

Competitive Markets When Customers Anticipate Stockouts

Cary Deck
cdeck@walton.uark.edu
University of Arkansas &
Chapman University

Amy Farmer
afarmer@walton.uark.edu
University of Arkansas

August 2012

How shoppers react to an empty shelf is an ongoing concern in naturally occurring markets. The anticipation of stockouts impacts where customers shop, which in turn affects optimal prices and inventory choices. In this paper we develop a differentiated product duopoly model of this situation. Theoretically, market outcomes hinge on the cost to the shopper of visiting a second seller after experiencing a stockout. If costs are high, the prices at both outlets and the inventory of the high quality seller are relatively low as the low quality seller attempts to draw in shoppers rather than serving the residual market. Importantly, the model illustrates that in some market conditions, a stockout may be a strategic decision by a seller and not simply a costly mistake. This suggests the importance of modeling seller competition and buyer behavior. A laboratory experiment largely confirms the comparative static effects predicted by the model, but shoppers have difficulty in coordinating their behavior as in other market entry game experiments so that excess inventory may actually be the result of ordering too little inventory.

Keywords: On Shelf Availability, Market Entry Game, Shopper Reaction, Experiments

Deck gratefully acknowledges financial support from the Center for Retail Excellence for this project. The authors wish to thank Josh Foster and Brendan Joyce for excellent research assistance.

Competitive Markets When Customer Anticipate Possible Stockouts

“No one goes there anymore. It’s too crowded.” - Yogi Berra

Stockouts are potentially costly to retailers in that they represent missed sales opportunities. A shopper searching for a specific item may decide to purchase nothing, purchase a substitute good, or shop elsewhere if faced with an empty shelf.¹ Gruen et al (2002) find that about half of stockouts result in the purchase of a substitute product. In this case the profitability of the seller may be positively or negatively affected depending on the relative profitability of the substitute item (see Kamakura and Russell 1989 for an empirical study suggesting people tend to trade up). Alternatively, the shopper may simply decide to abandon the shopping trip and visit a competitor.² Anderson et al (2006) show that current stockouts impact future purchases (see also Jing and Lewis 2011). Thus, retailers devote tremendous attention to ensuring that shelves are not empty.³ Matsa (2011) finds that grocery stores with more competition, especially from Walmart, are more likely to avoid shortfalls. To this end, some retailers have begun using RFID tags and other technologies to better track inventory from the stock room until it is purchased in order to improve on shelf availability (see Hardgrave, et al. 2007).

Recently, there have been several papers dealing with the optimal pricing of a good conditional on inventory levels (see Chen and Simichi-Levi 2010 for a survey).⁴ One inventory situation that has been studied extensively is markdown pricing, where the seller has multiple periods over which to sell products and can mark remaining inventory down to induce sells. For example, Cachon and Swinney (2009) consider the inventory problem faced by a seller who anticipates dropping its price at some point during the season. Liu and van Ryzin (2008) consider stockout risk as a way to induce customers to buy earlier in the season (see also Aviv and Pazgal 2008, Allon and Bassamboo 2011, and Qi and van Ryzin 2011).

Many of the optimal pricing papers mentioned above have focused on sellers who are insulated from competition or do not take shopper expectations into account.⁵ If shopping is costly (in

¹ Concern about how shoppers react to a stockout goes back to at least Walter and Grabner (1975). More recently, Honhon, et al. (2010) offers a dynamic programming solution to the optimal assortment problem when customers engage in stock out based substitution.

² Balachander and Farquhar (1995) suggest that in some circumstances stock outs may have a positive effect on price competition. Mahajan and van Ryzin (1999) provide a general survey of the literature on the impact of substitution on inventory management.

³ Retailers may prefer to run out of stock if they can offer rain checks (see Hess and Gerstner 1987) or as part of a bait and switch (see Wilke, et al 1998a,b and Hess and Gerstner 1998).

⁴ While much of the literature on inventory pricing is separate from the literature on substitutability between products, a recent paper by Transchel (2011) looks at the interplay between the two.

⁵ Nagarajan and Rajagopalan (2009) look at a newsvendor style duopoly model where firms consider stock out

terms of time, gas, etc.), then people who visit a given retailer may be captive on that shopping trip. However, prior to visiting a given seller, customers will choose where to shop based upon their perceived likelihood of finding the desired product in stock, which is a function of the quantity the retailer carries and the expected behavior of other shoppers, in addition to standard considerations such as price (travel costs, loyalty, etc.). This creates a variation of a “market entry game” played by shoppers who want to coordinate their actions as each shopper prefers to not experience an empty shelf, but wants to pursue the better deal if she will be successful. In the traditional (non-cooperative) market entry game, players privately decide if they wish to take a sure payoff or enter a pool where payoffs are decreasing in the total number of entrants. This game has a natural interpretation as firms deciding to enter a market where a monopolist would earn more than a duopolist who in turn would earn more than a triopolist and so on. The tension arises because there is a threshold number of entrants below which a firm wants to enter and above which it does not. Hence, in equilibrium only some firms should enter the market, but absent asymmetries there is a coordination problem as to who the entrants should be.

Controlled laboratory experiments have consistently found that people quickly converge to equilibrium behavior in aggregate despite considerable individual heterogeneity (Rapoport 1995, Sundali, et al. 1995, and Rapoport, et al. 1998).⁶ In fact, this pattern is so striking that Kahneman (1988) describes it as being “magic.” However, as the coordination problem becomes more difficult due for example to overconfidence (Camerer and Lovo 1999) or ambiguity (Brandts and Yao 2010) excess entry is often observed.

When sellers create a market entry game for shoppers, a seller could have inventory on the shelf that is not sold because customers (falsely) anticipate a stockout and thus shop elsewhere, the retail variant of Yogi Berra’s famous quip. So whereas excess inventory is normally considered a sign that too much product was offered, the opposite may in fact be true depending on the behavioral response of shoppers playing their coordination game. Somewhat perversely, carrying a larger inventory may induce more shoppers to visit a store resulting in greater sales. That is having excess inventory could be a sign that too little inventory was offered depending on how buyers react to the potential for a stockout. In this setting, price could become a double edged sword for the retailer. Lowering the relative price of the high quality item makes it more attractive, which should increase the number of shoppers who visit; but, this makes a visit riskier and may have the unwanted effect of discouraging shoppers.

This paper examines how the potential for stockouts affects buyers’ decisions and thus optimal prices and inventory levels. We first construct a theoretical model with a three stage game in which two sellers offer differentiated products with one being superior to the other (i.e. customers have a greater willingness to pay for the high quality seller’s product). The high

based substitution and competitor inventory.

⁶ For reviews of the literature on market entry experiments see Ochs (1999) and Rapoport and Seale (2008).

quality seller first selects an inventory, then both sellers post prices, and finally shoppers select which seller to visit and attempt to make purchases. In equilibrium, if visiting the low quality retailer after experiencing a stockout at the high quality seller is not too costly, then all shoppers visit the high quality seller first. However, if it is prohibitively costly for shoppers to visit a second store, then the number of shoppers who visit each seller depends on the inventory level of the high quality seller and the buyer surplus (value minus price) at each location. The more inventory that the high quality seller orders, the lower the price it will have to charge in order to compete with the low quality seller whose price is also decreasing in the high quality seller's inventory in order to attract shoppers. Therefore, in this case the high quality seller strategically chooses to serve only a fraction of the market in order to maximize profits. The model we develop is in the vein of Deneckere and Peck (1995).⁷ However, in their model, sellers offer a homogenous product and shoppers are limited to visiting a single seller.

After developing the theoretical model, we investigate its predictive power using controlled laboratory experiments. We find that the qualitative predictions of the model generally hold. Inventory is higher when shoppers can costlessly visit a second seller after experiencing a stockout. Further, observed prices are generally higher in this case as expected. Shoppers have difficulty coordinating their actions when visiting the high quality seller is risky. In general *too few* people attempt to purchase from the high quality seller, an outcome consistent with shoppers exhibiting some degree of risk aversion, but contrary to previous experiments that have focused exclusively on the market entry game. Seller behavior at earlier stages of the game appears to be consistent with this behavioral response by shoppers.

Theoretical Model

Suppose there are two sellers selling a differentiated product, one of high quality and one of low quality. Define the two sellers as type H and type L sellers respectively. A shopper desires only one unit, and will prefer the product that generates the greatest surplus. All shoppers are identical and value each product at V_H and V_L respectively. They will each make a decision regarding the product to purchase, and visit that seller initially. However, there is a possibility of a stockout at the high quality seller, in which case some shoppers may get shut out of the market. If this occurs, a shopper can then choose to visit the low quality seller at some cost, which is captured by depreciating V_L by a factor of δ . It is guaranteed that the low quality seller will have sufficient quantity to serve the market.

Given this structure, the type H seller will choose the inventory capacity, C , they would like to carry. High quality inventory has a per unit holding cost K_C , which is sunk once the product is procured. Additionally, each seller faces a marginal cost for each unit sold, denoted K_H and K_L respectively. Once the high quality seller's inventory level is determined, it becomes common

⁷ See also Peters (1984).

knowledge; both sellers privately and simultaneously set prices and then shoppers make their purchasing decisions.⁸

Given this general setup, the stages of the game are as follows:

Stage 0: Nature chooses the depreciation factor, δ , and the number of shoppers, n

Stage 1: Type H seller chooses C

Stage 2: Each seller chooses P_i $i = H, L$

Stage 3: Shoppers choose to purchase type L or H conditional on knowing C , δ , and n

Analyzing the game using backward induction, we begin with the shopper behavior in stage three.

Stage 3: Shopper Choice

The shopper will choose the product that offers the greatest expected surplus. As such, the decision whether to seek the high quality product depends upon their valuation of both products less the price as well as the probability they arrive at the type H seller and are shut out. The shopper will then have a reaction function that depends on seller prices as well as the number of shoppers, m , who choose to enter the type H market. Conditional on m , which will be determined in equilibrium, an individual shopper's strategy differs depending upon whether $m > C$ (stockout occurs) or not (H has sufficient inventory to meet its demand). Thus, we characterize the shopper reaction function in equation (1).

A shopper will choose to visit H

$$\begin{aligned} &\text{iff } \frac{C}{m}(V_H - P_H) + \left(1 - \frac{C}{m}\right) \max\{\delta V_L - P_L, 0\} \geq V_L - P_L \text{ when } C \leq m \\ &\text{iff } V_H - P_H \geq V_L - P_L \text{ when } C > m \end{aligned} \quad (1)$$

The first portion of (1) states that the shopper will visit H even though a stockout will occur if the expected value of visiting H and risking being shut out is greater than the expected value of going directly to L. The second portion of (1) says that a shopper will visit H if there is not going to be a stockout and it is more beneficial to visit H than L.

Clearly the shopper decision turns on two conditions: 1) $\delta V_L \geq P_L$ or not and 2) $m \geq C$ or not. Let us consider the various possibilities in turn in order to fully characterize shopper choice.

Case 1

Suppose $m < C$. Regardless of the relationship between δV_L and P_L , in this case, shoppers will successfully purchase the high quality product if they choose. As such they will enter this

⁸ For a discussion of a similar problem where availability is unobserved see Dana (2001).

market iff $V_H - P_H \geq V_L - P_L$. This choice is independent of δ since type H is guaranteed if the shopper should choose it. Note, however, that since shoppers are identical, if this condition holds for one, it will hold for all. As long as $n > C$, then all shoppers will enter, violating the possibility that $m < C$ in equilibrium. As such, this case will never be an equilibrium outcome when the high value product is desired. Alternatively, if $V_H - P_H < V_L - P_L$ the type H product is not desired by any shopper. In this case $m=0$, and the game becomes uninteresting.

Case 2:

Now let us turn to the possibilities when $m \geq C$. First, suppose $P_L \leq \delta V_L$. In this case the shopper may get shut out of the high quality product, but if so, she will then visit the type L seller and purchase the product at a depreciated value. In this case the shopper will enter the high quality market iff

$$\frac{c}{m}(V_H - P_H) + \left(1 - \frac{c}{m}\right)(\delta V_L - P_L) \geq V_L - P_L \quad (2)$$

Thus, there exists a critical value m^* such that any m above this value will deter entry into the high quality market as the probability of successful purchase falls too low. Solving (2) as an equality we find

$$m^* = \frac{c(V_H - \delta V_L - P_H + P_L)}{(1 - \delta)V_L} \quad (3)$$

Conditional on the seller having set the price in stage 2 such that $P_L \leq \delta V_L$, each shopper faces the identical decision that depends upon m . As such, in equilibrium, exactly m^* shoppers will enter. To reach this value, shoppers will play a coordination game in which m^* shoppers will enter in equilibrium. Given that $m^* \geq C$ in equilibrium, we can see from (3) that it must also be the case that in equilibrium $V_H - \delta V_L - P_H + P_L \geq (1 - \delta)V_L$ which can be rewritten as

$$V_H - P_H \geq V_L - P_L. \quad (4)$$

Thus, any equilibrium in which $P_L \leq \delta V_L$ must also satisfy (4).

Case 3:

Now let us turn to the possibilities when $m \geq C$, and $P_L > \delta V_L$

In this case, if a shopper gets shut out, they will not return to the low quality seller. Given this, they will choose to enter the high quality market iff $\frac{c}{m}(V_H - P_H) \geq V_L - P_L$. This behavior generates a critical value of m^* such that for any value exceeding m^* a shopper will choose not to visit H. Thus, shoppers will enter for all $m < m^*$ where

$$m^* = \frac{C(V_H - P_H)}{V_L - P_L} \text{ and } m \geq C \quad (5)$$

As in case 2, shoppers play a coordination game, and in equilibrium $m=m^*$. And, as in case 2, given that this equilibrium is only consistent with $m^* \geq C$, equation (5) implies once again that $V_H - P_H \geq V_L - P_L$. Thus, any equilibrium, regardless of whether $P_L \leq \delta V_L$ or $P_L > \delta V_L$, must also satisfy (4).

Now we turn to stage two in which each seller makes a pricing decision conditional on the value of C chosen in stage 1 and the expected shopper behavior in stage 3.

Stage 2: Seller Pricing

In deriving the reaction functions of both sellers, we must consider the fact that shopper behavior changes if $P_L \leq \delta V_L$ or $P_L > \delta V_L$. In maximizing seller L profit, we recognize this discontinuity and derive the optimal prices and the corresponding equilibrium profits in each case. Seller L's optimal choice will then be the one that produces the greater profit of the two. Specifically, the type L seller chooses the optimal P_L conditional on $P_L \leq \delta V_L$ and the optimal P_L conditional on $P_L > \delta V_L$ and then compares profits in each case.

Now we consider each seller's pricing decision in turn.

Type H Seller:

The objective function for a type H seller will be

$$\pi_H = (P_H - K_H)C - K_C C \quad (6)$$

Given that stage 3 shopper behavior generates the result that $m^* \geq C$, in equilibrium H will sell all C units they ordered in stage 1. Optimizing the profit function, it is clear that $\frac{d\pi_H}{dP_H} = C > 0$. Thus, a type H seller will set P_H as high as possible. However, given the constraint from (4) that must be satisfied in equilibrium (or the type H seller will fail to get any shoppers), the type H seller's reaction function given type L's price will be

$$P_H = V_H - V_L + P_L. \quad (7)$$

Note for clarity that if the type H seller does violate this constraint and sets a higher price, this implies that $m < C$. Recall from equation (1) that in this case that a shopper will enter the type H market iff $V_H - P_H \geq V_L - P_L$. Otherwise, $m = 0$, and profits are zero.

Note that this reaction function is type H's response given P_L , but it is independent of whether $P_L \leq \delta V_L$ or $P_L > \delta V_L$. Thus, seller H's reaction function can be given generally by (7).

Type L Seller:

This seller must consider the choice to set price such that $P_L \leq \delta V_L$ or $P_L > \delta V_L$ and will then compare profits in each case.

Case 1:

Consider first the choice to set a price low enough that shoppers who pursue a type H product and are stocked out turn to the type L seller and purchase; that is $P_L \leq \delta V_L$. In this case, seller L will serve all customers who do not receive the high quality item. Given the results from stage 3 which implies $m^* = C$, the remaining number of customers that the type L seller will serve is $n - C$. Thus, the objective function of the type L seller is:

$$\pi_L = (P_L - K_L)(n - C) \quad (8)$$

Differentiating (8) yields

$$\frac{d\pi_L}{dP_L} = n - C \geq 0 \quad (9)$$

Just as was the case with the type H seller, the type L seller will set P_L as high as possible subject to being in this case (i.e. $P_L \leq \delta V_L$). Thus, a type L seller will set

$$P_L^* = \delta V_L \quad (10)$$

In other words, δV_L dominates any price between 0 and δV_L regardless of P_H .

In equilibrium, conditional upon being in this case, the intersection of reaction functions (7) and (10) yields

$$P_H^* = V_H - V_L + \delta V_L = V_H - (1 - \delta)V_L \quad (11)$$

Plugging (10) and (11) into (5) yields

$$m^* = C \left(\frac{V_H - \delta V_L - [V_H - (1 - \delta)V_L] + \delta V_L}{(1 - \delta)V_L} \right) = C \quad (12)$$

Therefore, type L seller's profit in this case in which they choose to keep the price low enough to attract customers that get shut out at H is $\pi_L = (P_L - K_L)(n - C)$ or $\pi_L^* = (\delta V_L - K_L)(n - C)$.

Case 2:

Suppose instead the low quality seller is willing to forego those customers who fail to receive the high quality good by choosing a higher price such that $P_L > \delta V_L$. If so, seller L will sell $n - m$, the number of shoppers who do not seek the high quality product. In this case, seller L's objective function will be $\pi_L = (P_L - K_L)(n - m)$ where $m = C \left(\frac{P_H - V_H}{P_L - V_L} \right)$ which is

$$\pi_L = (P_L - K_L) \left(n - C \left(\frac{P_H - V_H}{P_L - V_L} \right) \right). \quad (13)$$

Taking the first order condition yields $\frac{d\pi_L}{dP_L} = (P_L - K_L) \left[\frac{C(P_H - V_H)}{(P_L - V_L)^2} \right] + n - C \left(\frac{P_H - V_H}{P_L - V_L} \right) = 0$ which simplifies to the following quadratic: $P_L^2 - 2P_L V_L + V_L^2 + \frac{C}{n} (V_H - P_H)(V_L - K_L) = 0$.

Solving for P_L , gives two solutions for seller L's reaction function given by

$P_L = V_L \pm \sqrt{\frac{C}{n} (V_H - P_H)(V_L - K_L)}$. Since it must be the case that $P_L < V_L$ or no shopper will purchase, one of the solutions can be eliminated leaving seller L's reaction function to be

$$P_L = V_L - \sqrt{\frac{C}{n} (V_H - P_H)(V_L - K_L)}. \quad (14)$$

To determine equilibrium prices when $P_L > \delta V_L$, requires simultaneously solving (7) and (14), which yields

$$P_L^* = \frac{(n-C)V_L + CK_L}{n} \quad (15)$$

$$P_H^* = V_H - V_L + \frac{(n-C)V_L + CK_L}{n} \quad (16)$$

Plugging (15) and (16) into (5) yields $m^* = C \left(\frac{P_H - V_H}{P_L - V_L} \right) = C \left(\frac{P_L - V_L}{P_L - V_L} \right) = C$.

To compute the type L seller's optimal profit conditional on being in this case in which shoppers do not visit L after being stocked out at H, substitute (15) into (13). This results in an optimal profit of $\pi_L^* = \frac{(n-C)^2(V_L - K_L)}{n}$. Since $P_L > \delta$, $P_L^* = \frac{(n-C)V_L + CK_L}{n} > \delta V_L$ which can be rewritten as

$$\frac{(n-C)V_L + CK_L}{nV_L} > \delta \quad (17)$$

In other words, this equilibrium collapses if (17) does not hold.

For the final step in identifying the type L seller's reaction function, one must compare optimal profit when $P_L > \delta V_L$ (Case 2) and when $P_L \leq \delta V_L$ (Case 1).

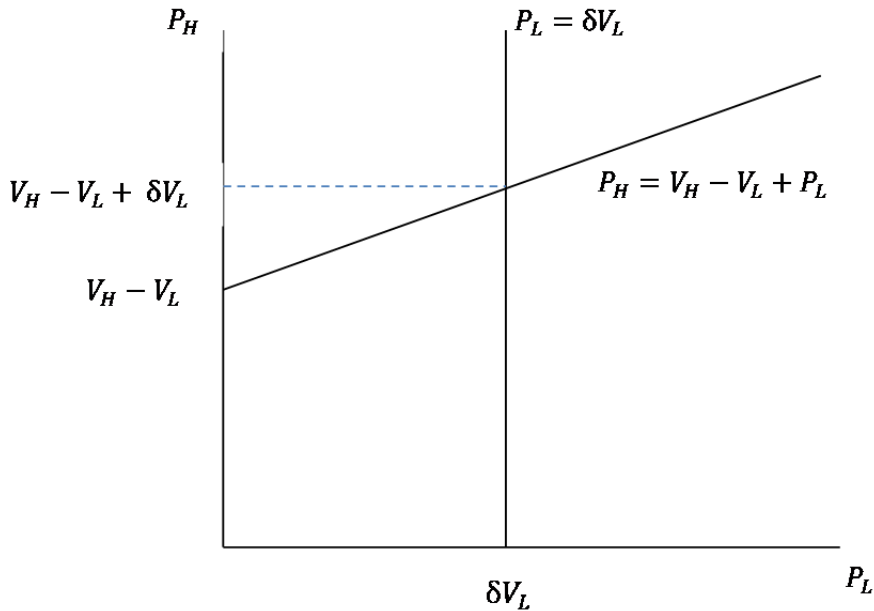
Recall that in Case 1, $\pi_L^* = (\delta V_L - K_L)(n - c)$ and in Case 2, $\pi_L^* = \frac{(n-c)^2(V_L - K_L)}{n}$. Thus the type L seller will choose $P_L > \delta V_L$ iff $(\delta V_L - K_L)(n - c) < \frac{(n-c)^2(V_L - K_L)}{n}$, which simplifies to $\frac{(n-c)V_L + cK_L}{nV_L} > \delta$. This condition is identical (17), the condition required to support $P_L > \delta V_L$. Thus, when (17) holds $P_L > \delta V_L$, and otherwise $P_L = \delta V_L$. Therefore, the Type L seller's reaction function is completely characterized by:

$$P_L = \begin{cases} V_L - \sqrt{\frac{c}{n}(V_H - P_H)(V_L - K_L)} & \text{when } \delta < \frac{(n-c)V_L + cK_L}{nV_L} \\ \delta V_L & \text{else} \end{cases} \quad (18)$$

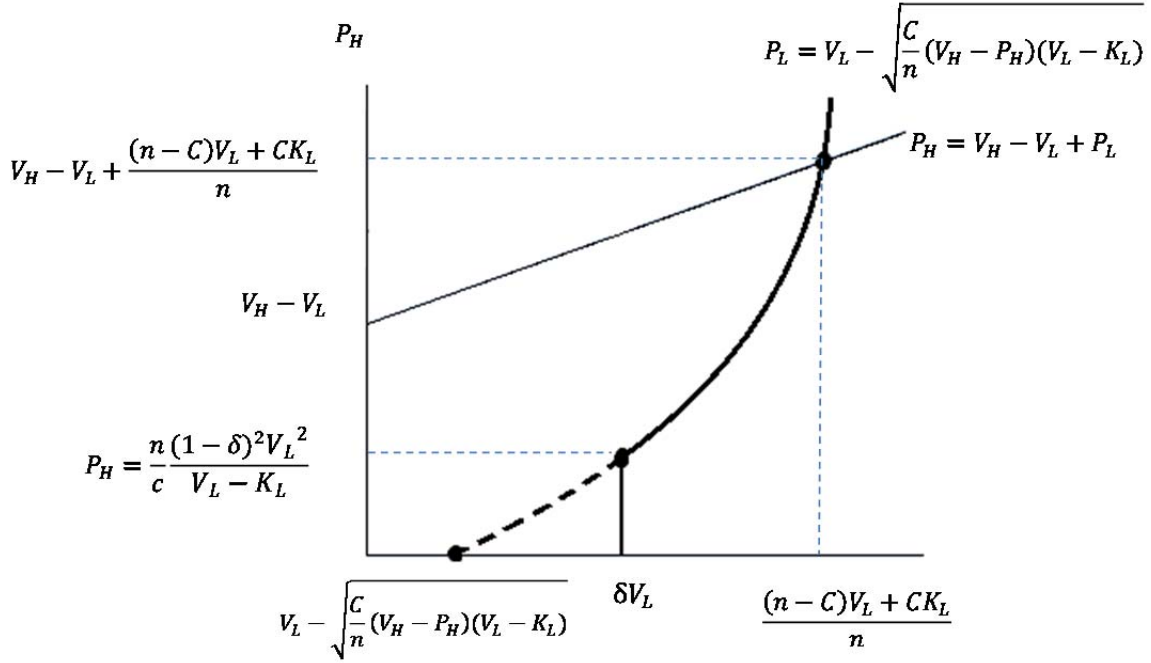
Equilibrium:

To summarize, equilibrium prices depend on the relationship between δ and $\frac{(n-c)V_L + cK_L}{nV_L}$. When $\delta \geq \frac{(n-c)V_L + cK_L}{nV_L}$, equilibrium prices are given by (10) and (11). This equilibrium is shown in the best response graph shown in Panel A of Figure 1. When $\delta < \frac{(n-c)V_L + cK_L}{nV_L}$ equilibrium prices are given by (15) and (16). This equilibrium is shown in the best response graph in Panel B of Figure 1.

Figure1. Best Response Curves
Panel A. When Cost of Visiting Second Seller is Low



Panel B. When Cost of Visiting Second Seller is High



Stage 1: Capacity Choice

Given the optimal prices that will arise in equilibrium conditional upon C , the high quality seller must choose C in stage 1. If $\delta > \frac{(n-C)V_L + CK_L}{nV_L}$, then the type H seller will maximize $\pi_H = (P_H - K_H)C - K_C C$ with respect to C , yielding $\frac{d\pi_H}{dC} = P_H - K_H - K_C$. If $P_H > K_H + K_C$, then $C = n$. Otherwise $C = 0$. That is, the High quality seller will serve the entire market if it can sell units at a positive profit.

If instead $\delta < \frac{(n-C)V_L + CK_L}{nV_L}$, then $\pi_H = (V_H - V_L + \frac{(n-C)V_L + CK_L}{n} - K_H - K_C)C$.

The first order condition obtained by setting the first derivative of the profit function equal to 0 gives $\frac{d\pi_H}{dC} = V_H - V_L - K_H - K_C + \frac{(n-C)V_L + CK_L}{n} + C \left[\frac{-V_L}{n} + \frac{K_L}{n} \right] = 0$. Solving for C yields $C = \frac{n(V_H - K_H - K_C)}{2(V_L - K_L)}$. As C must be less than or equal to n , if $V_H - K_H - K_C > 2(V_L - K_L)$ then the corner solution $C = n$ holds.

The above model offers several insights into expected behavior. When δ is large, meaning that the cost to shoppers of visiting a second seller is low, the type L seller will in fact price low enough to attract consumers who experience a stockout at the high quality seller. The low

quality seller will ultimately set a price equal to the discounted value of its product. In turn, the high quality seller will offer the shopper no more surplus than does the low quality seller. Further, as the high quality seller can unload its entire inventory, it should order as much as possible up to completely serving demand. However, when visiting a second seller is sufficiently costly, the low quality seller will offer the buyer a price less than the value of its product in order to attract customers away from the high quality seller. The high quality seller will again have to offer shoppers the same surplus as the low quality seller, but will no longer find it optimal to serve the entire market in general as the price discount of the low quality seller depends on the high seller's inventory.

Experimental Design

To explore how buyers and sellers are likely to behave in a setting where customers experience stockouts, we rely upon controlled laboratory experiments where the assumptions of the model can be exogenously imposed. As the solution to the theoretical model hinges on the cost to shoppers of visiting the low quality seller if the find the high quality seller's shelf empty, this is the primary treatment variable. In one experimental condition, the cost of visiting a second seller is prohibitively expensive, formally determined by setting $\delta = 0$. In the second condition, it is costless for a shopper to visit a second seller in the event of stockout as $\delta = 1$.

The other model parameters were set as follows. V_H and V_L were set equal to 15 and 9, respectively. The marginal cost per unit sold, K_H and K_L , were both set equal to 0. Setting these costs to 0 does not alter the structure of the problem faced by the sellers, but makes it easier to describe the decision making environment as these costs do not have to be introduced. K_C , the inventory cost for each item the high quality seller orders in stage 1 was set equal to 3. Finally, the number of buyers in the market, n , was set to 6. Because the high quality seller should serve the entire market when shoppers can freely visit a second seller (i.e. the high quality seller should set $C^* = n$ in stage 1 when $\delta = 1$), a capacity constraint or maximum inventory level of $\hat{C} = 5$ was imposed on high quality sellers to ensure that low quality sellers cannot be completely shut out of the market. This limit was imposed in both conditions, but is only theoretically binding when shoppers can freely visit a second seller. When the condition is binding, the high quality seller will set $C = \hat{C}$ in stage 1, and the equilibrium prices will still be as described Panel B of Figure 1. Table 1 gives the equilibrium choices for each party in both conditions.

In the experiments, the roles of shoppers (18 people), high quality seller (3 people) and low quality seller (3 people) were randomly assigned among a group of 24 participants. Once a role was assigned, it was maintained throughout the 20 period experiment. A total of 4 sessions were conducted, resulting in a total of 240 markets. In two of the sessions, subjects first experienced the $\delta = 1$ condition for 10 periods and then the $\delta = 0$ condition for the last 10 periods. In the

other two sessions, the condition order was reversed. Thus, the treatment effect is measured using a within-subjects design.

Table 1. Equilibrium Behavior and Outcomes by Condition

	$\delta = 0$	$\delta = 1$
C^*	4	5
P_H^*	\$9	\$15
P_L^*	\$3	\$9
Shopper Behavior	4 of 6 visit High Quality Seller first. 2 of 6 visit Low Quality Seller first.	6 of 6 visit High Quality Seller first. ⁺ 1 of 1 visits Low Quality Seller second.
π_H^*	\$24	\$60
π_L^*	\$6	\$9
Shopper Surplus	\$6	\$0

⁺ 5 of 6 shoppers visiting the high quality seller and the other only visiting the Low Quality Seller is also an equilibrium.

Every period, three distinct markets were in concurrent operation. One high quality seller, one low quality seller and six shoppers were randomly assigned to each of the markets each period. That people were randomly shuffled each period was common information and no identifying information was presented so participants did not know with whom they were interacting in any period, nor did they know if and when they might interact with that person again. Each market period proceeded in three steps corresponding to those in the theoretical model described above, with all parameter values being public information. First, the high quality seller selected her inventory, which was then revealed to the low quality seller. The high and low quality sellers then privately and simultaneously set their prices. Finally, shoppers could observe both prices in their market as well as the inventory of the high quality seller. Shoppers privately and simultaneously determined which seller they wanted to visit, if any. Any shopper that experienced a stockout at the high quality seller was subsequently allowed to choose between visiting the low quality seller or not in the condition where $\delta = 1$. Subjects only received feedback about their own market each period. The experiment was presented in a market context to the subjects, but the sellers were identified as “Firm A” and “Firm B” and no mention of high and low quality was made.

The experiments were run at the Behavioral Business Research Laboratory at the University of Arkansas. The participants were undergraduates at that institution and were drawn from a standing database of study volunteers, a majority of whom are in the business school. None had previously participated in any related studies. In addition to the salient payment, which averaged

\$13.57, subjects also received a \$5 participation payment for the 90 minute session. Upon entering the laboratory, participants were seated at individual workstations separated by privacy dividers. Subjects then read the computerized instructions and answered a series of comprehension questions.⁹ The text of the directions and the questions are included in the Appendix. Once everyone had finished the instructions, answered the comprehension questions, and had any remaining questions answered, the computerized experiment began. After the 10th market period, a second set of directions and comprehension questions describing the second treatment was administered. Participants did not know the number of market periods nor did they know in advance that there would be a second condition. At the conclusion of the experiment, subjects were paid in private based upon their cumulative earnings, which were denoted in Experimental Dollars (\$E). The conversion rate into \$US was \$E 20 = \$US 1 for sellers and \$E 10 = \$US 1 for shoppers. Because high quality sellers could experience a loss due to the inventory cost, these sellers received an endowment of \$E 200 that was added to their salient earnings. After receiving their payment, subjects were dismissed from the study.

Behavioral Results

We consider each stage of the game in turn. As appropriate, we consider either the behavior in comparison to the equilibrium prediction or in comparison to the optimal response to a previous choice at an earlier stage of the game. After this analysis, we examine how non-equilibrium behavior at subsequent steps may have impacted behavior earlier in the game.

Stage 1: Inventory Decision

In the inventory ordering stage, high quality sellers should order 4 units when shoppers will not visit a second seller after experiencing a stockout ($\delta = 0$) and should order 5 units when shoppers will ($\delta = 1$). This modest treatment effect was intentional because it allows for greater separation in equilibrium prices at the second stage. The average observed inventory when $\delta = 0$ was 4.09, and the average inventory when $\delta = 1$ was 4.35. This nominal difference between the treatments is consistent with the theory, and the observed behavior when $\delta = 0$ is close to the theoretical prediction indeed. However, given the small expected inventory difference between treatments and the fact that when $\delta = 1$ inventory errors are necessarily one sided as high quality sellers could not order more than $\hat{C} = 5$, for statistical evidence of a treatment effect on inventory decisions, we focus on the percentage of times that high quality sellers ordered the maximum possible inventory (i.e. $C = \hat{C}$). The estimated logit model, which clusters standard errors by seller to control for the repeated measures from the same observational unit, is shown in Table 2. As the results indicated, high quality sellers are marginally statistically more likely to order the maximum possible inventory when $\delta = 1$, consistent with the directional prediction of the model (p-value = 0.085 for the appropriate one-sided alternative).

⁹ The entire experiment was programmed in ztree (Fischbacher 2007).

Table 2. Logit Estimation for Stage 1 Inventory Decision

	<u>Coefficient</u>	<u>Robust Standard Error</u>	<u>Z</u>	<u>p-value</u>
Constant	0.03	0.44	0.07	0.940
δ	0.55	0.40	1.37	0.170

Number of observations = 240.

Stage 2: Pricing Decisions

In equilibrium, prices depend upon the viability of a shopper visiting the low quality seller after experiencing a stockout. In the laboratory, the average observed prices were as shown in Table 3 along with the theoretical predictions for comparison. Several features of the data are readily apparent. First, on average, prices at low quality sellers are well below the prices set by high quality sellers. While this direction is consistent with theory, the difference is expected to be 6 ($= V_H - V_L$) and in fact is less than half of that difference. Further, it is high quality sellers who are generally pricing too low. In part, this behavior by high quality sellers may be due to a concern about being stuck with costly inventory.

Table 3. Observed Pricing Behavior by Condition

	<u>$\delta = 0$</u>		<u>$\delta = 1$</u>	
	Equilibrium	Observed	Equilibrium	Observed
High Quality Price	\$9	\$7.29	\$15	\$7.33
Low Quality Price	\$3	\$3.88	\$9	\$4.83

It is interesting to note that prices are much closer to the theoretical prediction when shoppers cannot visit the low quality seller after a stockout. With the increase in δ , prices at the low quality seller are increasing as predicted by the model, but do not increase as much as predicted. Prices at the high quality seller do not appear to change. It is worth pointing out that in equilibrium when $\delta = 1$ shoppers receive no surplus. Many previous laboratory experiments on the ultimatum game have found that individuals frequently reject offers that yield a very asymmetric allocation of a surplus and that this is anticipated so that relatively few such offers are actually observed (see Hoffman, et al. 2008 for a discussion). A similar pattern has been observed in basic posted offer market experiments where buyers often do not purchase at prices too close to their private values leading sellers to lower their prices (see Davis and Holt 1993 for a discussion). A similar phenomenon is likely at play here.

For statistical comparisons we rely upon a linear random effects regression model that allows for each individual seller to have an idiosyncratic random effect. Standard errors are clustered at the

session level to account for the lack of independence within a session. *High* is a dummy variable for a high quality seller. The econometric results shown in Table 4 indicate that High quality sellers set higher prices. The p-value reported in Table 4 is based upon a two sided alternative; however, the model suggests a one sided hypothesis. There is marginal evidence that low quality sellers are charging higher prices when $\delta = 1$ (one sided p-value = 0.084). However this is not the case for High quality sellers as the interaction term $\text{High} \times \delta$ offsets the primary effect of δ .

Table 4. Linear Random Effects Model for Stage 2 Price Decision

	<u>Coefficient</u>	<u>Robust Standard Error</u>	<u>z</u>	<u>p-value</u>
Constant	3.88**	0.32	12.10	<0.001
δ	0.95	0.69	1.38	0.167
High	3.41**	0.31	11.08	<0.001
$\text{High} \times \delta$	-0.91	0.70	-1.30	0.194

Number of observations = 480. ** indicates significance at the 1% level.

The above analysis ignores the variation that is introduced due to high quality sellers ordering inventory out of equilibrium. Figure 2 shows observed average prices as a function of the high quality inventory by experimental condition and seller type. When $\delta = 1$, inventory should have no impact on prices, and by and large this holds (see top panel of Figure 2) although prices are substantially below the equilibrium level as discussed above. When $\delta = 0$, prices should fall as inventory increases (a one-sided alternative hypothesis) and low quality sellers are trying to compete. While there is some evidence of this for low quality sellers, this does not appear to be the case for high quality sellers. It is important when viewing Figure 2 to realize that only 5% of the markets involved a high quality inventory less than 3, so that the left hand side of this figure is highly sensitive to outliers.

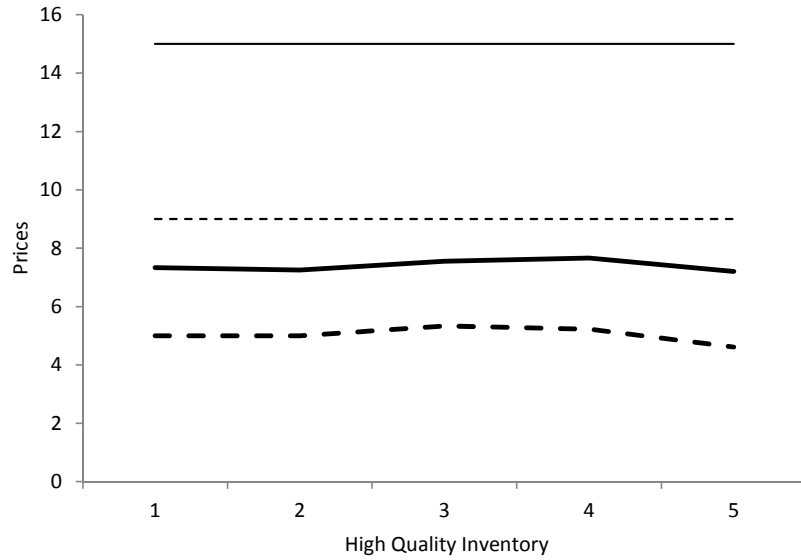
To investigate the impact of inventory decisions on subsequent prices, we again rely on a liner mixed effects model similar to that presented in Table 4. However, that analysis includes the *Inventory* of the high quality seller and allows this effect to differ for each value of δ and *High*. Again, there is a random effect for each seller and standard errors are clustered at the session level. The estimation results are shown in Table 5.

The regression results confirm that the level of inventory acquired by the high quality seller does not impact prices for low or high quality sellers when $\delta = 1$ as $\text{Inv} \times \delta \times (1-\text{High})$ and $\text{Inv} \times \delta \times (1-\text{High})$, respectively, are not different from 0. That low quality sellers reduce their price as the high quality seller's inventory increases when $\delta = 0$ is demonstrated by the negative and significant value for $\text{Inv} \times (1-\delta) \times (1-\text{High})$ with p-value = 0.049 for the appropriate one-sided alternative.

Figure 2. Observed Prices by Seller Type for each Condition as a Function of Inventory

Legend:
Solid (Dashed) Lines Denote High (Low) Quality Sellers
Thick (Thin) Lines Denote Observed (Theoretically Optimal) Behavior
Dark (Light) Lines Denote that the Cost to Visit a Second Seller is not (is) Prohibitive

Panel A: Cost to Visit a Second Seller is Not Prohibitive ($\delta = 1$).



Panel B: Cost to Visit a Second Seller is Prohibitive ($\delta = 0$).

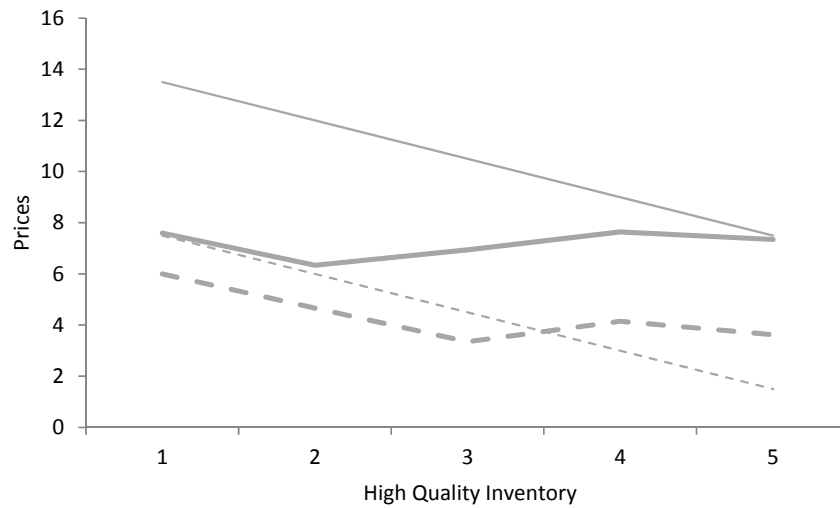


Table 5. Linear Random Effects Model for Stage 2 Price Decision Conditional on Inventory

	<u>Coefficient</u>	<u>Robust Standard Error</u>	<u>Z</u>	<u>p-value</u>
Constant	5.45**	0.78	6.99	<0.001
δ	0.74	1.38	0.54	0.591
High	1.96	1.48	1.33	0.185
High \times δ	-0.87	1.48	-0.59	0.556
Inv \times $\delta \times (1-High)$	-0.31	0.28	-1.10	0.273
Inv \times $\delta \times High$	0.01	0.41	0.03	0.977
Inv $\times (1-\delta) \times (1-High)$	-0.38*	0.23	-1.66	0.097
Inv $\times (1-\delta) \times High$	-0.03	0.25	-0.11	0.909

Number of observations = 480. ** indicates significance at the 1% level and * indicates significance at the 10% level.

Stage 3: Shopper Behavior

In equilibrium, exactly four shoppers should visit the high quality seller when visiting a second seller is prohibitively costly. The average number of observed shoppers visiting the high quality seller in that condition is 3.54. In the other condition either 5 or 6 shoppers should visit the high quality seller, and on average 4.80 are observed to do so. For the statistical determinants of buyer behavior, we rely upon a multinomial logit model where the dependent variable is the number of buyers visiting the high quality seller and standard errors are clustered at the session level. The estimation, shown in Table 6, reveals that the value of δ has no aggregate effect on buyer behavior. However, this is due in part to the fact that stage 1 (inventory) and stage 2 (pricing behavior) is out of equilibrium, and thus the expected shopper behavior is not the optimal response to the realized situation. A more complete multinomial logit estimation is presented in Table 7. This estimation controls not only for δ and *Inv*, but also the variable *PriceDiff*, which captures the difference between the high quality price and the low quality price observed by the buyer at a particular decision point. Table 7 shows the results of this estimation, but one must bear in mind that the baseline case is when the high quality seller has no inventory and there is no price difference, explaining the negative and significant coefficient δ .

Based upon the results in Table 7, the inventory level of the high quality seller does not significantly impact buyer behavior in either treatment, but the price difference does have a significant impact on whether or not shoppers visit the high quality sellers. Specifically, the bigger the price difference the less likely shoppers are to visit the high quality seller and this effect is larger when $\delta = 0$ as would be expected since customers experiencing a stockout will not be able to make a purchase from the low quality seller in this treatment.

Table 6. Multinomial Logit Model for Number of Buyers Visiting High Quality Seller in Stage 3

	<u>Coefficient</u>	<u>Robust Standard Error</u>	<u>Z</u>	<u>p-value</u>
Constant	2.20**	0.15	14.53	<0.001
δ	0.32	0.59	0.53	0.593

Number of observations = 240. ** indicates significance at the 1% level.

Table 7. Multinomial Logit Model for Number of Buyers Visiting High Quality Seller in Stage 3 Conditional on Market Observables

	<u>Coefficient</u>	<u>Robust Standard Error</u>	<u>Z</u>	<u>p-value</u>
Constant	13.47**	5.22	2.58	0.010
δ	-7.93*	4.20	-1.89	0.059
PriceDiff	-2.07**	0.69	-2.98	0.003
Inv	0.191	0.35	0.54	0.586
PriceDiff \times δ	1.24**	0.45	2.72	0.007
Inv \times δ	0.05	0.45	0.10	0.919

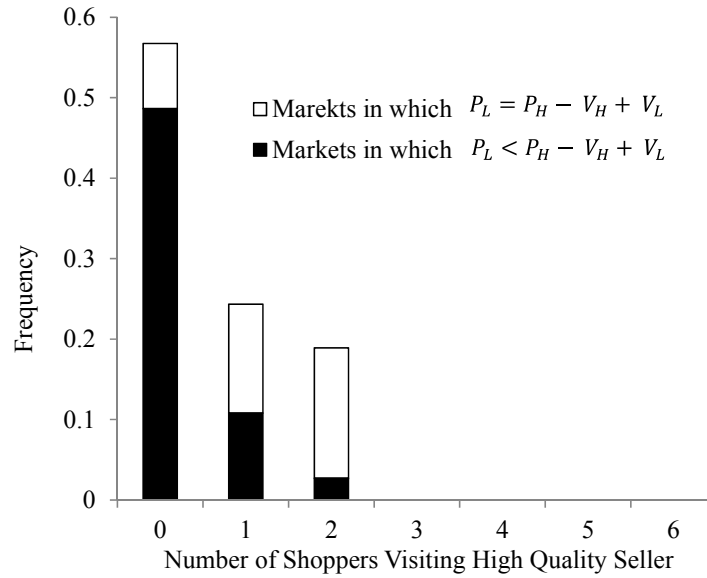
Number of observations = 480. ** indicates significance at the 1% level and * indicates significance at the 10% level.

While the average number of shoppers visiting the high quality seller is similar to the theoretical predictions and the reaction to market variables is intuitive, the above analysis ignores buyers' piecewise reaction functions to the market variables as discussed in the theory section. Therefore, we now take a more careful look at the problem directly from the shopper's perspective. As a shopper, one of three states can occur. First, the low quality seller could offer at least as much surplus to the buyer as the high quality seller, which occurs if $P_L \leq P_H - V_H + V_L$. In this case, visiting the low quality seller is at least a weakly dominant strategy for the shopper (strictly dominant for a strict inequality). In the second and third cases, more surplus for the shopper is generated by the high quality seller than by the low quality seller. When $\delta = 1$ it is strictly dominant for the shopper to visit the high quality seller as it is costless to visit a second seller. However, if $\delta = 0$ then shoppers faces a risk-return tradeoff when making their initial decisions.

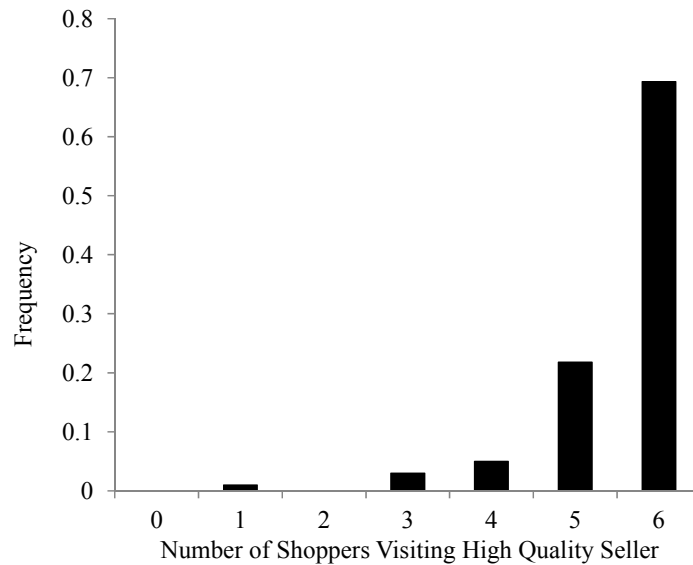
Figure 3 shows shopper reaction in the first two cases. Panel A shows the frequency with which a given number of shoppers visit the high quality seller when it is weakly dominant for shoppers to visit the low quality seller. Such markets account for approximately 15% of all observed markets. From Panel A of Figure 3, it is clear that shoppers are evaluating the relative return from the two types of sellers and rarely visit the high quality seller when it is offering the worse

Figure 3. Shopper Behavior When Shoppers Have (at least) Weakly Dominant Strategies

Panel A: Markets in which $P_L \leq P_H - V_H + V_L$
so that Shoppers Should Visit Low Quality Seller Initially



Panel B: Markets in which $P_L > P_H - V_H + V_L$ and $\delta = 1$
so that Shoppers Should Visit High Quality Seller Initially



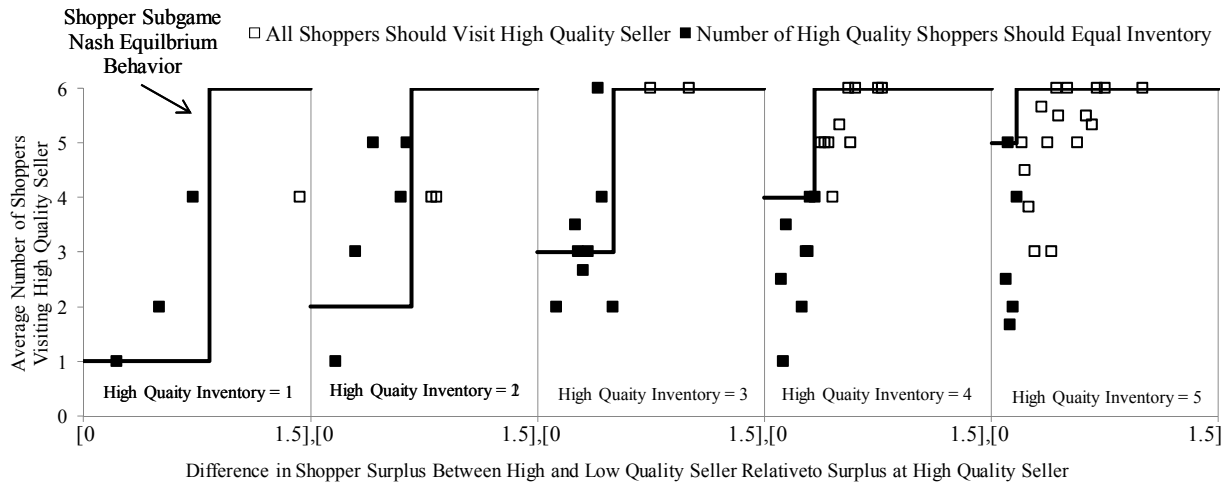
deal. Of those that visit the high quality seller when the returns are equal from the shoppers' perspective, many are from the $\delta = 1$ condition so that they are indifferent between visiting the low quality seller first, buying the high quality item, or experiencing a stockout at the high

quality seller and then buying the low quality item. Panel B of Figure 3 shows the frequency with which shoppers visit the high quality seller when $P_L > P_H - V_H + V_L$ and $\delta = 1$ so that shoppers have a weakly dominant strategy to visit the high quality seller. This situation arises in 42% of the experimental markets (84% of the markets for which $\delta = 1$).¹⁰ As shown in the figure, shoppers overwhelmingly visit the high quality seller in this case, again indicating that shoppers understand their incentive structure.

The truly interesting case for shoppers is when the high quality seller offers a better deal than the low quality seller, but the shopper faces the risk of a stockout and, therefore, being unable to buy anything. The results of this situation are shown in Figure 4, which plots the average number of shoppers (out of 6) that attempt to purchase from the high quality seller as a function of the inventory level and the relative benefit to a shopper of purchasing from that high quality seller defined as $\frac{(V_H - P_H) - (V_L - P_L)}{V_H - P_H} = 1 - \frac{(V_L - P_L)}{V_H - P_H}$. As discussed in the model section, from the shopper's perspective it is better to go to the high quality seller even if the other $n - 1$ shoppers are also visiting this seller when $\frac{C}{n}(V_H - P_H) + \frac{n-C}{n}0 > V_L - P_L$. The term before the inequality is the expected surplus from visiting the high value seller, and the term after the inequality is the surplus from visiting the low quality seller. Thus, if $1 - \frac{(V_L - P_L)}{V_H - P_H} > 1 - \frac{C}{n}$ or $\frac{V_L - P_L}{V_H - P_H} < \frac{C}{n}$ the Nash equilibrium of the subgame given C, P_H, P_L is for all shoppers to visit the high quality seller. If this inequality is reversed (still assuming that $P_L > P_H - V_H + V_L$ and $\delta = 0$) then the Nash equilibrium of this subgame is for exactly C shoppers to visit the high quality seller. Essentially, given the inventory level, if the relative benefit of visiting the high quality seller is low, only C shoppers should go, but if the relative benefit is sufficiently high then everyone should go. This pattern is shown in Figure 4 as step function for each inventory level, with the step occurring when $\frac{V_L - P_L}{V_H - P_H} = \frac{C}{n}$. As is evident in Figure 4, the relative benefit at the high quality seller that is needed to encourage all buyers to visit the high quality seller is decreasing in C . Because shopper behavior is expected to depend on this relative benefit, conditional on inventory level, the observed behavior is marked separately depending on the relationship between $\frac{V_L - P_L}{V_H - P_H}$ and $\frac{C}{n}$. For relative benefits from the high seller that are sufficiently low so that only C shoppers house visit the high quality store, a black square markers is used. A white square marker is used for situations in which the relative benefit is sufficiently high so that all shoppers should visit the high quality seller.

¹⁰ This also indicates that situations in which the low quality seller offered the better deal to the buyer were randomly distributed between conditions.

Figure 4. Shopper Behavior when $P_L > P_H - V_H + V_L$ and $\delta = 0$



As Figure 4 clearly reveals, shoppers are more willing to visit the high quality seller, the greater the relative benefit of visiting the high quality seller. That is, the markers in each block are generally trending up. Also evident from the figure is that shoppers are reticent about visiting the high quality seller even when the relative benefit is large enough that everyone should; i.e., the white blocks often fall short of 6 in many observations. This pattern is consistent with the shoppers exhibiting risk aversion in aggregate, as is common in laboratory experiments. When shoppers are expected to coordinate their actions so that only some visit the high quality seller, they do not. When the high quality seller has a small inventory, too many shoppers visit. When the high quality seller has a large inventory, too few shoppers visit. Somewhat more surprising is that the number of shoppers visiting when coordination is required appears to be decreasing in inventory from the second unit on. This is the retail equivalent of Yogi Berra's quote as shoppers do not go there because it is (expected to be) too crowded.

Possible Behavioral Explanations for non-Equilibrium Outcomes

At the third stage, when $\delta = 1$ the behavioral results clearly show that shoppers are going to visit the seller offering the greatest surplus. This may be perceived by the subject sellers as a strong signal to engage in a price war resulting in observed prices well below the predicted level. On the other hand, when $\delta = 0$ shoppers are reluctant to visit the high quality seller unless it is offering a *really* good deal making it worth the risk of being shutout; this is consistent with shoppers exhibiting risk aversion. Caution on the part of the buyers in this condition may be encouraging the low quality seller to maintain relatively high prices (and indeed this is the only case where sellers price above the equilibrium level on average). If, in response to buyer risk aversion, low quality sellers are not pushing their prices down, then high quality sellers should not have to lower theirs as much either; however, consistent with the hypothesis that it is risk

aversion causing buyers to choose to avoid the high quality seller, these sellers do need to offer the shopper a good deal, which may explain why they are pricing below equilibrium in this condition while the low quality sellers are not. At the first stage, high quality sellers order too little inventory when $\delta = 1$. This response seems reasonable given the price war that will occur in the second stage exposing the high quality seller to the risk of incurring losses. When $\delta = 0$, high quality sellers expect second stage prices to be close to the equilibrium level and order inventory accordingly.

Conclusions

In this paper, we model seller pricing and inventory ordering behavior in a competitive market where consumers respond to producer decisions and the cost to visit a second seller. By analyzing the consumer response, we show that when it is difficult for consumers to visit another seller if they encounter a stockout, the low quality seller should lower its price causing the high quality seller to do so as well. In addition, inventory orders will fall as buyers face increasing costs of visiting a second seller. This occurs because although greater inventory implies more potential sales, a tradeoff exists as the low quality seller becomes more price competitive when inventories are high. Further, this model shows that excess inventory and/or a stockout may not be a retailer mistake, but can be a strategic response to market condition and pricing decisions.

In addition to developing theoretical insights that prior models of a single seller have not been able to analyze, we identify behavioral responses in this setting using controlled laboratory experiments. In so doing we identify several interesting observations. First, when consumers have a dominant strategy, they tend to follow it. Specifically, when they are able to visit a second seller costlessly, they visit the high quality seller first unless the low quality seller offers greater surplus. Also, as the price difference grows, they visit the low quality seller more frequently.

Given that consumers behave as expected when costs are low, the high quality sellers are indeed ordering more as they face no risk of not being able to sell their inventory. However, we do not see them raising their prices as expected in this case. So while they do place the orders, they still seem to worry about not selling their inventory, and they price lower than theory predicts. As expected though, the inventory itself does not affect prices in this case.

As the cost of visiting a second seller becomes prohibitive, consumers no longer have a dominant strategy and must rely on coordination. When this is the case, we observe fewer than predicted buyers visiting the high quality seller and risking a stockout. This suggests risk aversion on the part of the consumer. In terms of pricing, we do see sellers pricing lower as expected, with high quality sellers pricing lower than is predicted by theory, likely a response to buyer risk aversion. In addition, the low quality seller actually raises price when inventory orders are sufficiently low,

likely taking advantage of the risk aversion of consumers who are reluctant to face a the possibility of a stockout. But aside from this extreme case, prices are lower as expected with the high quality sellers pricing even lower than theory suggests.

Possibly the most interesting observation from the experiments, likely arising from buyer risk aversion, is that as inventory rises, fewer consumers risk going to the high quality seller whereas theoretically more should visit this seller. This is laboratory evidence of the retail version of the Yogi Berra phenomenon. Clearly risk averse consumers fail to coordinate, and this in turn may explain why low quality sellers don't drop their price and why high sellers drop it too much.

References

- Allon, G. and A. Bassamboo. 2011. "Buying from the Babbling Retailer? The Impact of Availability Information on Customer Behavior." *Management Science* 57, pp. 713-726.
- Anderson, E., G. Fitzsimons and D. Simester. 2006. "Measuring and Mitigating the Costs of Stockouts." *Management Science* 52(11), pp. 1751-1763.
- Aviv, Y. and A. Pazgal. 2008. "Optimal Pricing of Seasonal Products in the Presence of Forward-looking Consumers." *Manufacturing Service Operations Management* 10(3), pp. 339–359.
- Balachander, S. and P. Farquhar. 1994. "Gaining More by Stocking Less: A Competitive Analysis of Product Availability." *Marketing Science* 13, pp. 3-22.
- Brandts, J. and L. Yao. 2010. "Ambiguous Information and Market Entry: An Experimental Study." Working Paper, available at <http://mpra.ub.uni-muenchen.de/25276/>.
- Cachon, G. and R. Swinney. 2009. "Purchasing, Pricing, and Quick Response in the Presence of Strategic Customers." *Management Science* 55(3), pp. 497-511.
- Camerer, C. and D. Lovo. 1999. "Overconfidence and Excess Entry: An Experimental Approach." *American Economic Review* 89(1), pp. 306-318.
- Chen, X. and D. Simchi-Levi. 2010. "Pricing and Inventory Management." In Ozer, O. and R. Phillips (Eds.), *Oxford Handbook of Pricing Management*, Oxford University Press.
- Dana, J. 2001. "Competition in Price and Availability when Availability is Unobservable." *The RAND Journal of Economics* 32(3), pp. 497-513.
- Davis D. and C. Holt. 1993. *Experimental Economics*, Princeton, NJ: Princeton University Press.

- Deneckere, R. and J. Peck. 1995. "Competition over Price and Service Rate when Demand is Stochastic: A Strategic Analysis." *The RAND Journal of Economics* 26(1), pp. 148-162.
- Fischbacher, U. 2007. "z-Tree: Zurich Toolbox for Ready-made Economic Experiments." *Experimental Economics* 10(2), pp. 171-178.
- Gruen, T., D. Corsten, and S. Bharadwaj. 2002. "Retail Out-of-stocks: A Worldwide Examination of Extent, Causes and Consumer Responses." Grocery Manufacturers of America, Washington, D.C.
- Hardgrave, B., M. Waller and R. Miller. 2007. "Does RFID Reduce Out of Stocks ? A Preliminary Analysis." *International Journal of RF Technologies: Research and Applications* 1(1), pp. 44-56.
- Hess, J. and E. Gerstner. 1987. "Loss Leader Pricing and rain Check Policy." *Marketing Science* 6(4), pp. 358-374.
- Hess, J. and E. Gerstner. 1998. "Yes, 'Bait and Switch' Really Benefits Consumers." *Marketing Science* 17(3), pp. 283-289.
- Hoffman, E., K. McCabe and V. Smith. 2008. "Reciprocity in Ultimatum and Dictator Games: An Introduction." In Plott, C. and V. Smith (Eds.), *Handbook of Experimental Economics Results* 1, North-Holland, Amsterdam.
- Honhon, D., V. Gaur, S. Seshardi. 2010. "Assortment Palnning and Invetory Decisions Under Stockout-Based Substitution." *Operations Research* 58(5), pp. 1364-1379.
- Jing X. and M. Lewis. 2011. "Stockouts in Online Retailing." *Journal of Marketing Research* 48(2), pp. 342-354.
- Kahneman, D. 1988. "Experimental Economics: A Psychological Perspective." in Tietz, R. W. Albers and R. Selten (Eds.), *Bounded Rational Behavior in Experimental Games and Markets*. New York, NY: Springer-Verlag.
- Kamakura, W. and G. Russell. 1989. "A Probabilistic Choice Model for Market Segmentation and Elasticity Structure." *Journal of Marketing Research* 26(4), pp. 379-390.
- Liu, Q. and G. van Ryzin. 2008. "Strategic Capacity Rationing to Induce Early Purchases." *Management Science* 54(6), pp. 1115-1131.
- Liu, Q. and G. van Ryzin. 2011. "Strategic Capacity Rationing when Customers Learn." *Manufacturing and Service Operations Management* 13, pp. 89-107.

Mahajan, S. and G. van Ryzin. 1999. "Retail Inventories and Consumer Choice." In Tayur, S., R. Ganeshan and M. Magazine (Eds.), *Quantitative models for supply chain management*, Norwell, MA: Kluwer's International Series.

Matsa, D. 2011. "Competition and Product Quality in the Supermarket Industry." *The Quarterly Journal of Economics* 126(3), pp. 1539-1591.

Nagarajan, M. and S. Rajagopalan. "Technical Note – A Multiperiod Model of Inventory Competition." *Operations Research* 57(3), pp. 785-790.

Ochs, J. 1999. "Coordination in Market Entry Games." in Budescu, D., I. Erev and R. Zwick (Eds.), *Games and Human Behavior: Essays in Honor of Ammon Rapoport*, Lawrence Erlbaum Associates.

Rapoport, A. 1995. "Individual Strategies in a Market-Entry Game." *Group Decision and Negotiation* 4(2), pp. 117- 133.

Rapoport, A., D. Seale, I. Erev and J. Sundali. 1998. "Equilibrium Play in Large Group Market Entry Games." *Management Science* 44(1), pp. 119-141.

Rapoport, A. and D. Seale. 2008. "Coordination Success in Non-Cooperative Large Group Market Entry Games" In Plott, C. and V. Smith (Eds.), *Handbook of Experimental Economics Results* 1, North-Holland, Amsterdam.

Sundali, J., A. Rapoport and D. Seale. 1995. "Coordination in Market Entry Games with Symmetric Players." *Organizational Behavior and Human Decision Processes* 64(2), pp. 203-218.

Transchel, S. 2011. "Joint Pricing and Inventory Decisions Under Stockout-based and Price-dependent Substitution." Working Paper, available at SSRN: <http://ssrn.com/abstract=1807484>

Walter, C. and J. Grabner. 1975. "Stockout Cost Models: Empirical Tests in a Retail Situation." *Journal of Marketing* 39, pp. 56-68.

Wilke, W., C. Mela, and G. Gundlach. 1998a. "Does 'Bait and Switch' Really Benefit Consumers?" *Marketing Science* 17(3), pp. 273-282.

Wilke, W., C. Mela, and G. Gundlach. 1998b. "Does 'Bait and Switch' Really Benefit Consumers? Advancing the Discussion..." *Marketing Science* 17(3), pp. 290-293.

Appendix: Subject Instructions and Comprehension Questions

Items in italics were not observed by the subjects. Items in brackets were role specific.

Subject Instructions

Instructions, Page 1

In this experiment some people will be in the role of a firm and others will be in the role of a buyer. Buyers and firms will have the opportunity to buy and sell fictitious products with each other via their computers in a market. Firms earn money when they sell these items for more than their costs and buyers earn money when they purchase items at prices below their values. At the end of the experiment you will be paid based upon your earnings. Since you are paid based upon your decisions, it is important that you understand the directions completely. If you have any questions, please raise your hand and someone will come to your desk.

Instructions, Page 2 for Sellers

This experiment will last for several market periods. In each period you will be randomly matched with other people in the experiment.

In each market there are 2 Firms, A and B, and 6 buyers.

You will be Firm [A/B] and will retain the same role throughout the experiment. However, it is very important to understand how all the roles work.

All of the buyers value Firm A's product at \$15.
All of the buyers value Firm B's product at \$9.
A buyer can only purchase one unit in each period.

Each market period has three phases.
Phase 1: Firm A makes an inventory decision.
Phase 2: Firms A and B set their prices.
Phase 3: Buyers decide what to buy.
We will next describe each phase in detail.

Instructions, Page 2 for Buyers

This experiment will last for several market periods. In each period you will be randomly matched with other people in the experiment.

In each market there are 2 Firms, A and B, and 6 buyers.

You will be a buyer and will retain the same role throughout the experiment. However, it is very important to understand how all the roles work.

All of the buyers value Firm A's product at \$15.
All of the buyers value Firm B's product at \$9.
A buyer can only purchase one unit in each period.

Each market period has three phases.
Phase 1: Firm A makes an inventory decision.
Phase 2: Firms A and B set their prices.
Phase 3: Buyers decide what to buy.
We will next describe each phase in detail.

Instructions, Page 3

During Phase 1, Firm A will decide what quantity to order. This is the maximum amount that Firm A can sell in the market. Firm A can order between 0 and 5 units. Notice that this means Firm A cannot order enough units to serve all 6 buyers. Each unit Firm A orders costs Firm A \$9 regardless of whether or not Firm A ultimately sells the unit or not. Units cannot be carried forward from one market period to the next.

Instructions, Page 4

During Phase 2, Firm B will learn how many units Firm A ordered. Firm B always has 6 units of available to sell each period and does not incur any cost for these units. Firm A and Firm B will both set their price for the current period. Both firms will set their prices in private, but both firms will learn of the other firm's price after both prices are set.

Instructions, Page 5 for $\delta = 0$ treatment

During Phase 3, each buyer chooses to go to Firm A, Firm B, or neither.

Any buyer who goes to Firm B will buy a unit from Firm B at Firm B's price. These buyers' earnings will be \$9 minus Firm B's price. Recall that Firm B always has enough units to serve all buyers.

If the total number of buyers who go to Firm A is less than or equal to the number of units that Firm A ordered, each of the buyers who goes to Firm A will buy a unit from Firm A at Firm A's price. These buyers' earnings will be \$15 minus Firm A's price.

If the total number of buyers who go to Firm A is greater than the number of units that Firm A ordered, then Firm A experiences a stock out and the computer will randomly pick which buyers actually get to purchase Firm A's units.

The buyers who get to buy from Firm A will earn \$15 minus Firm A's price.

The buyers who are not randomly selected to buy units from Firm A will earn \$0.

Any buyer who chooses to go to neither firm will not buy a unit and will earn \$0 for the period.

Instructions, Page 5 for $\delta = 1$ treatment

During Phase 3, each buyer chooses to go to Firm A, Firm B, or neither.

Any buyer who goes to Firm B will buy a unit from Firm B at Firm B's price. These buyers' earnings will be \$9 minus Firm B's price. Recall that Firm B always has enough units to serve all buyers.

If the total number of buyers who go to Firm A is less than or equal to the number of units that Firm A ordered, each of the buyers who goes to Firm A will buy a unit from Firm A at Firm A's price. These buyers' earnings will be \$15 minus Firm A's price.

If the total number of buyers who go to Firm A is greater than the number of units that Firm A ordered, then Firm A experiences a stock out and the computer will randomly pick which buyers actually get to purchase Firm A's units. The buyers who get to buy from Firm A will earn \$15 minus Firm A's price.

The buyers who are not randomly selected to buy units from Firm A will then have the option to either go to Firm B or not. If these buyers choose to go to Firm B they will earn \$10 minus Firm B's price. If these buyers choose not to go to Firm B they will earn \$0.

Any buyer who chooses to go to neither firm will not buy a unit and will earn \$0 for the period.

Instructions, Page 6 for Sellers

Firm A's earnings for the period equal (Firm A's price \times number of units Firm A sold) - (\$9 \times number of units Firm A ordered).

Firm B's earnings for the period equal (Firm B's price \times number of units Firm B sold).

After each period, a table on the right-hand side of your screen will be updated with information about how many units Firm A ordered, the prices of both firms, and the number of units that each firm sold. Buyers' summary tables also record their own choice of which firm to visit. Keep in mind that all of the other people in your market are determined randomly each period.

At the end of the experiment, the amount you earned will be divided by 20 to determine your payment in US dollars. If you have any questions, please raise your hand. Remember that you are paid based upon your decisions so it is important that you understand the directions completely.

Instructions, Page 6 for Buyers

Firm A's earnings for the period equal (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered).

Firm B's earnings for the period equal (Firm B's price \times number of units Firm B sold).

After each period, a table on the right-hand side of your screen will be updated with information about how many units Firm A ordered, the prices of both firms, and the number of units that each firm sold. Buyers' summary tables also record their own choice of which firm to visit. Keep in mind that all of the other people in your market are determined randomly each period.

At the end of the experiment, the amount you earned will be divided by 10 to determine your payment in US dollars. If you have any questions, please raise your hand. Remember that you are paid based upon your decisions so it is important that you understand the directions completely.

Comprehension Questions

Subjects were presented with a scenario and had to answer a series of questions on the computer. The feedback depended on the answers given. In the scenario, X, Y and Z are all discrete uniform random variables in an attempt not to bias subsequent behavior.

X was equally likely to be 2, 3, 4 or 5.

Y was equally likely to be 9, 10, 11, 12, 13, 14 or 15.

Z was equally likely to be 1, 2, 3, 4, 5, 6, 7, 8 or 9.

The version below is for the treatment when $\delta = 0$. The version for the treatment when $\delta = 1$ is omitted.

Page 1

Let's work through a few questions to make sure you understand the way the experiment will work. The following questions will not impact your payoff in any way. Instead, these questions are designed to ensure that everyone understands exactly how this experiment is structured and exactly how your payment will be calculated when the study is over. Please feel free to raise your hand at any point if you have any questions.

Page 2

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\langle Y \rangle$ while Firm B sets a price of $\langle Z \rangle$.

If $\langle X - 1 \rangle$ buyer(s) visit Firm A,

...how many units will Firm A sell?

Page 3a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\langle Y \rangle$ while Firm B sets a price of $\langle Z \rangle$.

If $\langle X - 1 \rangle$ buyer(s) visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

That is correct.

Page 3b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\langle Y \rangle$ while Firm B sets a price of $\langle Z \rangle$.

If $\langle X - 1 \rangle$ buyer(s) visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

That is incorrect. The correct answer is $\langle X - 1 \rangle$. If Firm A orders at least as many units as it has customers visit, then it will always sell to whomever visits. Since Firm A ordered $\langle X \rangle$ unit(s) and only $\langle X - 1 \rangle$ buyers visited, Firm A would have been able to sell to each customer.

Page 4

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.
If $\langle X-1 \rangle$ buyer(s) visit Firm A,
...how many units will Firm A sell? You said: [subject's input]
...The correct answer was $\langle X-1 \rangle$.
...how much profit will Firm A earn? Recall that profit is equal to (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered).

Page 5a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.
If $\langle X-1 \rangle$ buyer(s) visit Firm A,
...how many units will Firm A sell? You said: [subject's input]
...The correct answer was $\langle X-1 \rangle$.
...how much profit will Firm A earn? Recall that profit is equal to (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered). You said: [subject's input]
That is correct.

Page 5b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.
If $\langle X-1 \rangle$ buyer(s) visit Firm A,
...how many units will Firm A sell? You said: [subject's input]
...The correct answer was $\langle X-1 \rangle$.
...how much profit will Firm A earn? Recall that profit is equal to (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered). You said: [subject's input]
That is incorrect. The correct answer is $\langle Y*(X-1) - 9*(X) \rangle$. To find Firm A's profit, we multiply the price it charges, $\langle Y \rangle$, by the number of units sold, $\langle X-1 \rangle$, and then subtract the costs that Firm A incurs for ordering units. Since Firm A is charged $\$9$ for each unit it orders, and since Firm A ordered $\langle X \rangle$ units, these costs are $9 \times \langle X \rangle$, or $\langle 9*X \rangle$. Therefore, the total earnings of Firm A is $\langle Y \rangle \times \langle X-1 \rangle - 9 \times \langle X \rangle = \langle Y*(X-1) - 9*(X) \rangle$.

Page 6

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.
If $\langle X-1 \rangle$ buyer(s) visit Firm A,
...how many units will Firm A sell? You said: [subject's input]
...The correct answer was $\langle X-1 \rangle$.
...how much profit will Firm A earn? Recall that profit is equal to (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered). You said: [subject's input]
...The correct answer was $\langle Y*(X-1) - 9*(X) \rangle$.
...how much profit will a buyer who visits Firm A earn?

Page 7a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.
If $\langle X-1 \rangle$ buyer(s) visit Firm A,
...how many units will Firm A sell? You said: [subject's input]
...The correct answer was $\langle X-1 \rangle$.
...how much profit will Firm A earn? Recall that profit is equal to (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered). You said: [subject's input]
...The correct answer was $\langle Y*(X-1) - 9*(X) \rangle$.
...how much profit will a buyer who visits Firm A earn? You said: [subject's input]
That is correct.

Page 7b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X - 1 \rangle$ buyer(s) visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

...The correct answer was $\langle X - 1 \rangle$.

...how much profit will Firm A earn? Recall that profit is equal to (Firm A's price \times number of units Firm A sold) - ($\$9 \times$ number of units Firm A ordered). You said: [subject's input]

...The correct answer was $\langle (Y * (X - 1) - 9 * (X)) \rangle$.

...how much profit will a buyer who visits Firm A earn? You said: [subject's input]

This is incorrect. The correct answer is $\langle 15 - Y \rangle$. To calculate how much an individual will profit from purchasing a unit we take how much they value the good and subtract the price that is charged. In this case, the buyer values Firm A's product at $\$15$ and Firm A decided to set a price of $\$ \langle Y \rangle$. Therefore the profit to a buyer who buys from Firm A is the difference between these two values: $15 - \langle Y \rangle$, or $\langle 15 - Y \rangle$.

Page 8

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell?

Page 9a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

That is correct.

Page 9b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

That is incorrect. The correct answer is $\langle X \rangle$. If Firm A orders fewer units than it has buyers visit then it will sell all the units it ordered. Since Firm A ordered $\langle X \rangle$ unit(s) and $\langle X + 1 \rangle$ buyers visited, Firm A would have been able to sell all $\langle X \rangle$ of its units.

Page 10

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn?

Page 11a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

That is correct.

Page 11b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

That is incorrect. The correct answer is $\langle Y * X - 9 * X \rangle$. To find Firm A's profit, we multiply the price it charges, $\langle Y \rangle$, by the number of buyers who visit the store and can purchase, $\langle X \rangle$, and then subtract the costs that Firm A incurs for ordering units. Since Firm A is charged $\$9$ for each unit it orders, and since Firm A ordered $\langle X \rangle$ units, these costs are $9 \times \langle X \rangle$, or $\langle 9 * X \rangle$. Therefore, the total earnings of Firm A is $\langle Y \rangle \times \langle X \rangle - 9 \times \langle X \rangle = \langle Y * (X) - 9 * (X) \rangle$.

Page 12

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

...The correct answer was $\langle Y * X - 9 * X \rangle$.

...how much profit will a buyer who actually buys a unit from Firm A earn?

Page 13a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

...The correct answer was $\langle Y * X - 9 * X \rangle$.

...how much profit will a buyer who actually buys a unit from Firm A earn? You said: [subject's input]

That is correct.

Page 13b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

...The correct answer was $\langle Y * X - 9 * X \rangle$.

...how much profit will a buyer who actually buys a unit from Firm A earn? You said: [subject's input]

That is incorrect. The correct answer is $\langle 15 - Y \rangle$. To calculate a buyer's profit we take the value the buyer has for the good and subtract how much the buyer paid for the good. Since this buyer bought from Firm A, the value of the good is 15, and the price was $\langle Y \rangle$. Therefore the buyer's profit is $15 - \langle Y \rangle$, or $\langle 15 - Y \rangle$.

Page 14

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

...The correct answer was $\langle Y * X - 9 * X \rangle$.

...how much profit will a buyer who actually buys a unit from Firm A earn? You said: [subject's input]

...The correct answer was $\langle 15 - Y \rangle$.

...what happens to a buyer who visits Firm A but is unable to purchase a unit?

Button: {"Has the option to visit Firm B"; "Is unable to purchase in this period"}

Page 15a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

...The correct answer was $\langle (Y * X - 9 * X) \rangle$.

...how much profit will a buyer who actually buys a unit from Firm A earn? You said: [subject's input]

...The correct answer was $\langle 15 - Y \rangle$.

...what happens to a buyer who visits Firm A but is unable to purchase a unit? You said: [subject's input]

That is correct.

Page 15b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle X + 1 \rangle$ buyers visit Firm A,

...how many units will Firm A sell? You said: [subject's input]

The correct answer was $\langle X \rangle$.

...how much profit will Firm A earn? You said: [subject's input]

...The correct answer was $\langle (Y * X - 9 * X) \rangle$.

...how much profit will a buyer who actually buys a unit from Firm A earn? You said: [subject's input]

...The correct answer was $\langle 15 - Y \rangle$.

...what happens to a buyer who visits Firm A but is unable to purchase a unit? You said: [subject's input]

That is incorrect. If a buyer is unable to buy a unit from Firm A it will not have the opportunity to visit Firm B in the same period.

Page 16

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle 6 - X + 1 \rangle$ buyers visit Firm B,

...how much profit will Firm B earn?

Page 17a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle 6 - X + 1 \rangle$ buyers visit Firm B,

...how much profit will Firm B earn? You said: [subject's input]

That is correct.

Page 17b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle 6 - X + 1 \rangle$ buyers visit Firm B,

...how much profit will Firm B earn? You said: [subject's input]

That is incorrect. The correct answer is $\langle (6 - X + 1) * Z \rangle$. To calculate Firm B's profit, we multiply how many buyers visit Firm B, $\langle 6 - X + 1 \rangle$ by the price that Firm B set, $\langle Z \rangle$. This gives us $\langle 6 - X + 1 \rangle * \langle Z \rangle$, or $\langle (6 - X + 1) * Z \rangle$.

Page 18

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle 6 - X + 1 \rangle$ buyers visit Firm B,

...how much profit will Firm B earn? You said: [subject's input]

...The correct answer was $\langle (6 - X + 1) * Z \rangle$.

Page 19a (screen shown when subject's answer was correct)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle 6 - X + 1 \rangle$ buyers visit Firm B,

...how much profit will Firm B earn? You said: [subject's input]

...The correct answer was $\langle (6 - X + 1) * Z \rangle$.

...how much profit will a buyer who visits Firm B earn? You said: [subject's input]

That is correct.

Page 19b (screen shown when subject's answer was incorrect)

Suppose Firm A orders $\langle X \rangle$ unit(s) and sets a price of $\$ \langle Y \rangle$ while Firm B sets a price of $\$ \langle Z \rangle$.

If $\langle 6 - X + 1 \rangle$ buyers visit Firm B,

...how much profit will Firm B earn? You said: [subject's input]

...The correct answer was $\langle (6 - X + 1) * Z \rangle$.

...how much profit will a buyer who visits Firm B earn? You said: [subject's input]

That is incorrect. To calculate how much profit a buyer will earn from visiting Firm B take the value of Firm B's product, 9 and subtract the price charged by Firm B, $\langle Z \rangle$. Therefore, the profit earned by the buyer would be $9 - \langle Z \rangle$, or $\langle 9 - Z \rangle$.

Page 20

We are now ready to begin the experiment. If you do not have any questions, please click the BEGIN button below.