Exclusionary Bundling and the Effects of a Competitive Fringe

by

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The traditional analysis of exclusionary bundling examines the impact of a monopolist bundling product A with another product B, which is competitively provided. Using experimental posted-offer markets, we investigate the exclusionary and welfare implications of having a fringe competitor in the A market. We find that the fringe seller increases the consumer surplus while decreasing the seller surplus and that the fringe seller does not affect the consumer surplus extracted from the bundle despite a decrease in the bundle transaction price. The consumer surplus gains generated by the fringe seller erode if the dominant seller has a lower average cost. (JEL: C99, D43, K21, L13, L41)

1. Introduction

A seller is said to bundle two products, A and B, when he sells them together at a single price. The U.S. v. Microsoft [2001] and LePage's Inc. v. 3M [2003] cases in the U.S. and the failed GE-Honeywell merger [2001] and the Microsoft [2004] cases in Europe revived the interest in the leverage theories on bundling. Two recent studies, NALEBUFF [2004] and GREENLEE, REITMAN, AND SIBLEY [2005], show that depending on the demand and supply characteristics bundling may allow a seller to exclude his competitors from the B market given that he is the monopolist in the A market.

Even though the assumption of a monopolized A market has been at the center of most leverage theories on bundling, naturally occurring markets, particularly those subject to the antitrust debate, are more likely to be dominated by a seller who faces fringe competition in the A market. This paper is an attempt to close this gap by addressing the following question: Does the introduction of a fringe seller in the formerly monopolized A market alter the exclusionary and welfare implications of bundling?

In an initial series of 20 experimental sessions conducted under four treatments we found that a fringe seller in the A market, with 8% of the dominant seller’s capacity, increased the total consumer surplus realized from the A and B markets by 12.24% and decreased the total seller surplus by 10.52%. The residual increase in the total system (consumer + seller) surplus was not statistically significant. However, bundling did not lead to statistically significant entry deterrence or any adverse or favorable effect on the consumer and system surplus. Thus the fringe seller in this experimental design did not change the exclusionary and welfare implications of bundling even though he decreased the bundle transaction price by 10.78%.

The observations from this original design raised more questions to be explored. The most important among them was the fact that we failed to find any statistically significant evidence of the exclusionary effects of bundling. Therefore, we constructed a second *exclusion design* with several alterations from the original. In the exclusion design a total of 24 sessions conducted under four treatments showed that bundling helped the dominant seller to exclude his competitors from the B market, leading to complete foreclosure in 30% of the observations. However, bundling still did not produce any statistically significant effect on either the consumer or system surplus. In the exclusion design the fringe seller was given 5%, instead of 8% in the original design, of the capacity that the dominant seller had. With this diminished relative capacity level, the fringe seller increased the total consumer surplus in the A and B markets by 6.97% (compared with 12.24% in the original design) and decreased the total seller surplus by 4.51% (10.58%). The residual increase in the total system surplus remained statistically insignificant. Again the fringe seller, despite decreasing the bundle price by 7.79% (10.78%) did not affect the exclusionary and welfare implications of bundling as in the original design.

Although the fringe's relative capacity affected the distribution of surplus, we still suspected that its relative efficiency in producing A would also have an effect on how much competitive pressure it could exert. We formalized this concern with the following additional research question: Does decreasing the fixed cost that the dominant seller incurs in the A market affect the consumer (and seller) surplus generated by having a fringe seller? In a final treatment that used the original design as a basis we found that decreasing the fixed cost that the dominant seller incurred in the A market by 50% transferred the consumer surplus that the fringe seller originally generated back to the sellers.

In the exclusionary bundling literature, we have identified the following papers that relax the assumption of a monopolized A market. In WHINSTON's [1990] study, A and B are complementary products and the dominant seller faces imperfect competition in the B market. In the absence of a competitor in the A market, the seller prefers to independently price A and B. However, if the dominant seller faces entry into the A market, bundling A and B and refusing to sell them independently makes him better off even though the entrant's A product is inferior. Nevertheless, the welfare implications of such a bundling practice is not known.

NALEBUFF [2000] examines the effects of bundling on the competition in the A and B markets by assuming that A and B are perfect complements and A (and B) products supplied by different sellers are imperfect substitutes. Nalebuff finds that a seller can adversely affect competitor profits by bundling A and B as long as his competitors sell A and B independently. However, the seller indeed experiences a loss in his profits when he bundles instead of independently selling A and B although the loss disappears when he increases the number of different products in the bundle.

CHOI AND STEFANADIS [2001] take on the idea of complementary products, and use a three-stage game to investigate the effects of bundling on an entrant's investment decision in a risky environment. In their model, the dominant seller does not have an incentive to bundle A and B unless he faces an entry threat. The potential entrant, on the other hand, can produce A or B or both. The entrant can decrease his marginal cost below that of the dominant seller by undertaking an initial investment, albeit there is a positive probability that the investment will not succeed. CHOI AND STEFANADIS find that bundling decreases the expected returns for the potential entrant, and therefore, may lead to foreclosure and reduce total welfare.

CARLTON AND WALDMAN [2002] study two perfectly complementary products with a two-period model. In their model, the dominant seller competes against a second seller in the B market who provides a superior product and can enter the A market by incurring a fixed cost. Since the competitor has to pay this fixed cost from his earnings in the B market, the dominant seller can decrease the competitor's earnings by bundling A and B, which leads to the foreclosure of the A market to the competitor for an intermediate range of fixed costs.

Our study differed from the aforementioned papers in four ways: A and B were unrelated and undifferentiated products, only the dominant seller participated in both A and B markets, all sellers incurred fixed costs of capital, and bundling was an optimal pricing strategy even in the absence of a competitor in the A market. The latter premise allowed us to examine how the welfare implications of bundling change with the addition of a fringe competitor in the A market.

2. Market Structure of the Experimental Environment

Each of the 50 automated buyers has a valuation for A and a valuation for B, and as long as his valuation of a product is greater than or equal to its price he demands one unit; otherwise, he demands no units. The valuations for A and B are uniformly distributed over the intervals [38, 136] and [19, 68] respectively, and have *perfect positive correlation*[1] across the buyers in order to control for the price discrimination motivation to bundle and isolate the exclusionary effects of bundling [STIGLER, 1963; ADAMS AND YELLEN, 1976; SCHMALANSEE, 1982; MCAFEE, MCMILLAN, AND WHINSTON, 1987; CARBAJO, DE MEZA, AND SEIDMANN, 1990; NALEBUFF, 2004]. Figure 1 contains the demand schedules in the A and B markets. Complementarities in production or consumption of A and B are absent.

[Figure 1 about here]

There are two sellers in the A market. The dominant seller S_{d1} also participates in the B market where he faces three identical competitors, S_{c2}, S_{c3}, and S_{c4}. S_{d1} competes against a fringe seller S_{f5} in the A market. Each of the five sellers has a capacity, has to incur a fixed cost to obtain his capacity, and is subject to a constant marginal cost. Figure 1 also displays the marginal cost schedules and Table 1 shows the capacities, fixed and marginal costs.

[Table 1 about here]

[1] The buyer with the nth highest value in the A market also has the nth highest value in the B market.

The system surplus in the A market is maximized when S_{d1} provides each of the 50 buyers with A at a price equal to his marginal cost, and buyers make a lump-sum transfer to S_{d1} amounting to his fixed cost. On the other hand, in the B market, the maximum system surplus is attained when S_{d1} and two of the three identical competitors supply 49 units at a price equal to their marginal cost, and buyers again make a lump-sum transfer to the three sellers amounting to the sum of their fixed costs.

In the A market, the monopoly price is $p_m^A = 88$ and the monopoly quantity is $q_m^A = 25$. At the competitive outcome, price equals the marginal cost, $p_c^A = c^A = 38$, and the quantity traded is $q_c^A = 50$. However, neither the monopoly nor the competitive outcome is an equilibrium in the A market. There is no pure-strategy equilibrium though an equilibrium in mixed strategies does exist. When both S_{d1} and S_{f5} charge the monopoly price, the profit of S_{d1} is $\Pi_1^A = 182.42$ on average, whereas the profit of S_{f5} is $\Pi_5^A = 22.00$. But both S_{d1} and S_{f5} are better off with undercutting each other. For example, if S_{d1} still charges the monopoly price $p_m^A = 88$, S_{f5} increases his profit to $\Pi_5^A = 118.00$ when he decreases his price to 87. Symmetrically, when S_{f5} maintains the monopoly price, S_{d1} increases his earnings to $\Pi_1^A = 250.00$ by lowering his price to 87. S_{f5} undercuts S_{d1} until S_{d1}'s price is equal to 48. At that point, S_{f5} is indifferent between decreasing his price to 47 and sharing the demand with S_{d1} by charging the same price of 48. S_{d1}, on the other hand, undercuts S_{f5} until S_{f5}'s price is 72 where instead of decreasing his price to 71, S_{d1} is better off with charging the monopoly price on the residual demand. Such a price increase is not an option for S_{f5} since S_{d1} never leaves a residual demand. As long as S_{d1}'s price is above 48, S_{f5} always prefers to undercut S_{d1}. Hence S_{d1} mixes his prices over [72, 88], and the support for S_{f5}'s pricing is [71, 87].

In the B market, the monopoly price and quantity are $p_m^B = 44$ and $q_m^B = 25$. The competitive outcome is attained when the price equals the marginal cost $p_c^B = c^B = 19$ and the quantity is $q_c^B = 50$. As in the A market, an equilibrium exists only in mixed strategies. We can use an analysis similar to the one we have used for the A market to describe the possible pricing behavior. When all four sellers charge the monopoly price, each of the three identical sellers, S_{c2}, S_{c3}, and S_{c4}, makes a mean profit of $\Pi_2^B = \Pi_3^B = \Pi_4^B = 45.95$ whereas S_{d1} earns $\Pi_1^B = 128.15$ on average. Any of the three identical sellers (let this seller be S_{c2} for illustration) can increase his profit to $\Pi_2^B = 211.00$ by undercutting the others and charging a price of 43. On the other hand, S_{d1} can increase his profits to $\Pi_1^B = 472.00$ by using a similar undercutting strategy. At the competitive outcome, each seller has to incur a loss amounting to his fixed cost. However, given that the other sellers maintain their prices at the competitive outcome, a seller is better off with charging the monopoly price on the residual demand. If this seller is one of the three identical sellers (again let this seller be S_{c2} for illustration), he can increase his earnings to an average $\Pi_2^B = -64.50$ from $\Pi_2^B = -77.00$: still not a very good alternative compared to exiting. S_{d1} on the other hand can increase his profits to $\Pi_1^B = 47.00$ in the mean from $\Pi_1^B = -128.00$. When S_{c2} or any one of the identical competing sellers leaves the B market because he cannot cover his fixed cost by charging the monopoly price on the residual demand, the remaining two identical sellers, say S_{c3} and S_{c4}, mix their prices over [26, 44] while S_{d1} mixes over [29, 44].

3. *Experimental Procedures and Design*

Subjects were recruited from the George Mason University undergraduate population for two hours. Each group participated in a session as sellers, competing against one another. Subjects were not provided with any information regarding the demand schedule and were paid $5 for showing up on time plus their earnings from the experiments.[2] Throughout the experiment, the experimental software displayed their earnings in both experimental and US dollars.

Table 2 defines the treatments using two treatment variables, *Fringe (F)* and *Bundle (B)*.

[Table 2 about here]

In the two treatments without bundling, the dominant seller S_{d1} could independently sell A and B only. In the remaining two treatments with bundling, S_{d1} was allowed to sell the bundle containing one unit of A and one unit of B in addition to being able to sell A and B independently. A buyer preferred to purchase the bundle as long as his individual surplus from the independent A or B or both A and B was less than or equal to his surplus from the bundle. S_{d1} could not bundle if he exited either the A or B market.

In the two treatments with a fringe, the dominant seller, S_{d1}, faced competition from the fringe seller, S_{f5}, in the A market. In treatments without a fringe, S_{d1} was the

[2] The average subject earnings per session were $26.36. The treatment specific earnings are displayed in Appendix I.

sole supplier in the A market. In the baseline *NoBundlingFringe* treatment S_{d1} competed against S_{f5} in the A market and S_{d1} was not allowed to bundle.

Under *BundlingNoFringe* S_{d1} is predicted to sell only the bundle, refusing to sell A and B independently. Assuming a Stackelberg conjecture, as in NALEBUFF [2004], and a single hypothetical competitor in the B market, we can derive the predictions regarding the exclusionary implications of bundling. If the S_{d1} charges p^{AB} for the bundle and the hypothetical competitor S_c charges p^{B} for the independent B, S_{d1} would sell the bundle to the buyers whose valuation of A is greater than its effective price, $p^{AB} - p^{B}$. In this case, S_c serves the residual demand. The profit functions for S_{d1} and S_c are provided in Appendix I. Simultaneously solving these profit equations, the Stackelberg outcome is [$p^{AB} = 118, p^{B} = 30$]. The Stackelberg prices give the monopoly profit, $\Pi_c^B = 154$ to S_c on the residual demand. Returning to our original experimental design, $\Pi_C^B = 154$ would provide only one of the three identical competitors, S_{c2}, S_{c3}, and S_{c4}, with a positive amount of profit. Therefore, when S_{d1} bundles and charges the Stackelberg bundle price, only one competitor survives in the B market and two should exit.

We conducted five sessions under each of the four treatments. Each session contained multiple blocks. At the beginning of each block subject screens were refreshed and their earnings were set to zero, though the subjects had no previous information that this would occur. At the end of the session earnings from all blocks were totaled.

Each block was divided into a sequence of market periods. Subjects had no information concerning the number of periods in each block. Each period we executed a posted-offer market [KETCHAM, SMITH, and WILLIAMS, 1984]. Every period, five seconds long, automated robot buyers arrived at the marketplace in random order. Upon arriving a buyer searched for the best price offers that maximized his individual surplus. The search resulted in a purchase only if the buyer's individual surplus from the best offer was nonnegative and the seller providing the offer had available capacity. If two or more sellers made the same best offer, the buyer randomly chose one of them.

During a period, each seller could change any of his product prices. The new price became effective in the next period. Whenever the seller did not make any price changes, the prices he had posted for the current period remained in effect for the next period.

In addition to changing his prices, a seller could also decide to exit and re-enter a market. When he chose to exit, his capacity was removed from the supply schedule and he was not charged any fixed cost for maintaining this capacity. An exit decision required the seller to stay out for at least a fixed number of periods, after which he was allowed to re-enter the market. A re-entry decision required the seller to stay in the market for at least the same fixed number of periods. Exit and entry frictions are provided in Appendix I.

DAVIS AND KORENOK [2005] provide the motivation on the particular design choice about the duration of the periods. They show that keeping the session length as constant, increasing the number of periods while decreasing their duration increases the speed at which behavior converges to the equilibrium predictions. DECK and WILSON [2006] also implement a "near continuous" posted-offer institution.

Upon entering the laboratory subjects were seated at computer terminals displaying the instructions which were divided into two parts. The first part explained to the subjects that they would be sellers in a market setting with a posted-price institution. The instructions also explained the information displayed on the computer terminals throughout the experiment and how subjects would use computer terminals to post a price and exit or enter a market.[3]

After the first part of the instructions, the first block of the experiment began. The first block was called the *selection block* and, unannounced to the subjects, was used as a screening process to choose S_{d1}, the dominant seller in the A market for the remainder of the experiment. During the selection block subjects were paired in an environment in which there were two symmetric monopoly markets A and A' and each acted as the monopolist in either the A or A' market who competed with the other in the B market. The selection block consisted of 103 periods. At the end of the selection block, the highest earner of any of the pairs was assigned the position of the dominant seller S_{d1} in the A market for the remainder of the session, and the remaining sellers were assigned the positions of S_{c2}, S_{c3}, S_{c4}, and S_{f5} if the session was conducted with a fringe.[4]

Following the selection block, under the treatments with bundling, subjects went through the second part of the instructions. The second part told the subjects that a seller

[3] The instructions are available upon request from the authors.

[4] A six-person subject group was recruited for the treatments with a fringe. Three symmetric two person selection blocks were run simultaneously and one of the five lesser earning subjects, was randomly selected to leave the experiment after the selection blocks were completed.

who supplied A and B products could also provide a package containing one unit of A and one unit of B. After the second part of the instructions, the remaining blocks of the experiment were run consecutively. In the remainder of the experiment, the subjects who were assigned the S_{c2}, S_{c3}, and S_{c4} roles as B competitors could also participate in another C market. The C market was structured as a Bertrand-Edgeworth oligopoly and provided S_{c2}, S_{c3}, and S_{c4} with an alternative profit opportunity and also the cost of entry into the B market. The valuations of C were distributed independently from A and B across the buyers. The demand and marginal cost schedules in the C market and the capacity and cost structures are displayed in Appendix I.

After the selection block in the treatments without bundling, and after the second part of the instructions in the treatments with bundling, we conducted a *trainer block* of 187 periods to provide experience to the subjects with our environment of interest. Following the trainer block, we conducted a block of 210 periods for data collection, which we will refer to as the *data block*. The experimental design was the same for both the trainer and data block. The only exception was treatments with a fringe in which the capacity of the fringe seller S_{f5} was gradually increased to train the dominant seller S_{d1}. In the first 103 periods of the trainer block, S_{f5}'s capacity was only one unit whereas in the remaining 84 periods of the trainer his capacity was increased to two. Finally, during the data block S_{f5}'s capacity was set to four.

Throughout the experiment, each seller was provided with all information on every other seller's cost and capacity, the number of units that each sold, and his revenue in each market. The screen also displayed the seller's own product specific revenue, cost, and profit information as well as his cumulative earnings. The subjects were not told how long the session or any block in the session would take. At the end of the experiment, the subjects were paid their total earnings in cash.

4. Experimental Results

For the data analysis, we discarded the first and last 30 of the periods of the data block to minimize startup and closedown gaming effects.[5] Thus we were left with 150 repeated measures from each session.

Finding 1. The fringe seller increases the surplus that the buyers extract from consuming A and B by 12.24%. The seller surplus decreases by 10.52%. The total surplus in the A and B markets remain unchanged.

Support. Figure 2 illustrates the changes in the mean consumer surplus and seller surplus extracted in the A and B markets across the treatments.

[Figure 2 about here]

In the baseline *NoBundlingFringe* treatment, buyers gain an average surplus amounting to 65.24% of the maximum surplus attainable in the A and B markets, which represents an increase from a mean 53.00% realized without a fringe under *NoBundlingNoFringe*. In the treatments with bundling the fringe seller also increases the

[5] The subjects did not know the number of periods in each block, but they may have extrapolated from the length of the training block to predict the number of periods in the data block and alter their behavior toward period 187: we don't include periods 181-210 in the data analysis.

total consumer surplus, from a mean 55.30% under *BundlingNoFringe* to 71.98% under *BundlingFringe*.

The observed increase in the consumer surplus from having the fringe seller is a transfer from sellers. Under treatments both without and with bundling, the presence of the fringe seller decreases the seller surplus. Under the baseline *NoBundlingFringe* treatment, sellers gain an average surplus of 9.12% from the A and B markets, while the same statistic takes on a higher value under *NoBundlingNoFringe*, 16.96%. Similarly, under the treatments with bundling, the presence of the fringe seller causes sellers to experience a decrease in the surplus that they extract in the A and B markets: from an average 16.65% under *BundlingNoFringe* to 7.65% under *BundlingFringe*.

We test the statistical significance of the observed welfare effects with the random effects regressions (1, 2, and 3) that include a regressor for the *Fringe (F)* treatment variable. The models are provided in Appendix II together with the regression results. The coefficient for *Fringe (F)* is positive and statistically significant when the dependent variable is the total consumer surplus extracted in the A and B markets, and negative and statistically significant when the dependent variable is the total seller surplus in the A and B markets. For the total system (consumer plus seller) surplus, the coefficient is not statistically significant.

Finding 2. Bundling does not affect the consumer and total surplus extracted from A and B. Bundling does not lead to exclusion in the B market either.

Support. A look back at the summary statistics from a different angle shows that under the treatments without a fringe, bundling marginally increases the surplus that buyers extract in the A and B markets from an average 53.00% under *NoBundlingNoFringe* to a mean of 55.30% under *BundlingNoFringe*.

Across the treatments with a fringe, bundling again on average increases the consumer surplus, from 65.24% under the baseline *NoBundlingFringe* treatment to 71.98% under *BundlingFringe*.

In the treatments without a fringe, bundling decreases the surplus that sellers earn from A and B marginally from 16.96% under *NoBundlingNoFringe* to 16.65% under *BundlingNoFringe*. The decrease in the seller surplus from bundling is more pronounced in the treatments with a fringe, from 9.12% under the baseline *NoBundlingFringe* treatment to 7.65% under *BundlingFringe*.

These changes in surplus, however, are not statistically significant: referring to the results from the random effects regressions 1, 2, and 3, the coefficient for the *Bundle (B)* treatment variable is found to be statistically insignificant for all three of the dependent variables, the consumer surplus, seller surplus, and total surplus.

Comparing the *NoBundlingNoFringe* and *BundlingNoFringe* treatments, the average number of competitors that simultaneously exist in the B market marginally decreases from 2.15 to 1.96. Figure 3 reports that the percentage of the observations in which the dominant seller competes against only one seller in the B market increases from 8.13% under *NoBundlingNoFringe* to 28.53% under *BundlingNoFringe*.

[Figure 3 about here]

In the treatments with a fringe, the mean number of competitors in the B market decreases from 2.44 under the baseline *NoBundlingFringe* treatment to 2.13 under *BundlingFringe*.

The Poisson regression model (4) provided in Appendix II tests the exclusionary effects of bundling using the number of competitors in the B market as the dependent variable and the *Bundle (B)* treatment variable as one of the regressors. The coefficient for *Bundle (B)* is found to be negative, but not statistically significant. The regression results are provided below the model in Appendix II.

Finding 3. The fringe seller does not affect the exclusionary and welfare implications of bundling even though his presence leads to a decrease in the bundle transaction price by 11.53%.

Support. In the treatments without a fringe, bundling results in a marginal 2.30% increase in the mean consumer surplus from A and B, which is found to be statistically insignificant. The summary statistics also show that the presence of the fringe seller enhances the positive effect of bundling on consumer surplus. In the treatments with a fringe, bundling increases the average consumer surplus by 6.74%. However, referring to the results from the random effects regressions 1, 2, and 3, the coefficient for the interaction term for the two treatment variables *Bundle (B)* and *Fringe (F)* is found to be statistically insignificant.

The fringe seller decreases the mean transaction price in the A market from 88.80 under *NoBundlingNoFringe* to 79.45 under the baseline *NoBundlingFringe* treatment. The mean transaction price in the B market also decreases marginally from 31.60 under *NoBundlingNoFringe* to 30.12 under the baseline *NoBundlingFringe* treatment. In the treatments with bundling, the fringe seller also decreases the average transaction price in the A market from 89.81 under *BundlingNoFringe* to 74.94 under *BundlingFringe*. On the other hand, the average transaction price in the B market now experiences a marginal increase from 30.53 under *BundlingNoFringe* to 30.59 under *BundlingFringe*. The fringe seller lowers also the bundle transaction price from 117.50 under *BundlingNoFringe* to 103.95 under *BundlingFringe*.

The random effects regression models (5, 6 and 7) in Appendix II test the statistical significance of the observed effects of the fringe seller on the transaction prices in the A and B markets, and also on the bundle transaction price. The regressions with the transaction prices in the A and B markets as the dependent variables contain an interaction term for the *Bundle (B)* and *Fringe (F)* treatment variables. The coefficient for *Fringe (F)* is negative and statistically significant for the A and bundle transaction prices. The same coefficient is not statistically significant for the transaction price in the B market. The coefficient for the interaction term is not statistically significant for either the transaction price in the A market or the transaction price in the B market.

The decrease in the bundle transaction price from 117.50 to 103.95 does not translate to an increase in the consumer surplus generated from the bundle. The random effects regression (8) in Appendix II supports this finding as the coefficient on the *Fringe (F)* treatment variable is small in magnitude and not statistically significant.

Overall, combining all three of the experimental results, the fringe seller seems to affect the welfare in the A market by decreasing the transaction price, and bundling does not have an effect on the consumer and producer surplus with or without the fringe seller.

The exit and entry statistics indicate that in the treatments without a fringe, bundling decreases the average number of competitors in the B market by 8.84%. Meanwhile, in the treatments with a fringe, the mean number of competitors falls by 12.70% with bundling. The results from the Poisson regression 4, which uses the number of competitors in the B market as the dependent variable, show that not only the coefficient for the *Bundle (B)* treatment variable, but also the coefficients for the *Fringe (F)* and the interaction term for *Bundle (B)* and *Fringe (F)* are not statistically significant.

5. Exclusion Environment and Experimental Results

The original design in which we conducted our first 20 sessions yielded results that we thought required further examination. First and foremost, we failed to find any evidence to the exclusionary effects of bundling. Second, bundling had no effect on the consumer or total surplus. Third, with a capacity of four the fringe seller had 8% of the capacity that the dominant seller owned. However, in the absence of the fringe seller the dominant seller supplies the monopoly quantity, so the fringe seller's capacity was implicitly equivalent to 16% of the monopolist's sales. Fourth, both the dominant seller and the fringe seller operated at the same average cost when each supplied his maximum capacity in the A market.

With these four concerns in mind we created a new *exclusion* design intended to tease out significant bundling and fringe effects. Below is a list of the environmental changes from the original design that we incorporated into the exclusion design:

1. The number of buyers was increased from 50 to 100, and all of the seller capacities except the fringe seller S_{f5} were doubled.

2. The capacity of S_{f5} was increased from four to five. Therefore, S_{f5} had 5% of the capacity that the dominant seller S_{d1} had in the A market, but relative to the monopoly quantity, S_{f5}'s capacity was now reduced to 10% of the dominant seller.

3. In order to maintain the monopoly price at $p_m^A = 88$, the buyer valuations of A were uniformly distributed over [38, 137] instead of [38, 136]. Coupled with doubling the number of buyers, this support for the value distribution altered the profit function in the A market so that it was monotonically increasing, which presumably would help sellers in the price search process.

4. As Figure 4 displays, the demand schedule in the B market was altered in order to enhance the exclusionary implications of bundling. CALISKAN, PORTER, RASSENTI, SMITH, AND WILSON [2006] find this demand structure to be successful in deterring entry to the B market when S_{d1} is allowed to bundle.

[Figure 4 about here]

5. Due to doubling the number of buyers from 50 to 100, the fixed cost that each of the three identical competitors, S_{c2}, S_{c3}, and S_{c4}, incurred in the B market was doubled to 154. Since the alteration of the demand schedule in the B market increased the returns

to S_{d1} from bundling as well, the fixed cost of S_{d1} in the B market was increased from 128 to 481. This decrease in his relative B market efficiency should lead S_{d1} to stay out of the B market unless he successfully bundles, making the entry deterrence effect much more pronounced and increasing the adverse effects of bundling on welfare.

6. The fixed cost that S_{d1} had to incur in the A market was decreased from 975 to 487 making the average cost that S_{d1} was exposed to when he supplied his maximum capacity lower than the average cost of S_{f5}. Table 3 displays the capacities, fixed and marginal costs in the exclusionary environment.

[Table 3 about here]

7. Exit and entry frictions (required number of periods in or out of the market) were removed for all sellers in all markets. CALISKAN [2006] shows that the particular friction parameters imposed on the competitors in the B market under the original design do not have any effect on the consumer and total surplus and are an unnecessary complication.

In order to train the dominant seller while conducting the original design, S_{f5}'s capacity was set to one in the first 103 and two in the remaining 84 periods of the trainer block, then 4 in the data block. However, due to the relative decrease in S_{f5}'s capacity in the exclusion design the same procedure was not essential. Instead, the trainer block procedure used for treatments with bundling in CALISKAN et al. [2006] was adopted. In the first 103 periods S_{d1} was allowed to sell only a bundle, and in the remaining 84 period part S_{d1} could sell A and B in a bundle as well as independently.

In the exclusion design, as in the original design, only mixed-strategy equilibria exist in the both A and B markets. The monopoly and competitive prices in the A market are also the same as in the original design. However, the range of the price mixing differs. The decrease in the capacity of S_{f5} relative to the capacity of S_{d1} increases the lower boundary of the mixing interval. S_{d1} now mixes his prices over [74, 88]. Therefore, S_{f5} chooses his prices over [73, 87] since he is better off with undercutting S_{d1} until S_{d1}'s price is equal to 46.

In the B market, the monopoly price and quantity are $p_m^B = 100$ and $q_m^B = 27$. On the other hand, the competitive outcome is attained at a price equal to the marginal cost $p_c^B = c^B = 19$ where the quantity supplied is $q_c^B = 64$. Sharing the demand at the monopoly price, on average, S_{d1} earns a profit of $\Pi_1^B = 415.31$ whereas each of the three identical competitors, S_{c2}, S_{c3}, and S_{c4}, earns $\Pi_2^B = \Pi_3^B = \Pi_4^B = 415.31$. Undercutting the other sellers at the monopoly price increases S_{d1}'s earnings to $\Pi_1^B = 1679.00$. If one of the competitors, S_{c2} for instance, undercuts the others and lowers his price to 99, he earns $\Pi_2^B = 1766.00$. S_{d1} can avoid a loss and continue undercutting the other sellers until his price is equal to 29. Meanwhile, each of the three identical competitors can lower his price until it is 26. At least one seller must exit the market since none of the sellers can make a positive profit by charging the competitive price 19 and there is no residual demand. We expect the seller leaving the market to be S_{d1} due to his relative cost disadvantage. The B market would then provide a mixed strategy environment for the remaining three identical competitors, with each of S_{c2}, S_{c3}, and S_{c4} mixing his prices over [25, 100].

For the exclusion design, as in the original, we defined four treatments using two treatment variables, *Bundle (B)* and *Fringe (F)* as displayed in Table 4.[6]

[Table 4 about here]

Maintaining the assumptions in the original design, we can compute the Stackelberg price predictions for *BundlingNoFringeExclusion*. At the Stackelberg outcome, the dominant seller S_{d1} charges $p^{AB*} = 124$ for the bundle and a single hypothetical competitor S_c charges $p^{B*} = 28$ for the independent B in response, leaving $\Pi_c^B = 81.00$ in profits to S_c. But $\Pi_c^B = 81.00$ does not cover the fixed cost of any competitor. Therefore, none of the three identical competitors, S_{c2}, S_{c3}, and S_{c4}, can survive in the B market when S_{d1} charges the Stackelberg bundle price. Indeed, S_{d1} can increase his price to $p^{AB*} = 131$ without invoking any entry.

Finding 4. In the exclusion design, bundling deters entry to the B market. However, bundling still does not affect the consumer and total surplus extracted in the A and B markets.

Support. Under *NoBundlingNoFringeExclusion*, 2.50 competitors simultaneously exist in the B market on average. When the dominant seller is allowed to bundle under *BundlingNoFringeExclusion*, the mean number of competitors decreases to 1.54.

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[6] On average subjects earned $29.82 excluding the $5 show-up fee. The average earnings per treatment are provided in Appendix I.

Interestingly, in the treatments with a fringe, the adverse effects of bundling on the number of competitors in the B market are more dramatic. The mean number of competitors decreases from 2.41 under *NoBundlingFringeExclusion* to 1.04 under *BundlingFringeExclusion*.

Appendix I contains a histogram analysis of the number of competitors in the B market in the exclusion environment. The shift in the frequency distribution to the left with bundling is noteworthy. In particular, under *BundlingFringeExclusion* the dominant seller completely forecloses the B market in 34.67% of the observations.

Despite the observed entry deterrence in the B market, bundling still fails to generate an adverse effect on the surplus that buyers extract in the A and B markets. The average consumer surplus increases from 57.61% under the baseline *NoBundlingFringeExclusion* treatment to 61.75% under *BundlingFringeExclusion*. The mean total surplus increases marginally but insignificantly from 82.46% in the baseline *NoBundlingFringeExclusion* treatment to 83.56% in *BundlingFringeExclusion*. In the treatments without a fringe, the increase in the average consumer surplus when bundling is allowed is even more striking: from 56.89% under *NoBundlingNoFringeExclusion* to 66.93% under *BundlingNoFringeExclusion*.

An idiosyncrasy that draws immediate attention is that in the treatments with bundling, the presence of a fringe seller decreases the mean number of competitors in the B market from 1.54 to 1.04 and the average consumer surplus in the A and B markets from 66.93% to 61.75%. A look at the time series of the transaction prices displayed in Appendix I provide a clue as to why. Under *BundlingNoFringeExclusion*, the dominant seller's bundle pricing fails to deter entry to the B market. In 95.33% of the observations, the dominant seller competes against at least one seller in the B market (compared to only 65.33% of the observations under *BundlingFringeExclusion*). For instance, the behavior in Session 50 is remarkable in this regard. The dominant seller sells only the bundle, refusing to sell A and B independently, and charges an average bundle price of 111.77. The bundle price of 111.77 is below the price required to foreclose the B market, which is equal to 124. However, despite this aggressive pricing, the dominant seller fails to completely foreclose the B market except only in 11.33% of the observations. This entry is costly to the competitors. In Session 50, the competitors in the B market incur a total loss amounting to 1.60% of the maximum surplus attainable in the A and B markets. Meanwhile, this excessive entry into the B market also decreases the return to the dominant seller from bundling. In some cases, the profit that the dominant seller earns with bundling deteriorates to below the amount that he can make by participating only in the A market. For example, in Session 46 the dominant seller foregoes the bundling option, abandons the B market, and sells only A.

Under *BundlingFringeExclusion*, the dominant seller does not experience such aggressive pricing and excludes competitors from the B market. For instance, in Session 56 and 57, he successfully forecloses the B market in most of the observations and in the absence of any competitors increases his bundle price to extract even more surplus.

This idiosyncrasy raised the question of a possible correlation between the *Fringe (F)* treatment variable and the session specific disturbances. In order to address this question, we invited the subjects who had participated in *BundlingNoFringeExclusion* and *BundlingFringeExclusion* for another set of experiments. The subjects who had assumed the role of the dominant seller under *BundlingNoFringeExclusion* became the dominant sellers again, but this time were subject to *BundlingFringeExclusion*. Each of these dominant sellers competed against the four subjects who had participated in *BundlingFringeExclusion* as the three identical competitors and the fringe seller. Symmetrically, the dominant sellers who had taken part in *BundlingFringeExclusion* now participated in *BundlingNoFringeExclusion* and competed against the subjects who had assumed the roles of the three identical sellers under *BundlingNoFringeExclusion*. Four such additional experiments were conducted with the dominant sellers from Session 50 under *BundlingNoFringeExclusion*, and Session 56, 57, and 60 under *BundlingFringeExclusion*. Appendix I contains the time series of the transaction prices in these four additional experiments.

Including the data from the four additional experiments to our sample increases the frequency of the complete foreclosure in the B market under *BundlingNoFringeExclusion* from 4.67% to 30.00%. On the other hand, the frequency of the complete foreclosure under *BundlingFringeExclusion* stays the same at 34.67%. Figure 5 displays the updated histogram analysis of the number of competitors in the B market. The mean number of competitors in the B market becomes equal to 1.26 under *BundlingNoFringeExclusion* and 1.03 under *BundlingFringeExclusion*.

[Figure 5 about here]

With the data from the four additional experiments included, the average consumer surplus extracted in the A and B markets is now equal to 61.39% under *BundlingNoFringeExclusion* whereas the total surplus is 83.27%. Meanwhile, the mean consumer surplus under *BundlingFringeExclusion* is observed to be 62.36% and the average total surplus 83.55%.

The Poisson regression model (9) presented in Appendix II tests the statistical significance of the effects of bundling on the number of competitors that simultaneously exist in the B market by using the *Bundle (B)* treatment variable as a regressor. The sample includes the data from the four additional experiments. The regression results are also presented in Appendix II below the model. The coefficient for the *Bundle (B)* treatment variable is found to be negative and statistically significant.

Meanwhile, the random effects regression models (10, 11, and 12) in Appendix II examine the statistical significance of the *Bundle (B)* treatment variable on the consumer, seller, and total surplus. Again, the sample contains the data from the four additional experiments. As a result, the coefficient for *Bundle (B)* is found to be statistically insignificant in all three of the regressions.

Finding 5. In the exclusion design, the fringe seller increases the surplus that buyers extract in the A and B markets by 6.97%. The seller surplus decreases by 4.51%. The total surplus also goes up by 2.46%.

Support. Under *NoBundlingNoFringeExclusion*, buyers extract an average 56.89% surplus from consuming A and B. With the fringe seller, the mean consumer surplus increases marginally to 57.61% under *NoBundlingFringeExclusion*. In the treatments with bundling, having a fringe seller leads to a marginal increase in the average consumer surplus from 61.39% under *BundlingNoFringeExclusion* to 62.36% under *BundlingFringeExclusion* after the data from the four additional sessions are included.

Across the treatments without bundling, the fringe seller decreases the seller surplus, on average, from 26.59% under *NoBundlingNoFringeExclusion* to 24.85% under the *baseline* treatment. The fringe seller generates an even less significant decrease in the seller surplus under the treatments with bundling, from a mean 21.87% under *BundlingNoFringeExclusion* to 21.19% under *BundlingFringeExclusion*.

The results from the random effects regressions 10, 11 and 12 show the coefficient for the *Fringe (F)* treatment variable to be statistically insignificant in determining the consumer, seller, and total surplus. We might not expect the welfare implications of the reduced capacity fringe seller in the exclusion environment to be as dramatic as in the original environment. Indeed, the mean transaction price in the A market only slightly decreases from 87.93 under *NoBundlingNoFringeExclusion* to 85.20 under the baseline *NoBundlingFringeExclusion* treatment. We fail to find this decrease to be statistically significant using the random effects regression model (13) displayed in Appendix II.

In the treatments with bundling, we observe the possibility of a correlation between session specific behavior generated by the dominant seller and the treatment variables. Considering the possibility that this might produce inconsistent results, we conduct four additional experimental sessions. This also provides us with the opportunity to investigate the effects of the fringe seller using a fixed effects model.

We first examine how the fringe seller affects the transaction price in the A market using the fixed effects regression (14) provided in Appendix II. The regression contains a single independent variable, *Fringe (F)*. We find the coefficient to be negative and statistically significant.

Second, we also estimate the *Fringe (F)* treatment effects on the B and bundle transaction prices using similar fixed effects models (15 and 16) as provided in Appendix II. We find the coefficient for the *Fringe (F)* treatment variable to be negative and statistically significant in both regressions. The fringe seller evidently decreases each of the A, B, and bundle transaction prices.

Third, using the fixed effects models (17, 18, and 19) in Appendix II, we examine the effects of the fringe seller on the consumer, seller, and total surplus. The regression results show that the coefficient for the *Fringe (F)* treatment variable is statistically significant in all three regressions and positive for the consumer and total surplus and negative when the regressand is the seller surplus.

Finding 6. In the exclusion design, the fringe seller does not have an effect on the welfare implications of bundling although he decreases the bundle transaction price by 7.79%.

Support. Referring to the results from the fixed effects regressions 14, 15, and 16, we find that the fringe seller leads to a decrease in the transaction prices in the A and B markets as well as the bundle transaction price. We also know that the fringe seller increases the consumer surplus extracted from A and B as the results from the fixed effects regression

17 indicate. However, looking at the surplus that the buyers extract from the bundle we find the presence of the fringe seller to have no effect. The related fixed effects regression model (20) is presented in Appendix II.

6. Low Fixed Cost Treatment and Experimental Results

In the original design, the presence of the fringe seller increases the surplus that buyers extract from A and B by 12.24%. But in the exclusion design, the fringe seller results in only 6.97% increase in the consumer surplus. Going from the original to the exclusion design, the following is a list of the alterations made in the A market:

- The fringe seller S_{f5} capacity was 5% instead of 8% of the dominant seller S_{d1}.
- The number of buyers was increased from 50 to 100, with the reservation values uniformly distributed over [38, 137].
- S_{d1} incurred a lesser fixed cost in the A market, decreased from 975 to 487.
- Entry and exit frictions were removed.

Among these alterations, only the first one is predicted to lead to a less stringent competition in the A market by changing the mixed strategy equilibrium. Indeed, in the original design, S_{d1} is predicted to mix his prices over [72, 88] whereas the mixing interval becomes [74, 88] in the exclusion design. Although not just the supports, but also the mixed-strategy price distributions might change between these two designs, the difference in the effects of the fringe seller on the consumer surplus between the two environments is significant enough to investigate whether the decrease in the fixed cost that S_{d1} incurs in the A market has an effect on the consumer surplus.

For this purpose, we returned to the original design, and decreased the fixed cost that the dominant seller S_{d1} incurred in the A market from 975 to 487. In the single treatment we conducted, S_{d1} was allowed to bundle A and B, and competed against S_{f5} in the A market. Except the decrease in the fixed cost, the experimental design was the same as in *BundlingFringe*. *BundlingFringeLowFixedCost* denotes the new treatment and *LowFixedCost (LFC)* is the new treatment variable.[7]

Finding 7. Decreasing the fixed cost that the dominant seller incurs in the A market by 50% decreases the consumer surplus by 12.97% and increases the seller surplus by 10.52%. The change in the total surplus is not statistically significant.

Support. Under *BundlingFringe*, the average consumer surplus in the A and B markets is observed to be 71.98%. The mean consumer surplus decreases to 59.02% under *BundlingFringeLowFixedCost*. The mean seller surplus, on the other hand, increases from 7.65% under *BundlingFringe* to 18.16% under *BundlingFringeLowFixedCost*.

The random effects regression models 1, 2, and 3 also test the statistical significance of the observed welfare effects of lowering the fixed cost that the dominant seller incurs in the A market. The regression results indicate that the coefficient for the *LowFixedCost (LFC)* treatment variable is negative and statistically significant when the

[7] In *BundlingFringeLowFixedCost* the mean subject earnings were equal to $29.84 excluding the $5 show-up fee.

regressand is the consumer surplus and positive and statistically significant when the dependent variable is the seller surplus. For the total surplus, the coefficient is not statistically significant.

A simple look at the summary statistics show that the mean transaction price in the A market is 74.94 under *BundlingFringe*. The average A transaction price increases to 79.00 under *BundlingFringeLowFixedCost*. The bundle transaction price is equal to 103.95 under *BundlingFringe* on average, and increases to *104.08* under *BundlingFringeLowFixedCost*. In the B market, the effects of lowering the fixed cost that the dominant seller faces in the A market is a bit different. The average transaction price decreases from 30.59 under *BundlingFringe* to 27.67 under *BundlingFringeLowFixedCost*, apparently reflecting the more stringent competition.

The random effects regression models 5, 6, and 7 help to investigate the observed effects of the *LowFixedCost (LFC)* treatment variable on the transaction prices. The regression results find the coefficient for *LowFixedCost (LFC)* to be positive and statistically significant when the dependent variable is the transaction price in the A market. On the other hand, the coefficient is not statistically significant for the transaction price in the B market and the bundle transaction price.

7 Conclusion

CALISKAN et al. [2006] reports that by bundling two products A and B, a seller can deter entry to the B market contingent on the demand and supply characteristics. In most of the exclusionary bundling studies the A market is assumed to be a monopoly. However, most naturally occurring markets have a dominant seller with some fringe competition. In this study we used controlled laboratory experiments to examine this environment.

We conducted 49 sessions under nine treatments and found that a fringe seller in the A market increased the consumer surplus and decreased the seller surplus in the A and B markets. The effect on total surplus was ambiguous. The fringe seller in the A market not only decreased the transaction price in the A market, but also decreased the bundle transaction price. The effect on the transaction price in the B market was ambiguous.

Despite the decrease in the bundle transaction price in the presence of a fringe, we failed to find an increase in the surplus that consumers extracted from the bundle. A potential reason might be the difference between the bundle transaction price and the sum of the monopoly prices for A and B. The Envelope theorem suggests that in the neighborhood of the sum of the A and B monopoly prices, a small reduction in price brings a large increase in consumer surplus. However, the increase in consumer surplus from a marginal decrease in price gets smaller as the price moves away from the monopoly price.

The fringe seller not only had no effect on the surplus that the buyers gained from the bundle, but also did not change the effects of bundling on the total consumer surplus extracted in the A and B markets: the dominant seller's ability to bundle did not harm the buyers with or without a fringe seller.

This study examined the welfare effects of the fringe seller under two different experimental designs. In the exclusion (second) design, four additional treatments that we conducted provided us the opportunity to analyze the effects of the fringe seller using several fixed effects models. We found that the fringe seller increased the surplus that consumers extracted not only in the A market but also in the B market when the dominant seller was allowed to bundle. We can only speculate at this point that bundling somehow transfers the effects of the fringe seller into the B market by leading to a more stringent competition among the suppliers of the independent product B.

Establishing a definitive connection between the findings from the original design and the exclusion design is not possible due to the simultaneous alterations made from one environment to the other. For instance, we observed that the additional consumer surplus generated in the A and B markets by the fringe seller decreased from the original to the exclusion design. The transaction price in the A market also went down. The decrease in the capacity of the fringe seller relative to the dominant seller might predict these outcomes. However, there were three other alterations made in the A market structure. We find that one of the remaining alterations, halving the fixed cost that the dominant seller incurs in the A market, mitigates the increase that the fringe seller generates in the consumer surplus. Whether the change in relative capacities in the A market also effects the welfare implications of a fringe seller requires further exploration.

That the fixed cost has an effect on the transaction price in the A market is a surprising finding. However, as DURHAM, MCCABE, OLSON, RASSENTI, and SMITH [2004, p. 158] note, "Fixed costs will affect pricing behavior when it becomes a matter of survival for firms." Indeed, in our original environment the dominant seller earns his profits from the last six units he sells when he charges the monopoly price in the absence of a fringe seller, and the fringe seller can capture approximately *67%* of the dominant seller's profitable units with a capacity of four. Declining unit cost environments can be brutally price competitive because the last units are the most profitable and no firm wants to sell below their capacity.

This study also confirms the findings from CALISKAN et al. [2006] by showing that despite its exclusionary effects bundling fails to either adversely or favorably affect the consumer and seller surplus extracted in the A and B markets. CALISKAN et al. [2006] introduces two reasons as to why we observe this. First, the dominant seller independently offers A and B in addition to the bundle, and this study supports this explanation. A potential reason for such a mixed bundling strategy stems from the excess capacity in the A market. The capacity of the dominant seller in the B market is half of his capacity for A. Therefore, the dominant seller might have an incentive to charge the monopoly price on the residual demand in the A market when he sells his B capacity in the bundle. Future work may examine the effects of symmetric capacities in the A and B. CALISKAN et al. [2006] also argue that the second reason for the failure to observe any welfare changes from exclusionary bundling is the capacity constrained mixed strategy environment used in the experiments. In the absence of bundling, the transaction price in the B market fluctuates above the competitive outcome. However, there are two motivations for choosing a mixed strategy environment. First, this particular structure helps to avoid the Bertrand paradox; second, DURHAM et al. [2004] show that in an oligopolistic posted-offer market with only a pure-strategy Nash equilibrium that is the competitive outcome, sellers implicitly cooperate and maintain supra-competitive prices:

they have no choice in order to survive. However, despite these two motivations but in response to the existing bundling literature, CALISKAN [2006] examined the effect of completely removing the capacity constraints in the B market. Parallel to the findings by DURHAM et al. [2004], even with unconstrained capacities sellers are able to maintain higher transaction prices through signaling. Given these results and the experimental observations reported here and in CALISKAN [2006], the case for adverse long term welfare effects due to bundling remains without substantial evidence, with or without a fringe.

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FIGURES

Figure 1

Demand and Marginal Cost Schedules in A and B Markets

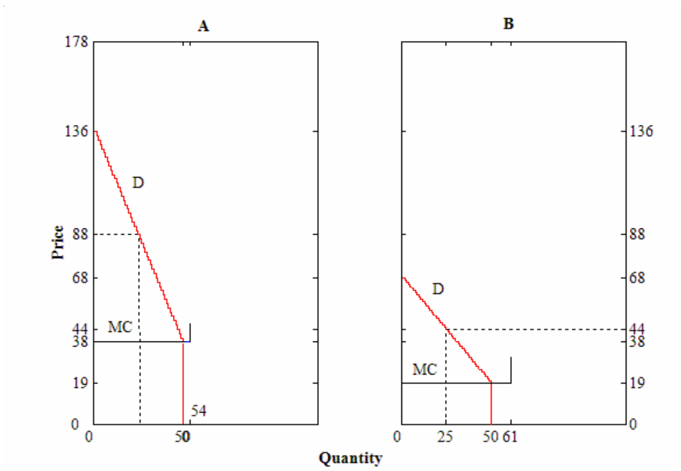


Figure 2

Average Consumer and Seller Surplus under Each Treatment

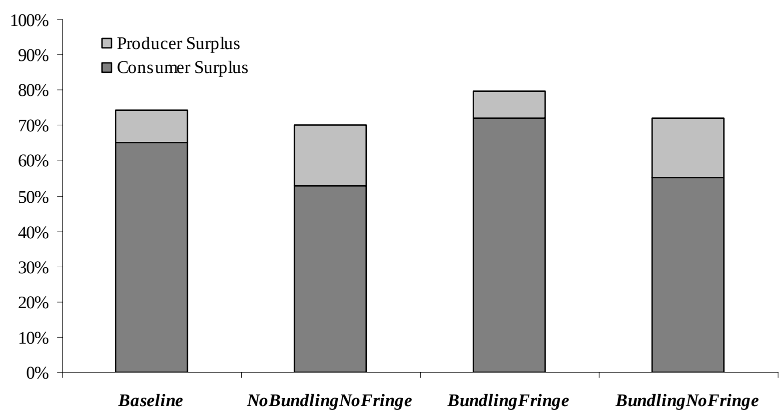


Figure 3

Histogram of Number of Competitors in B Market

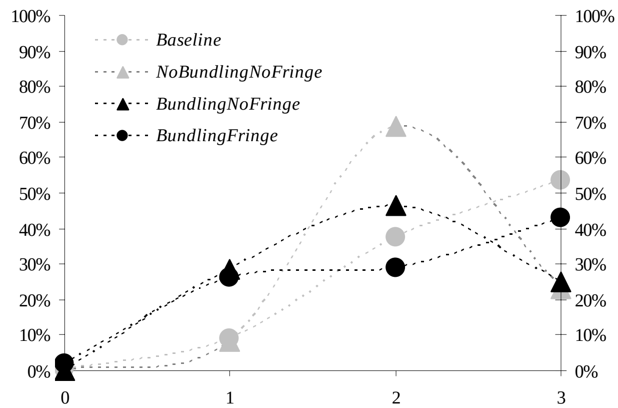


Figure 4

Demand and Marginal Cost Schedules in A and B Markets under *Exclusion* Design

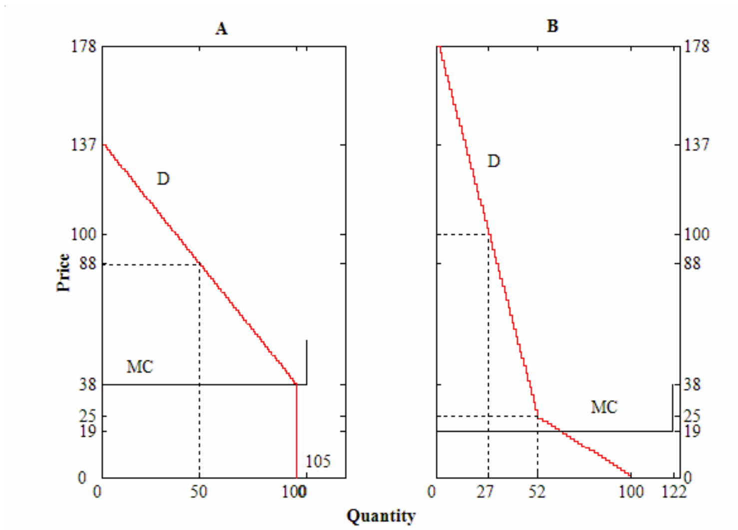
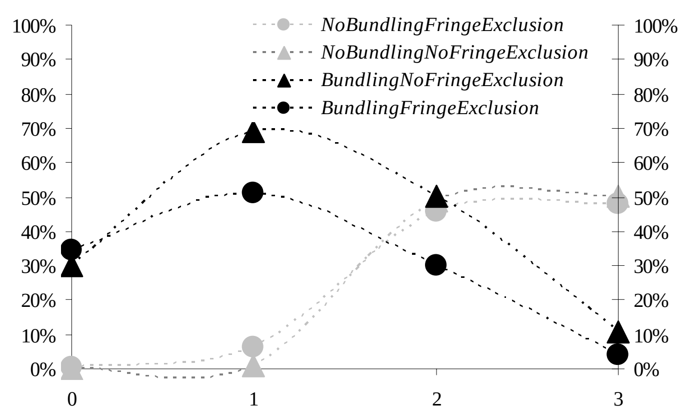


Figure 5

Histogram of Number of Competitors in B Market under *Exclusion* Design



TABLES

Table 1

Supply Parameters in A and B Markets

Market	Seller	Capacity	Fixed Cost	Marginal Cost
A	S_{d1}	50	975	38
	S_{f5}	4	78	38
B	S_{d1}	25	128	19
	S_{c2}, S_{c3}, and S_{c4}	12	77	19

Table 2

Treatment Design

		Bundle (B)	
		Not Allowed	Allowed
Fringe (F)	Exists	*(Baseline)* *NoBundlingFringe*	*BundlingFringe*
	Does Not Exist	*NoBundlingNoFringe*	*BundlingNoFringe*

Table 3

Supply Parameters in A and B Markets under *Exclusion* Design

Market	**Seller**	**Capacity**	**Fixed Cost**	**Marginal Cost**
A	S_{d1}	100	487	38
	S_{f5}	5	78	38
B	S_{d1}	50	481	19
	S_{c2}, S_{c3}, and S_{c4}	24	154	19

Table 4

Treatment Design under *Exclusion* Design

		Bundle (B)	
		Not Allowed	Allowed
Fringe (F)	Exists	*(Baseline)* *NoBundlingFringeExclusion*	*BundlingFringeExclusion*
	Does Not Exist	*NoBundlingNoFringeExclusion*	*BundlingNoFringeExclusion*