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By

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Bertrand competition with an asymmetric no-discrimination constraint*

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Abstract

We study the competitive and welfare consequences when only one firm must commit to uniform pricing while the competitor's pricing policy is left unconstrained. The asymmetric no-discrimination constraint prohibits both behaviour-based price discrimination within the competitive segment and third-degree price discrimination across the monopolistic and competitive segments. We find that an asymmetric no-discrimination constraint only leads to higher profits for the unconstrained firm if the monopolistic segment is large enough. Therefore, a regulatory policy objective of encouraging entry is not served by an asymmetric no-discrimination constraint if the monopolistic segment is small. Only when the monopolistic segment is small and rivalry exists in the competitive segment does the asymmetric no-discrimination constraint enhance welfare.

JEL classification: D11

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1 Introduction

This paper analyses an oligopoly with a price discrimination constraint on only one firm. We label this as an asymmetric no-discrimination constraint. An asymmetric no-discrimination constraint occurs in practice in both regulatory and competition policy contexts and is typically imposed on a firm with significant market power.

In a regulatory context such no-discrimination constraints are often imposed on former state monopolists. The objective is to encourage entry after liberalisation, by prohibiting selective rebates by the incumbent for customers that switched to entrants. Another objective is the protection of certain groups of customers that still do not have a choice after liberalisation, by prohibiting the incumbent to selectively charge higher prices for only those groups. In this respect, regulators impose a universal service obligation on the incumbent that may take the form of a uniform pricing constraint across its monopoly and competitive segments. Examples of regulatory asymmetric no-discrimination constraints include the energy regulator in the United Kingdom, Ofgem, which investigated customer win-back pricing strategies by the former incumbent, London Electricity, following a complaint by an entrant.[1] Another example concerns the gas sector in the United Kingdom. The incumbent British Gas was not allowed to price discriminate between customers with dual-fuel equipment that had alternatives to gas and customers that had not.[2]

Asymmetric no-discrimination constraints are also imposed in a competition policy context. In Europe, for example, article 102 of the Treaty on the Functioning of the European Union prohibits dominant firms to abuse their dominant position. Price discrimination, for example in the form of selective price cuts specifically targeted at competitors' customers, may constitute such an abuse. Also charging different prices to different groups of customers may already establish abuse on itself under article 102. Examples of price discrimination abuse of dominance cases in Europe include Compagnie Maritime Belge and Irish Sugar.[3] In Compagnie Maritime Belge, the European Court of Justice judged that selective price cuts aimed at eliminating competitors

[1] Ofgem decided that this behaviour by London Electricity was not illegal because of the limited number of customers that were targeted (see Ofgem's decision "The Gas and Electricity Market Authority's Decision under the Competition Act 1998 that London Electricity Plc has not infringed the Prohibition Imposed by Section 18(1) of the Act with regard to a "Win Back" Offer", 12 September 2003.

[2] Monopolies and Mergers Commission (MMC), "British Gas", 1988.

[3] Judgment of the Court of First Instance, Compagnie Maritime Belge v. Commission, C-395/96 and C396/96, 3 March 2000; Judgment of the Court of First Instance, Irish Sugar v. Commission, Case T-228/97, 7 October 1999.

on contested shipping routes, while continuing higher prices for uncontested services, was an abuse. In Irish Sugar, the European Court of First Instance judged several price discrimination practices by Irish Sugar to establish abuse of dominance, including selective rebates to customers of a French sugar importer, "sugar export rebates" to industrial customers that exported outside Ireland and "border rebates" to customers close to the border with Northern Ireland that could purchase sugar cheaper from the United Kingdom.

In fact, two different price discrimination practices occur in these examples taken from regulation and competition policy. First, a firm with significant market power applies behaviour-based price discrimination *within* the competitive segment when it selectively targets customers that switched to entrants in order to win them back. Second, third-degree price discrimination is practiced when a firm with significant market power sets different prices *across* its competitive and monopolistic segments. This paper analyses an asymmetric no-discrimination constraint which is a combined constraint of price discrimination *within* a competitive segment (behaviour-based) and *across* the monopolistic and competitive segments (third-degree) that applies only to the firm with significant market power.

Our paper contributes to the existing literature in various ways. First, while the existing price discrimination literature mainly studies the consequences of changing all firms' pricing strategies in a symmetric way, our focus is on the consequences of limiting the pricing strategies of one firm only. In particular, we study the welfare consequences when only one firm must commit to uniform pricing for regulatory reasons (e.g. a universal service obligation) or competition purposes (e.g. abuse of dominance), while the competitor's pricing mode is left unconstrained. Second, our model studies how the competitive effects of an asymmetric no-discrimination constraint *within* a competitive segment (i) alter when the constraint also applies *across* competitive and monopolistic segments, and (ii) change with the size of the monopolistic segment. We show that an asymmetric no-discrimination constraint on the firm with significant market power enhances welfare as long as its monopoly segment is not too large. Third, we highlight that interaction between a static (third-degree) and dynamic (behaviour-based) form of price discrimination may result in opposing policy conclusions. In particular, while a no-discrimination constraint in a static analysis suggests that competitition may be augmented if the entrant must still decide on entry, a dynamic framework may result in less entry. More generally, our analysis contributes to the competition policy and regulation literature as it shows that the combination of two instruments (a no-discrimination constraint within and across segments) may lead to outcomes that are unintended by each instrument separately.

We consider a model with a monopolistic and competitive segment in the spirit of Armstrong and Vickers (1993), with two periods and strategic interaction in the competitive segment. When the dominant firm can set its prices unrestrainedly, it practices third-degree price discrimination by charging the monopoly price in its monopolistic segment. The dominant firm competes with its rival on the competitive segment in uniform prices in the first period and practices, as in Fudenberg and Tirole (2000) behaviour-based price discrimination in the second period. We study the competitive and welfare effects when there is an asymmetric no-discrimination constraint imposed on the firm that serves the monopolistic and the competitive segment, while the other firm serving only the competitive segment is left unrestrained.

Our two-period analysis yields the following results as compared to the benchmark model where both firms can set prices unrestrainedly. First, both firms' profits suffer most from the asymmetric no-discrimination constraint when the size of the monopolistic segment is small. An asymmetric no-discrimination constraint *within* the competitive segment results in lower prices to both firms, whereas an asymmetric no-discrimination constraint *across* segments shifts prices upwards. These two forces affect the unrestrained firm's profits in the following way. When the monopoly segment is large enough, the profit-increasing effect of the asymmetric (third-degree) no-discrimination constraint across segments outweighs the profit-decreasing effect of the asymmetric (behaviour-based) no-discrimination constraint within the competitive segment. The profits of the dominant firm, however, augment when the effect of the asymmetric no-discrimination constraint in the competitive segment (i.e. the behaviour-based constraint) is less pronounced. Second, from a welfare perspective we find that the asymmetric no-discrimination constraint increases total welfare and consumer welfare whenever the monopolistic segment is not too large and entry is profitable.

The literature on oligopolistic price discrimination mainly addresses the welfare implications when all firms either engage in price discrimination or have symmetric pricing constraints; see e.g. Chen (1997, 2009), Taylor (2003), Villas-Boas (1999), and Armstrong (2006, 2008) and Stole (2007) for reviews. Yet, only few papers study the implications of asymmetric restrictions on price discrimination.

An important paper which does study an asymmetric price discrimination constraint is Armstrong and Vickers (1993). They consider the competitive and welfare effects of a ban for the dominant firm on third-degree price discrimination. In their one-period model, the dominant firm serves a monopolistic segment and competes in prices with a price-taking entrant on the remaining competitive segment. They find that an asymmetric no-discrimination constraint across segments decreases the price in the monopolistic segment while, given entry, the price rises in the competitive segment. With this asymmetric no-discrimination constraint, the incumbent monopolist protects its monopolistic segment and, consequently, responds less aggressively to entry. The results of our dynamic two-period model lead to conclusions that may contradict those from a static, one-period model. Our two-period analysis shows that when the monopoly segment is not too large, competition intensifies when the dominant firm faces an asymmetric no-discrimination constraint, so that both firms obtain less profit. In other words, when the monopoly segment is not too large, the profit-increasing effect of the no-discrimination constraint across segments is dominated by the profit-decreasing effect within the competitive segment. Consumer welfare then increases with the asymmetric no-discrimination constraint not only because more consumers pay lower prices, but also because more consumers are served by their nearby provider. However, when the size of the monopoly segment increases, our results become more in line with the static framework. That is, average prices increase with the size of the monopolistic segment, and eventually result in higher average prices in the competitive segment when its size becomes sufficiently large.

Another paper which is closely related to our contribution is Chen (2009), who uses three variants of a dynamic model to study behaviour-based price discrimination between competing firms. In his model, an incumbent has a monopoly position in the monopolistic segment and competes in prices for consumers with a more efficient firm in the competitive segment. Firms can engage in behaviour-based price discrimination by observing consumers' purchase history. Chen's model shows that uniform pricing weakens competition while it is sufficient for price discrimination to enhance long-run consumer welfare when the more efficient firm in the competitive segment does not exit as a result of the incumbent's pricing strategy. Our analysis and findings differ in two respects. First, our model studies the effects on competition when there is an asymmetric no-discrimination constraint, while the other firm is left unconstrained. In Chen's model, a ban restricts both firms' pricing strategies. In contrast, our modeling allows to study the asymmetric treatment of a dominant firm by a regulatory body or competition authority. Second, we show that an asymmetric no-discrimination constraint may intensify competition when the size of the monopolistic segment is not too large, and consequently, may enhance consumer welfare only when the rival firm remains in the market.

Gehrig et al. (2010) consider that the entrant has no customer information and therefore, cannot discriminate between customers. The incumbent, in contrast, has consumer information and can discriminate between loyal and other customers. They find that the entry possibilities do not hinge on the incumbent's possibility to price discriminate on the basis of history-based pricing. However, the price level is higher when the incumbent makes use of price discrimination as opposed to uniform pricing. Our set-up, however, differs since our approach endogenizes first-period competition, and therefore, takes into account intertemporal price competition. Furthermore, we also consider a (third-degree) no-discrimination constraint across segments, linking the competitive and monopolistic segments served by the incumbent.

Valletti et al. (2002) study the relationship between entry and a universal service obligation that takes the form of a uniform pricing constraint. In their static model, they look at the strategic effects of a uniform pricing and coverage constraint on hitherto unrelated markets. The uniform pricing constraint in their model is only binding for the incumbent who serves markets with different characteristics whereas the entrants are only active in markets with identical customers. In our model, a pricing constraint on all firms would result in uniform pricing in both periods.

Finally, our model has similarities with Pazgal and Soberman (2008). They consider whether firms want to adopt behaviour-based discrimination in an environment where firms can (i) commit whether or not to price discriminate and (ii) offer additional benefits to their past consumers in the second period. They find that when the benefits that firms can give to customers are identical, behaviour-based discrimination generally leads to lower profits for both firms. When firms differ substantially in providing second-period benefits, the best response of the firm providing the lowest second-period benefits sometimes is to set a uniform price and avoid behaviour-based pricing. Our analysis differs in three important aspects. First, we assume that a firm only can commit not to practice price discrimination when it faces regulatory restrictions. These restrictions are asymmetric as they restrict the best response of one firm only. When unrestricted, firms cannot commit to forego price discrimination. We believe that lack of commitment is often more realistic; in particular, when consumers know they are easily recognized by firms, it remains difficult for sellers to commit not to use their customer information for price setting purposes. Second, in our setting, the impact of an asymmetric no-discrimination constraint within the competitive segment hinges on whether price discrimination across segments is allowed or not. When not allowed, customers of the restrained firm anticipate additional "harm" when they buy from that firm in the second period: they anticipate higher prices as a result of the asymmetric no-discrimination constraint. In other words, the asymmetric payoffs assumed in Pazgal and Soberman (2008) result in our case from an asymmetric restriction across segments. The size of the monopolistic segment determines the impact of this asymmetry. Third, in our setting, we have the interesting feature that an asymmetric no-discrimination constraint across segments links unrelated segments and creates an asymmetry in payoffs. The total impact of this restriction is driven by profit both on the competitive and monopolistic segment.

The remainder of this article is organised as follows. Section 2 presents the benchmark model where firms can price freely. In Section 3 we analyze competitive behaviour with an asymmetric no-discrimination constraint. This allows us to study regulatory and competition policy issues. Section 4 offers a welfare comparison while Section 5 concludes.

2 The benchmark model

Two profit-maximizing firms, A and B, compete in prices on a Hotelling unit interval, with A located at 0 and B at 1. They compete during two periods and set prices in each period. Their marginal production costs are constant and normalized to zero. Consumers are distributed uniformly on this competitive segment, have inelastic and unit demand in each period, and incur transportation costs t per unit of distance. Their willingness to pay is sufficiently high to cover the market and they have fixed preferences over time. Firms and consumers discount the future at a common rate $0 \leq \delta \leq 1$. Both firms charge a uniform price p_1^i in the first period, where $i = A, B$. Our benchmark model closely follows Fudenberg and Tirole (2000) where firms can distinguish in period two their first-period customers from their rival's. Customer recognition at the firm level across the two periods, therefore, offers both firms the possibility in period two to engage in behaviour-based price discrimination. In addition to their model, firm A also enjoys a monopolistic segment where consumers have a willingess to pay w. The mass of the competitive segment is normalized to 1 while the mass of the monopolistic segment equals a.

Firm A serves its entire *monopolistic segment* and charges a price w in both periods. Accordingly, its total discounted profits in the monopolistic segment (denoted by subscript m) equal

$$\Pi_m^{A^*} = a(1+\delta)w.$$

Consider the *competitive segment.* Starting the analysis with second-period competition, assume that, without of loss of generality, first-period competition results in firm A serving customers who are located "to the left of x" and firm B serving customers "to the right of x", with $0 \leq x \leq 1$. There are two indifferent consumers in the second period. The first indifferent consumer is at $0 \leq \alpha \leq x$ and satisfies

$$p_2^{AA} + t\alpha = p_2^{AB} + t(1-\alpha)$$

where p_2^{ij} refers to a price charged in the second period to a consumer who purchased from firm i in period 1 and from firm j in period 2, with $i = A, B$ and $j = A, B$. The second indifferent consumer is at $x \leq \beta \leq 1$ and satisfies

$$p_2^{BA} + t\beta = p_2^{BB} + t(1-\beta).$$

Firm A maximizes its second-period profits in the competitive segment (subscript c)

$$\Pi_{2c}^A(p_2^{AA}, p_2^{BA}) = p_2^{AA}\alpha + p_2^{BA}(\beta - x)$$

whereas firm B maximizes

$$\Pi_{2c}^B(p_2^{BB}, p_2^{AB}) = p_2^{BB}(1-\beta) + p_2^{AB}(x-\alpha).$$

Both firms now have two best-responses; one for each part of the competitive segment they serve. Firm A's first best-response function satisfies $p_2^{AA} = 0.5\left[t + p_2^{AB}\right]$ and is determined by the trade-off of losing marginal customers and extracting rents on inframarginal customers $[0,\alpha]$. This trade-off is independent of x. Firm A's second best-response can be written as $p_2^{BA} = 0.5\left[t + p_2^{BB} - 2tx\right]$ and depends on x. A larger x makes A more price-aggressive as the decrease in rents on inframarginal customers is lower in x. Furthermore, p_2^{BA} is lower than p_2^{AA} as first-period customers already have revealed that they have a lower preference for A.[4]

Turning to first-period competition, the forward-looking first-period indifferent consumer in the competitive segment is located at x such that

$$p_1^A + tx + \delta[p_2^{AB} + t(1-x)] = p_1^B + t(1-x) + \delta[p_2^{BA} + tx],$$

where p_1^i is firm i's first-period price, with $i = A, B$. Firm A maximizes its total discounted profit

$$\Pi_c^A(p_1^A, p_1^B) = p_1^A x + \delta\left(p_2^{AA}\alpha + p_2^{BA}(\beta - x)\right)$$

in the competitive segment, whereas firm B maximizes

$$\Pi_c^B(p_1^B, p_1^A) = p_1^B(1-x) + \delta\left(p_2^{BB}(1-\beta) + p_2^{AB}(x-\alpha)\right).$$

From the first-order conditions, equilibrium prices amount to

$$p_1^{i*} = \frac{t(\delta+3)}{3}, \; p_2^{AA*} = p_2^{BB*} = \frac{2t}{3} \text{ and } p_2^{BA*} = p_2^{AB*} = \frac{t}{3}.$$

[4] Firm B's best responses are symmetric, i.e. $p_2^{BB} = 0.5\left[t + p_2^{BA}\right]$ and $p_2^{AB} = 0.5\left[t + p_2^{AA} - 2t(1-x)\right]$.

As Fudenberg and Tirole (2000) have shown, consumers rationally anticipate that a price decrease today will result in a higher price tomorrow. As a result, first-period prices are higher than in a static model because consumers' demand is less price elastic. In equilibrium, both firms equally share the competitive segment and enjoy identical profits in that segment. In the second period, one third of the consumers in the competitive segment switch supplier since $\alpha = 1/3$ and $\beta = 2/3$. From a total welfare perspective, consumers inefficiently switch provider. Since firms poach each other's first-period customers, second-period prices are so much lower so that overall profits decrease. The discounted profits for both firms in the competitive segment amount to

$$\Pi_c^{i*} = \frac{t(8\delta + 9)}{18}.$$

The firms' total discounted profits on the *entire market* are the combined results from the competitive and monopolistic segments, or $\Pi^{A*} \equiv \Pi_m^{A*} + \Pi_c^{A*}$ and $\Pi^{B*} \equiv \Pi_c^{B*}$. It is clear that A generates greater profits than does B as it enjoys a monopoly position in its monopolistic segment.

Sections 3 and 4 offer the competitive and welfare effects of an *asymmetric* no-discrimination constraint imposed on one firm only, i.e. firm A. Since firm A is active on a monopolistic and competitive segment, general competition law or regulatory constraints may impose such a no-discrimination constraint on firm A. Firm B, in contrast, is free to charge its customers different prices at any moment. The asymmetric no-discrimination constraint imposes on firm A (i) to not price discriminate *within* the competitive segment (between prior customers and customers from the other firm) and (ii) to not price discriminate *across* segments (the monopoly segment and the competitive segment). When the size of the monopolistic segment is zero, the asymmetric no-discrimination constraint coincides with no discrimination within the competitive segment only. For larger sizes of the monopolistic segment, the asymmetric no-discrimination constraint also imposes no discrimination across segments.[5] Competition law typically applies when a firm has significant market power which implies in our setup a sufficiently large monopolistic segment. Regulatory constraints, in contrast, may apply for different sizes of the monopolistic segment.

We assume throughout our analysis that the constrained firm A finds it always profitable to

[5] In Section 4, we briefly turn to the welfare implications of a restriction that imposes a no-discrimination constraint between segments but allows for price discrimination within the competitive segment. However, in case of a universal service obligation, no-discrimination constraints are typically observed either within a competitive segment or both within and across segments. Our welfare results will show that such a constraint would generally lead to lower welfare. This may explain the observed practice of universal service obligations either *within* competitive segments or *within and across* segments.

serve its monopolistic segment, to remain active in the competitive segment, and poach some of its rival's customers in the second period.

3 Asymmetric no-discrimination constraint: competitive effects

An asymmetric no-discrimination constraint implies that firm A can neither engage in behaviour-based price discrimination *within* the competitive segment, nor third-degree price discriminate *across* its monopolistic segment and the competitive segment. Although firm A can charge different prices across both periods, it must charge a uniform price within each period. In other words, firm A has a no-discrimination constraint and must charge $\widetilde{p}_1^{A^*}$ in period one and $\widetilde{p}_2^{A^*}$ in period two to all its customers, where "$\sim$ " is used to denote the asymmetric no-discrimination constraint. In contrast, firm B practices behaviour-based discrimination. Clearly, such an asymmetric no-discrimination constraint introduces a link between the monopolistic segment and the competitive segment when the size of the monopolistic segment is strictly positive. Firm A's profit on the monopolistic segment now equals

$$\widetilde{\Pi}_m^{A^*} \equiv a\left(\widetilde{p}_1^{A^*} + \delta\widetilde{p}_2^{A^*}\right),$$

and is lower than the benchmark model since we assumed that A preferred to charge w to all its customers in the benchmark model.

We now first provide our analysis in a general way, and discuss the two forces leading to differential prices compared to the benchmark model. Afterwards we discuss how an asymmetric no-discrimination constraint within the competitive segment generates competitive effects and how adding an asymmetric no-discrimination constraint across the competitive and monopolistic segment impacts competition. We further link our findings with competition law and regulatory issues.

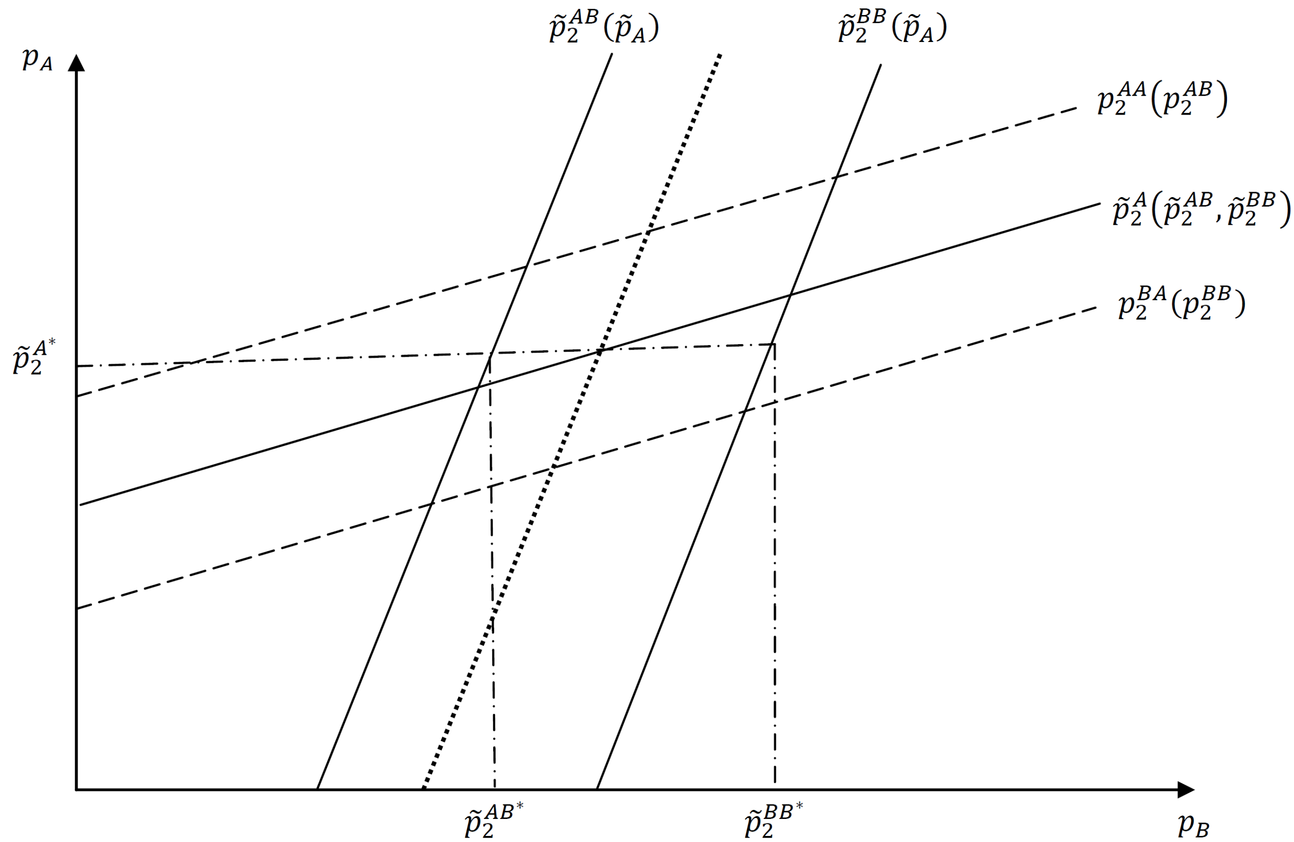
Starting from period two, suppose first-period competition has led firm A to serve all consumers to the left of $\widetilde{x}$ in the competitive segment, and firm B to serve all consumers to the right of $\widetilde{x}$. In the second period, there are two indifferent consumers. The first is located at $0 \leq \widetilde{\alpha} \leq \widetilde{x}$ and is characterized by

$$\widetilde{p}_2^A + t\widetilde{\alpha} = \widetilde{p}_2^{AB} + t(1-\widetilde{\alpha})$$

while the second indifferent consumer located at $\widetilde{x} \leq \widetilde{\beta} \leq 1$ is characterized by

$$\widetilde{p}_2^A + t\widetilde{\beta} = \widetilde{p}_2^{BB} + t(1-\widetilde{\beta}).$$

Figure 1: Second-period best-reply curves for $a = 0$.



Hence, firm A determines the price $\widetilde{p}_2^A$ that maximizes its second-period profits in both the monopolistic and competitive segments

$$\widetilde{\Pi}_2^A(\widetilde{p}_2^A) \equiv \widetilde{p}_2^A \left[a + \left(\widetilde{\alpha} + \widetilde{\beta} - \widetilde{x}\right)\right]$$

while firm B maximizes

$$\widetilde{\Pi}_2^B(\widetilde{p}_2^{AB}, \widetilde{p}_2^{BB}) \equiv \widetilde{p}_2^{AB}\left[\widetilde{x} - \widetilde{\alpha}\right] + \widetilde{p}_2^{BB}[1 - \widetilde{\beta}].$$

The best-responses look like

$$\tilde{p}_2^A = 0.5[t(1 + a - \tilde{x}) + 0.5(\tilde{p}_2^{AB} + \tilde{p}_2^{BB})]$$

$$\tilde{p}_2^{AB} = 0.5(\tilde{p}_2^A + t(2\tilde{x} - 1)) \text{ and } \tilde{p}_2^{BB} = 0.5(\tilde{p}_2^A + t)$$

for firm A and B, respectively.

By making use of the best-reply curves of Figure 1, we illustrate the forces that explain the differences with our benchmark model. (Figure 1 illustrates a situation for a equal to zero.) Second-period profit maximization leads to best-reply curves which now depend on a and $\tilde{x}$. Firm A's best-response contains two parts. The first part, $t(1+a-\tilde{x})$, tells us that A's price increases with the size a of the monopolistic segment and decreases with the first-period market share on the competitive segment. The second part reveals that firm A now optimally reacts on B's *averaged* best-response price $0.5(\tilde{p}_2^{AB}+\tilde{p}_2^{BB})$. This averaged best-response is depicted as the dotted line. The solid line $\tilde{p}_2^{A}(\tilde{p}_2^{AB},\tilde{p}_2^{BB})$ in Figure 1 represents firm A's best response when the no-discrimination constraint applies. The dashed lines $p_2^{AA}(p_2^{AB})$ and $p_2^{BA}(p_2^{BB})$ offer a comparison with firm A's best-responses from the benchmark model. Firm B's best-responses $\tilde{p}_2^{AB}(\ \tilde{p}_A)$ and $\tilde{p}_2^{BB}(\ \tilde{p}_A)$ also increase with the size of firm A's monopolistic segment a since $\tilde{p}_2^{A}$ depends positively on a. Solving the best responses results in

$$\begin{aligned}\widetilde{p}_2^{A} &= \frac{t(2\,(a+1)-\widetilde{x})}{3}\\ \widetilde{p}_2^{AB} &= \frac{t\,(5\widetilde{x}+2a-1)}{6}\\ \widetilde{p}_2^{BB} &= \frac{t(5-\widetilde{x}+2a)}{6}.\end{aligned}$$

We now turn to first-period competition. The forward-looking first-period indifferent consumer in the competitive segment is located at $\widetilde{x}$ such that

$$\widetilde{p}_1^{A}+t\widetilde{x}+\delta[\widetilde{p}_2^{AB}+t(1-\widetilde{x})]=\widetilde{p}_1^{B}+t(1-\widetilde{x})+\delta[\widetilde{p}_2^{A}+t\widetilde{x}].$$

After substitution of both firms' second-period prices, one obtains firm A's first-period market share on the competitive segment:

$$\widetilde{x}=\frac{6(\widetilde{p}_1^{B}-\widetilde{p}_1^{A})+t\,(6-\delta)+2at\delta}{t(12-5\delta)}.$$

Firm A maximizes the following total discounted profit in both segments

$$\widetilde{\Pi}^{A}(\widetilde{p}_1^{A},\widetilde{p}_1^{B})\equiv\widetilde{p}_1^{A}(a+\widetilde{x})+\delta\widetilde{p}_2^{A}\left[a+\left(\widetilde{\alpha}+\widetilde{\beta}-\widetilde{x}\right)\right]$$

whereas firm B maximizes

$$\widetilde{\Pi}^{B}(\widetilde{p}_1^{B},\widetilde{p}_1^{A})\equiv\widetilde{p}_1^{B}(1-\widetilde{x})+\delta\left[\widetilde{p}_2^{BB}(1-\widetilde{\beta})+\widetilde{p}_2^{AB}(\widetilde{x}-\widetilde{\alpha})\right].$$

Taking the first-order conditions, an interior solution results in

$$\widetilde{p}_1^{A*} = \frac{t\,(12-\delta)}{12} + \frac{ta(37\delta^2 - 564\delta + 864)}{12(54-31\delta)};\ \widetilde{p}_1^{B*} = \frac{t\,(3-\delta)}{3} + \frac{ta(19\delta^2 - 99\delta + 108)}{3(54-31\delta)}$$
$$\widetilde{p}_2^{A*} = \frac{t}{2} + \frac{ta\,(84-47\delta)}{2\,(54-31\delta)};\ \widetilde{p}_2^{AB*} = \frac{t}{4} + \frac{ta\,(12-13\delta)}{4\,(54-31\delta)};\ \text{and}\ \widetilde{p}_2^{BB*} = \frac{3t}{4} + \frac{ta\,(84-47\delta)}{4\,(54-31\delta)}.$$

We explain the intuition behind these equilibrium prices by distinguishing two effects – a commitment effect and price sensitivity effect. First consider the commitment effect. Observe that $\widetilde{p}_1^{A*} > \widetilde{p}_1^{B*}$. If the indifferent consumer $\widetilde{x}$ opts for firm B in period 1, she expects to be poached in the next period by firm A at a price $\widetilde{p}_2^{A}$. Firm A's poaching price is rather high as A must charge an identical price to its first-period customers in the competitive and the monopolistic segment. If, however, the indifferent consumer visits firm A in the first-period, she anticipates a more attractive second-period poaching price by firm B since $\widetilde{p}_2^{AB*} < \widetilde{p}_2^{A}$. Firm A is therefore regarded as an unattractive poacher because it is committed to charge a high poaching price. This forces firm B to charge a lower price than A in period 1 and allows firm A to extract more surplus from its first-period customers. This *commitment effect* explains the differences between the prices charged. We also observe that both prices $\widetilde{p}_1^{A*}$ and $\widetilde{p}_1^{B*}$ are increasing in a, although $\widetilde{p}_1^{A*}$ depends much stronger on the size of the monopolistic segment. An asymmetric no-discrimination constraint implies that all prices in the competitive segment increase in a, indicating that the degree of competition depends on the size of the monopolistic segment.

Second, there is also a price sensitivity effect. The price levels with the asymmetric no-discrimination constraint differ from the benchmark model. A price sensitivity comparison of the marginal consumer between the benchmark model and asymmetric no-discrimination constraint is useful to explain the different price levels. We start with our benchmark model for the competitive segment. As in Fudenberg and Tirole's (2000) set-up, first-period demand increases with γ when firm A decreases its first-period price by a small amount ε. The marginal consumer is now located at $x = 0.5 + \gamma$, where γ measures the marginal consumer's sensitivity to this price change. Accordingly, substitution of the second-period prices, and simplifying[6], results in

[6] Following Armstrong (2006), we solve

$$p_1^A - \varepsilon + t(0.5+\gamma) + \delta[\frac{t}{3}\,(1+4\gamma) + t(0.5-\gamma)] = p_1^B + (0.5-\gamma)t + \delta[\frac{t}{3}\,(1-4\gamma) + t(0.5+\gamma)]$$

for γ.

$$\gamma = \frac{\varepsilon}{2t(1+\delta/3)}.$$

Clearly, the marginal consumer is *less* sensitive to a first-period price change than in the static Hotelling model (see Armstrong, 2006a) – indeed, in a static model, where $\delta = 0$, we find that $\gamma = \varepsilon/2t$. The reasoning is that she now weighs off two alternatives. On the one hand, if the marginal consumer decides to buy from firm A, he enjoys a first-period price cut of one unit by firm A but suffers in the next period since firm B's second-period poaching price increases in γ at rate $4t/3$. On the other hand, when he decides to buy from firm B, he does not enjoy the price cut today but will enjoy a lower price in the next period as firm A's second-period poaching price decreases in γ at rate $4t/3$. The total effect as reflected by the value of γ results in a lower price sensitivity of demand compared to the static Hotelling model, and coincides with a model in which neither firm practices behaviour-based discrimination. We now turn to the case with an asymmetric no-discrimination constraint where we can compute $\tilde{\gamma}$ as follows. When firm A changes its first-period price slightly to $\tilde{p}_1^A - \epsilon$, it follows after simplification[7] that $\tilde{\gamma}$ satisfies

$$\tilde{\gamma} = \frac{\varepsilon}{2t(1-5\delta/12)}.$$

While the marginal consumer again weighs off two similar alternatives as before, we find that an asymmetric no-discrimination constraint results in more price-sensitive consumer behavior than the static or unconstrained benchmark model. This stems from the following forces. If the marginal consumer decides to buy from firm A, he enjoys a first-period price cut of one unit by firm A. In the next period, he now only incurs a small increase in price as firm B's second-period poaching price increases by $5t/6$ in γ only. However, when he decides to buy from firm B, he does not enjoy the price cut today but will enjoy a lower price in the next period as firm A's second-period poaching price which decreases in γ at rate $t/3$. Thus the indirect effects on the poaching prices make the demand more elastic, reflected in the value of γ, as compared to the static Hotelling model or the unconstrained benchmark model. This *price sensitivity effect* explains the difference of the price level between the asymmetric no-discrimination constraint and the benchmark model.

[7] The indifferent consumer is characterized by $\tilde{p}_1^A - \varepsilon + t(\widetilde{x}+\gamma) + \delta(\frac{t}{6}(5(\widetilde{x}+\gamma)+2a-1) + t(\widetilde{x}-\gamma)) = \tilde{p}_1^B + (\widetilde{x}-\gamma)t + \delta(\frac{t}{3}(2(1+a)-\widetilde{x}-\gamma) + t(\widetilde{x}+\gamma))$.

Firm A's first-period and second-period market share in the competitive segment are

$$\widetilde{x}^* = \frac{1}{2} - \frac{a(36-17\delta)}{2(54-31\delta)}, \text{ and } \widetilde{\alpha}^* + \widetilde{\beta}^* - \widetilde{x}^* = \frac{1}{2} - \frac{3a(8-5\delta)}{2(54-31\delta)},$$

respectively. Both are not larger than 0.5 but firm A's total market share in both segments increases from period one to period two. This leads to discounted profits in the competitive segment for both firms of

$$\begin{aligned}
\widetilde{\Pi}_c^{A^*} &= \frac{t(5\delta+12)}{24} + \frac{t(a^2(-3601\delta^3+3408\delta^2+22896\delta-31104)-4a(54-31\delta)(43\delta^2-9\delta-108))}{24(54-31\delta)^2} \\
\widetilde{\Pi}_c^{B^*} &= \frac{t(7\delta+24)}{48} + \frac{t(a^2(983\delta^3+6624\delta^2-32400\delta+31104)-6a(54-31\delta)(29\delta^2+116\delta-288))}{48(54-31\delta)^2}.
\end{aligned}$$

The first part of both expressions captures firms' profits if there would be no monopolistic segment. It indicates that both firms' profits decrease when firm A faces a no-discrimination constraint. Firm B suffers more than firm A.[8] The second part reflects the positive effect on both firms' profits in the competitive segment when the size of the monopolistic segment augments. Firm A's pricing behavior is less aggressive with the size of the monopolistic segment since the incentives to protect its monopoly rents increase.

Finally, firms' total discounted profits on the *entire market* are obtained by adding up the results in the competitive and monopolistic segments, resulting in

$$\widetilde{\Pi}^{A^*} \equiv \widetilde{\Pi}_m^{A^*} + \widetilde{\Pi}_c^{A^*} \text{ and } \widetilde{\Pi}^{B^*} \equiv \widetilde{\Pi}_c^{B^*}.$$

We now interpret the effects of an asymmetric no-discrimination contraints on competition. Consider first a situation where the asymmetric no-discrimination constraint only applies *within* the competitive segment (i.e. the size of the monopolistic segment is zero). Overall competition for both firms is now keener than in the benchmark case: the commitment effect induces firm B to price more aggressively in the first period and the price sensitivity effect makes first period

[8] This result should not be seen as contradicting Thisse and Vives (1988). They show that a firm has a profit incentive to engage in price discrimination whenever its rival makes use of a uniform pricing strategy. From this reasoning, firm B should perform better than firm A. The following two elements explain however why firm B performs worse. First, the no-discrimination constraint imposed on firm A makes it an unattractive poacher in period 2. This commitment effect forces firm B to charge a lower price than A in the first period. Since both firms serve half of the market, firm B performs worse in period 1. Second, firm B cannot commit not to price discriminate in the second period. In line with Thisse and Vives (1988), firm B finds it optimal to charge two prices $\widetilde{p}_2^{AB^*} < \widetilde{p}_2^{A} < \widetilde{p}_2^{BB^*}$ since firm B's profits are lower.when charging only one price in period 2. Firm B's profits, however, suffer more from the commitment effect and explain its worse performance.

demand more elastic. Next, we add an asymmetric no-discrimination constraint *across* segments by considering a positive size for the monopolistic segment, and evaluate it for varying size of a. For low enough a, overall competition for both firms is still keener than in the benchmark case. However, for a high enough a, competition on the competitive segment becomes less severe so that B's profits are higher than in the benchmark model. That is, firm B enjoys higher overall profits with an asymmetric no-discrimination constraint since firm A now sufficiently weakens its competitive response. Firm A's profits suffer from the asymmetric no-discrimination constraint when δ is not too small. Intuitively, when δ is small (i.e. close to zero), our setup approaches a static analysis: firm A then may increase its profits from being able to commit to non-discrimination for at least some range of a (as in Armstrong and Vickers (1993)).

Our discussion above is summarized in Result 1.

Result 1. *Compared to the benchmark model, an asymmetric no-discrimination constraint leads to (i) firms' joint profits to increase if and only if the monopolistic segment is sufficiently large; (ii) firm A's profits to decrease for δ not too small; and (iii) firm B's profits to increase if and only if the monopolistic segment is large enough.*

Proof: See Appendix.

4 Asymmetric no-discrimination constraint: welfare analysis

We now study how an asymmetric no-discrimination constraint impacts welfare on the competitive segment. We make a distinction between total welfare and consumer welfare. Total welfare in our setting is determined by frictions, i.e. transportation costs. Consumer welfare, however, also takes into account prices incurred by consumers. Results for both total welfare and consumer welfare hinge on the size of the monopolistic segment. We therefore start our discussion by considering a small monopolistic segment a. To identify forces, take a to be zero. This implies that the asymmetric no-discrimination constraint is only a prohibition to not price discriminate by firm A within the competitive segment. With a equal to zero, the asymmetric no-discrimination constraint provides greater total welfare and consumer welfare compared to the benchmark model. These results stems from two complementary forces. First, the restriction improves the second-period allocation of consumers as fewer consumers visit their non-nearby provider, whereas the first-period allocation is identical to our benchmark model. The asymmetric no-discrimination constraint, therefore, results in a higher total welfare. Second, overall competition with the asymmetric no-discrimination constraint is greater than when firms can set prices unrestrainedly. Consumer welfare is therefore higher with the no-discrimination constraint as both prices and frictions incurred by consumers are lower.

Consider now the forces when the size of the monopolistic segment becomes positive and increases further. That is consider the situation where one adds a no-discrimination constraint across segments – monopolistic and competitive segments to the no-discrimination constraint within the competitive segment. As long as a is small, total welfare and consumer welfare are higher with the asymmetric no-discrimination constraint: the negative welfare impacts of the asymmetric no-discrimination constraint across segments does not dominate the positive welfare effects of an asymmetric no-discrimination constraint within the competitive segment. However, a large monopolistic segment increases prices and stimulates inefficient travelling in the competitive segment. This leads to lower consumer welfare and total welfare. Consumer welfare and total welfare become lower than in the benchmark model when a becomes large. The asymmetric no-discrimination constraint then is mainly driven by its across market segments impact, and therefore dampens competition in the competitive segment and induces firm B to enjoy larger profits than in the benchmark model. Therefore the asymmetric no-discrimination constraint generates redistributive effects: it favours consumers in the monopolistic segment by introducing competition at the expense of consumers in the competitive segment where competition decreases. Furthermore, it stimulates the impact of frictions as more consumers visit their non-nearby supplier, leading to lower total welfare. Finally, an asymmetric no-discrimination constraint unambiguously increases consumer surplus in the monopolistic segment.

The above discussion on consumer and total welfare is summarized in result 2.

Result 2. *Compare the asymmetric no-discrimination constraint to the benchmark model with unrestricted pricing and consider the competitive segment. We find that (i) the asymmetric no-discrimination constraint strictly increases total welfare as long as the size of the monopolistic segment is not too large; otherwise total welfare is higher in the benchmark model, and (ii) the asymmetric no-discrimination constraint strictly increases consumer welfare as long as the size of the monopolistic segment is not too large; otherwise the benchmark model yields higher consumer welfare.*

Proof: See Appendix 4.

We now compare this result to Armstrong and Vickers (1993) and further discuss what would happen if entry were modelled. Armstrong and Vickers (1993) have shown that in a static model, an asymmetric no-discrimination constraint weakens competition and reduces welfare on the competitive segment if the entrant is already in the market. In our model, we have shown the opposite when the monopoly segment is small enough: (i) the asymmetric no-discrimination constraint reduces all firms' profits (Result 1), and (ii) the asymmetric no-discrimination constraint leads to greater social welfare (Result 2). This stands in strong contrast with the Armstrong and Vickers result. However, when the monopoly segment is more important to firm A, all firms' profits increase from an asymmetric no-discrimination constraint and the Armstrong and Vickers results reappear in our setting. In other words, when the monopoly segment is small enough, the effect of an asymmetric no-discrimination constraint within the competitive segment (i.e., a dynamic behaviour-based price discrimination constraint) outweighs the effects from an asymmetric no-discrimination constraint across segments (i.e., a static third-degree price discrimination constraint). The opposite results holds when the monopoly segment is sufficiently important.

Armstrong and Vickers (1993) also notice that when the entrant must still decide to enter, an asymmetric no-discrimination constraint may be pro-competitive when absent such a constraint, keener competition results in preventing profitable entry. A no-discrimination constraint may then serve as an entry-enhancing and pro-competitive policy measure. Our analysis has shown that this entry-enhancing feature of an asymmetric no-discrimination constraint only carries over to our setting when the size of the monopolistic segment is sufficiently large as then the entrant's profits increase. However, when the size of the monopolistic segment is small and the entrant's profits decrease, an asymmetric no-discrimination constraint may result in firm B not entering the market, leaving firm A with a monopoly. Summing up, if entry were costly, the probability of entry might be lower in the presence of an asymmetric no-discrimination constraint as firm B might not be able to recover the fixed cost of entry. Whether ex ante welfare would be greater with or without such an asymmetric no-discrimination constraint depends therefore on the size of the monopoly segment.

We conclude the welfare section by discussing the welfare implications of an asymmetric no-discrimination constraint which would apply only *across market segments but not within* the competitive segment. In other words, poaching within the competitive segment would be allowed but firm A would need to charge the same price to its loyal customers on the competitive segment and its customers on the monopolistic segment. From a welfare perspective, such a no-discrimination constraint is dominated by an asymmetric no-discrimination constraint within the competitive segment and across segments. Total welfare and consumer welfare are lower when the asymmetric no-discrimination constraint only applies across market segments compared to when it also applies within the competitive segment. This may explain why an asymmetric no-discrimination constraint across market segments but not within the competitive segment is not observed. This is in line with the actual practice of universal service obligation restrictions where a no-discrimination constraint applies first within market segments, or applies both within and across market segments.

5 Conclusion and policy implications

This paper has analysed the competitive and welfare effects of an asymmetric no-discrimination constraint. A regulator or competition authority typically imposes such a constraint in an oligopoly only on the one firm with significant market power. In our model the firm with significant market power is the only firm serving a certain part of the market (the monopolistic segment), whilst facing competition on another part (the competitive segment). In a regulatory context this firm can be the former state monopolist after the market has been liberalised and competition has been introduced in part of the market. In a competition policy context this firm can be a dominant firm that may abuse its position by applying price discrimination.

The asymmetric no-discrimination constraint that we have studied prohibits both behaviour-based price discrimination within the competitive segment and third-degree price discrimination across the monopolistic and competitive segments. These forms of price discrimination are often observed in a regulatory and competition policy context, judging by actual regulatory measures and by case law. The policy justifications for the constraint include the prevention of competition-reducing exclusionary strategies by dominant firms, the protection of certain customer groups that face no choice of supplier and that risk paying excessively high prices, and the encouragement of entry by weakening the price responses to entrants by the incumbent.

Our main findings and their policy implications are as follows. First, an asymmetric no-discrimination constraint is only welfare-enhancing if the monopolistic segment is not too large. For a competition authority with the objective to optimize total or consumer welfare this implies the following. In the case of "super-dominance", where the monopolistic segment is very large relative to the competitive segment, imposing an asymmetric no-discrimination constraint on the dominant firm does not improve welfare. Only in circumstances of weak dominance does the constraint enhance welfare.

Whilst most competition authorities are interested mainly in optimising total and consumer welfare, regulators often pro-actively encourage entry to create more competition. We find that an asymmetric no-discrimination constraint only leads to higher profits for the entrant if the monopolistic segment is large enough. Practically this implies that the policy objective of encouraging entry is not served by the asymmetric no-discrimination constraint if the monopolistic segment is small relative to the competitive segment. In recently liberalised sectors the incumbent typically has a relatively large monopolistic segment; in these circumstances the constraint imposed by the regulator does encourage entry. In later stages after liberalisation, however, once the competitive segment has become large relative to the monopolistic segment, the asymmetric constraint effectively reduces the further growth of entrants.

6 Appendix

In order to have an internal solution where firm A is active both on its own first-period turf and on firm B's first-period turf, we need to have that $0 < \widetilde{\alpha} < \widetilde{x} < \widetilde{\beta} < 1$. The most stringent condition is that $\widetilde{\alpha} > 0$ which is satisfied whenever $a < \frac{54-31\delta}{52-27\delta} \equiv a_{\max}$. So we will assume that the monopolistic segment is always sufficiently small, i.e. smaller than $a_{\max}$ such that firm A is active also on its first-period turf of the competitive segment.

Proof of Result 1:

(i) Define the difference in firms' joint profits on the competitive segment between the asymmetric no-discrimination constraint and the benchmark model as $\Delta\Pi_{A+B} \equiv \widetilde{\Pi}_c^{A^*} + \widetilde{\Pi}_c^{B^*} - 2\Pi_c^{i^*}$. The function $\Delta\Pi_{A+B}$ is quadratic in a, and $\Delta\Pi_{A+B} = 0$ whenever $a = \{a_1, a_2\}$ with $0 < a_1 < a_{\max} < a_2$. Moreover since $\Delta\Pi_{A+B} \mid_{a=0} = -77\delta t/144 < 0$ and $\partial^2\Delta\Pi_{A+B}/\partial a^2 < 0$, firms' joint profits on the competitive segment increase whenever $a_1 < a < a_{\max}$.

(ii) Define the difference in firm A's profits on the competitive segment between the asymmetric no-discrimination constraint and the benchmark model as $\Delta\Pi_A \equiv \widetilde{\Pi}_c^{A^*} - \Pi_c^{A^*}$. Note that $\Delta\Pi_A \mid_{a=0} = -17\delta t/72 < 0$. Further, $\Delta\Pi_A$ is a quadratic expression in a and exhibits an inverse U-shape. Simulations reveal that $\Delta\Pi_A$ remains negative for all possible values of a as long as δ is larger than approximately 0.35. Put differently, as long as δ is larger than 0.35, firm A's profits on the competitive segment are harmed by the asymmetric no-discrimination constraint. For lower values of δ, the impact of the asymmetric ban on firm A's profits hinges on the size of a.

(iii) Define the difference in firm B's profits on the competitive segment between the asymmetric no-discrimination constraint and the benchmark model as $\Delta\Pi_B \equiv \widetilde{\Pi}_c^{B^*} - \Pi_c^{B^*}$. The function $\Delta\Pi_B$ is quadratic in a, $\partial^2\Delta\Pi_B/\partial a^2 > 0$, and $\Delta\Pi_B = 0$ whenever $a = \{a_{1B}, a_{2B}\}$ with

$a_{1B} < 0 < a_{2B} < a_{\max}$. Since $\Delta\Pi_B \mid_{a=0} = -43\delta t/144 < 0$ and $\partial\Delta\Pi_B/\partial a \mid_{0\leq a\leq a_{2B}} \geq 0$, we have that $\Delta\Pi_B > 0$ for all $a_{2B} < a < a_{\max}$.

Proof of Result 2

Consider first the result regarding total welfare which is part (i) of the result. We focus on the non-financial outlays, i.e. inefficiencies stemming from transportation costs, to discuss total welfare. The lower the non-financial outlays, the higher total welfare. Non-financial outlays in the benchmark model are

$$\frac{t}{4} + \delta t \left[\frac{2}{3}\frac{1}{6} + \frac{1}{3}\frac{7}{12}\right] = \frac{t\,(11\delta + 9)}{36}.$$

Non-financial outlays in the model with uniform pricing obligation become

$$t\left(\frac{x^2}{2} + \frac{(1-x)^2}{2}\right) + \delta t\left(\frac{\alpha^2}{2} + \frac{(\beta + x)(\beta - x)}{2} + \left(1 - \frac{(\alpha + x)}{2}\right)(x - \alpha) + \left(1 - \frac{(1+\beta)}{2}\right)(1 - \beta)\right)$$
$$= \frac{t\left(a^2(2073\delta^3 - 4480\delta^2 - 4464\delta + 10368) + 2a\delta(17\delta - 36)(31\delta - 54) + (9\delta + 8)(31\delta - 54)^2\right)}{(31\delta - 54)^2}.$$

As we can see, the non-financial outlays under uniform pricing obligation are quadratic in the size of the monopolistic segment a. It is easy to show that for $a = 0$, the non-financial outlays in the benchmark model are higher than for the uniform pricing obligation. The two equations above become identical to each other when $a = a_1$,where a_1 is the highest root which makes these two equations identical. (The lowest root is negative and therefore not relevant.) Notice that a_1 is smaller than $a_{\max}$. In sum, we therefore have shown that for $0 \leq a < a_1$ total welfare is strictly higher under the uniform pricing obligation. For $a_1 \leq a \leq a_{\max}$, total welfare is higher under the benchmark model.

Consider now consumer surplus which is part (ii) of our Result. To address the issue of consumer surplus, we compare total outlays on the competitive segment – financial outlays and non-financial outlays. This boils down to the sum of the non-financial outlays and the firms profits on the competitive segment.

Start with the benchmark model. Firms' profits on the competitive segment are

$$\Pi_c^A + \Pi_c^B = \frac{t\,(8\delta + 9)}{9}.$$

Adding this to the non-financial outlays of

$$\frac{t\,(11\delta+9)}{36}$$

yields the total outlays

$$\frac{t\,(43\delta+45)}{36}.$$

Financial outlays on the competitive segment are

$$\begin{aligned}
\widetilde{\Pi}_c^{A*} &= \frac{t(5\delta+12)}{24} + \frac{t(a^2(-3601\delta^3+3408\delta^2+22896\delta-31104)-4a(54-31\delta)(43\delta^2-9\delta-108))}{24(54-31\delta)^2} \\
\widetilde{\Pi}_c^{B*} &= \frac{t(7\delta+24)}{48} + \frac{t(a^2(983\delta^3+6624\delta^2-32400\delta+31104)-6a(54-31\delta)(29\delta^2+116\delta-288))}{48(54-31\delta)^2}.
\end{aligned}$$

Total outlays for the uniform pricing obligation are the sum of these financial outlays and the previously mentioned non-financial outlays.

Evaluated for $a=0$, we find that the total outlays for the benchmark model are larger than those for the uniform pricing obligation since the difference between the two models then equals

$$\frac{t(61\delta+120)}{96}.$$

Furthermore, evaluated for $a=0$ we find that total outlays increase in a for the model with

uniform pricing whereas they are constant for the benchmark model. More general (i.e. for all admissible values of $a<a_{\max}$) we have that the total outlays for the two models are identical when $a=a_2$, with $a_2<a_{\max}$. Again the second root for which the total outlays are identical lies outside the relevant range. We therefore have shown that for $0\leq a<a_2$ consumer welfare is strictly higher under the uniform pricing obligation. For $a_2\leq a\leq a_{\max}$, consumer welfare is higher under the benchmark model. Finally, we find that $a_1\geq a_2$ if δ is low whereas $a_2\geq a_1$ otherwise.

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