Bargain or Post the Price?*

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Abstract

This paper studies the choice between two modes of trade: selling at a posted price or bargaining. It is shown that the choice of one of the regimes may be a signal of quality of the good, otherwise unobservable to the buyer. The main insight is that the two modes can coexist on the same market. Two alternative specification are considered, different in whether sellers strategically choose the quality of their good or not.

1 Introduction.

This paper studies pricing behavior of sellers on markets where not only price but the trading rule is a choice variable. The question that is addressed here is why some retailers choose to post the prices of their merchandise and others choose not to post prices, but instead bargain with potential buyers.

The phenomenon that originally motivated this study is pottery selling in the Old City of Jerusalem (also observed on many other similar markets). There are many shops that

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sell similar pottery; sometimes these shops are located next door to each other, but still follow different pricing policies. Some sellers have prices of their goods posted, while others do not have posted prices and expect a potential buyer to inquire about price and then bargain on it. The question of particular interest in this setup is how the two modes of trade can coexist within the same market, in shops operating in the same location.[1]

There are two empirical observations about pottery shops in Jerusalem, registered by anyone who ever tried to buy merchandise in both. First, shops that post prices are usually bigger than those that do not. Second, although the goods look very similar to each other, in fact those sold at fixed price turn out to be of higher quality. The theory that I build in this paper helps explain both these phenomena.

There has been a literature on the choice of price posting versus bargaining. The emphasis in these studies is put mostly on comparing the two modes of trade under various specifications of costs and benefits. The present paper is the first, to the best of my knowledge, where the coexistence of both modes of trade is addressed.

Another market that exhibits a similar phenomenon is the market for cars, both new and used. In this market there are also retailers who bargain and retailers who sell at fixed prices; however, a number of differences make it difficult to apply the the logic usually put forward in the context of the car market to the pottery market.

One obvious difference is that a car is a significantly more important purchase than a piece of pottery; consequently, a buyer is likely to have spent time thinking about what car she wants, what its quality parameters (e.g., features and performance) are, etc.; therefore a buyer has a good idea about her value for a car of a specific model. In contrast, such prior analysis is hardly possible in a pottery market, since the merchandise is to a large extent specific to the place and the buyer typically possesses little information about its quality.

Second, on the pottery market, there are little or no opportunities for the seller to advertise his goods and to build any reputation of selling high quality merchandise – each

[1]Guide books on Jerusalem describe haggling as the prevailing mode of trade on a bazaar, but also specifically mention a few shops that commit to posted prices.

buyer is likely to be there only once and there is little chance that she will remember what shop she visited once she gets home, so most likely a new buyer will be ignorant about the reputation of each place.[2] The one-off nature of trade limits the applicability of price-quality or advertising signaling associated with repeated interactions (such as in Nelson [7], Schmalensee [8], Shapiro [9], Kihlstrom and Riordan [5]). On the other hand, some buyers may in fact be experts and be able to assess the quality of goods prior to buying. I show that under certain conditions even if the fraction of informed buyers is very small, sellers of different types will be willing to choose different pricing policies.

Finally, the entire pottery market is located within a very small area, so a typical customer may well be able to inspect many shops prior to making a decision. This is not so much the case in the car market, where convenient dealership location has been mentioned by 49% of the buyers as one of the reasons for first visiting the dealership where they actually purchased the car[3].

A number of papers has studied the seller's choice between bargaining and price posting under assumptions that are arguably more relevant for car markets than for pottery markets. Wernerfelt ([12]) focuses his analysis on heterogeneous buyers facing transportation and inspection costs that a buyer has to incur whether or not a purchase actually happens. This creates opportunities for holdup on the part of sellers. Similarly, Bester ([2]) emphasizes costs that a buyer faces when switching from one shop to another, while buyers are assumed to be homogeneous in their preferences and the quality is assumed to be observable once a buyer enters a shop. Consequently, there is no scope for quality signaling and the resulting predominant trade structure (bargaining or posting the price) is determined by the force of the lock-in effect, i.e., by the relative bargaining power of the parties and buyer's switch costs; no arrangements are considered with both modes of trade simultaneously present in the market. Wang ([11]) compares the two modes of trade based on the costs of each, i.e., displaying costs versus costs of bargaining. However, his study is

[2]Although tourist guides sometimes recommend specific shops, they do not typically explicitly claim that merchandise in these shops has superior quality.

[3]I am grateful to J.D.Powers and the International Motor Vehicle Program at MIT for this data.

focused on the case of a single seller and does not aim at explaining the coexistence of the two modes of trade.

Wolinsky ([13]) builds a model in which buyers are different in their willingness to pay for quality and prices serve as signals of quality (which is not directly observable to consumers) at the separating equilibrium; to establish the existence of a separating equilibrium, he assumes that buyers get noisy signals on quality (other than prices). His setup does not allow for bargaining.

There has also been a number of studies that compare and contrast posting a price with running an auction (in connection with e-Bay buyout option). Zeithammer ([14]) argues that posting a price is more appropriate than auctioning when the seller has a large number of sufficiently uniform items of a good, since the costs of posting the price (in particular, of choosing the price) is only incurred once whereas auctioning has per unit costs.[4]

The main purpose of this paper is to study price posting versus bargaining choice as well as coexistence of the two modes in a setting that models souvenir markets in tourist areas. The key ingredients of the model that I build are the following: buyers do not observe the quality of the good until after they buy it; buyers are heterogeneous in their taste for quality; buyers can costlessly observe pricing policy of all operating shops; finally, sellers are professionals in the sense that they can estimate buyer's valuation of the good upon seeing him and they bargain better than buyers (in the sense of having higher bargaining power). Under these assumptions I show how the choice to post the price may be a signal of high quality and how sellers voluntarily adopt different modes of trade.

The rest of the paper is organized as follows. The model is presented in Section 2. Section 3 studies the case of a single seller in full detail. In Section 4 the case of two sellers is studied and sufficient conditions are derived for existence of a separating equilibrium. Section 5 refers to large markets with endogenous quality choice. Section 6 concludes.

[4]See also [10].

2 The Model.

There is a unit mass of potential buyers and a finite number of sellers in the market for a certain good, differentiated in quality. The good may be either of high quality (or type) q_H or of low quality q_L, such that $q_H > q_L > 0$. Denote $\triangle q = q_H - q_L$.

Sellers are risk neutral and each seller may carry only one type of good. Supplying a unit of good of quality q_H costs $c_H = 1$ to the seller; supplying a good of quality q_L does not cost anything: $c_L = 0$. A seller incurs costs only if trade takes place.

Buyers are risk neutral. Each buyer needs at most one unit of the good. All buyers prefer a high quality good to a low quality good, but they differ in their willingness to pay for quality. In particular, each buyer has a type θ, a taste parameter that I assume is uniformly distributed on $[0, 1]$. The buyer's utility of obtaining a good of quality q (either q_H or q_L) and paying p for it is equal to $\theta q - p$; the buyer's reservation utility is zero. Assume that $\triangle q > 1$, that is, if a buyer is of low type it is efficient to supply her a low quality good, whereas if she is of high type it is efficient to supply her a high quality good.

Informational assumptions are as follows: each buyer knows her type; each seller knows the quality of his good. With the exception of the section on large markets, I assume that a buyer does not know the quality of the good until after she has bought it (when I discuss large markets, I assume that some fraction of buyers are informed and observe the quality of the good). Once a seller sees a buyer, the seller observes her type θ.

The timing is as follows. First, the quality of goods that all sellers have is chosen simultaneously. Under the endogenous quality specification, sellers choose quality of their goods themselves; under the exogenous quality specification, the quality of the good each seller has is picked randomly and independently, with λ being the probability that the quality is high ($q = q_H$). Denote average quality as $\bar{q} = \lambda q_H + (1 - \lambda) q_L$. Next, sellers observe each other's types and choose their pricing policy, that is, whether to post the price and, if so, at what level. Then buyers arrive and costlessly observe all posted prices. Each buyer chooses whether to buy the good and, if so, at what shop. If the chosen shop has a posted price, she buys at that price (for simplicity I assume that a posted price can not be negotiated). Otherwise, she bargains with the seller.

I consider the following very simple bargaining procedure: either party is randomly selected to make a take it or leave it offer to the other party. With probability α the buyer gets to make the offer; with probability $1 - \alpha$ the seller makes the offer. Under full information and risk neutrality, the outcome of such bargaining is represented by the generalized Nash bargaining solution, in which the buyer receives share α of the gains from trade and the seller receives share $1-\alpha$ on average. I assume that the seller is more skilled in bargaining and appropriates a larger share of bargaining surplus: $\alpha < \frac{1}{2}$. There are three factors that determine the outcome of the bargaining. First, the final price depends on the buyer's type θ; other things equal, the higher θ, the higher the expected payoff to both parties. Second, the outcome depends on seller's perceived quality q and costs c; although these are not directly observable to buyers, in equilibrium a buyer may be able to correctly infer them. Finally, the disagreement point of the buyer of type θ depends on the other sellers' pricing policies: if there is another seller that offers a good that a buyer believes to be of quality q at (posted) price p, that buyer's disagreement point is $\theta q - p$ (or the best of such offers if there is more than one). This is the way in which sellers impose an externality on each other: the more aggressive a price poster is, the lower the expected revenue of a bargainer will be.

If there is more than one seller who does not post the price, the buyer can only bargain with one of them. That is, if the buyer approaches one of the sellers, begins bargaining with him but does not reach an agreement, all other sellers who bargain observe it and do not trust this buyer anymore, so she can not subsequently bargain with anybody else (she can still buy at a posted price though).[5] I need this assumption to make sure that the buyer does not default by refusing to trade if he is not chosen to make a take the offer (in the hope that he will have luck with another seller).[6]

[5] Guide books specifically suggest that you do not engage in bargaining unless you are prepared to buy the good.

[6] An alternative assumption could be that each buyer can try his luck with each seller who posts no price, resulting in his effective bargaining power being equal to $1-(1-\alpha)^k$ where k is the number of sellers

The equilibrium concept is Perfect Bayesian Equilibrium (PBE). Although I mention pooling equilibria (in which sellers of both types choose the same pricing policy) the main focus is on equilibria in which buyers are able to correctly infer the quality of the good from the seller's pricing policy. To distinguish between two alternative specifications of quality choice, I refer to *separating* equilibria in environments where the quality of the good (or the type of the seller) is exogenous and sellers of different types choose different strategies. I refer to *signaling* equilibria in environments where sellers are ex ante identical, but some of them choose high and others low quality and, importantly, subsequently adopt different pricing policies that signal their choice.

3 Single seller and exogenous quality.

In this section I study equilibria in a game where there is only one seller who does not strategically choose the quality of his good.

Proposition 1. *There always exists a pooling equilibrium in which the seller of neither type posts the price.*

Proof. Let all buyers believe that any good with a posted price is of low quality and that if the price is not posted, the good is of high quality with probability λ and low quality with probability $1-\lambda$. Clearly these beliefs are consistent with the seller of neither type posting the price. All there is to show is that the seller of neither type wants to deviate and post a price instead.

Under these beliefs, the buyer of type θ is expecting the surplus of $\theta\bar{q}$ and with probability $1-\alpha$ the seller will get to make the offer and thus to expropriate this surplus. If the seller is of high type, he will only be trading with buyers of type $\theta = \frac{1}{\bar{q}}$ or above, making his total expected profit equal to

$$(1-\alpha)\int_{\frac{1}{\bar{q}}}^{1}(\theta\bar{q}-1)d\theta_L = \frac{1-\alpha}{2}\cdot\frac{(\bar{q}-1)^2}{\bar{q}}.$$

who post no price. This specification will complicate algebra without significantly altering the conclusions.

Alternatively he may post some price p; by assumption, he will then be believed to have low quality good and only buyers with type $\theta = \frac{p}{q_L}$ or above will buy the good,[7] making his profit equal to

$$\left(1 - \frac{p}{q_L}\right)(p-1).$$

The seller's profit is maximized at $p = \frac{q_L+1}{2}$ and equals $\frac{(q_L-1)^2}{4q_L} < \frac{1-\alpha}{2} \cdot \frac{(\bar{q}-1)^2}{\bar{q}}$. The last inequality follows from $\alpha < \frac{1}{2}$ and $q_L < \bar{q}$ (and also from the fact that $g(x) = \frac{(x-1)^2}{x}$ is an increasing function for $x \geq 1$). Therefore, high type seller will not be willing to deviate.

The low type seller's profit from bargaining is equal to

$$(1-\alpha)\int_0^1 \theta q_L d\theta = \frac{(1-\alpha)q_L}{2},$$

while his profit if he deviates and posts a price p is

$$\left(1 - \frac{p}{q_L}\right)p,$$

maximized at $p = \frac{q_L}{2}$ at the level $\frac{q_L}{4} < \frac{(1-\alpha)q_L}{2}$, so he will not be willing to deviate either. This completes the proof.

Proposition 2. *Assume $\alpha < \frac{1}{2}$, i.e., the seller has higher bargaining power than the buyer. Then in any separating equilibrium, i.e., in any equilibrium where pricing behavior of the seller fully reveals his type, a seller of high type posts the price and a seller of low type does not post a price.*

Proof: Assume the converse. That in a separating equilibrium buyers must believe that the good with no posted price is of high quality. Then the low type seller posts some price p, and by assumption that price signals low quality. The low type seller will then serve buyers with type θ greater than or equal to $\frac{p}{q_L}$, earning total profit of $(1 - \frac{p}{q_L})p$, which is not greater than $\frac{q_L}{4}$. On the other hand, if he deviates and posts no price, by assumption he will be believed to be of high type and a buyer with type θ will be ready to pay up to

[7] If $q_L < 1$, the high type seller will be making no profit if he posts a price, since he will then only be able to sell at prices below his marginal costs $c = 1$.

θq_H for the good. With probability $(1-\alpha)$ the seller will be making the offer and will be able to extract the entire surplus θq_H (with the remaining probability α the seller will be earning no profit). The total expected profit of the low type seller if he posts no price is therefore equal to

$$(1-\alpha)\int_0^1 \theta q_H d\theta = \frac{(1-\alpha)q_H}{2} > \frac{q_L}{4},$$

so the low type seller will be willing to deviate and post no price, which contradicts the assumption of an equilibrium.

Therefore, if the seller posts no price, in any separating equilibrium he is believed to be of low type. His expected profit from not posting the price is then equal to $\frac{(1-\alpha)q_H}{2}$, which is greater then $\frac{q_L}{4}$. Hence, the low type seller will post no price in any separating equilibrium, QED.

It follows that in any separating equilibrium the high type seller will be posting some price p and the low type seller will be posting no price. Equilibrium conditions require that the seller of neither type must be willing to imitate the other type. The profit that the low type seller earns if he imitates the high type seller is equal to $(1-\frac{p}{q_H})p$. If instead the high type seller posts no price his good will be believed to have low quality and be valued at θq_L by a buyer with type θ. In particular, if $q_L < 1$ he will not come to an agreement with any buyer and will be earning zero profit; if $q_L \geq 1$ the seller will trade with buyers with types $\theta \geq \frac{1}{q_L}$ and only if he (not the buyer) will get to make the offer (which happens with probability $1-\alpha$). Seller's expected profit will be equal to

$$(1-\alpha)\int_{\frac{1}{q_L}}^1 (\theta q_L - 1)d\theta = \frac{1-\alpha}{2}\cdot\frac{(q_L-1)^2}{q_L}.$$

Therefore, the necessary condition for existence of a separating equilibrium are that there exists p such that both incentive compatibility constraints are satisfied:

$$IC_H: \qquad \left(1-\frac{p}{q_H}\right)(p-1) \geq \frac{1-\alpha}{2}\cdot\frac{(\min\{0, q_L-1\})^2}{q_L}, \tag{1}$$

$$IC_L: \qquad \frac{(1-\alpha)q_L}{2} \geq \left(1-\frac{p}{q_H}\right)p. \tag{2}$$

It is easy to see that this condition is also sufficient: take such p and let buyers believe that goods priced at p are of high quality and all other goods are of low quality. Then the high type seller will choose to post price p and the low type seller will choose to post no price; and conditions (1) and (2) ensure that the seller of neither type is willing to deviate, i.e., this is a separating equilibrium.

The following two propositions help to restate the necessary and sufficient condition derived above in terms of q_H, q_L and α.

Proposition 3. *If $q_L \leq 1$, a separating equilibrium always exists.*

Proof: If $q_L \leq 1$, incentive compatibility for high type (1) is satisfied for any $p \in [1, q_H]$. The other incentive compatibility (2) is satisfied for p close enough to q_H, QED.

Proposition 4. *Suppose $q_H > q_L > 1$. Then a separating equilibrium exists if and only if*

$$\frac{(q_H - 1)^2}{4q_H} \geq \frac{1-\alpha}{2} \cdot \frac{(q_L - 1)^2}{q_L}. \tag{3}$$

Proof: Necessity. At the price posted by the high type seller, condition (1) must be satisfied; hence it must at least be satisfied for price $p^M = \frac{1+q_H}{2}$ that maximizes the left hand side of (1); this gives (3).

The proof of *sufficiency* is more technical and is relegated to the appendix.

Therefore, if the single seller has substantially higher bargaining power than the buyer then in any separating equilibrium the high type seller posts the price and the low type seller bargains. Moreover, if either high quality good is costly to produce compared to the value of the low quality good or the quality of both types of goods are sufficiently valuable compared to the high type production costs, a separating equilibrium exists. High type seller does not want to pretend to be of low type, because he would then get few buyers ready to cover even his costs, and low type seller does not want to pretend to be of high type, because he does not want to lose the large low type segment of the market.

To address the welfare properties of the equilibria found above, one must first calculate the expected surplus of the buyer with type θ. Consider pooling equilibrium first, with no price posted. If the seller (who observes buyer's type) gets to make the offer, the buyer

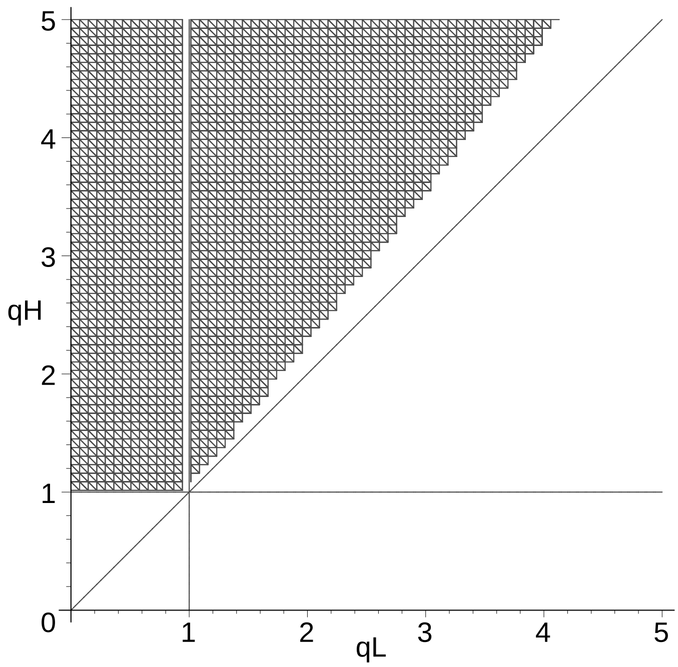

Figure 1: $\{q_L, q_H\}$ pairs for which a separating equilibrium exists on the market with a single seller (drawn for $\alpha = \frac{1}{3}$).

will receive no surplus. If the buyer gets to make the offer, he faces a choice: either to make offer zero, which only the low type seller will accept, or to make offer one, which the seller of either type will accept. In the first case, his expected payoff is $\alpha(1-\lambda)\theta q_L$, in the second case it is $\alpha(\theta\bar{q}-1)$. It is easily verified that a low type buyer will choose the first option and a high type buyer will choose the second option. Buyer's expected payoff in the pooling equilibrium is equal to

$$\Pi_p^*(\theta) = \begin{cases} \alpha(1-\lambda)\theta q_L, & \text{for } \theta \leq \frac{1}{\lambda q_H}, \\ \alpha[(1-\lambda)\theta q_L + \lambda\theta q_H - 1], & \text{for } \theta > \frac{1}{\lambda q_H}. \end{cases} \tag{4}$$

In contrast, in a separating equilibrium with posted high type seller price p the buyer's expected payoff equals

$$\Pi_s^*(\theta) = \begin{cases} \alpha(1-\lambda)\theta q_L, & \text{for } \theta \leq \frac{p}{q_H}, \\ \alpha(1-\lambda)\theta q_L + \lambda(\theta q_H - p), & \text{for } \theta > \frac{p}{q_H}. \end{cases} \tag{5}$$

Now I can compare the two types of equilibria in terms of their payoffs to the buyer. If $\lambda p \leq 1$, then all buyers (weakly) prefer separating equilibrium to pooling equilibrium with no posted price. If $\lambda p > 1$, then low type buyers are indifferent, medium type buyers (with $\theta \in [\frac{1}{\lambda q_H}, \frac{p}{q_H}]$) prefer pooling equilibrium and the preferences of high type buyers depend on α. In general, the higher the price in the separating equilibrium and the higher the probability that the seller is of low type, the more likely that buyers will prefer pooling equilibrium.

As for the seller, the low type seller obviously prefers pooling equilibrium. The high type seller gets $(1-\alpha)\frac{(\bar{q}-1)^2}{2\bar{q}}$ in the pooling equilibrium and $\frac{(q_H-1)^2}{4q_H}$ in the best separating equilibrium. Therefore, the lower α, the higher λ and the further signaling price p away from his optimal price $p^M = \frac{1+q_H}{2}$, the more likely he will prefer the pooling equilibrium to the separating equilibrium with no posted price.

To complete the description of the equilibria in a single seller case, one must also consider the possibility of a pooling equilibrium in which both types post the same price. This is done in the following proposition.

Proposition 5. *A necessary condition for the existence of a pooling equilibrium with posted price is $\bar{q} \geq 2(1-\alpha)q_L$. If it is satisfied, then it is necessary and sufficient that at least one of the following two conditions are satisfied:*

$$\frac{\bar{q}2-1}{4\bar{q}} \geq \frac{(1-\alpha)q_L}{2},$$

$$\frac{\bar{q}+\sqrt{\bar{q}^2-2(1-\alpha)q_L\bar{q}}}{2} \geq \frac{q_L^2}{2q_L-1}.$$

Proof is similar to that of Proposition 4 and is omitted.

Note that in the single seller case the low quality good seller is better off in equilibrium than his high quality counterpart. The intuition for this is that low type seller can always mimic high type seller by posting price and then make more money since his costs are lower. In particular, this observation implies that if the unique seller can choose the quality of the good upfront, he will choose low quality good; even if it is socially efficient to produce high quality good.[8]

In the next section I explore a market with two sellers and show that in a separating equilibrium the low type seller does not necessarily earn higher profits than the high type seller.

4 Two sellers: coexistence of the two modes of trade.

In this section I show how the two modes of trade – posting the price and bargaining – can coexist on the market. I stick to the assumption of exogenous quality of the good.

Assume that there are two sellers who observe the quality of the each other's good and then choose their pricing policy. I am looking for a separating equilibrium, in which the seller of one type posts the price and the seller of the other type bargains. I will derive sufficient conditions on the parameters for existence of a separating equilibrium in which a seller of low type bargains and a seller of high type posts the price.

One important insight that this section conveys is that in principle the range of parameters that support the equilibrium will expand if buyer's beliefs about the seller's type can be conditional on *both* sellers' strategies. To see this, I focus first on the more restrictive (but also more realistic) case when beliefs about seller's type are restricted to be a function of this seller's pricing policy alone; at the end of this chapter I remark on the more general case.

Assumption 1. *Buyers beliefs about the type of a seller depend on this seller's pricing policy alone and do not depend on the other seller's pricing policy.*

First I show that the result parallel to Proposition 2 holds: it can not be the case that in a separating equilibrium a low type seller posts the price and a high type seller bargains.

Proposition 6. *Suppose Assumption 1 holds. Than in any separating equilibrium a seller who does not post the price has the low quality good.*

[8]This adverse selection phenomenon parallels findings in Bester ([1]).

Proof: Assume the converse. Consider an equilibrium in which the high type seller posts no price and the low type seller posts some price p.

The high type seller will be serving buyers with θ between $\frac{p}{q_L}$ and $\frac{1-p}{q_H-q_L}$. Buyers with θ below $\frac{p}{q_L}$ will not be buying at all and buyers with θ higher than $\frac{1-p}{q_H-q_L}$ will be bargaining, since the joint surplus from trade with the high type seller, $\theta q_H - 1$, will be above that for the low type seller, $\theta q_L - p$.

Therefore, the low type seller will be making profit equal to

$$\pi_L = \left(\frac{1-p}{q_H - q_L} - \frac{p}{q_L} \right) p, \tag{6}$$

which is maximized over p at $p = \frac{q_L}{2q_H}$ where the profit is equal to $\frac{q_L}{4q_H(q_H-q_L)}$.

However, the low type seller may consider mimicking the high type seller: post no price and bargain with buyers of type $\frac{1}{q_H}$ or above. By Assumption 1, he will then be believed to be of high type and earn profit equal to

$$\pi_{dev} = \frac{(1-\alpha)}{2} \int_{\frac{1}{q_H}}^{1} \theta q_H d\theta = \frac{(1-\alpha)(q_H^2 - 1)}{2q_H} \tag{7}$$

The low type seller will be willing to deviate as long as expression $\pi_{dev} > \frac{q_L}{4q_H(q_H-q_L)}$; this inequality easily follows from $\alpha < \frac{1}{2}$ and $q_H - q_L > 1$. Therefore, the low type seller will be willing to pretend to be of high type, which is inconsistent with the definition of a separating equilibrium, QED.

For the rest of this section I will restrict attention to the case $q_L \leq 1$. This assumption implies that the high type seller will never be willing to signal the low type, since that way he will not be making any sales (perceived value of his good will not exceed his costs) and hence the only incentive compatibility constraint that remains to be checked is that the low type seller does not find it profitable to pretend to be of high type.

Consider a pair of strategies and beliefs such that the low type seller does not post a price, the high type seller posts price $p^* \leq \triangle q$ and the buyer believes that a seller has high quality good if and only if he posts price p^*;[9] if a buyer is indifferent between buying

[9] The high type seller will be making no sales if $p^* > \triangle q$ since even with $\theta = 1$ the buyer only gets

from two sellers, he buys from either with equal probabilities. For this pair of strategies and beliefs to constitute an equilibrium, it is necessary and sufficient that a low type seller does not want to deviate and post some price p, whether or not the other seller turns out to be posting price p^* or posting no price.

Proposition 7. *If buyers's beliefs are such that a good is believed to be of high type if and only if its price is posted at p^*, a low type seller is better off posting no price that posting any price other than p^*.*

Proof: If the other seller posts no price, than posting any price other than p^* will result in no sales. Indeed, by assumption about buyers' beliefs, both sellers are then believed to be of low type. A buyer will always choose to bargain, holding the posted price p as his threat point: she will have a chance to win the entire surplus θq_L if she gets to make the offer or $\theta q_L - p$ otherwise, which is on average better than just $\theta q_L - p$ if she buys at posted price. Therefore, posting any price other than p^* is a bad idea for a low price seller if the other seller does not post a price.

If the other seller posts price p^*, thus signaling high type, posting any price other than p^* is not profitable either. The proof parallels that of Proposition 2 and is omitted.

Therefore, the only deviation that may potentially be profitable for a low type seller is to pretend to be of high type and to post price p^* (there are no profitable deviations for the high type seller). If both sellers are of low type, than posting no price results in their splitting the market equally and getting $\frac{(1-\alpha)q_L}{4}$ each. If one of them deviated and posts price p^*, he is believed to be of high type and sells to all buyers with $\theta q_H - p^* \geq \theta q_L$ or $\theta \geq \frac{p^*}{\triangle q}$. His profit is then equal to $(1 - \frac{p^*}{\triangle q})p^*$ and a necessary condition for an equilibrium is

$$\frac{(1-\alpha)q_L}{4} \geq \left(1 - \frac{p^*}{\triangle q}\right) p^*. \tag{8}$$

If instead one seller is of high type and posts price p^*, then the other seller who is of low type and posts no price serves all buyers with $\theta < \frac{p^*}{\triangle q}$; his profit equals $\frac{(1-\alpha)q_L p^{*2}}{2\triangle q^2}$. If

the increment utility of $\triangle q$ from buying high quality good rather than low quality good and a separating equilibrium with low type seller posting no price can only be sustainable if the high type makes some sales.

instead he deviates and posts price p^*, buyers will believe that both sellers are of high type and will buy from either with equal probability as long as $\theta q_H \geq p^*$, so that the low type seller will earn $\frac{1}{2}(1 - \frac{p^*}{q_H})p^*$. Hence low type seller's incentive compatibility condition is

$$\frac{(1-\alpha)q_L p^{*2}}{2\triangle q^2} \geq \frac{1}{2}\left(1 - \frac{p^*}{q_H}\right)p^*. \tag{9}$$

Therefore, a separating equilibrium exists (for $q_L \leq 1$) if and only if there exists $p^* \leq \triangle q$ such that both (8) and (9) are satisfied. Note that condition (9) is linear in p^*; so the higher p^* the more is it likely that it is satisfied. In particular, if there exists $p^* \leq \triangle q$ that satisfies both (8) and (9), then so must $p^* = \triangle q$ (note that $p^* = \triangle q$ trivially satisfies (8)). Plugging $p^* = \triangle q$ into (9) results in condition $\alpha q_H \leq q_L$.

The following proposition summarizes the above considerations.

Proposition 8. *Suppose that beliefs of the buyer about the quality of the good each seller has can depend on this seller's pricing policy only. Then it a necessary condition for a separating equilibrium on the market with two sellers and exogenous quality to exist is* $\alpha q_H \leq q_L$. *If further* $q_L \leq 1$ *this condition is also sufficient.*

Proposition 8 can be easily generalized to the case of n sellers. If $k \geq 1$ sellers turn out to have high quality good and $l \geq 1$ sellers turn out to have low quality good, then it is straightforward to derive the relevant condition, which turns out to be $\triangle q \leq \frac{k+1}{2l}(1-\alpha)q_H$, and it must hold for any k and l such that $k+l = n$. Clearly the most restrictive is the case when $k = 1$ and $l = n-1$ which, after rearrangement, reads $q_L \geq \frac{n+\alpha-2}{n-1}q_H$. In particular, for fixed q_L and q_H no separating equilibrium can exist for large n in which buyers form their beliefs about the quality of goods in a particular shop based on pricing policy of this shop only. In the next section I will show that this negative result may no longer hold as long as at least a tiny fraction of buyers can directly observe the quality of goods.

The timing assumption that I make is essential for results of this section: it is important that sellers observe each other type prior to choosing their pricing policies. Note that I check incentive compatibility for a low type seller both if his rival is of high type and if he is of low type; this gives two constraints as opposed to one on his 'average' gains from deviation if he did not observe his rival's type.

This timing assumption also allows for the following construction which concludes this section. I show that if buyers' beliefs about the quality of seller's good are not bound to be the function of this seller's policy only, there always exists a separating equilibrium, at least for $q_L \leq 1$. To see this, assume the following beliefs for some $p_1, p_2 \in [1, \triangle q]$ such that $p_1 \neq p_2$: if one seller posts the price and the other seller does not, the price posting seller is believed to have high quality good if and only if his price equals p_1 (sellers who post no price are assumed to have low quality goods). If both sellers post the price, they both are assumed to have high quality good if and only if they *both* post p_2; otherwise they *both* are assumed to have low quality good. Then in equilibrium a high type seller, after learning that his rival is of low type, will post either p_1; given this, any price the low type seller post will be signaling low type (since $p_1 \neq p_2$) and hence the best strategy for a low type seller is to post no price. Likewise, if both sellers turn out to be of high type, none of them alone can post any price other than p_2 without being believed to be of low type and hence making no sales, so both will prefer to stick to posting p_2. The only potentially profitable deviation could be for a low type seller to post p_1 if the other seller is also of low type; this can be precluded by setting p_1 close enough to $\triangle q$. Therefore, with such beliefs a separating equilibrium always exists. This construction can easily be expanded onto arbitrarily many sellers.

The assumption that buyer's beliefs about seller's type can only be a function of this seller's pricing policy helps to narrow the range of potential equilibria. A slightly stronger version of it is introduced and studied in the next section in the context of large markets.

5 Large markets and endogenous quality.

By *large* I mean markets in which there are at least two sellers of high type and at least two sellers of low type. In this section I will study how signaling equilibria can arise in large markets when sellers endogenously choose the quality of their goods.

When all sellers are uninformed and the choice of quality is endogenous, a high type seller can always deviate and produce low quality good, while mimicking the pricing strategy of a seller with high quality good. Since low quality goods are cheaper to produce, it is always a profitable deviation, so in any equilibrium all goods will be of low quality. Therefore, a mechanism is needed to keep high quality sellers from shifting to low quality good while maintaining high quality good price.

As I showed in the previous section, if buyers' beliefs about seller's type may depend on other sellers' strategies, this problem is easily resolved: a low type seller will not choose to mimic a high type seller since this will result in a strategy profile that will activate buyer's 'punishment' mode. Such argument has the following obvious problem: while it is plausible that the sellers engage in complicated strategies in order to maintain market segregation, it is arguably unlikely that buyers's beliefs are so sophisticated. To keep the analysis realistic, I impose the following restriction on buyers' beliefs about seller's types and focus on equilibria that involve beliefs satisfying this restriction.

Definition. *Buyer's beliefs are said to be monotonic in price if they have the following form: a seller who does not post any price or posts a price that is below some price* $p^* \geq 1$ *is believed to have low quality good; otherwise he is believed to have high quality good.*

Assumption 2. *Buyers' beliefs (both on and off equilibrium path) are always monotonic.*

Given monotonicity assumption on buyers' beliefs, the problem of enforcing high quality production of the sellers who signal high quality price needs fixing, and an additional structure must be imposed. I do it by introducing a small fraction of buyers who are informed about the quality of the good and who are particularly valuable customers (i.e., their valuation is high). In this setup a high quality good seller will be willing to keep those customers and hence not willing to switch to low quality product; therefore, informed customers must constitute a significant share of all customers that he has. On the other hand, he must not be willing to undercut another high quality seller. He may want to refrain from that only in fear of losing uninformed customers because they will no longer believe that his good is of high quality; therefore, uninformed customers must also constitute a significant share of all customers that he has. Proposition 11 establishes conditions under which the two incentive compatibility constraints outlined above can simultaneously be met. Informally, the condition is going to be that producing high quality good should not be too expensive relative to benefits that high quality good brings to the consumers.

Assume that there is a (small) fraction ε of buyers who can correctly identify the quality of the good once they enter the shop, and, moreover, these are exactly the buyers with the highest value of type θ, i.e., those with $\theta \in [1-\varepsilon, 1]$.[10] Denote by n the total number of sellers, by h the number of sellers who choose to sell high quality good and by l the number of sellers who choose to sell low quality good, so that $h + l = n$.

Proposition 9. *Given $\varepsilon > 0$, a necessary condition for existence of a signaling equilibrium with monotonic buyer's beliefs in large markets is that the threshold value p^* is greater than or equal to $p(\varepsilon) = \frac{\triangle q}{1+\varepsilon \triangle q}$.*

Proof. Consider a signaling equilibrium with more than two sellers producing high quality good and posting price at or above threshold p^*. First, note that all sellers must post the same price, otherwise at least one of them will be making no sales. Second, the price that they all post must be equal to p^*, otherwise one of them will be willing to undercut others. The only reason why none of the sellers is willing to cut price must be that the uninformed buyers would not buy at a lower price because they would not believe that the good is of high quality.

If a seller offers high type good at price p^*, i.e., adheres to suggested equilibrium strategy, his profits are equal to

$$\Pi(H, p^*) = \frac{1}{h}\left(1 - \frac{p^*}{\triangle q}\right)(p^* - 1). \tag{10}$$

If instead he deviates and produces low quality good, while still posting price p^*, he will make more on each sale (p^* instead of $p^* - 1$) but will be making less sales because informed

[10] Perfect correlation is not necessary for qualitative results, but it simplifies algebra significantly. Any strong enough correlation will work.

buyers will not be buying at him. His profits will then be

$$\Pi(L, p^*) = \frac{1}{h}\left(1 - \varepsilon - \frac{p^*}{\triangle q}\right) p^*. \tag{11}$$

Note that for p^* above monopoly price $p^M = \frac{\triangle q+1}{2}$ profit $\Pi(H, p^*)$ is a decreasing function of p^*, whereas $\Pi(L, p^*)$ is an increasing function of p^* and that they are equal at $p^* = p(\varepsilon)$. Therefore, a necessary condition for existence of a signaling equilibrium is $p^* \geq p(\varepsilon)$, QED.

Note that $p(\varepsilon) \to \triangle q$ as $\varepsilon \to 0$, i.e., when the share of informed buyers is small, signaling price p^* is almost as high as the maximum price at which the buyer with highest possible type $\theta = 1$ is willing to buy high quality good; the sales at this price are naturally very low. Any seller would be happy to cut the price since this would increase his sales and ultimately profits; he does not do it only for fear of losing uninformed customers, who would not believe that such price cut is consistent with high quality good.

Proposition 10. *Given $\varepsilon > 0$, a necessary condition for existence of a signaling equilibrium on a large market with h high quality sellers is $p^* \leq \triangle q(1 - h\varepsilon)$.*

Proof is similar to that of Proposition 9: I have to rule out a specific deviation of a seller of high quality good. This time the deviation is to slightly undercut his high-type competitors while maintaining high quality of his good. The deviant will then lose all uninformed buyers, since they will no longer believe that he has high quality good, but will gain the entire market of informed buyers, which will give him profits of approximately

$$\Pi(H, p^* - 0) = \varepsilon(p^* - 1), \tag{12}$$

which should not exceed $\Pi(H, p^*)$. This immediately implies the desired inequality, QED.

Now I can formulate the main result of this section.

Proposition 11. *A signaling equilibrium with monotonic buyers' beliefs exists for small enough ε if and only if $\triangle q > 2$.*

Proof. Necessity follows from propositions 3 and 4: in any such equilibrium threshold value p^* must not be lower than $p(\varepsilon) = \frac{\triangle q}{1+\varepsilon\triangle q}$ and must not be higher than $\triangle q(1 - h\varepsilon)$.

Combining the two inequalities gives $\frac{\triangle q}{1+\varepsilon\triangle q} \leq \triangle q(1-h\varepsilon)$ and then, after simplification, $hr\varepsilon \leq \triangle q - h$. This implies $\triangle q > h \geq 2$.

Sufficiency: assume $\triangle q > 2$, pick h to be any integer lower than r but not lower than 2. Take ε small enough so that $hr\varepsilon \leq \triangle q - h$. Pick $p^* = p(\varepsilon)$. Calculate profits of each high type seller:

$$\Pi(H,p^*) = \frac{1}{h}\left(1 - \frac{p(\varepsilon)}{\triangle q}\right)(p(\varepsilon)-1) = \frac{\triangle q(\triangle q - 1 - \triangle q\varepsilon)}{h(1+\triangle q\varepsilon)^2}\varepsilon.$$

In equilibrium all l low quality sellers bargain, which gives each of them the profit of

$$\frac{B}{l} = \frac{(1-\alpha)q_L p^{*2}}{2lq_H\triangle q}.$$

Note that if ε is small enough, the profit of each of the high quality sellers will be small too (of the order ε), so that the total profit B of all low type sellers will exceed that. Choose $l \geq 2$ in such a way that

$$\frac{B}{l+1} < \frac{\Pi}{h} \leq \frac{B}{l}.$$

Then there is a signaling equilibrium with h sellers choosing high quality good and posting price p^* and l sellers choosing low quality good and bargaining.

To verify that it is indeed an equilibrium, consider possible deviations. A high quality seller is not willing to offer low quality good at high quality price since he would lose informed buyers and that is unprofitable by choice of p^*. He is not willing to undercut other high quality sellers because then he would lose credibility in the eyes of uninformed buyers and that is not profitable since $h < r$ and ε is small enough. He is not willing to switch to producing low quality good and bargaining since $\frac{B}{l+1} < \frac{\Pi}{h}$. Finally, a low quality seller is not willing to switch to producing high quality good since $\frac{\Pi}{h+1} < \frac{\Pi}{h} \leq \frac{B}{l}$. This completes the proof.

Note that, although the maximum total profits made by all price posting shops goes to zero as $\varepsilon \to 0$, the volume of trade of an individual price posting shop relative to that of a bargaining shop converges to a final limit. Indeed, this ratio is approximately equal to

$$\frac{h}{l}\frac{1}{\triangle q\varepsilon} = \frac{2q_H(\triangle q - p^*)(p^*-1)}{(1-\alpha)q_L p^{*2}\triangle q\varepsilon} \longrightarrow \frac{2q_H(\triangle q - 1)}{(1-\alpha)q_L\triangle q} = \frac{2q_H(\triangle q-1)}{(1-\alpha)q_L\triangle q} \geq \frac{q_H}{(1-\alpha)q_L} > 1.$$

Therefore, in any signaling equilibrium a price posting shop has higher sales compared to a bargaining shop. This is one explanation of the empirical observation that price posting shops tend to be larger than bargaining shops.

6 Conclusion.

In this paper I compared two modes of selling: selling at a posted price and bargaining. In particular, I focused on the question how the two modes of trade can coexist on the same market. Besides building a theory behind the phenomenon itself, this paper also explains two facts associated with it, namely, the difference in size and quality of good between shops operating in the two modes.

Motivated by the market of souvenirs in a touristy area, I abstracted from issues such as choice or transportation costs and uncertainty about the price. However, uncertainty about the quality of the good being sold is the key factor in explaining the existing structure. Reputation concerns of a seller, which are usually viewed as a functional mechanism that induces sellers to supply high quality goods even when the quality is not directly observable by the buyer, do not work here, since I assume that the market under consideration is small and anonymous, and that each buyer makes a purchase at most once.

I show, first, that with only one seller on the market with exogenous quality of the good, there exists a separating equilibrium, in which sellers of different types choose different pricing strategies. Next, I demonstrate how a separating equilibrium may emerge when there are two sellers, one of each type.

When a seller may choose the quality of his good endogenously, a mechanism is needed to prevent him from choosing low quality and mimicking the price strategy of the high quality seller. I do it by assuming that a fraction of buyers who value the good the most also observe the quality of the good. It is shown that, no matter how small this fraction, a signaling equilibrium exists under simple restrictions on parameters.

This last finding may be of particular interest in helping to explain markets for 'exclusive' products. In particular, I show that the price in such equilibrium may be well above the full information monopoly price. This apparent paradox arises because a high quality seller has to credibly signal his type to uninformed buyers and the way to do it is to choose price high enough so that the only way for him to make profit is to have informed buyers buy at him. Realizing this, uninformed buyers of will believe the signal and assume him to be of high quality.[11]

One inherent feature of the model is that typically there will exist multiple equilibria, both pooling and separating, for any number of sellers. A natural idea would be to rule out some of them by means of refining the equilibrium concept, for example, to apply the intuitive criterion of Cho and Kreps ([3]). However, the intuitive criterion will not work in this case for the following reason: the high type good is *more* valued by buyers, while the high type seller is *worse off* playing any given strategy than is the low type seller. Therefore, it is always cheaper for a low type seller to send any signal (price in this case) than it is for a high type seller to send the same signal; hence, there is no chance to conclude that some signals can only be meaningfully sent by high type sellers.

There is a number of issues that are left open in this study. First, in each case the number of sellers is assumed exogenous; it is interesting to study whether conclusions of the analysis continue to hold when the number of active sellers is determined endogenously. Second, I assume that a posted price is a commitment not to renegotiate it; no specific mechanism to support this commitment is discussed. Finally, I do not address the question of costs of bargaining per se, both for the seller and for the buyer. While seller's costs are likely to be represented only by time lost, the costs for the buyer are more complex: it is a widely observed phenomenon that some buyers refuse to bargain almost at any costs. These issues remain to be studied.

[11]In a multiperiod setup the price charged by a firm may also be above the monopoly price for a different, although related, reason: a seller signals high quality by committing to substantial losses if low quality is discovered by the buyers; see Klein and Leffler [4] and Milgrom and Robetrs [6].

7 Appendix

Proof of Proposition 4: Sufficiency. I have to show that as soon as (3) is satisfied, there exists p that satisfies both (1) and (2). First try $p = p^M = \frac{1+q_H}{2}$. For this value of p condition (1) becomes (3) and condition (2) becomes

$$\frac{(1-\alpha)q_L}{2} \geq \frac{q_H^2 - 1}{4q_H}. \tag{13}$$

If (13) is satisfied, then the proof is complete. Assume it is not; this can be rewritten as

$$q_H^2 - 2(1-\alpha)q_H q_L > 1. \tag{14}$$

Take p equal to p^* – the higher value at which (2) is satisfied with equality, i.e., $p^* = \frac{q_H + \sqrt{q_H^2 - 2(1-\alpha)q_L q_H}}{2}$ so that

$$\left(1 - \frac{p^*}{q_H}\right) p^* = \frac{(1-\alpha)q_L}{2}.$$

At $p = p^*$ condition (1) becomes, after some rearrangement,

$$\frac{q_H + \sqrt{q_H^2 - 2(1-\alpha)q_L q_H}}{2} \geq \frac{q_L^2}{2q_L - 1} \tag{15}$$

Because of (14), left hand side of (15) is greater than or equal to $\frac{q_H+1}{2}$. It now suffices to show that $\frac{q_H+1}{2} \geq \frac{q_L^2}{2q_L-1}$ or $2q_L^2 \leq 2q_L q_H - q_H + 2q_L - 1$. The last inequality easily follows from assumption $q_H > q_L > 1$, QED.

References

[1] Bester, H. (1988) "Qualitative Uncertainty in a Market with Bilateral Trading", *Scandinavian Journal of Economics,* Vol. 90, No. 3, pp. 415-434.

[2] Bester, H. (1993) "Bargaining versus Price Competition in Markets with Quality Uncertainty" *The American Economic Review,* Vol. 83, No. 1., pp. 278-288.

[3] Cho, I.-K. and D.Kreps (1987) "Signaling Games and Stable Equilibria" *Quarterly Journal of Economics,* Vol. 102, pp. 179-221.

[4] Klein, B. and K. Leffler (1981) "The Role of Market Forces in Assuring Contractual Performance" *The Journal of Political Economy,* Vol. 89, No. 4, pp. 615-641.

[5] Kihlstrom, R. and M. Riordan (1984) "Advertising as a Signal" *The Journal of Political Economy,* Vol. 92, No. 3, pp. 427-450.

[6] Milgrom, P and J. Roberts (1986) "Price and Advertising Signals of Product Quality", *The Journal of Political Economy,* Vol. 94, No. 4, pp. 796-821.

[7] Nelson, P. (1974) "Advertising as Information" *Journal of Political Economy,* Vol. 94, pp. 729-754.

[8] Schmalensee, R. (1978) "A Model of Advertising and Product Quality", *The Journal of Political Economy,* Vol. 86, No. 3, pp. 485-503.

[9] Shapiro, C. (1983) "Premiums for High Quality Products as Returns to Reputation", *The Quaterly Journal of Economics*, Vol. 98, No. 4, pp. 659-680.

[10] Wang, R. (1993) "Auctions versus Posted-Price Selling", *The American Economic Review,* Vol. 83, No. 4, pp. 838-851.

[11] Wang, R. (1995) "Bargaining versus Posted-Price Selling", *The European Economic Review,* Vol. 39, pp. 1747-1764.

[12] Wernerfelt, B. (1994) "Selling Formats for Search Goods", *Marketing Science,* Vol. 13, No. 3, pp. 298-309.

[13] Wolinsky, A. (1983) "Prices as Signals of Product Quality" *The Review of Economic Studies,* Vol. 50, No. 4., pp. 647-658.

[14] Zeithammer, R. (2003) "When should Sellers use Auctions instead of Posted Prices?", working paper.