

The sequence of play for the “passive-buyer” markets was the same as above, except that buyers did not get to come together for any discussion at any point during the game. In other words, the passive-buyer markets followed the conventional posted-offer protocol.

4. Findings

Is it possible that buyers in a purchasing alliance use the opportunity to collude, thereby reducing seller profits? Or are sellers relatively unharmed because the partners in a buying alliance act in rational self-interest? We attempt to answer these questions in the present section by comparing the pattern of play in the two experimental conditions on a number of parameters, the most important being the profits made by the sellers and buyers, the posted prices in the markets, and the overall efficiency of the markets. Further, we assess the extent to which observed play in the two conditions conforms to

the theoretical pricing distribution⁸ for the experimental design. We describe the results briefly in this section, and discuss them in detail in the next section.

4.1 Posted prices higher in buyer-alliance condition

Sellers' posted prices were significantly *higher* in buyer-alliance markets compared to the passive-buyer markets (Figure 2: $p^s_{alliance}=12.90$, $p^s_{passive}=11.25$, $p<.05$). Exit interviews and observation of players revealed that sellers in the buyer-alliance markets became uneasy during the buyers' pre-trading discussions and priced their product more aggressively, often refusing to undercut the other seller's prices. In the passive-buyer condition, sellers did not perceive the buyers as adversaries, leading to lower posted prices in the passive condition. In fact, when the buyers were passive price-takers, the posted prices were even below p_{min} , the lower bound theoretically predicted under the mixed-strategy Nash distribution.

4.2 Contract prices higher in buyer-alliance markets

Buying alliances were expected to result in deflated contract prices.⁹ However, mean contract prices, just like posted prices, were significantly higher in the buyer-alliance condition than when buyers were passive ($p^c_{alliance}=11.88$ $p^c_{passive}=9.58$, $p<.01$).

4.3 Buyer profits *not* higher, seller profits higher in buyer-alliance condition

⁸ As outlined in Holt and Solis-Soberon (1992) and Davis and Holt (1993), this design does not have a pure-strategy Nash equilibrium. The mixed-strategy equilibrium involves price randomization over the range $[(r+2c_2)/3, r]$. This mixed-strategy distribution, which is symmetrical for the two sellers, is given by $\square(p) = \{3p-2c_2-r\} / \{2p-2c_2\}$ and is bounded between $p_{min}=(r+2c_2)/3$ and r .

⁹ We use the standard definition of contract price, namely the price at which the contract for a sold unit is struck in a market. It is computed as the total revenue generated in the market for any given period divided by the total number of units sold in that period. It is different from the posted selling price since it is meant to capture the average price of a *sold* unit.

When buyers have an opportunity to collude, buyer profits are expected to be higher. We found, however, that buyer profits in the two conditions were not significantly different. ($\pi^b_{passive}=49.12$, $\pi^b_{alliance}=49.29$, ns). What prevented buyers from making higher profits given opportunities to form alliances? Exit interviews revealed that buyers in the alliance condition became acutely conscious of the other buyer and started competing with fellow buyers rather than with sellers alone, which adversely affected their profits. Further, as seen in Figure 3, seller profits were in fact significantly higher in the buyer-alliance condition than in the passive-buyer condition ($\pi^s_{alliance}=29.11$, $\pi^s_{passive}=19.19$, $p<.01$).

4.4 Higher surplus extracted by sellers in buyer-alliance markets

In order to analyze equity effects and explore the distribution of surplus between buyers and sellers, we calculated seller profits as a percentage of the total accrued surplus. In buyer-alliance markets, sellers extracted an average surplus of 36.76%, significantly higher than the 27.99% surplus they extracted in the passive-buyer markets ($p<.05$). We find therefore that the formation of purchasing alliances actually tilts the equation in favor of sellers. Looking at it another way, buyers extracted significantly lower surplus ($p<.05$) in alliance markets (63.24%) than in passive markets (72.01%).

4.5 Market efficiency higher in buying-alliance condition

The above results suggest that the formation of buying alliances tilts the equation in favor of sellers. Are buyer-alliance markets more efficient than passive-buyer markets? To determine this, we computed efficiency as the percentage of maximum surplus extracted. Buyer-alliance markets were significantly more efficient than passive-buyer markets

($e_{alliance}=81.67$, $e_{passive}=72.30$, $p<.01$). More units were traded in buyer-alliance markets than in passive-buyer markets, although the difference was not statistically significant ($v_{passive}=3.65$, $v_{alliance}=3.95$, $p=0.09$).

4.6 Buyer-alliance pricing closer to theoretical mixed-strategy distribution

It is interesting to assess whether players in our experimental markets followed the theoretical mixed-strategy Nash pricing distribution. Figure 4 shows theoretical predictions as well as observed densities for both experimental conditions. Interestingly, while the theoretical prediction is that players randomize between p_{min} and r as per the mixed-strategy distribution, in general, sellers in the passive condition posted prices well below those levels. Clearly, players in the buying-alliance condition did not randomize as per the theoretical predictions either, but their observed density weight was comparatively closer to theoretical predictions.

4.7 Comparison with theoretical distribution: long-run effect

To understand the long-term effects of buying alliances, we analyzed the pattern of play for the last two-thirds of each market. Recall that demand and supply parameters were not perfectly known to the players, and hence the initial periods of the game were likely used by the players to learn these market parameters. We therefore analyzed the pattern of play for periods 6 through 19, when we expect play to have stabilized after this initial learning. As seen in Figure 5, the observed density weight for the buyer-alliance markets is closer to the Nash equilibrium predictions even in the stabilized portion of the game; the passive markets are farther away from theoretical predictions.

pricing distributions for the passive and buyer-alliance markets for these trading periods

5. Discussion and concluding comments

The experimental posted-offer markets we conducted aimed to study the effect of buyer alliances on market outcomes. We were motivated by the fact that suppliers and antitrust authorities are concerned about the potential anti-competitive effects of buying alliances. Our aim was to study whether suppliers would in fact make lower profits in buyer-alliance markets, given that buying alliances are formed between firms that may find it hard to cooperate with each other in the alliance since they are rivals in the marketplace.

We found that prices posted by the sellers were higher in the buyer-alliance condition. It was almost as if the very fact that the buyers could “gang up” against the sellers made the sellers want to post higher prices. Mean contract prices were also higher in the buyer-alliance condition. This would seem natural, since the prices posted by the sellers were higher. However, we would have expected to find buyers in the buyer-alliance condition withholding their purchases in the face of the higher posted prices, resulting in lower contract prices; this did not happen. Even though the buyers did discuss withholding strategies, the need to maximize individual profits seems to have won over the need to punish sellers for setting high prices. Recall that as per posted-offer protocol, if the buyers withheld purchase and did not buy during a trading period, they could not make any profits on the unbought units. Hence it appears that buyers only acted in a selfish, individually-rational manner even when afforded the opportunity to align with the other buyer.

Consequently, buyer profits were lower in buyer-alliance markets compared to passive-buyer markets, although the difference was not statistically significant. Similarly, seller profits were significantly higher in buyer-alliance markets. Sellers also extracted a higher proportion of the total available surplus in buyer-alliance markets.

We also found that in the alliance condition, buyers became acutely aware of the other buyer and started competing with fellow buyers. This prevented buyers from making higher profits, in spite of opportunities to collude. This suggests that the uneasiness with which suppliers and antitrust authorities view mega-buyer conglomerates may not be warranted.

Further, the buyer-alliance markets were more efficient than the markets with passive buyers, with more units traded each trading period. We would have expected greater buyer withholding when buyers were given the opportunity to form an alliance, thus decreasing the number of units traded and hence decreasing the efficiency. This however, did not happen, with buyers being more concerned with individual profit maximization as opposed to alliance building.

Finally, a comparison between the observed and theoretical pricing distributions showed that pricing frequencies in the buyer-alliance markets followed the theoretical density function much more closely. This is a noteworthy result because the theoretical mixed-strategy distribution is derived under the assumption of individual rationality and per-period self-interested optimization by buyers. Thus, in the buyer-alliance markets, buyers appear to have put individual self-interest ahead of the welfare of the alliance, resulting in favorable outcomes for the sellers.

It is also interesting to note that the passive-buyer condition, which more closely resembles the assumptions of game theory, exhibited a pattern of play that was comparatively farther removed from game-theoretic predictions. Although the shape of the distribution for the passive-buyer condition mimics the theoretical distribution, we find that it is farther removed compared to the buyer-alliance frequency distribution.

A similar result was observed for the long-run pattern of play. A comparison of the pricing distributions in the latter periods showed that the buyer-alliance condition was closer to the Nash equilibrium prediction. This suggests that even over the long haul, buyers in the alliance were acting in their own rational best interest, instead of collaborating with their competitor. We analyzed play in these latter periods of the game to study long-run effects by excluding those earlier periods where players may have only been learning the parameters of the market. In the real world, many alliances get dissolved during this learning phase, even before they can begin to understand the parameters within which they are operating. Several studies have documented that alliances have failure rates as high as 60-70% (Ertel, 2002) with the most important reason for failure being a lack of trust between the partners (Ertel, Weiss and Visioni, 2001). The finding from our study that even in the long run, players in the buying alliance were not able to trust each other enough to collude in their buying, is in keeping with this literature.

Ironically, therefore, we found that the buyer-alliance condition was detrimental to the buyers. Players in the buying alliance condition behaved as though they were adversaries, with individual rationality winning out over mutual cooperation between the buyers.

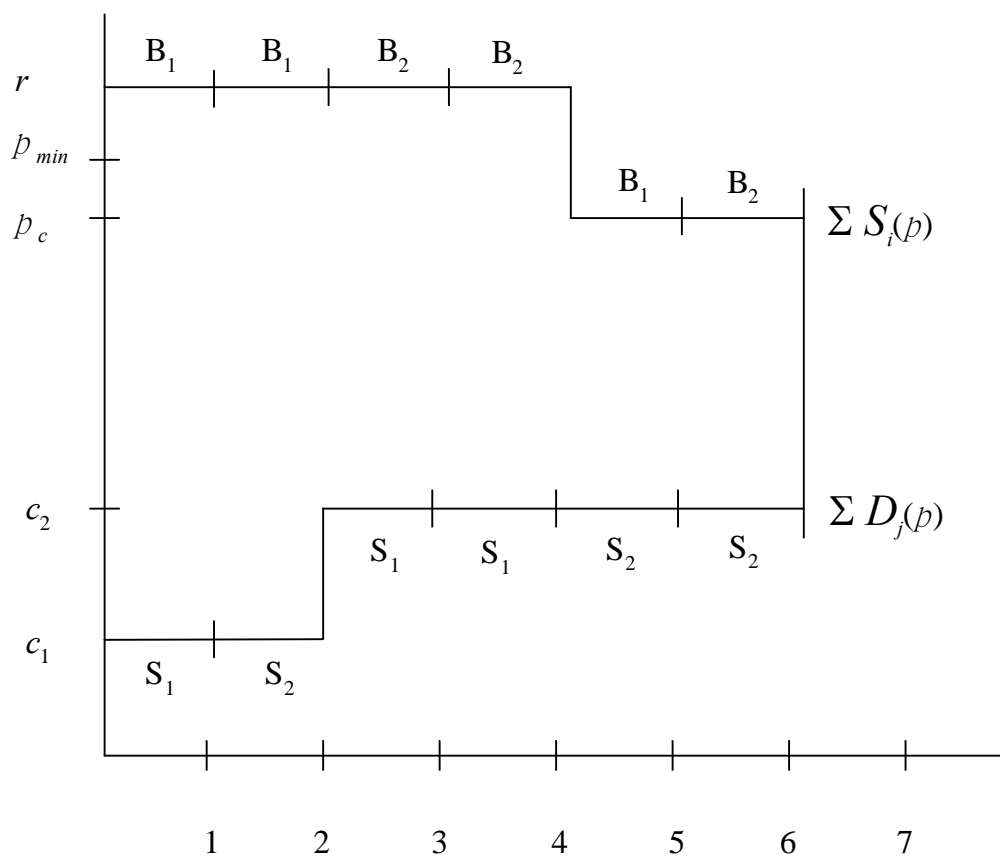
This tension between individual rationality and group cooperation has been recognized in the literature. Researchers have noted that distrust exists between partners in an alliance. Hamel (1991) for instance, points out that managers are keenly aware that “... the fact that a firm chose to collaborate with a present or potential competitor could not be taken as evidence that the firm no longer harbored a competitive intent...” (pg. 84). Axelrod et al (1995) incorporate this tension in their specification of the utility function of the firm when they develop their model for predicting how firms form alliances to develop and sponsor technical standards. They assume that the utility of a firm for joining a particular standard-setting alliance decreases with the presence of rivals in the alliance, especially close rivals. Similarly, Nault and Tyagi (2001) recognize that partnerships amongst firms in similar businesses can be successful only if individual alliance-member incentives are properly aligned with the incentives of the partnership itself, in their theoretical examination of coordination mechanisms for horizontal alliances. Park and Ungson (2001) have noted that interfirm rivalry is a major reason for the failure of strategic alliances.

Similarly, the pattern of results that we obtained in our posted-offer markets seems to broadcast a consistent message that ironic as it may seem, the formation of buying alliances paradoxically tilts the equation in favor of sellers. An interesting avenue for future research would be to study this phenomenon further by experimentally manipulating the degree of competitiveness/alignment of interests of the partners in a buying alliance. Rindfleisch and Moorman (2003) have studied the effect of degree of competitiveness between alliance members on their level of customer orientation using

longitudinal survey data. Varying the levels of competitiveness in a laboratory controlled situation promises to be a fruitful research direction in the study of buying alliances.

If the results from our exploratory study are any guide, they would suggest that the FTC or the sellers need not be overly concerned about the growth of buying alliances since the intrinsic rivalries of the members of a buying consortium are likely to keep the power of these alliances in check. We do acknowledge that these are the results from an experimental study with all the caveats regarding generalizability that accompany experimental research. We hope, however, that this paper has introduced to researchers who study alliances the great potential of the posted-offer implementation so widely used by experimental economists, while at the same time shedding some light on the paradoxical workings of a buyer alliance in which companies seek to form collaborative relationships with their competitors.

Figure 1



$$c_1 = 4, c_2 = 5, p_c = 10, r = 26$$

$$p_{min} = (r + 2c_2)/3 = 12$$

Figure 2
POSTED PRICES

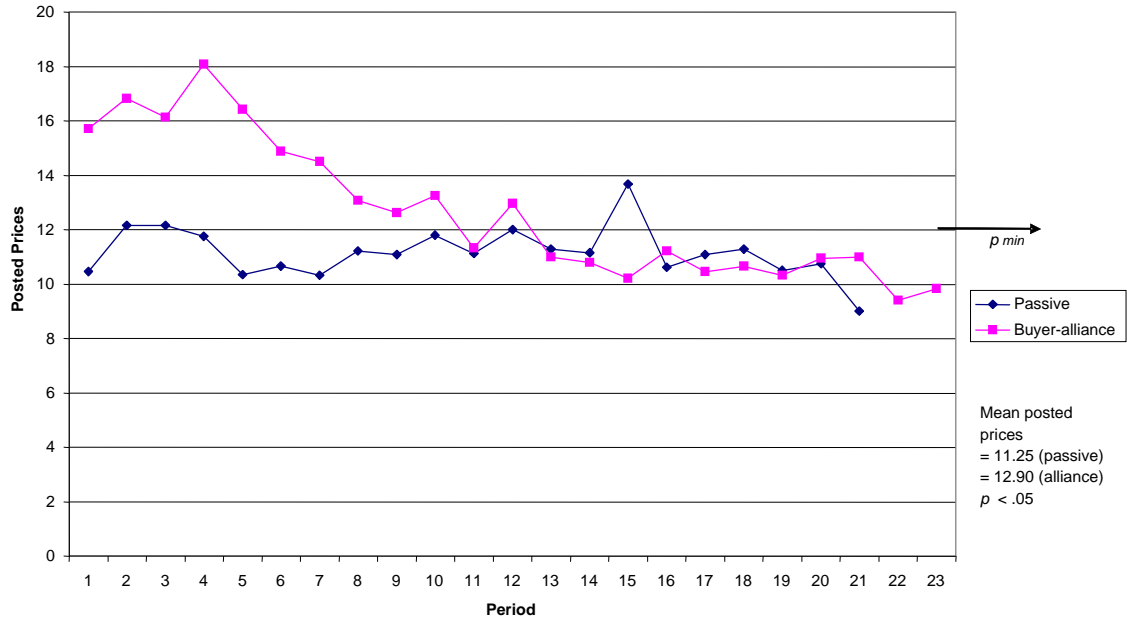


Figure 3
SELLER PROFITS

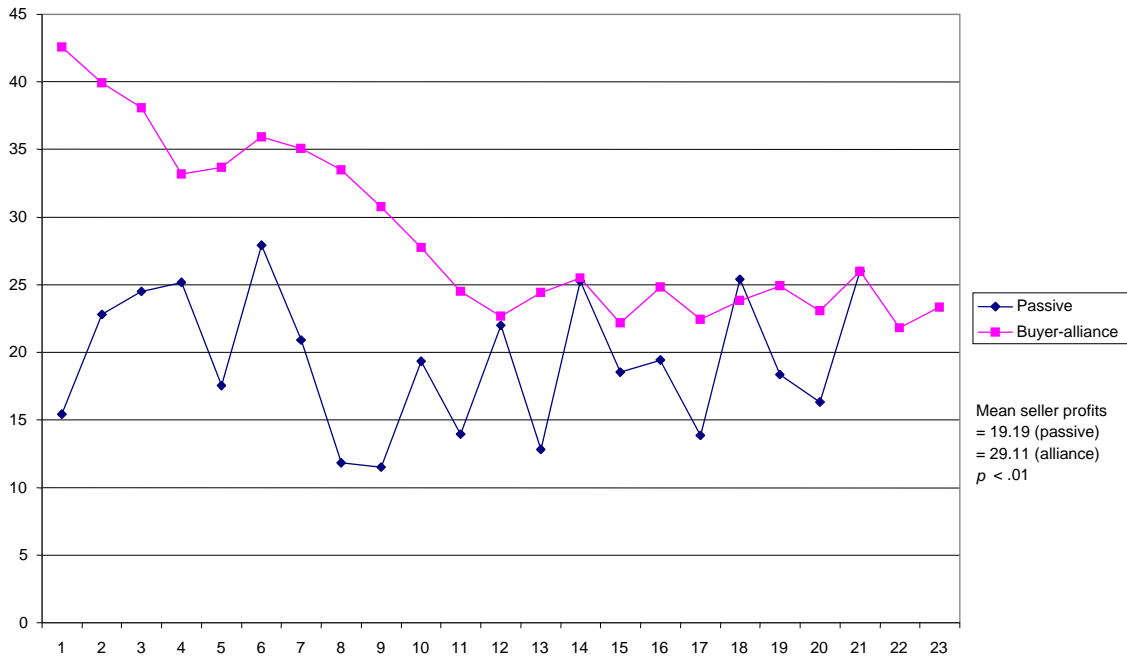


Figure 4
Density functions - theoretical predictions and observed densities

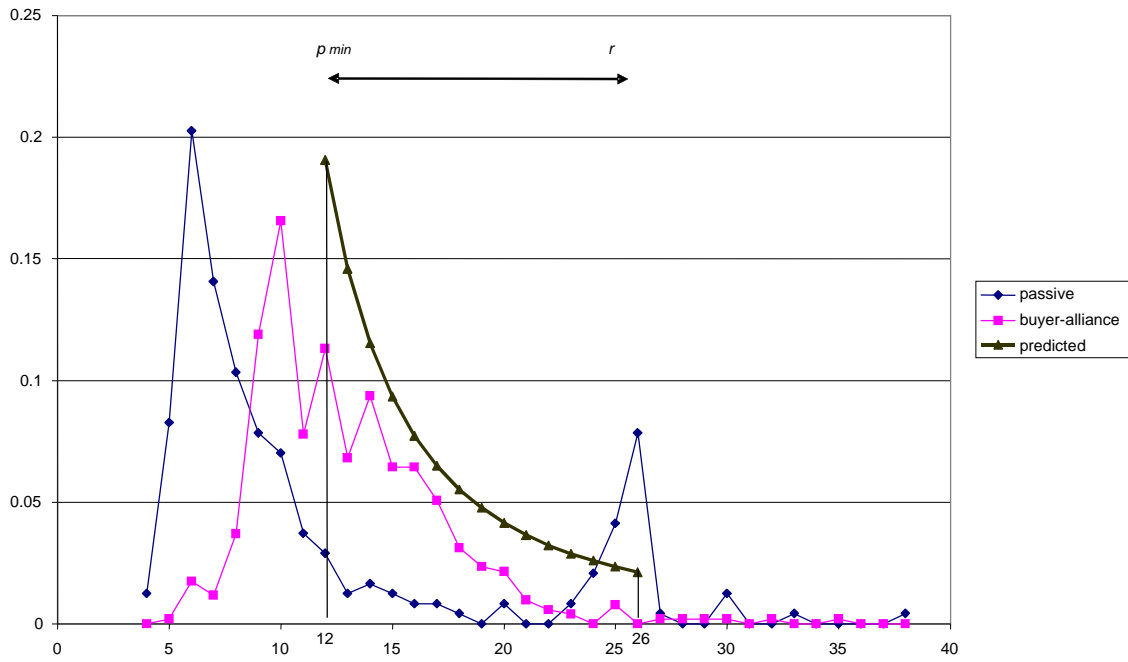
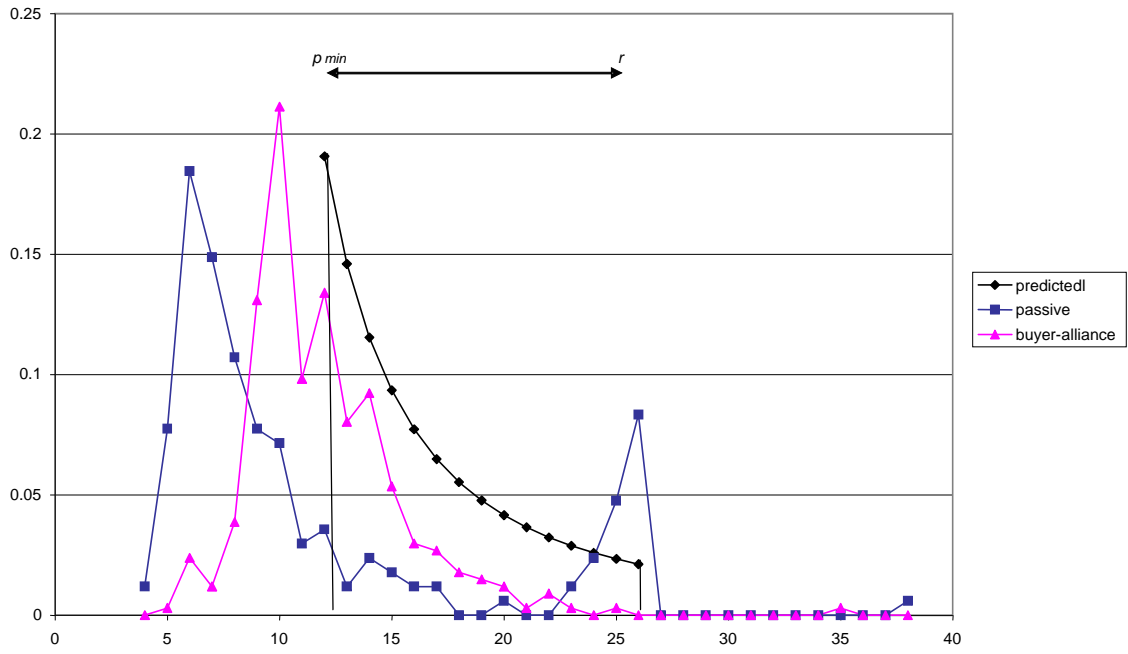


Figure 5
Density functions for long-run/stabilized play



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Appendix: Computation of Nash Equilibria¹⁰

The Nash equilibria we derive below are for the stage game. Since the players in our experiment played the same game repeatedly, it is important to note that the same stage-game equilibria we derive below hold for any finite repetition of the game. In other words, the equilibrium solutions derived below are the solutions even when the game is repeated a finite number of times. This is the result of using a standard backward-induction argument of game theory: the same equilibria hold for a finite repetition of the stage game since the payoffs in the stage-game equilibria are unique and finite repetition does not create any additional subgame-perfect equilibria. Thus, even when this game is played repeatedly, the Nash equilibrium outcomes presented below for the static game hold by virtue of backward induction.

Recall that the design used in our experimental markets is shown in figure 1 which depicts the aggregate supply and demand arrays. Buyers B_i , $i=1,2$ face a symmetric number of Sellers S_i , $i=1,2$ with a total market capacity of six units, the capacity being arrayed in a two-step supply configuration. The identities of the sellers endowed with the units are indicated on the supply curve below the corresponding units. S_i 's may sell one low-cost unit at a per unit cost of c_1 and two higher-cost units at a per unit cost of c_2 , giving them a total capacity of three units each. Also, the demand function is arrayed as a two-step function, where B_i 's value the four high-reservation units at r and the valuation of the two lower-value units is denoted by p_c .

¹⁰ To compute the Nash equilibrium, we follow closely the algorithmic process outlined by Holt and Solis-Soberon (1992) and Davis and Holt (1993). Although we have drawn heavily from these two works, this computation is outlined here in considerable detail for the benefit of audiences unfamiliar with posted-offer procedures and computation of mixed-strategy equilibria for step function demand and supply structures.

Obviously there is an excess supply of two units when S_i 's price above p_c . The competitive equilibrium for this design therefore involves a price in the range $[c_2, p_c]$; in other words the highest competitive equilibrium price is p_c . At the highest competitive price, earnings to each S_i are

$$\pi_{ci} = (p_c - c_1) + 2(p_c - c_2) \quad i= 1,2.$$

i.e. $\pi_{ci} = 3p_c - c_1 - 2c_2$

Although p_c is the highest competitive equilibrium price, it may or may not be the non-cooperative Nash equilibrium, depending on the relationship between π_{ci} and $(r - c_1)$. Let us now turn our attention to the non-cooperative equilibrium for the PO-design under consideration. Note that either S_i can price supra-competitively at r and still sell one low-priced unit because four units are demanded at a price r . If the seller makes a profit that is greater than π_{ci} , this deviation from the competitive equilibrium price of p_c will be profitable. In other words, the deviation will be profitable if

$$r - c_1 > \pi_{ci}$$

Thus, the deviation will be profitable if

$$r - c_1 > 3p_c - c_1 - 2c_2$$

i.e. if $r > 3p_c - 2c_2$ (1)

Hence, when $r > 3p_c - 2c_2$ the competitive equilibrium is not Nash, since either S_i can profitably raise price to r and make supra-competitive profit by selling a single unit costing c_1 . On the other hand, if the inequality was reversed, the highest competitive equilibrium price p_c itself would be a pure-strategy Nash equilibrium. It is easy to see why p_c would be Nash: a unilateral price hike by one seller would not be profitable, and a

unilateral price reduction will not bring in additional sales either; hence neither S_i will have any incentive to deviate from p_c .

Is our design in figure 1 likely to have a pure-strategy Nash equilibrium? First observe that a price of r itself cannot be Nash, because if one seller offers the products at a price r , the other seller has an incentive to lower the price slightly to $p = r - \epsilon$. Thus both S_i 's have an incentive to "shade" on any price in order to be able to sell all three available units. This incentive to price shade on any common price down to a minimum price p_{min} eliminates the existence of any pure-strategy Nash equilibria in our design¹¹.

If a pure-strategy Nash equilibrium eludes us, what is the mixed-strategy equilibrium? Observe that it would be optimal for each S_i to undercut her competitor for all prices in the range $[p_{min}, r]$, and the mixed-strategy Nash equilibrium involves randomizing the posted price over the range p_{min} to r . This minimum price p_{min} is the price such that (A)=(B), where

(A) = profits from selling one low-cost unit at price r , and

(B) = profits from selling available capacity of three units at price p_{min} .

Thus, p_{min} is arrived at by equating

$$(A) = r - c_1, \text{ and}$$

$$(B) = (p_{min} - c_1) + 2(p_{min} - c_2)$$

Therefore,

$$r - c_1 = p_{min} - c_1 + 2p_{min} - 2c_2$$

or $r = 3p_{min} - 2c_2$

Or equivalently, $p_{min} = \frac{(r + 2c_2)}{3}$(2)

¹¹ Note that p_{min} is not Nash either for obvious reasons.

Thus, the mixed-strategy equilibrium in this design involves price randomization over the range $[(r + 2c_2)/3, r]$. We will now compute the equilibrium pricing distribution for the two sellers.

The equilibrium pricing distribution is computed by noting that in order for a seller to be willing to randomize prices over the range $[p_{min}, r]$, all prices in that range should provide the same expected profit. Further, since a seller's profit is a function of the pricing distribution followed by her competitor, we arrive at the mixed-strategy distributions by estimating for each S_i the distribution that the other seller must follow such that expected profits are a constant.

Let Seller i choose a price p_i . When p_i is strictly greater than p_j , we denote the profit that results from the high price as $\pi_{Hi}(p_i)$. Likewise, let $\pi_{Li}(p_i)$ be S_i 's profit when her price is strictly lower than the other seller's price p_j .

$$\text{Thus, profits} = \begin{cases} \pi_{Hi}(p_i) & \text{for } p_i > p_j \\ \pi_{Li}(p_i) & \text{for } p_i < p_j \end{cases}$$

Let $G_{Hi}(p_i)$ denote the probability that p_i is the higher price, that is, the probability that $\pi_{Hi}(p_i)$ is the profit made. And let $G_j(p)$ be Seller j 's equilibrium price distribution, i.e. Seller j prices according to the distribution $G_j(p)$. Then,

$$G_{Hi}(p) = \text{Prob}(p_j < p) = G_j(p)$$

Now, Seller i 's expected profit can be denoted as V_i and can be written as

$$V_i = \pi_{Hi}(p) [\text{Prob}(p_i > p_j)] + \pi_{Li}(p) [\text{Prob}(p_i < p_j)]$$

Or equivalently,

$$V_i = G_{Hi}(p) \pi_{Hi}(p) + [1 - G_{Hi}(p)] \pi_{Li}(p) \quad i=1,2$$

Thus,

$$G_{Hi}(p) = \frac{\pi_{Li}(p) - V_i}{\pi_{Li}(p) - \pi_{Hi}(p)} \dots\dots\dots(3)$$

Since $G_{Hi}(p) = G_j(p)$, the above equation determines the pricing distribution for Seller j .

We will now compute V_i , $\pi_{Li}(p)$, and $\pi_{Hi}(p)$ for Seller 1 in order to arrive at the equilibrium mixed-strategy distributions. To compute V_i , note that Seller 1 is assured of a security profit of $r - c_1$, since he is assured of selling one low-cost unit by posting a price of r . Also, this security profit is earned irrespective of the price posted by S_2 . Hence, V_1 , which is Seller 1's expected profit, is equal to the security profit earned by posting the limit price of r .

i.e. $V_1 = r - c_1$

$\pi_{Li}(p)$ is the profit that S_1 makes when his price is lower than S_2 's price. When S_1 's price is lower, he sells all three of his units for a profit of

$$(p - c_1) + 2(p - c_2).$$

In other words,

$$\pi_{Li}(p) = 3p - c_1 - 2c_2$$

$\pi_{Hi}(p)$ is the profit when Seller 1's price is higher than the price posted by Seller

2. In this case, S_1 sells only one unit at a price of p , and earns a profit of $p - c_1$.

i.e. $\pi_{Hi}(p) = p - c_1$.

Hence, substituting these in expression (3), $G_{Hi}(p) = G_j(p) = G_2(p)$ is given by

$$\begin{aligned} G_2(p) &= \frac{3p - c_1 - 2c_2 - (r - c_1)}{3p - c_1 - 2c_2 - (p - c_1)} \\ &= \frac{3p - 2c_2 - r}{3p - 2c_2 - p} \end{aligned}$$

Hence,

$$G_2(p) = \frac{3p - 2c_2 - r}{2p - 2c_2} \dots\dots\dots(4)$$

The expression in (4) above is the mixed-strategy equilibrium pricing distribution for Seller 2. It specifies the distribution that S_2 must follow in order that S_1 makes equal expected profit in the range of p_{min} to r . Further, since Seller 1 is symmetric to Seller 2, the expression also specifies the distribution that Seller 1 must follow in order for S_2 to randomize.

We can easily verify that

$$G(p_{min}) = G\left(\frac{r + 2c_2}{3}\right) = 0; \quad \text{and}$$

$$G(r) = G\left(\frac{3r - 2c_2 - r}{2r - 2c_2}\right) = 1.$$

In other words, the mixed-strategy equilibrium pricing distribution specified in Equation (4) is bounded between $p_{min} = (r + 2c_2)/3$ and r .