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Third-Degree Price Discrimination with Buyer Power*

Roman Inderst and Tommaso Valletti

Abstract

This paper introduces a model of third-degree price discrimination where a seller's pricing power is constrained by buyers' outside options. Price uniformity performs more efficiently than discriminatory pricing, as uniform pricing allows weaker buyers to exploit the more attractive outside option of stronger buyers. This mechanism is markedly different from the mechanisms that are at work in case uniform pricing is imposed on an unconstrained monopolist.

KEYWORDS: price discrimination, uniform pricing

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1 Introduction

Much research has been devoted to analyzing the implications of prohibiting discriminatory pricing.¹ A smaller, but still substantial, fraction of this literature deals with third-degree price discrimination, which is where our own contribution lies. We see many examples of this type of price discrimination along geographic markets. For instance, imagine that price discrimination is unfeasible within a town (or within a country), possibly because of arbitrage possibilities, but it is feasible to set different prices among towns (or among countries). Typically, a profit-maximizing monopolist would want to charge the low-demand-elasticity customer group with a higher price than the high-demand-elasticity group. If, instead, the monopolist has to charge a single uniform price, under standard conditions, this price would lie between the two discriminatory prices. In her seminal work, Robinson (1933) defines the market that is charged more (respectively, less) under price discrimination than under uniform pricing as “strong” (respectively, “weak”). For instance, with a simple linear demand function, the “strong” buyer would be the larger buyer with a higher vertical intercept.

In this paper, we recognize the possibility of demand-side substitution: Buyers facing a high price in their market may want to switch to an alternative supplier. Although the (incumbent) seller is no longer perfectly unconstrained, the prevailing price may still lie substantially above the seller’s marginal costs. Therefore, price discrimination still has welfare effects. However, we find that the implications of imposing uniform pricing are markedly different from those in the more standard model, in which the seller is an unconstrained monopolist.²

In our model, under price discrimination, a stronger buyer receives a strictly lower price than a weaker buyer. As noted above, this is opposite to those in the standard setting, where the seller can act as an unconstrained monopolist. As a consequence, the stronger buyer obtains quantity discounts in our model. However, the mechanism at work is not due to self-selection, which is typical in models of second-degree price discrimination. In our model, self-selection does not play a role. Instead, stronger buyers benefit as their outside option becomes (endogenously) more attractive. To see why this is the case, we have

¹For authoritative overviews, see Varian (1989) and, more recently, Armstrong (2007) and Stole (2007).

²Clearly, no monopolist is truly unconstrained, as buyers always have the option of not buying at all. In this paper, we still refer to this situation as an unconstrained monopolist, distinguish it from the case in which the monopolist has to react to a genuine outside option that customers might have on top of not buying the good.

to lay out in more detail how buyers access their respective outside options.

Our model broadly applies to two different circumstances. In one possible application, a customer has to incur costs of locating an alternative seller to the incumbent monopolist. Such costs could be simply costs of search and information acquisition. Our model allows all buyers to locate the same alternative option after spending some fixed cost, and to find more attractive alternative options by expending more resources. In a second possible application, the outside option could arise from the threat of entry by alternative sellers. For instance, when a monopolist pharmaceutical company sells patented drugs in two countries, the outside option may come from competitive parallel traders that find a cheaper alternative supply from a third country. In order to serve customers, however, competitive parallel traders must also spend resources to set up a distribution network in each of the two countries served by the monopolist, which comes at a fixed cost.

The model here will focus on the first application, in which an individual buyer himself has to incur the respective expenditures or disutility in order to switch to an alternative seller. At first, the intuition for why stronger buyers with larger demand can obtain a discount would seem to be simply that they can spread any fixed cost of switching sellers over a larger number of purchased units. There are “economies of scale” with the outside option, which puts a limit on the maximum per-unit price that the (incumbent) seller can charge. However, the mechanism at work is more subtle since a larger buyer also obtains, for any given price, a greater surplus from the incumbent seller. We show that what matters is the difference between the surplus that can be obtained from the monopolist and the surplus that can be obtained from alternative sellers. Though they are both larger for the stronger than for the weaker buyer, the surplus realized with alternative sellers also ends up being *relatively* larger, which ultimately forces the incumbent seller to offer the strong buyer a discount.

Both in terms of positive predictions on which buyer obtains a discount and in terms of welfare implications, our findings differ markedly from those when the seller is an unconstrained monopolist. To bridge the two results, for the case of linear demand, we analyze outcomes as the outside options become more and more unattractive for all buyers. Realistically, this should be the case if costs of search and information acquisition are relatively high compared to the value of the good. Our analysis shows how, as the outside options become less and less attractive for buyers, the discount that the stronger buyer receives turns into a premium –i.e., a relatively higher price than that paid by the weaker buyer.

An analogous comparison between the outcome with a perfectly monop-

olistic seller and the outcome with a seller who is constrained by the threat of demand-side substitution is performed in DeGraba (1990), Yoshida (2000), and Inderst and Valletti (2009), who consider price discrimination in intermediary goods markets. The focus in those papers is on the case in which buyers themselves are competitors in a downstream market. The present paper introduces the role of binding outside options into the theory of third-degree price discrimination for final customers, which arguably has received far more attention than the theory of price discrimination in intermediary markets.

The rest of the paper proceeds as follows. Section 2 introduces the basic model, which is analyzed in Section 3. In Section 4, we flesh out in more detail the outside options when buyers can spend resources so as to locate more attractive alternative suppliers. Section 5 considers the case with linear demand, bridging our results under binding outside options with the more standard ones that are obtained when outside options do not bind. Section 5 also offers some concluding remarks.

2 The Model

The basic setup follows much of the literature comparing discriminatory and uniform pricing. We consider a single seller that sells to different buyers. The seller produces at a constant marginal cost, which we take to be zero to simplify our expressions. Without much loss of generality, we restrict attention to two buyers, $i = 1, 2$. Also in line with much of the literature, we suppose that the seller can make take-it-or-leave-it offers to buyers. Under price discrimination, the seller offers each buyer a constant price p_i , while under uniform pricing the same price, $p_i = p$, applies to both buyers.

Indirect utility of buyer i is $V_i(a_i; p)$ (plus exogenous income), where p is the price and a_i is some positive taste parameter, with $\partial V_i/\partial p < 0$ and $\partial V_i/\partial a_i > 0$. The variation in a_i between different markets provides a motive for price discrimination. The demand function, derived using Roy's Identity, is $q_i(a_i; p) = -\partial V_i/\partial p$. In our paper, the buyer with a higher taste parameter a_i represents the strong market, while the buyer with the lower a_i represents the weak market. Without loss of generality, we stipulate that $a_1 > a_2$.

The only assumption we presently make on a_i is that a higher taste parameter implies an outward shift of the demand function:

$$\frac{\partial^2 V_i}{\partial p \partial a_i} < 0. \tag{1}$$

As a specific example that we will consider at times, we take

$$V_i = \frac{(a_i - p_i)^2}{2}, \quad (2)$$

which gives rise to $q_i = a_i - p_i$. In this example, the taste parameter a_i is represented by the vertical intercept of the demand function. Note that, in this case, a monopolistic seller would optimally set $p_i = a_i/2$, which is increasing in a_i . We turn now to the specification of the outside options.

In the basic model, we follow Katz (1987) and suppose that any buyer can access an alternative supply option at some fixed costs $F > 0$. By doing so, we assume that the buyer can purchase a perfect substitute at constant unit price $\hat{p} \geq 0$. In contrast to Katz (1987), in which the outside option is feasible for only one buyer, in our main analysis, we suppose that the alternative option is sufficiently attractive for all buyers.

As noted previously, we will endogenize both F and \hat{p} from the optimal (search) strategy of buyers once they choose to locate a different supplier. Then, the respective equilibrium values for F and \hat{p} will depend on buyers' types i . As we will show, this further reinforces our main insights.

Note, finally, that though a buyer could, after incurring costs F , mix and match between the different suppliers, this will not be optimal. Once the costs F have been incurred, it will be strictly optimal to purchase all demand from the outside option.

The monopolist's objective is to choose p_i to maximize $q_i p_i$ since the seller has zero marginal cost. Take, first, the benchmark case in which the seller is an unconstrained monopolist that can price discriminate. We assume that $q_i p_i$ is strictly quasiconcave in p_i where $q_i > 0$. Thus, an unconstrained seller would optimally set p_i equal to

$$p_i^{UC} := \arg \max_{p_i} \{q_i p_i\}.$$

Recall that with linear demand, as derived from (2), we have $p_i^{UC} = a_i/2$. Similarly, if the unconstrained seller must offer a uniform price, it would set p equal to

$$p^{UC} := \arg \max_p \{(q_1 + q_2)p\}.$$

With linear demand, this becomes $p^{UC} = (a_1 + a_2)/4$. The uniform price, thus, lies exactly mid-way between the higher discriminatory price for the strong buyer and the lower discriminatory price for the weak buyer.³ While this

³More formally, 1 is the strong market and 2 is the weak market, as $p_1^{UC} > p^{UC} > p_2^{UC}$.

result does not hold for more general demand functions (cf. Nahata et al., 1990), it provides a helpful benchmark for our own results.

The distinctive feature of our model is that buyers' alternative supply options put a constraint on the seller's pricing power. For buyer i , the value of this alternative supply option equals

$$V_i^A := V_i(a_i; \hat{p}) - F.$$

Consequently, the seller's offer to each firm i must satisfy the respective participation constraint

$$V_i(a_i; p_i) \geq V_i^A. \tag{3}$$

The seller's program under price discrimination is, thus, to choose for each market the respective price p_i to maximize $q_i p_i$ subject to (3). If a uniform price is imposed, then the problem is to choose p to maximize $(q_1 + q_2)p$ subject to (3) for both $i = 1, 2$.

3 Results

In what follows, we focus first on the case where the outside option V_i^A is sufficiently attractive, such that for each buyer i , the respective condition (3) constrains the seller's optimal choice of p_i . Intuitively, this is the case if both \hat{p} and F are not too large. For the case of linear demand, this will become more explicit below.

Discriminatory Pricing

For the case with price discrimination, we obtain the following result.

Proposition 1. *With price discrimination, for $F > 0$, a buyer's price p_i is strictly lower the stronger the market –i.e., the higher its own taste parameter a_i .*

Proof. Given that the seller's profits are strictly quasiconcave in p_i , there is a unique value $\hat{p} < p_i$ at which (3) binds with equality. By implicitly differentiating this condition, we get

$$\frac{dp_i}{da_i} = - \frac{\partial V_i(a_i; \hat{p}) / \partial a_i - \partial V_i(a_i; p_i) / \partial a_i}{q_i(a_i; p_i)} < 0,$$

where the inequality is obtained as $\partial V_i(a_i; \hat{p}) / \partial a_i > \partial V_i(a_i; p_i) / \partial a_i$ follows from assumption (1) and from $\hat{p} < p_i$. **Q.E.D.**

This is precisely the terminology used by Robinson (1933).

Now, for a further illustration, take the case with linear demand, as derived from (2). Then (3) can be solved explicitly when it holds with equality, resulting in the following discriminatory price:

$$p_i = a_i - \sqrt{(a_i - \hat{p})^2 - 2F} > \hat{p}. \quad (4)$$

It is then also immediate to obtain

$$\frac{dp_i}{da_i} = 1 - \frac{a_i - \hat{p}}{\sqrt{(a_i - \hat{p})^2 - 2F}} < 0.$$

The linear case also allows for a direct comparison with the results when the seller can set its unconstrained optimal price, which is $p_i^{UC} = a_i/2$. There, the higher purchase volume q of a stronger buyer makes it optimal for the seller to charge a higher price to a stronger buyer than he would do to a weaker buyer. In contrast, with a constrained, seller we find that, for a stronger buyer, the respective participation constraint (3) becomes tighter, which allows the seller to charge only a lower price.

The intuition for this result is not simply that a stronger buyer ends up purchasing a larger quantity, $q_i(a_i; \hat{p})$, after switching, which would allow the buyer to spread the fixed costs F over a larger volume. In fact, from (1), both the buyer's surplus under a given offer p_i and her surplus from the outside option strictly increase in a_i . However, as shown in Proposition 1, the effect is strictly stronger for the outside option.

Figure 1 depicts our story graphically. The monopolist charges a markup above \hat{p} . The markup is determined in a way such that the buyer is left just indifferent between buying from the monopolist seller at a markup, or buying the outside option at \hat{p} while also spending a fixed amount F . Both the blue-shaded and pink-shaded trapeziums in the figure correspond to F . It is immediate to see that the stronger buyer 1, whose demand function lies outwards compared to the demand function of the weaker buyer 2, pays a strictly lower price $p_1 < p_2$. As shown in Proposition 1, linearity of the demand functions, or the particular type of outward shift, are not needed for our general argument.⁴

⁴For a further illustration of our mechanism under linear demand, imagine that indirect utility, instead of (2), is given by $V_i = a_i \frac{(1-p_i)^2}{2}$. This gives rise to a demand $q_i = a_i(1-p_i)$. In the standard case of an unconstrained monopolist, price discrimination has no effect and the price is $1/2$ in both markets. Still, a_i is a shift parameter that is higher for a larger firm. In the presence of outside options, (3) can, again, be solved explicitly. It is immediate to show that $\frac{dp_i}{da_i} = 1 - \frac{1-\hat{p}}{\sqrt{a_i(1-\hat{p})^2-2F}} < 0$ – that is, the larger buyer gets a discount.

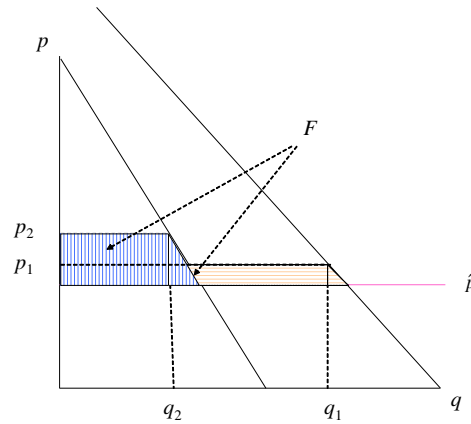


Figure 1: The role of the outside option for weak and strong buyers

The preceding argument relies crucially on the assumption that switching to the alternative source of supply comes at strictly positive costs $F > 0$. In contrast, for $F = 0$, the seller's offer to both buyers would just match the constant unit price under their alternative supply option, $p_i = \hat{p}$. More generally, we have the following comparative results for the discriminatory equilibrium prices.

Corollary 1. *With price discrimination, prices are strictly increasing in both F and \hat{p} .*

Proof. The assertion follows from implicit differentiation of the binding constraint (3), which from using the envelope theorem yields

$$\frac{dp_i}{dF} = \frac{1}{q_i(a_i; p_i)} > 0$$

and

$$\frac{dp_i}{d\hat{p}} = \frac{q_i(a_i; \hat{p})}{q_i(a_i; p_i)} > 0.$$

Q.E.D.

Note, finally, that, as an immediate implication of Proposition 1, buyers that end up purchasing larger volumes will pay a discounted price. As mentioned in the Introduction, this result comes from the outside options and not from self-selection constraints as in second-degree price discrimination.

Uniform Pricing

We turn now to the case of uniform pricing, where the seller must make any offer available to both buyers. From Proposition 1, the following result is immediate.

Proposition 2. *With uniform pricing, the seller offers both buyers the price that it would have offered to the stronger buyer under price discrimination. Consequently, compared to the case of price discrimination, under uniform pricing, the price for the stronger buyer stays unchanged, while that of the weaker buyer decreases.*

Uniform pricing is beneficial to the weaker buyer, as it allows him to hide behind the stronger buyer. If the seller were unconstrained, as we anticipated above, it is well known that uniform pricing would lead to an “average” price that lies strictly between the price of the strong and that of the weak buyer in the case of price discrimination, at least under linear or concave demand (cf. Nahata et al., 1990). Hence, in the unconstrained case, the imposition of uniform pricing hurts the weak buyer, which is opposite to our findings. In contrast, in our model, there is no price “bracketing,” and the stronger buyer is not penalized by price discrimination.

In our setting with a constrained seller, it follows immediately from Proposition 2 that uniform pricing increases total output if $a_1 \neq a_2$. This leads us to our final welfare result.

Proposition 3. *Uniform pricing unambiguously increases consumer surplus and welfare if $a_1 \neq a_2$.*

4 Searching for Better Deals

Arguably, the specification that all buyers, once they choose an alternative supply option, end up with the same option may often not be adequate. Instead, we may suppose that stronger buyers, who purchase larger quantities, may devote more resources, in terms of both expenditure and disutility, locating more-attractive alternatives. Such a search process will make both the costs of switching, F , and the resulting per-unit price, \hat{p} , type-dependent. As we show in this Section, this strengthens our results, by further increasing the discount that a stronger buyer enjoys relative to the terms obtained by a weaker buyer.

To be specific, consider the following search process. A buyer can decide to forego the seller’s offer and, instead, start searching for an alternative. For brevity’s sake, we specify a simple technology for this. Suppose that the buyer

commits the expenditures $F \geq 0$. These directly determine the attractiveness of the resulting alternative option, namely through a function $\widehat{p}(F)$, with $\widehat{p}(0) = \bar{p}$, $d\widehat{p}/dF < 0$, and $\widehat{p}(F) > 0$ for all F . With this specification, the buyer's alternative option has the endogenous value

$$V_i^A = \max_{F \geq 0} [V(a_i; \widehat{p}(F)) - F], \quad (5)$$

provided that this is positive. We can avoid case distinctions by stipulating that $\bar{p} \leq p_i^{UC}$.

Consider, now, the derivative of the right-hand side of (5) with respect to F :

$$\frac{dV(a_i; \widehat{p}(F))}{d\widehat{p}(F)} \frac{d\widehat{p}(F)}{dF} - 1. \quad (6)$$

Again for brevity's sake, we assume that the expression (6) is strictly positive at $F = 0$, implying that, indeed, $V_i^A > 0$, while the objective function $V(a_i; \widehat{p}(F)) - F$ is strictly quasiconcave in F , thus generating a unique value $F_i^* > 0$ and a corresponding value for $\widehat{p}(F_i^*)$.

Proposition 4. *Take the case with endogenous outside options. The larger a_i , the more the respective buyer invests in the outside options, which results in a higher value for F_i^* and a lower value for $\widehat{p}(F_i^*)$. The equilibrium discriminatory prices p_i are strictly lower for a stronger buyer with higher value a_i .*

Proof. That $F_i^* > 0$ is strictly increasing in a_i follows immediately from (1), together with inspection of the derivative (6). Next, with a binding outside option and given strict quasiconcavity of the seller's objective function, provided that $p_i \leq p_i^{UC}$, we have, again, a unique optimal discriminatory price satisfying

$$V(a_i; p_i) = V_i^A.$$

Implicit differentiation with respect to a_i yields again

$$\frac{dp_i}{da_i} = - \frac{\partial V_i(a_i; \widehat{p}(F_i^*)) / \partial a_i - \partial V_i(a_i; p_i) / \partial a_i}{q_i(a_i; p_i)} < 0,$$

where we have now used, in addition, the envelope theorem for the derivative $\partial V_i^A / \partial a_i$. **Q.E.D.**

5 The Role of the (Binding) Participation Constraints

Propositions 2 and 3 come with the caveat that, under uniform pricing, it is still optimal for the monopolist seller to make an offer that is acceptable to both buyers. Alternatively, the seller could decide to offer only the contract that satisfies the participation constraint of the weaker buyer, especially when the stronger buyer can obtain a more competitive deal elsewhere. The seller could then be better off by focusing only on the weaker buyer and extracting a higher price. We now explicitly derive the conditions for when either of the two cases applies. Moreover, by varying the attractiveness of the outside option, we can also relate our results more closely to those from the standard analysis with an unconstrained seller.

We do this by focusing, for convenience, on the case with linear demand. If buyer 1 is stronger than buyer 2, the seller prefers selling to both buyers rather than excluding buyer 1 when

$$p_1(a_1 - p_1 + a_2 - p_1) \geq p_2(a_2 - p_2). \quad (7)$$

It is possible to simply substitute the explicit equilibrium input prices from (4) into the previous inequality, but the resulting expression is cumbersome. However, it is easy to see how the inequality is satisfied with equality in the limiting case where a “market expansion” effect dominates, namely when F is small (and, therefore, both p_1 and p_2 tend to \hat{p} and the LHS of (7) is approximately twice the RHS).⁵

When F is small, therefore, the seller prefers to sell to both buyers, and the seller’s pricing choice is constrained by the outside options which both bind. This is indeed what we studied in the previous sections, in which we characterized the prices as long as the participation constraints of both buyers constrain the seller’s optimal choice of p_i . As F increases, however, the outside options become less palatable for the buyers. If F is high enough, the outside option no longer represents a credible threat to the monopolist. We now study this effect arising from outside options in greater detail.

To see when the outside options stop having any effect, recall that, in the linear case, the unconstrained solution to the seller’s problem is $p_i^{UC} = a_i/2$ and the corresponding utility of buyer i is $V_i = a_i^2/8$. The outside option of

⁵The expansion effect also dominates when α_1 and α_2 are close enough (and, therefore, both p_1 and p_2 are also close enough so that, again, the LHS of (7) is approximately twice the RHS).

buyer i then binds whenever

$$F \leq (a_i - \widehat{p})^2/2 - a_i^2/8, \tag{8}$$

which is satisfied for any $\widehat{p} < p_i^{UC}$ as long as F is sufficiently small.

Let \widetilde{F}_i denote the value of the fixed cost that makes the previous inequality (8) hold with equality. We have

$$\frac{d\widetilde{F}_i}{da_i} = \frac{3a_i - 4\widehat{p}}{4} > 0,$$

where we also used that it holds at the unconstrained solution that $p_i^{UC} = \frac{a_i}{2} > \widehat{p}$, or, likewise, that $a_i > 2\widehat{p}$. This result implies that the outside option is more likely to bind (i.e., it holds for a wider range of values of F) for the stronger buyer than for the weaker buyer – i.e., $\widetilde{F}_1 > \widetilde{F}_2$ as $a_1 > a_2$.

Thus, to summarize, we have that, under price discrimination, both outside options bind for low values of F , $0 \leq F < \widetilde{F}_1$, only the outside option of the stronger buyer 1 binds for intermediate values of F , $\widetilde{F}_1 \leq F < \widetilde{F}_2$, and no outside option binds for high values $F \geq \widetilde{F}_2$.

Figure 2 reports prices with discrimination (p_1 and p_2) and with uniform pricing (p_u) as a function of F , taking into account the participation constraints described above. Figure 3 plots the welfare analysis over the same parameter range, showing the difference between total welfare without and with discrimination.⁶

The right side of the diagrams represent the “standard” story of third-degree price discrimination under linear demand. When outside options do not bind in either market (high values of F), uniform pricing is better than discriminatory pricing, as it does not penalize the stronger buyer, which more than compensates for the disadvantage that uniform pricing imposes on the weaker buyer. This result is well-established.

The left side of the diagrams show our “new” results summarized by Propositions 2 and 3 when *both* outside options bind (low values of F). Uniform pricing still has better properties than price discrimination, but this is achieved via a very different mechanism. In particular, with an unconstrained seller, the main welfare benefits from imposing uniform pricing are to shift purchases away from weaker buyers, which is, in fact, the opposite of what occurs in our model. A uniform price does not penalize the strong market, but allows the

⁶In the Figures, parameters are chosen so that (7) is always satisfied for the entire range of F ; that is, the monopolist always wants to supply both markets, whether or not he is constrained by outside options.

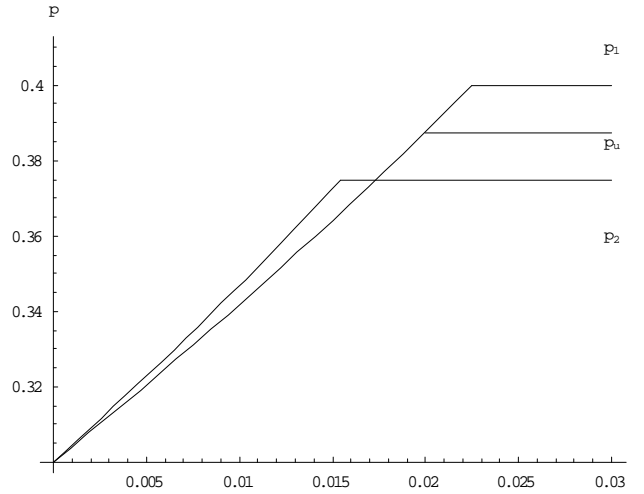


Figure 2: Prices under uniform pricing and under price discrimination [Parameter values: $a_1 = .8$, $a_2 = .75$; $\hat{p} = .3$]

weak market to enjoy a cheaper price, which is strictly welfare-improving.

The middle parts of the diagrams show the results when only the outside option of the stronger buyer binds (intermediate values of F). There is always a range where price discrimination has better welfare properties than uniform pricing. This happens when the discriminatory prices do not penalize the strong market (or, if they do, they do so only moderately because of the binding outside option), while prices would be lower than the uniform price for the weak market. Notice that this result is achieved when both markets are served. Hence, the described welfare benefits from price discrimination do *not* arise because of a standard market-expansion effect.

Next, note that, as reported in Figure 3, welfare under both pricing regimes is identical in three instances. First, this trivially happens when $F = 0$, so that $p_1 = p_2 = p_u = \hat{p}$. Second, in the region where the outside option of buyer 2 does not bind, while the outside option of buyer 1 binds, there is always a value of F such that $p_1 = p_2 = p_u$. (Given the parameters used for Figure 2, this value is $F \approx 0.017$.) This is because $p_2 < p_u$ holds when the outside options do not bind, while $p_2 > p_u$ holds when both outside options bind. Third, and again in the region where only buyer 1's outside option binds, there is a value of F such that buyer 1's discriminatory price is higher than the uniform price, but the outside option pushes it down compared to the unconstrained price. This dilutes the negative welfare impact of price discrimination. (In Figure 3, this value is $F \approx 0.0225$.)

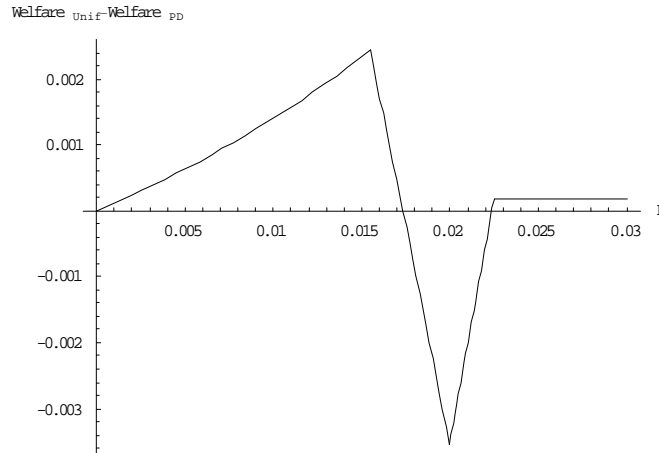


Figure 3: Welfare difference between uniform pricing and price discrimination [Parameter values: $a_1 = .8, a_2 = .75; \hat{p} = .3$]

The overall welfare comparison is, thus, non-monotonic in F . Price uniformity has better welfare properties either when outside options are not binding (the “standard” story) or when they both bind (our results). However, by the previous reasoning, there is an intermediate region where discriminatory pricing fares better than uniform pricing.

6 References

- Armstrong, Mark (2007), “Recent Developments in the Economics of Price Discrimination,” in R. Blundell, W. Newey and T. Persson (eds), *Advances in Economics and Econometrics: Theory and Applications: Ninth World Congress*, Cambridge University Press, Cambridge.
- DeGraba, Patrick (1990), “Input Market Price Discrimination and the Choice of Technology,” *American Economic Review*, 80, 1246-53.
- Inderst, Roman, and Tommaso Valletti (2009), “Price Discrimination in Input Markets,” *RAND Journal of Economics*, 40, 1-19.
- Katz, Michael (1987), “The Welfare Effects of Third Degree Price Discrimination in Intermediate Good Markets,” *American Economic Review*, 77, 154-67.

- Nahata, Babu, Krzysztof Ostaszewski and P. K. Sahoo (1990), "Direction of Price Changes in Third-Degree Price Discrimination," *American Economic Review*, 80, 1254-58
- Robinson, Joan (1933), *The Economics of Imperfect Competition*, 1950 reprint, Macmillan, London.
- Stole, Lars (2007), "Price Discrimination and Imperfect Competition," in M. Armstrong and R. Porter (eds), *Handbook of Industrial Organization: Volume III*, North-Holland, Amsterdam.
- Varian, Hal (1989), "Price Discrimination," in R. Schmalensee and R. Willig (eds) *Handbook of Industrial Organization: Volume I*, North-Holland, Amsterdam.
- Yoshida, Yoshihiro (2000), "Third-Degree Price Discrimination in Input Markets: Output and Welfare," *American Economic Review*, 90, 240-46.