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Posted prices and bargaining: the case of Monopoly[1]

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Abstract

If buyers can choose to initiate bargaining with a seller, how does this alter the price that the seller `posts' in the market? And does the option of bargaining raise or lower expected welfare?

This paper develops a simple model to answer these questions. With a single seller, the potential for bargaining raises the profit maximising posted price. In part, as has been noted in related literature, this reflects the role of the posted price as a fall-back option if bargaining fails. However, our model highlights a separate effect. When the choice to bargain is endogenous, a seller will raise the posted price to encourage buyers to bargain. The posted price not only exceeds the monopoly price, it can be higher than the price a seller would set if he knew in advance that all buyers would bargain. Further, the posted price can change discontinuously in exogenous parameters such as the buyers' distribution of bargaining costs. While we assume efficient bargaining, the welfare consequences are ambiguous.

[1] We would like to thank seminar participants at Monash University for their useful comments. Contact details: Department of Economics, Monash University, Caulfield East, Victoria, Australia; E-mail: Stephen.King@monash.edu

1 Introduction

Different retailers use different modes of pricing to sell their merchandise. Some retailers post a 'take it or leave it' price for buyers. Individual buyers cannot bargain and, even if a buyer wanted to bargain, the sales staff have no authority to engage in bargaining. This mode of pricing is common for mass market retailers.

Alternatively, retailers may invite price bargaining. Any posted price is simply an 'invitation to treat' and buyers expect to negotiate a sale price below the posted price. In developed countries this mode of pricing is common for car sales, real estate and some high value electronic items.

What, however, determines whether or not a seller allows buyers to bargain and, if bargaining is allowed, when will it occur? Further, what is the effect of potential bargaining on both the price that is posted by a retailer and on customers' expected welfare?

In this paper we present a simple model to examine these questions. A single seller sets a posted price and can either allow bargaining or commit not to bargain.[1] However, the choice of whether or not to bargain rests with each buyer and this choice will depend on the buyer's costs of bargaining. Buyers differ in their bargaining costs and this information is private to each buyer. If a buyer has a high cost of bargaining then she may choose to simply accept the posted price. But if this cost is low, the buyer will (efficiently) bargain with the seller, raising the expected surplus for both the buyer and the seller. When setting a posted price, the seller must weigh up the chance of simply having the price accepted versus having a buyer choose to bargain, given the posted price.

We show that in this situation, the seller will have an incentive to set a posted price above the standard monopoly price. Raising the posted price

[1] Sellers can credibly commit not to bargain using a variety of techniques. For example, Bester (1994) considers the strategic implications of committing to a posted price in a setting with multiple firms and consumer search. He briefly discusses how sellers might commit to not bargain. Zeng, Dasgupta and Weinberg (2013) empirically analyse the implications of 'no haggle' pricing policies focusing on Toyota's Access Program in Canada.

has two benefits for the seller:

The 'encourage bargaining' effect: A higher posted price raises the relative surplus a buyer receives from bargaining compared to simply accepting the posted price so that a higher posted price encourages more bargaining by buyers. Because the seller gets a higher expected surplus when a buyer bargains, the seller wants to encourage buyers to bargain through a higher posted price.

The 'outside option' effect: A higher posted price may reduce the outside option to both the buyer and the seller. If the posted price is the fall back option for the buyer and the seller when bargaining fails, then a higher posted price undermines this fallback option. However, at the monopoly price, this harms the buyer more than the seller. Thus, raising the posted price above the monopoly price shifts relative bargaining power to the seller.

The seller will only allow bargaining if it raises his expected profit. However, if the seller allows buyers to have the option to bargain, then the seller will also raise the posted price. Consequently, the option of bargaining may either raise or lower the expected gains from trade for buyers. If a buyer has a low bargaining cost then the option of being able to bargain is valuable. But if a buyer has a high bargaining cost and chooses not to bargain, then the high posted price lowers the buyer's surplus. Indeed, it is possible to have outcomes where the seller allows bargaining, bargaining is 'efficient' in that it leads to the optimal level of trade, but this reduces consumer welfare and the total gains from trade compared to the standard monopoly situation.

The option of bargaining can lead to discontinuities in the profit maximising posted price. Small changes in exogenous parameters can result in discontinuous 'jumps' in the profit maximising price for the monopoly seller. These discontinuities reflect the alternatives facing the seller: set a high price to encourage bargaining but with a poor outcome if the buyer chooses not to bargain; set a lower price where bargaining is less likely but profit is higher when bargaining does not occur; or set the monopoly price and avoid bargaining altogether. Small changes , for example, in the distribution of buyers' bargaining costs or the level of the seller's bargaining cost, can lead the seller to 'jump' between these alternatives.

This paper contributes to a small but growing literature on pricing and bargaining by retailers. A number of these papers, such as Gill and Thanassoulis (2013 and 2009), Desai and Purohit (2004) and Raskovich (2007) consider the role of bargaining with multiple sellers. When other sellers provide an outside option, the potential for customers to negotiate can feed back to posted prices through this option. One seller's posted price becomes the outside option for customers when bargaining fails with another seller. This role of the posted price — as an outside option that will sometimes be exercised — reduces competitive pressure and tends to raise posted prices.[2]

The analysis of posted prices and consumer bargaining with multiple sellers is complementary to the analysis presented in this paper. With multiple sellers, assumptions on consumer behaviour are simplified compared to our analysis. For example, Gill and Thanassoulis (2013) consider consumers with unit demand who are exogenously either 'price takers' or 'bargainers'. Because our paper focuses on a single seller, we can allow for more general consumer behaviour. Consumers bargain over non-linear prices so successful bargaining increases both the quantity sold and total surplus. Consumers are *ex ante* identical except for their (private) bargaining costs so the choice to bargain is endogenous.

Further, our paper is able to highlight some simple economic forces that encourage higher posted prices in the monopoly setting. Some of these, such as the 'outside option' effect, are similar to the analysis on bargaining with competition. Others, such as the 'encourage bargaining' effect, are novel and only arise because the choice of bargaining is internalized. We show that these two effects are independent. In particular, even if the 'outside option' effect is removed, the 'encourage bargaining' effect continues to operate and pushes the posted price above the standard monopoly price.

Korn (2007) analyses consumer bargaining in a single-seller model. Korn's

[2]For example, in Raskovitch (2007) there is an equilibrium where all sellers post the monopoly price.

model is motivated by amendments to German laws to allow greater customer bargaining. The removal of the law led to claims that "[r]etailers would demand excessive prices and only those customers who were able and willing to bargain would pay a reasonable price" (Korn 2007, p.125). Korn develops a single seller model where consumers have exogenously different bargaining power to analyse and dispute this claim.

Like our model, Korn allows individual consumers to vary the quantity they demand depending on the outcome of negotiations. However, Korn's groups of consumers vary exogenously both with respect to the choice of bargaining and their bargaining power. Parties face no bargaining costs and bargaining does not lead to an efficient outcome. In contrast, in our model, sellers face a real choice of whether to allow bargaining and consumers must choose whether to initiate bargaining. We concentrate on efficient bargaining and, unlike Korn, show that the possibility of bargaining will always lead to higher posted prices. That said, consumers may benefit from the ability to bargain in expectation (unlike, say, Gill and Thanassoulis, 2013). Further, the price set by the seller can be discontinuous for small changes in bargaining parameters.

We proceed as follows. Section 2 presents a model of interactions between a seller and an arbitrarily large number of *ex ante* identical buyers. We solve the model using backward induction, considering the buyer's choice, given the posted price, in section 3 and then the seller's optimal posted price in section 4. Section 4 also presents our key results showing how the potential for bargaining raises the posted price but has ambiguous welfare effects. We discuss these results in section 5. In section 6 we illustrate our analysis with a simple numerical example that shows how prices can rise well above the standard monopoly level and can vary discontinuously with changes small changes in the buyer's distribution of bargaining costs. We conclude in section 7.

2 The model

Consider a single firm that sells a homogeneous product to an arbitrarily large group of potential buyers. The firm has constant returns to scale production technology with marginal cost c.

Each potential buyer has an identical individual inverse demand function for the good denoted by $p(q)$ where q is the quantity for an individual buyer and p is the uniform price that would lead the buyer to demand quantity q. We assume that demand is bounded in that there is a well-defined price $p(0)$ such that for all $p \geq p(0)$, a buyer demands none of the product but for all $p < p(0)$ the buyer demands a finite, positive quantity of the product. For all $q > 0$, we assume that $p(q)$ is twice continuously differentiable with $p'(q) \leq 0$ and $2p'(q) + p''(q)q < 0$.[3]

Prior to interacting with any buyers, the seller sets a uniform 'posted price' for the product, denoted by ρ and decides whether to allow bargaining or to commit not to bargain. If the seller decides to commit not to bargain then each buyer will simply take the price ρ as given and will purchase q_ρ units where $p(q_\rho) = \rho$.

If the seller decides to 'allow' bargaining then an individual buyer may still choose to simply accept the posted price ρ and buy q_ρ units. However, the buyer, at her discretion, may choose to bargain with the seller. In other words, bargaining can arise where the seller allows bargaining and the buyer chooses to initiate bargaining.

If a particular buyer initiates bargaining, then the buyer pays an individual bargaining cost $b_i \in [\underline{b}, \overline{b}]$ where $\overline{b} \geq \underline{b} \geq 0$. We assume that b_i is a random variable with cumulative distribution function F. F is upper semicontinuous over the real line with $F(b) = 0$ for all $b < \underline{b}$ and $F(b) = 1$ for all $b \geq \overline{b}$.

The realised value of b_i is known to buyer i but is not known to the seller, although the seller knows the distribution function F. Thus we can think of each buyer i independently drawing their own value of b_i from the distribution F prior to approaching the seller. From the buyer's perspective, b_i is a sunk

[3]This is the standard 'decreasing marginal revenue' condition. It ensures that there is a well-defined, unique, profit-maximimizing uniform price for the seller.

cost of bargaining. In other words, once the buyer initiates bargaining, she pays b_i and this cost cannot be recovered even if bargaining 'breaks down'.

The seller also has a cost of bargaining, denoted by b_s. This is a sunk cost to the seller as soon as the buyer initiates bargaining.[4]

We consider a very simple bargaining game. If bargaining is initiated by the buyer then with probability β bargaining will be successful. Under successful bargaining, the buyer receives a quantity q_c of the product and pays a fixed fee f. We assume that bargaining is efficient, so that q_c is the amount of the product that the buyer would choose to purchase if she faced a uniform price equal to the seller's marginal cost c. In other words, $c = p(q_c)$.

The fixed fee is equal to the amount that the seller would have received if the buyer had simply accepted the posted price ρ plus a share α of any extra surplus created by the bargain, where $\alpha \in [0, 1]$. We use a simple measure of Marshallian consumer surplus as the extra surplus from bargaining.[5] Thus, the surplus from bargaining is given by $S = \int_{q_\rho}^{q_c} (p(q) - c)\, dq$. In other words, the surplus is the Marshallian deadweight loss associated with the posted price ρ when $\rho > c$.

The fixed fee paid by the buyer when bargaining is successful is $f = \rho q_\rho + (q_c - q_\rho)\, c + \alpha S$. By substitution, $f = \rho q_\rho + \alpha \int_{q_\rho}^{q_c} (p(q) - c)\, dq + (q_c - q_\rho)\, c$.

However, with probability $(1 - \beta)$ bargaining will not be successful and will breakdown. In that situation, the consumer simply receives the uniform price ρ and purchases q_ρ units, exactly as if she had not initiated bargaining.

Both the fixed fee and the outcome when bargaining breaks down, reflect that the buyer can always revert to the posted price. This may reflect legal constraints, such that the buyer can always accept the posted price and the seller must honour that price, or convention, so that once a price is posted it is not withdrawn by the seller. It may also reflect an agency option for the buyer. The buyer can simply leave the "store" if bargaining breaks down and

[4] b_s may or may not be common knowledge. It will not affect the outcome of the game so long as the seller knows b_s. Also, the seller could refuse to bargain with the buyer, but this would never arise in equilibrium, so we can assume without loss of generality that the seller always bargains once bargaining is initiated by the buyer.

[5] This is exact if there are no income effects.

send back an agent in her place. The agent cannot restart bargaining but can accept the posted price and purchase q_ρ units. The seller is unable to tell whether a potential purchaser who accepts the posted price is a buyer with a high bargaining cost or a buyer's agent and so cannot otherwise 'punish' a buyer after bargaining breaks down.

The timing of interactions is as follows:

t=1: Each potential buyer independently draws a bargaining cost b_i from a cumulative distribution F. The value of b_i is private information to potential buyer i.

t=2: The seller sets the posted price ρ and chooses whether to 'allow' bargaining or 'commit not to bargain'.

t=3: One buyer i is drawn randomly from the set of potential buyers. This buyer observes the posted price ρ and the seller's bargaining decision. If the seller has committed not to bargain, then the buyer i purchases quantity q_ρ for a payment ρq_ρ and the game ends. If the seller has allowed bargaining, then the buyer decides whether or not to initiate bargaining. If the buyer i does not initiate bargaining, then the buyer purchases quantity q_ρ for a payment ρq_ρ and the game ends.

t=4: If the buyer i does initiate bargaining then bargaining commences by buyer i paying b_i and the seller paying b_s. With probability β bargaining is 'successful' and with probability $(1-\beta)$ bargaining is unsuccessful. In either case the game ends.

We can think of the seller as setting the posted price and either allowing or not allowing bargaining, then playing steps $t = 3$ and $t = 4$ either sequentially and/or simultaneously with the large number of buyers. However, as all buyers are *ex ante* identical and the seller cannot discriminate between buyers on the basis of their bargaining cost, we can simply consider the outcomes of the seller setting the price and (potentially) bargaining with a single buyer.[6]

Payoffs from the game are given as below:

[6]If dealing with a finite number of buyers sequentially, the seller can only set the posted price before interacting with any buyers. This avoids issues of the seller changing

If bargaining is not initiated: The payoff to the buyer is her surplus $\int_0^{q_\rho}(p(q)-\rho)dq$. The payoff to the seller is $(\rho - c)q_\rho$.

If bargaining is initiated and is successful: The payoff to the buyer is $\int_0^{q_c}(p(q))dq - f - b_i$ and the payoff to the seller is $f - cq_c - b_s$ where $f = \rho q_\rho + \alpha \int_{q_\rho}^{q_c} (p(q) - c)\, dq + (q_c - q_\rho)\, c$.

If bargaining is initiated and is unsuccessful: The payoff to the buyer is $\int_0^{q_\rho}(p(q) - \rho)dq - b_i$. The payoff to the seller is $(\rho - c)q_\rho - b_s$.

As usual, we solve the game through backward induction, starting with the buyer's decision.

3 The buyer's decision

Suppose that the seller has chosen to 'allow' bargaining. When deciding whether or not to initiate bargaining, a buyer will consider her relative return from bargaining and not bargaining. The return from simply taking the market price ρ as given and not bargaining is given above by:

$$C_{nb} = \int_0^{q_\rho} (p(q) - \rho)dq$$

In contrast if a buyer initiates bargaining, her expected payoff is:

$$\begin{aligned} C_b &= \beta \left[\int_0^{q_c} (p(q))dq - \left(\rho q_\rho + \alpha \int_{q_\rho}^{q_c} (p(q) - c)\, dq + (q_c - q_\rho)\, c \right) \right] \\ &\quad + (1 - \beta) \left[\int_0^{q_\rho} (p(q) - \rho)dq \right] - b_i \end{aligned}$$

Simplifying, buyer i's payoff from bargaining is

$$C_b = \int_0^{q_\rho} p(q)dq - \rho q_\rho - b_i + \beta(1 - \alpha) \left[\int_{q_\rho}^{q_c} (p(q) - c)dq \right]$$

the posted price to 'punish' parties if bargaining fails. The probability that bargaining will fail and the seller will sell to the buyer at the posted price is included in the relevant payoffs.

The net benefit to a buyer i from bargaining is given by:

$$\Delta_C = C_b - C_{nb} = \beta(1-\alpha)\left[\int_{q_\rho}^{q_c}(p(q)-c)dq\right] - b_i$$

Any individual buyer will choose to bargain if $\Delta_C \geq 0$. Thus, for any value of q_ρ there will be a unique value of b_i, denoted by $\tilde{b}(q_\rho)$, such that

$$\Delta_C(q_\rho) = \beta(1-\alpha)\left[\int_{q_\rho}^{q_c}(p(q)-c)dq\right] - \tilde{b}(q_\rho) = 0$$

Given the posted price ρ and the associated quantity q_ρ, the probability that any particular buyer i will have a bargaining cost b_i that is less than $\tilde{b}(q_\rho)$ is $F(\tilde{b}(q_\rho))$. Let $\Gamma(q_\rho)$ denote the function $F(\tilde{b}(q_\rho))$. Given given the posted price ρ and the associated quantity q_ρ, the probability that any particular buyer will choose to bargain is $\Gamma(q_\rho)$.

The function $\Gamma(q_\rho)$ has a number of features. First $\tilde{b}(q) \leq 0$ for $q \geq q_c$. Thus $\Gamma(q) = 0$ for all $q \geq q_c$. Further, as $\beta(1-\alpha)\left[\int_{q_\rho}^{q_c}(p(q)-c)dq\right]$ is a continuous, decreasing function of q_ρ for $q_\rho \in [0, q_c]$, $\tilde{b}(q_\rho)$ is also continuous and decreasing for $q_\rho \in [0, q_c]$. As F is upper semicontinuous, this means that $\Gamma(q_\rho)$ is upper semicontinuous and decreasing over $q_\rho \in [0, q_c]$. Finally, it immediately follows that $\Gamma(0) \leq 1$ as, depending on F and $\bar{b}$, not all customers may choose to bargain, even if the posted price is at least $p(0)$.

In summary, for any posted price ρ set by the seller, and associated quantity $q_\rho \geq 0$, there is a unique and well defined probability $\Gamma(q_\rho)$ that the buyer will bargain where Γ is upper semicontinuous and decreasing in q_ρ, with $\Gamma(0) \leq 1$ and $\Gamma(q_\rho) = 0$ for $q_\rho \geq q_c$.

4 The seller's decision

Given the buyer's behaviour, the seller will determine whether or not to allow bargaining and will set the posted price (and hence the quantity q_ρ) to maximize expected profits. If the bargaining does not occur (either because the seller does not allow bargaining or the buyer chooses not to initiate bargaining) the seller receives $(p(q_\rho) - c)q_\rho$.

If bargaining is allowed and the buyer decides to initiate bargaining then the seller's expected payoff is:

$$\beta\left[\rho q_\rho + \alpha\int_{q_\rho}^{q_c}(p(q)-c)\,dq + (q_c-q_\rho)\,c - cq_c\right] + (1-\beta)\left[(p(q_\rho)-c)q_\rho\right] - b_s$$

Simplifying, and remembering that $\rho = p(q_\rho)$, a seller's expected payoff if bargaining is initiated by the consumer is given by:

$$(p(q_\rho)-c)q_\rho - b_s + \beta\alpha\int_{q_\rho}^{q_c}(p(q)-c)dq$$

The probability that a buyer i will initiate bargaining (when it is allowed) given the posted price $\rho = p(q_\rho)$ is given by $\Gamma(q_\rho)$. If the seller allows bargaining and sets a posted price ρ, his expected profit is:

$$\pi_{ab}(q_\rho) = (p(q_\rho)-c)q_\rho + \Gamma(q_\rho)\left[\beta\alpha\int_{q_\rho}^{q_c}(p(q)-c)dq - b_s\right]$$

If the seller allows bargaining then he will set q_ρ (or equivalently set the posted price ρ) to maximize $\pi_{ab}(q_\rho)$.

In contrast, if the seller does not allow bargaining then his payoff is simply:

$$\pi_{nb} = (p(q_\rho)-c)q_\rho$$

It is useful to define two relevant quantities.

Definition (monopoly quantity): Consider the optimisation problem $\max_{q_\rho}(p(q_\rho)-c)q_\rho$. Note, by our assumptions on $p(q)$ this problem has a well-defined and unique solution. Denote that solution by q^m where q^m solves $p'(q^m)q^m + p(q^m) - c = 0$. Denote by p^m the posted price such that $p^m = p(q^m)$.

Definition (all-bargain quantity): Consider the constrained optimisation problem $\max_{q_\rho}(p(q_\rho)-c)q_\rho + \beta\alpha\int_{q_\rho}^{q_c}(p(q)-c)dq$ subject to $q_\rho \geq 0$. Denote the solution to this problem by q^l where q^l solves $\left[p'(q^l)q^l + p(q^l) - c\right] - \left[\beta\alpha(p(q^l)-c)\right] + \lambda = 0$ where $\lambda q^l = 0$ with $\lambda \geq 0$ and λ is the Lagrange multiplier. As this is a well defined concave programming problem with strictly negative second order conditions in q_ρ, the solution q^l is well defined, unique and either zero or strictly positive but less than q^m.

The quantity q^m is simply the standard monopoly quantity that maximizes π_{nb}. The seller will set this quantity (or equivalently, the posted price $\rho = p^m$) if he does not allow bargaining or, if bargaining is allowed, bargaining occurs with zero probability. The quantity q^l is the quantity associated with the posted price $p(q^l)$ that the seller would set if, when bargaining is allowed, all buyers choose to bargain, subject to this price being no greater than $p(0)$.

Proposition 4.1 *There exists an equilibrium to the price setting/bargaining game. In equilibrium, the posted price set by the seller is never less than p^m where $p^m = p(q^m)$.*

Proof: First, note that by not allowing bargaining, the seller can guarantee himself a monopoly payoff $\pi_{nb}(q^m)$. This is well defined and unique. So the seller will only allow bargaining if it leads to an expected payoff of at least $\pi_{nb}(q^m)$.

Second, note that if the seller allows bargaining then the posted price set by the seller will be at least $p(q^m)$ (or equivalently the posted price will be associated with a quantity no greater than q^m). To see this, suppose that this did not hold and consider a putative equilibrium posted price less than p^m with an associated quantity $\tilde{q} > q^m$. Remember that the seller's expected profit from allowing bargaining is

$$\pi_{ab}(q_\rho) = (p(q_\rho) - c)q_\rho + \Gamma(q_\rho)\left[\beta\alpha \int_{q_\rho}^{q_c} (p(q) - c)dq - b_s\right]$$

Note that for $q_\rho > q^m$, $(p(q) - c)q$ and $\Gamma(q)$ are both decreasing in q with $(p(q)-c)q$ strictly decreasing. Thus there exists an $\varepsilon > 0$ such that $\tilde{q}-\varepsilon > q^m$, $(p(\tilde{q}-\varepsilon)-c)(\tilde{q}-\varepsilon) > (p(\tilde{q})-c)\tilde{q}$ and $\Gamma(\tilde{q}-\varepsilon) \geq \Gamma(\tilde{q})$. Hence, $\pi(\tilde{q}-\varepsilon) > \pi(\tilde{q})$ unless $\left[\beta\alpha \int_{\tilde{q}}^{q_c} (p(q) - c)dq - b_s\right] < 0$. But note that this can never hold in equilibrium as it would result in equilibrium profits less than $\pi_{nb}(q^m)$ and the seller would prefer to deviate and not allow bargaining. Thus the putative equilibrium quantity $\tilde{q}$ can never be an actual equilibrium quantity as the seller would increase his profits by raising q or not allowing bargaining to occur.

Third, to show that an equilibrium always exists, consider the function $\pi(q_\rho) = \max\{\pi_{nb}(q^m), \pi_{ab}(q_\rho)\}$ for $q_\rho \in [0, q^m]$. Note that $\max\{\cdot\}$ is continuous and $\pi_{nb}(q^m)$ is a positive constant. Further, by construction, π_{ab} can only exceed π_{nb} if $\left[\beta\alpha \int_{q_\rho}^{q_c} (p(q) - c)dq - b_s\right] > 0$. Remembering that $\Gamma(q_\rho)$ is upper semicontinuous, this means that $\pi(q_\rho)$ is upper semicontinuous. But as $\pi(q_\rho)$ is an upper semicontinuous function over a closed interval of the real line, $[0, q^m]$ it attains a maximum on $q_\rho \in [0, q^m]$.

Let (one of) the value(s) of q_ρ that is associated with the maximum of $\pi(q_\rho)$ be denoted by q^* with associated posted price $p^* = p(q^*)$. By construction, if $\pi_{ab}(q^*) > \pi_{nb}(q^m)$ then it is an equilibrium for the seller to allow bargaining and to set a posted price p^*. Alternatively, if $\pi_{ab}(q^*) \leq \pi_{nb}(q^m)$ then it is an equilibrium for the seller to not allow bargaining and to set a posted price p^m. □

Proposition 4.1 shows that there will always be an equilibrium to the seller's problem. This equilibrium need not be unique. It will depend on the exact distribution of the bargaining costs for the buyers, F. However, the worst that the seller can do in equilibrium is to not allow bargaining and to set the standard monopoly price.

When will the seller allow bargaining? By construction, the seller's profits from bargaining are maximised if all buyers bargain and the seller sets $\rho = p^l$. A necessary condition for bargaining is that the seller prefers the 'all bargain' outcome to the standard monopoly outcome without bargaining. This is summarised in proposition 4.2.

Proposition 4.2 *The seller will only allow bargaining if:*

$$\left[(p^l - c)q^l - (p^m - c)q^m\right] + \beta\alpha \int_{q^l}^{q^c} (p(q) - c)dq - b_s \geq 0$$

Proof: If the seller allows bargaining and posts a price ρ, his expected profit is

$$\pi_{ab}(q_\rho) = (\rho - c)q_\rho + \Gamma(q_\rho)\left[\beta\alpha \int_{q_\rho}^{q_c} (p(q) - c)dq - b_s\right]$$

In contrast, if the seller does not allow bargaining then he will post a price p^m and sell q^m units with profit $\pi_{nb} = (p^m - c)q^m$. By definition, for any ρ and associated quantity q_ρ,

$$[(\rho - c)q_\rho - (p^m - c)q^m] \leq 0$$

Thus, a seller will only allow bargaining if

$$\Gamma(q_\rho)\left[\beta\alpha \int_{q_\rho}^{q_c} (p(q) - c)dq - b_s\right] \geq 0$$

Note, however, that for any ρ, this term increases as $\Gamma(q_\rho)$ increases. Thus, π_{ab} will be maximised when $\Gamma(q_\rho) = 1$ for all q_ρ. But this is simply the all bargain situation and the seller's profit in this case is maximised by setting price $\rho = p^l$. Given that the seller will only allow bargaining if $\pi_{ab} - \pi_{nb} \geq 0$, that π_{ab} is maximised if all buyers bargain, and π_{nb} is just the standard monopoly outcome, the proposition immediately follows. □

It immediately follows from proposition 4.2 that the seller will never allow bargaining if

$$\int_{q^l}^{q_c} (p(q) - c)dq < \frac{b_s}{\beta\alpha}$$

We can think of $(b_s/\beta\alpha)$ as being the 'adjusted' cost to the seller of bargaining. It is the direct cost b_s adjusted for both the probability that bargaining will succeed and the seller's share of any gains from bargaining. If this adjusted bargaining cost is too high, the seller will never permit bargaining. In this sense, $(b_s/\beta\alpha)$ provides a measure of the viability of bargaining for a seller, and all else equal, sellers with a lower adjusted bargaining cost are more likely to allow bargaining than sellers who have a higher cost.

Proposition 4.1 showed that in equilibrium, whether or not bargaining is allowed, the seller will never set a posted price below the standard monopoly price p^m. Proposition 4.3 considers the equilibrium price in more detail and provides sufficient conditions for the seller to both allow bargaining and to post a price that strictly exceeds the monopoly price.

Proposition 4.3 *In equilibrium, the seller will allow bargaining and set a posted price strictly above* p^m *if both* β *and* α *are strictly positive, with* $\Gamma(q^m) > 0$ *and* $\left[\beta\alpha\int_{q^m}^{q_c}(p(q) - c)dq - b_s\right] \geq 0$.

Proof: That the seller will never set a price less than p^m is shown in proposition 4.1. To see that the conditions are sufficient for the seller to allow bargaining and to set a price strictly greater than p^m, note that

$$\pi_{ab}(q_\rho) = (p(q_\rho) - c)q_\rho + \Gamma(q_\rho)\left[\beta\alpha\int_{q_\rho}^{q_c}(p(q) - c)dq - b_s\right]$$

If $\Gamma(q^m) > 0$ and $\left[\beta\alpha\int_{q^m}^{q_c}(p(q) - c)dq - b_s\right] > 0$ then $\pi_{ab}(q^m) > \pi_{nb}(q^m)$, so in equilibrium the seller will allow bargaining.

Taking the total derivative:

$$\begin{aligned} d\pi_{ab}(q_\rho) &= [q_\rho p'(q_\rho) + p(q_\rho) - c]\, dq_\rho \\ &+ \left[\beta\alpha\int_{q_\rho}^{q_c}(p(q) - c)dq - b_s\right] d\Gamma \\ &- \Gamma(q_\rho)\left[\beta\alpha(p(q_\rho) - c)\right] dq_\rho \end{aligned}$$

But, at $q_\rho = q^m$, $[q^m p'(q^m) + p(q^m) - c] = 0$ by definition, $d\Gamma \leq 0$ as Γ is decreasing, and $p(q^m) - c > 0$. Thus if $\beta > 0$, $\alpha > 0$, $\Gamma(q^m) > 0$ and $\left[\beta\alpha\int_{q^m}^{q_c}(p(q) - c)dq - b_s\right] \geq 0$, $d\pi_{ab}(q^m) < 0$ and the seller will not only want to allow bargaining but will also want to set the quantity, $q_\rho < q^m$ or, equivalently, post a price $\rho > p^m$. □

Proposition 4.3 presents a set of sufficient conditions under which the seller will both allow bargaining and will set a posted price strictly above the standard monopoly price. These conditions are intuitive. It is only profit maximizing to allow bargaining if the seller believes that some consumers will, with positive probability, choose to bargain. It is only in the seller's interest to allow bargaining if the probability that bargaining breaks down is not too high, the gain from bargaining is not too low, and the seller's share of that gain from bargaining is not too low. Bargaining involves a fixed cost b_s to the seller and the seller will only allow bargaining if his gross expected gain from bargaining exceeds b_s.

If these conditions hold, then the seller will always want to allow bargaining and to raise the posted price above the monopoly price. Raising the price above the standard monopoly level has only a 'second order' effect on the profits the seller gains from those consumers who choose not to bargain, but it has a 'first order' effect on the profits that the seller makes from buyers who do choose to bargain.

It is easy to see that conditions presented in proposition 4.3 are sufficient but not necessary. For example, suppose that $\beta > 0$, $\alpha > 0$ and $\left[\beta\alpha\int_{q^m}^{q_c}(p(q)-c)dq - b_s\right] > 0$ but $\Gamma(q^m) = 0$, so the conditions of proposition 4.3 do not hold. The seller would 'like' to have consumers bargain at a posted price of p^m but no consumer will ever choose to bargain at that posted price. However, suppose there exists a value of ε where ε is small but positive so that $\Gamma(q) = 1$ for $q \in [0, q^m - \varepsilon]$ and $\Gamma(q) = 0$ for $q \in (q^m - \varepsilon, q_c]$. Then it is easy to see that in equilibrium the seller will allow bargaining and set the posted price $p(q^l)$. Given that $q^l < q^m$, this posted price will strictly exceed the standard monopoly price.

While the posted price will never be below the monopoly price p^m, proposition 4.4 shows that the profit maximising posted price can be much higher. Indeed, depending on the distribution of buyers' bargaining costs, the posted price could be higher than the all-bargain price p^l, and can even be the "choke price", $p(0)$. Further, the optimal posted price can be discontinuous for small changes in the exogenous parameters.

Proposition 4.4 *Any price in* $[p^m, p(0)]$ *can be the equilibrium posted price but small changes in exogenous parameters can lead to discontinuous changes in the equilibrium posted price.*

Proof: Suppose that $\alpha = 1$, $b_s = 0$, $b_i = 0$ for all i and $p'(q) < 0$ for all $q \geq 0$. Then the seller will set the quantity q_ρ to maximise

$$(p(q)-c)q + \beta\int_q^{q_c}(p(q)-c)dq$$

The first order condition for the profit maximising quantity is given by

$$p'(q)q + p(q) - c - \beta p(q) \leq 0 \ \ (= 0 \ \text{ if } \ q > 0)$$

First, note that if $\beta = 0$ then the optimal quantity is q^m.

Second, as $p(q)$ is twice continuously differentiable, the optimal q is continuous in β and we can totally differentiate the first order condition. Thus:

$$\frac{dq}{d\beta} = \frac{p}{2p + p'' - \beta p'} < 0$$

Third, if $\beta = 1$, the left-hand-side of the first order condition becomes $p'(q)q - c < 0$ so the optimal quantity is $q = 0$ with posted price $p(0)$.

It immediately follows that as β increases from zero, any value of $q \in [0, q^m]$ can be implemented as the optimal quantity for the seller. Thus, any price in $[p^m, p(0)]$ can be the equilibrium posted price.

To see that the optimal posted price can be discontinuous in an exogenous parameter, suppose that $b_i = 0$ for all i and

$$\left[(p^l - c)q^l - (p^m - c)q^m\right] + \beta\alpha \int_{q^l}^{q^c} (p(q) - c)dq > 0$$

It follows from proposition 4.4 that the seller will allow bargaining and set the posted price $p^l > p^m$ if b_s is low enough (e.g. $b_s = 0$).

Define $\hat{b}_s$ such that

$$\left[(p^l - c)q^l - (p^m - c)q^m\right] + \beta\alpha \int_{q^l}^{q^c} (p(q) - c)dq - \hat{b}_s = 0$$

It immediately follows that the optimal posted price for the seller if $b_s < \hat{b}_s$ is $\rho = p^l$ with the seller allowing bargaining and the optimal posted price for the seller if $b_s > \hat{b}_s$ is $\rho = p^m$ with the seller not allowing bargaining. If $b_s = \hat{b}_s$ the seller is indifferent between allowing bargaining and setting a posted price of $\rho = p^l$, and not allowing bargaining and setting a posted price of $\rho = p^m$. But as $p^l > p^m$ this means that the optimal posted price varies discontinuously in b_s at $b_s = \hat{b}_s$. □

If we consider the welfare implications of potential bargaining, the ability of the seller to allow buyers to bargain may lower seller's profit in a specific situation, such as when bargaining breaks down. However, it will always raise the seller's expected profit in equilibrium. This follows directly from the seller's choice. The seller will only allow buyers the option of bargaining if he believes that, in expectation, this will make him better off.

In contrast, the ability of a buyer to bargain may make buyers better or worse off in expectation. If a buyer has low bargaining costs and receives a reasonable share of the gains from bargaining, then the ability to bargain can raise expected buyer surplus even though it leads to a higher 'posted price'. However, the ability to bargain may also make buyers worse off in expectation and may reduce social surplus. This is formalised in proposition 4.5.

Proposition 4.5 *Endogenous bargaining may result in higher or lower levels of social surplus compared to the standard monopoly market outcome.*

Proof: Note that the level of social surplus in the standard monopoly market outcome with no bargaining is given by $SW^m = \int_0^{q^m}(p(q) - c)dq$.

We consider two alternative cases for bargaining. First, suppose that $\beta = 1$ so that bargaining never breaks down. Let $\underline{b} = \overline{b} = 0$ so all buyers have zero bargaining cost. Further, suppose $b_s = 0$ so the seller has no bargaining cost. Then there will be a unique equilibrium to the pricing game where the seller sets the posted price $p^l = p(q^l)$ and all consumers bargain in equilibrium. Social welfare in this situation is given by $SW^1 = \int_0^{q^c}(p(q) - c)dq$. As $q^m < q^c$ it immediately follows that $SW^1 > SW^m$ and the ability of buyers to endogenously choose to bargain raises social welfare.

Alternatively, suppose that $\beta = 1$ so that bargaining never breaks down and bargaining costs are given by:

$$\underline{b} = \overline{b} = b_i = (1 - \alpha)\int_{q^l}^{q^c}(p(q) - c)dq - \varepsilon$$

and

$$b_s = (p^l - c)q^l - (p^m - c)q^m + \alpha\int_{q^l}^{q^c}(p(q) - c)dq - \varepsilon$$

where $\varepsilon > 0$.

Then in equilibrium the seller will set posted price $p^l = p(q^l)$ and all buyers will bargain. To see this, note that, given posted price p^l if the buyer chooses to bargain then she receives surplus

$$\int_0^{q^l}(p(q) - p^l)dq + (1 - \alpha)\int_{q^l}^{q^c}(p(q) - c)dq - b_i$$

If she chooses not to bargain then she receives $\int_0^{q^l}(p(q) - p^l)dq$. So if the buyer chooses to bargain she makes a net gain of ε which is positive. Thus if the seller posts the price of p^l all buyers will chooses to bargain.

Note however, that p^l, by definition, is the profit maximising posted price for the seller given that all buyers choose to bargain. Thus, it remains to be shown that the seller wants all buyers to bargain rather than to set the monopoly price and prevent bargaining.

If the seller sets p^l and all buyers bargain then the seller makes surplus

$$(p^l - c)q^l + \alpha \int_{q^l}^{q^c} (p(q) - c)dq - b_s$$

If the seller sets the standard monopoly price and does not allow bargaining then the seller's surplus is $(p^m - c)q^m$. So if the seller sets price p^l and allows bargaining, his net gain is given by ε which is positive. Thus the (unique) equilibrium is for the seller to set a posted price of p^l, to allow bargaining and for all buyers to choose to bargain.

In this equilibrium, the total social welfare is given by $SW^2 = \int_0^{q^c}(p(q) - c)dq - b_s - b_i$. Substituting in for b_s and b_i and simplifying, $SW^2 = \int_0^{q^l}(p(q) - p^l)dq + (p^m - c)q^m + 2\varepsilon$. Thus $SW^2 - SW^m = \int_0^{q^l}(p(q) - p^l)dq - \int_0^{q^m}(p(q) - p^m)dq + 2\varepsilon$. But note that as $q^m > q^l$, $SW^2 - SW^m < 0$ so long as ε is small enough, and social welfare falls in equilibrium when endogenous bargaining is allowed.

We have presented two examples of equilibria, one where social welfare is higher than at the standard monopoly price and one where social welfare is lower than the standard monopoly price. Thus, endogenous bargaining may result in higher or lower levels of social surplus compared to the standard monopoly market outcome. □

5 Why is the posted price above the monopoly price?

When buyers endogenously choose whether or not to bargain, the equilibrium price set by the seller will in general exceed the standard monopoly price. There are two effects that tend to push up the profit maximising posted-price. We call these the 'outside option' effect and the 'encourage bargaining' effect.

The 'outside option' effect

By raising the posted price, the seller changes the outside option that faces both the buyer and the seller if bargaining breaks down. This change to the fall back option changes the distribution of the gains from trade if bargaining is successful. In particular, it shifts surplus away from the buyer to the seller.

Naively it might be thought that raising the posted price equally harms the buyer and the seller. After all, both the buyer and seller face a less desirable fall back position if the posted price set by the seller is set above the monopoly price. However, the effect of raising the posted price is asymmetric. It harms the buyer more than the seller and it is this asymmetric effect that pushes surplus in the direction of the seller.

To see this, by definition, the standard uniform monopoly price is the profit maximising price for the seller. By raising this price slightly, the seller only faces a 'second order' loss in profits if bargaining breaks down. The fall back price remains 'close to' the monopoly price. However, buyers face a first order loss of consumer surplus when the price rises above the monopoly level. Thus the seller has an incentive to raise the posted price above the monopoly price because this harms buyers more than it harms the seller when bargaining is unsuccessful. The payoffs to each party from successful bargaining are constant shares above the fall back option so this asymmetry increases the seller's gains when bargaining is successful.

More formally, suppose that the bargaining costs are zero so that $b_s = b_i = 0$. In this situation the seller will always allow bargaining and the buyer will always prefer to bargain. Thus the posted price set by the seller will not change the proportion of buyers who choose to bargain.[7] It will only change the outside option if bargaining fails.

In such a situation, the unique equilibrium will involve the seller setting the posted price $p^l = p(q^l)$. As discussed above, this 'all bargain' outcome will either involve a price of $p(0)$ or will solve $p'(q^l)q^l + p(q^l) - c - \beta\alpha(p(q^l) - c) = 0$. Each of these is above the monopoly price.

This is clear if the posted price is $p(0)$ where no output is sold. To see that $p^l > p^m$ if $p^l < p(0)$, note that the monopoly quantity solves $p'(q^m)q^m + p(q^m) - c = 0$. Further, if β and α are both positive, $\beta\alpha(p(q^m) - c) > 0$. Finally, the seller's profit function is concave, so that $p'(q^l)q^l + p(q^l) - c - \beta\alpha(p(q^l) - c) = 0$ can only hold if $p'(q^l)q^l + p(q^l) - c > 0$ so $p^l > p^m$.

The 'encourage bargaining' effect

The seller will also have an incentive to increase the posted price to encourage buyers to chose to bargain.

In equilibrium, the seller must make more profit, in expectation, when a buyer chooses to bargain than when a buyer chooses to simply accept the posted price. If not, the seller would simply post the monopoly price p^m and not allow buyers to bargain.

The seller's expected profit when bargaining is allowed is simply the weighted sum of the seller's expected profit contingent on the buyer choosing not to bargain and the seller's expected profit contingent on the buyer choosing to bargain. Given that in equilibrium with bargaining, the seller will set a posted price no less than p^m, the seller's expected profit contingent on the buyer choosing not to bargain can be no higher than the monopoly profit. Thus, the seller's expected profit contingent on the buyer choosing to bargain must be at least as high as the monopoly profit if the weighted sum of the two contingent profits is at least as high as the monopoly profit.

Thus, given that the seller chooses to allow bargaining, the seller has an incentive to encourage the buyer to bargain. However, the buyer will only

[7] In other words, we have removed the "encourage bargaining" effect discussed below.

choose to bargain if the buyer's expected return from bargaining is positive. Raising the posted price raises the buyer's net return from bargaining relative to not bargaining *even if* the outside option (when bargaining breaks down) is independent of the posted price. In other words, by lowering the buyer's return from not bargaining, increasing the posted price increases the probability that the buyer will choose to bargain and this benefits the seller.

More formally, suppose that the buyer's 'outside option' if bargaining is unsuccessful is simply given by K and is independent of the posted price. This removes the 'outside option' effect of the posted price. The buyer's expected return from bargaining given a bargaining cost b_i is given by:

$$\begin{aligned} C_b &= \beta\left[\int_0^{q_\rho}(p(q)-p(q_\rho))dq+(1-\alpha)\int_{q_\rho}^{q_c}(p(q)-c)dq-b_i\right] \\ &+ (1-\beta)(K-b_i) \end{aligned}$$

Thus the buyer's net gain from bargaining is:

$$\begin{aligned} \Delta_C &= \beta(1-\alpha)\left[\int_{q_\rho}^{q_c}(p(q)-c)dq-b_i\right] \\ &+ (1-\beta)\left[K-\int_0^{q_\rho}((p(q)-p(q_\rho))dq-b_i\right] \end{aligned}$$

It is easy to confirm that there is a unique value of $b_i \geq 0$ such that $\Delta_C = 0$ so long as the outside option K is not too small. Further,

$$\frac{\partial \Delta_C}{\partial q_\rho} = -\beta(1-\alpha)\left(p(q_\rho)-c\right)-(1-\beta)p(q_\rho)q_\rho < 0$$

Thus by decreasing q_ρ (i.e. increasing the posted price) the seller can increase the buyer's net gain from bargaining even when the 'outside option' from the failure of bargaining is fixed. But increasing the buyer's net gain from bargaining increases the probability that the buyer will choose to bargain and, as discussed, this benefits the seller.

So raising the posted price when the seller allows bargaining has a benefit to the seller by encouraging the buyer to choose to bargain.

The "outside option" and "encourage bargaining" effects are independent. However, they both push the profit maximising posted price above the monopoly price.

6 Example

To illustrate the above results, consider a simple example. Suppose that each buyer has an inverse demand curve given by $p(q) = 100 - q$ and that marginal cost is $c = 10$. Thus the monopoly quantity is given by 45 with a monopoly posted price of 55. Monopoly profits are 2025. The 'all bargain' quantity is $q^l = \frac{90(1-\beta\alpha)}{2-\beta\alpha}$ and $p^l = \frac{110-10\beta\alpha}{2-\beta\alpha}$.

Given q_ρ, if a buyer bargains then she gains an expected surplus of

$$C_b = \frac{1}{2}q_\rho^2 + \frac{\beta}{2}(1-\alpha)(90-q_\rho)^2 - b_i$$

Her expected surplus if she does not bargain is $C_{nb} = \frac{1}{2}q_\rho^2$. Thus a buyer's expected gain from bargaining is

$$\Delta_C(q_\rho) = \frac{\beta}{2}(1-\alpha)(90-q_\rho)^2 - b_i$$

Suppose that buyers' bargaining costs are distributed uniformly over $[0, \bar{b}]$. Then given the posted price ρ and associated quantity q_ρ, the buyer's probability of bargaining is given by:

$$\Gamma(q_\rho) = \min\{\frac{1}{2\bar{b}}\left[\beta(1-\alpha)(90-q_\rho)^2\right], 1\}$$

The seller's profit if he allows bargaining is

$$\pi_{ab} = (90-q_\rho)q_\rho + \Gamma(q_\rho)\left[\frac{\beta\alpha}{2}(90-q_\rho)^2 - b_s\right]$$

Substituting in for $\Gamma(q_\rho)$ when some buyers choose not to bargain, and taking the derivative of π_{ab} with regards to q_ρ and setting it equal to zero gives the seller's optimal quantity. This is implicitly defined by:

$$90 - 2q_\rho - \frac{1}{\bar{b}}\beta^2\alpha(1-\alpha)(90-q_\rho)^3 + \frac{b_s}{\bar{b}}\beta(1-\alpha)(90-q_\rho) = 0 \qquad (1)$$

In contrast, if all buyers choose to bargain at q_ρ (i.e. $q_\rho < 90 - \sqrt{\frac{2\bar{b}}{\beta(1-\alpha)}}$), then $\Gamma'(q_\rho) = 0$, $\Gamma(q_\rho) = 1$ and $q_\rho = \frac{90(1-\beta\alpha)}{2-\beta\alpha}$.

To take the example further, we will substitute in for specific values of β, α, b_s and $\bar{b}$. Thus, suppose that the seller has no bargaining costs ($b_s = 0$), bargaining never breaks down ($\beta = 1$) and the gains from bargaining are equally shared ($\alpha = 0.5$). Then, $q^l = 30$ and $p^l = 70$.

In this situation there are three sets of solutions depending on $\bar{b}$.

- If $\bar{b} \leq 900$, then all buyers will choose to bargain if the seller sets a posted price of $p^l = 70$. The seller's profits are increasing in the posted price until $\rho = p^l = 70$. At a posted price below p^l, an increase in ρ leads to higher seller profits as more buyers choose to bargain, then (once all buyers bargain) the seller's profits rise until the posted price is the profit maximising price given that all buyers bargain. For example, if $\bar{b} = 600$, all buyers choose to bargain once the posted price reaches (approximately) 58. The seller's profit at that posted price is (approximately) 2569. Given that all buyers bargain, the optimal posted price for the seller is $\rho = 70$ with profit of 2700. Similarly if $\bar{b} = 800$, the seller's profits and the buyers' probability of bargaining are increasing until $\rho \approx 66$. At a posted price of (approximately) 66, all buyers choose to bargain and the seller's expected profit is just under 2700. So the seller will maximise profits by setting a posted price of 70.

- If $\bar{b} \in [900, \bar{b}^c]$ where $\bar{b}^c \approx 1778.378$ then the profit maximising posted price will be *greater* than p^l.[8] Raising the posted price encourages bargaining. When $\bar{b}$ is close to 900, the effect on seller's profits from raising the posted price and encouraging bargaining more than offsets the effect of raising the price above p^l. For example, if $\bar{b} = 992.2$ then the seller will maximise profits by setting the posted price of $\rho \approx 73$. All buyers will choose to bargain and the seller's profits will be approximately 2693. The seller's optimal posted price in this situation is a 'corner solution'. The seller sets the lowest price above p^l that leads all buyers to choose to bargain. But, as $\bar{b}$ gets closer to $\bar{b}^c$, a second local

[8]Formally, $\bar{b}^c$ is determined by considering the profits if the seller sets q_ρ low enough so that all buyers choose to bargain, with the profits determined from the first order condition (1).

maximum emerges. For example, when $\overline{b} = 1760$ the profit maximising solution for the seller is to set a posted price of approximately $\rho = 94$. At this posted price all buyers bargain and the seller's profit is approximately 2272. However, there is also a 'local' maximum of the seller's profit function at a posted price of approximately 72 with profits of approximately 2261 and buyers have a probability of bargaining of approximately 0.55. As $\overline{b}$ becomes closer to $\overline{b}^c$, the profits in the second (lower priced) local maximum approach those of the first (higher price) corner solution. At $\overline{b} = \overline{b}^c$, the seller has a choice. He can set a posted price of $\rho = 94.34$ or a posted price of $\rho = 70.79$. At the higher posted price all consumers will choose to bargain. At the lower price, only 52% of consumers will choose to bargain. However, the seller's expected profit per buyer from either alternative is $\pi_{ab} = 2255.61$.

- If $\overline{b} > \overline{b}^c$ then the profit maximising posted price will be between 70.79 and 45. The profit maximising price is discontinuous in $\overline{b}$ at $\overline{b} = \overline{b}^c$. For example, when $\overline{b} = 1800$, the seller's profits are maximised by setting a posted price of 70. Each buyer has a probability of bargaining of 0.5 and seller's profits are 2250.[9] The seller's profit maximising posted price will decreases as $\overline{b}$ rises and will approach the monopoly price as $\overline{b} \to \infty$. The seller's expected profit and the probability of the buyer bargaining both fall as $\overline{b}$ rises. For example, if $\overline{b} = 2700$, the optimal posted price is 61. Buyers have a probability of bargaining of approximately 0.25 and seller's expected profit is approximately 2146. If $\overline{b} = 10000$, the optimal posted price is 46. The buyers' probability of bargaining is approximately 0.05 and seller's expected profits are approximately 2052, just above the monopoly level in the absence of bargaining.

This example highlights a number of features of of our model. First, as noted in proposition 4.1, the profit maximising price for the seller is no less

[9] At $\overline{b} = 1800$, the posted price that will lead all buyers to bargain is $\rho = 94.85$. The seller's expected profits if he sets this posted price are 2236.75 which is less than if he posted the lower price of $\rho = 70$.

than the monopoly price p^m. Second, as the conditions in proposition 4.3 hold in this example, the seller will always allow bargaining and set a price strictly greater than p^m. Third, as noted in proposition 4.4, the posted price with bargaining may exceed the 'all bargain' price p^l and the profit maximising price for the seller can be discontinuous in changes in the parameters of the game. In particular, the example highlights that the profit maximising price can discontinuously jump for small changes in the distribution of buyers' bargaining costs.

7 Conclusion

The interaction between the price 'posted' by a seller, negotiation and the actual terms of trade, are of key importance to analysing a range of retail markets. The analysis presented in this paper provides insight into these interactions. In particular, we highlight two effects that may lead a single seller to set a posted price above the standard monopoly price.

The 'outside option' effect reflects the role of a posted price as a fallback option when bargaining between a buyer and seller fails. Raising the posted price lowers the value of the outside option for both the buyer and the seller. However, this effect is asymmetric. It harms the buyer more than the seller, making it desirable for the seller to raise the price.

This outside option effect has been noted in papers analysing posted prices and bargaining in a competitive setting.

Second, raising the posted price has an 'encourage bargaining' effect that benefits the seller. The seller wants to encourage bargaining as this leads to more efficient transactions and raises both buyers' and seller's surplus. If the posted price is higher then more buyers will find it worthwhile to bargain. At the same time, those buyers who choose not to bargain are worse off due to the higher posted price.

The 'encourage bargaining' effect is novel to our framework where buyers endogenously choose whether or not to bargain. We show that this effect is separate from the role of the posted price as an outside option and continues to 'push up' the posted price even if there is no outside option effect.

The analysis in this paper raises issues for both price theory and policy makers. The model highlights the sensitivity of prices to buyers' potential to bargain. Posted prices can be high — not just above the monopoly price but also above the profit maximising price that a seller would set when all buyers bargain. This is driven by the seller's desire to encourage bargaining. But it can lead to prices that, in the absence of bargaining, would appear inextricably high. Further, the potentially discontinuous nature of the posted price means that superficially similar monopoly markets may have very different prices.

Policy makers face the issue of 'what to do' about posted prices. In most jurisdictions, monopoly pricing by itself is not illegal for a single seller. In part, this reflects the benefits of allowing market prices to provide appropriate incentives for innovation and entry, albeit with short term efficiency costs, and the costs of regulatory intervention when a single seller has market power. However, our analysis shows that, when bargaining is possible, the posted price will be higher (and possibly much higher) than the standard monopoly price. Welfare effects are ambiguous. Consumers who, for whatever reason, have high costs of bargaining will suffer a loss of welfare. These costs may reflect time or simply a dislike of 'haggling', but mean that these consumers will be worse off when bargaining is possible.

Further, the possibility of bargaining may reduce the welfare for all consumers and lower total social welfare compared to simple uniform monopoly pricing. The monopolist gains by encouraging consumers to bargain. Raising the posted price may lead consumers to endogenously choose to bargain despite having high bargaining costs. The seller gains but the loss of welfare due to the costs of bargaining can outweigh these gains for society in general.

In this situation the market may appear to be efficient. Sellers and buyers will bargain to an optimal level of trade. But the gains from increased trade compared to the standard monopoly outcome are more than offset by the loss due to bargaining costs. For outside observers, such as policy makers, the market can appear to be functioning well despite the high posted price.

As discussed above, this paper is complementary to the recent literature that considers bargaining in imperfectly competitive markets. Integrating the insights from the monopoly model presented in this paper with these competitive models is the next step for future research.

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