Price-Matching With Supplier Power

Kenneth S. Corts*

Rotman School of Management; University of Toronto

March 8, 2018

Abstract

The dominant view in the literature on price-matching policies is that such policies soften price competition and raise prices. However, this literature examines models in which the firms adopting these policies interact strategically only with each other and not, in particular, with upstream firms with market power in an intermediate goods market. I consider the price, profit, and welfare effects of price-matching policies adopted by firms that face powerful suppliers. The analysis shows that the presence of such suppliers may both undermine the value of price-matching policies to downstream firms, reducing incentives for adoption, and also exacerbate the effects of such policies if adopted.

1 Introduction

A long theoretical literature establishes the tendency of apparently pro-competitive pricing policies—including "price-matching policies" and "low-price guarantees"—to soften price competition. Typically, this softening of price competition raises seller profits, leading to the adoption of such policies by sellers. However, this literature tends to demonstrate advantages of price-matching policies for at least some firms in any particular market, suggesting that there is virtually always at least some firm that would benefit from adopting such a policy. However, these policies are far from ubiquitous in practice. In this paper, I demonstrate one important downside to these policies, illuminating a countervailing force that may limit the attractiveness of these policies and contribute to their limited use in practice. In contrast to the existing literature, I consider the possibility that the suppliers to the firms in question are not perfectly competitive but instead have market power themselves in the upstream market. I show that the adoption of price-matching policies in the downstream market changes the pricing incentives in the upstream market. In particular, price-matching policies limit the downstream pass-through of upstream price increases, making implied demand in the upstream market more inelastic and creating incentives for upstream firms to set higher prices. These increased input prices tend to depress downstream profits, while softened downstream price competition tends to raise them. I show that for a wide range of parameter values, the input price-raising effect outweighs the competition-softening effect, and price-matching policies lower downstream profits for firms whose upstream suppliers have significant market power.

The analysis of this paper considers three alternative models of upstream competition. In all cases, I consider downstream firms that compete in price and face a differentiated products demand system. First, I consider perfectly a competitive upstream market, in keeping with the assumption maintained in the existing

*105 St. George St., Toronto, Ontario M5S 3E6; kenneth.corts@rotman.utoronto.ca.

literature. This would be applicable, for example, for the commoditized items resold by competing retailers, potentially including unbranded or "lightly branded" products such as eggs, meat, dairy, produce, and so on, in grocery stores, or cables, headphones, and other accessories in electronics retailers. Second, I consider a monopolized upstream market, which would be applicable to a situation in which, for example, competing retailers sell the same highly branded item, such as cereals and soft drinks in grocery stores or computers, televisions, and major appliances in electronics retailers. Finally, I consider "vertical structure monopolies", where each downstream seller is the unique downstream user of or channel for an individual upstream firm's intermediate product. This model requires careful interpretation, because for price-matching to be applicable downstream, the downstream products must be comparable or even "the same" in some meaningful sense, despite the fact that each downstream firm is working with a different upstream supplier. This would be applicable for example in cases where downstream firms sell competing products that are similar enough to qualify under the rival's price-matching policy, but where each downstream firm contracts for labor with a different union, procures its capital or technology (with some lock-in or switching costs) from different suppliers (e.g., two airlines serve the same routes with different equipment), or where the downstream products are ultimately identical (e.g., an identical book or DVD) but where the different downstream firms face upstream prices set by different wholesalers (and there is some at least short-term lock-in to those arrangements).

The literature on price-matching policies is surveyed in two comprehensive policy-oriented works (M. Hviid, 2010, and L. Aguzzoni et al., 2012) that contain detailed references and exhaustive consideration of the many models analyzed in the literature. Both surveys emphasize that there are four main logics for the effects of price-matching policies demonstrated in the literature. Papers such as Salop (1986) and Hviid and Shaffer (1999) demonstrate that price-matching policies may reduce incentives for price-cutting since price cuts are no longer as effective in stealing market share from a seller with a price-matching policy. Other papers such as Mao (2005) and Yankelevich (2016) argue that price-matching policies may limit the intensity of endogenous optimal consumer search, raising equilibrium prices. Both of these logics tend to imply negative welfare consequences for price-matching. Other papers such as Moorthy and Winter (2006) argue that with heterogeneous firms price-matching policies may be more costly for high-cost firms or naturally high-priced firms (those with a large captive consumer segment, for example) and thus may be adopted only by lower-priced firms, rendering price-matching policies a credible signal of price that may improve welfare for at least some consumers. And still other papers such as Corts (1996) argue that with heterogenously informed consumers price-matching may facilitate price discrimination, which typically lowers prices for at least some consumers.

While the literature considers many different assumptions about consumer preferences, consumer information, consumer search processes, and firm costs, no existing paper considers the interaction between price-matching in one market and the nature of competition in a vertically related market. This paper therefore enriches our understanding of the effects of these price-matching policies. By illuminating an additional set of considerations that affect the attractiveness of effectiveness of price-matching policies, it may assist competition authorities in assessing industries and markets in which such policies are of special concern and it may suggest additional questions and analysis to such authorities as they assess the competitive effects of such policies in particular circumstances.

2 Model

This paper considers the effects of price-matching policies in the downstream market of a two-tiered vertical structure. The model encompasses a number of variations in the structure of the upstream market, but in every case the downstream market consists of two symmetric, differentiated, price-setting firms. The timing always proceeds as follows. First, whether the downstream firms have price-matching policies is determined. This is then observed by all upstream and downstream firms. In the main model, the existence or non-existence of these policies is exogenous, with endogenous adoption discussed briefly in the conclusion. Second, upstream prices are determined by a standard process that depends on the particular model. These prices are then observed by both downstream firms. Third, downstream prices are set in a simultaneous pricing game subject to the existence of the price-matching policies. This basic structure is standard in this literature, in which the upstream price-setting phase is normally suppressed by an assumption that the downstream firms' input prices are exogenous, as in a competitive upstream market with upstream pricing at a constant marginal cost.

In the third stage, two symmetric downstream firms (or retailers), denoted D_i, $i = 1, 2$, compete in prices, simultaneously setting prices p_i. Demand in this downstream market is given by a standard differentiated products linear demand system, where each firm i's quantity demanded is given by $q_i = a - bp_i + dp_j$, for $a, b, d > 0$ and $b > d$. This last assumption is the standard assumption in this canonical model that ensures both that the game exhibits the usual strategic complementarity and that the collusive price is finite (i.e., that aggregate demand is downsloping in a common price). Marginal costs not associated with the input acquired from the upstream market are, for both firms, normalized to zero. Together with a normalization that one unit of upstream input is required for each unit of downstream output, this implies that, for each downstream firm, marginal cost equals the upstream (or wholesale) price of the input, which is denoted w_i. Upstream marginal cost is similarly normalized to zero.

2.1 Solution concept

In general, this paper takes the standard approach to games with such timing in focusing on subgame perfect equilibrium. This concept requires that equilibrium strategies represent equilibrium strategies at each stage of the game, including in particular the stages that include simultaneous pricing subgames. Because some of the pricing subgames, in particular those with price-matching policies, permit multiple equilibria in prices–either wholesale or retail, depending on the model–an additional revision to the solution concept is required for unique analytical predictions. The source of the multiple equilibria is quite specific, and there is an intuitive resolution of the equilibrium selection problem in this particular case. This intuitive approach, which will be described more fully later when the workings of the model are clear, essentially involves ruling out the play of weakly dominated strategies in the simultaneous pricing subgames. This, in turn, corresponds precisely to the trembling hand perfect equilibrium refinement, which is therefore employed throughout the paper.

2.2 Third-stage downstream pricing equilibrium

The structure outlined thus far is sufficient to fully characterize the pricing equilibrium in the third stage subgame, which will apply to all variants of the upstream market modeled later. This is a common pricing subgame that is straightforward to analyze, though one must take care to account for the existence of price-matching policies since they affect quantities demanded at asymmetric prices. Each firm D_i maximizes its profit $(p_i - w_i)(a - bp_i + dp_j)$. Absent price-matching, it is straightforward to obtain the best-response functions from the first-order conditions, $p_i^{BR} = (a + bw_i + dp_j)/(2b)$, which can in turn be solved for the equilibrium downstream prices in the third-stage subgame,

$$p_i^*(w) = \frac{(2b + d)a + 2b^2 w_i + bdw_j}{4b^2 - d^2}.$$

Note that the standard (no price-matching) equilibrium in this standard model exhibits the expected properties: the best-response function exhibits strategic complementarity, and the equilibrium price is increasing in both firms' marginal costs, although more quickly in one's own marginal cost.

With price-matching, the best-response and equilibrium calculations are a bit more complex and must be treated separately from the no-price-matching prices. Best-response and equilibrium prices in the case of price-matching will be designated by $\widetilde{p}_i$. At any given pair of prices, the lower priced downstream firm controls *both* prices as a consequence of the price-matching policy of the higher-priced firm being binding; the chosen price of the higher-priced firm is irrelevant to the buyer. Thus, when differentiating a firm's profit function at prices lower than the rival's price, one must account for the fact that the other firm's effective price is equal to the lower firm's price, and therefore moves with changes in the lower-priced firm's price. As a result, the lower-priced firm is picking from price pairs along the $p_i = p_j$ 45-degree line, up to the other firm's price. The best-response price is therefore given as $\widetilde{p}_i^{BR} = \arg\max_p (p - w_i)(a + (b - d)p)$ subject to the constraint that $p \leq p_j$.

This is the point at which the potential for multiple equilibria arises in the retail pricing subgame. The potential for multiple equilibria arises because of the constraint that, under price-matching, neither firm can achieve an effective price higher than the other firm's price. Suppose for example that for some particular w both firms have the same profit-maximizing price p_0 along the $p_i = p_j$ 45-degree line. Then $\widetilde{p}_i = \widetilde{p}_j = p_0$ is one equilibrium of that simultaneous pricing subgame with price-matching. However, so is every $\widetilde{p}_i = \widetilde{p}_j = p'$ for any $p' < p_0$. This is because of the constraint that neither firm can unilaterally achieve an effective price higher than the rival's price. At the same time, it is clear that for any $p' < p_0$ each firm is playing a weakly dominated strategy. By choosing $\widetilde{p}_i = p_0$ instead of $\widetilde{p}_i = p'$, firm i would not change its profits under the assumed play of the other firm ($\widetilde{p}_j = p'$); however, the firm would benefit in the event that instead the other firm chooses *any* higher price $\widetilde{p}_j > p'$. Thus, all $\widetilde{p}_i < p_0$ are weakly dominated strategies for firm i in this pricing subgame, and all $\widetilde{p}_i < p_0$ are ruled out by trembling hand perfect equilibrium. As a result, this refinement selects the equilibrium in which both firms set price equal to their own profit-maximizing price along the $p_i = p_j$ 45-degree line, and the effective equilibrium price to buyers is therefore the lower of those two prices as a result of the price-matching policies. A precisely analogous logic applies to the simultaneous wholesale price-setting subgame in the model in which it arises.

Returning now to the derivation of equilibrium downstream prices for any particular upstream prices, it is straightforward to derive the profit-maximizing price for one firm i ignoring the constraint of the other firm's price; as argued above, this gives the equilibrium prices in this subgame:

$$\widetilde{p}_i^*(w) = \frac{a + (b - d)w_i}{2(b - d)}.$$

When assessing quantity demanded and profits, one must apply the effective prices net of the price-matching policies. The realization of demand and profits is as if both firms set price equal to the lower of these prices: $\min_i \widetilde{p}_i^*$.

2.3 The extent of product differentiation

The extent of product differentiation in this model is effectively captured by the relative magnitudes of b and d. If $d = 0$, product demands are entirely independent, as firm j's price drops out of firm i's demand function. As d approaches b, the two products become a particular kind of perfect substitutes: a price increase by firm i creates a decrease in quantity demanded that is completely offset by an increase in quantity demanded for firm j. Since every buyer who leaves from i switches to firm j at existing prices, this is a kind of perfect substitution; however, because a firm does not lose all its sales by raising price above the rival it is not perfect substitution in the usual sense employed in simple Bertrand competition. As d approaches b, aggregate demand also becomes perfectly inelastic, which need not be the case in simple Bertrand competition for example.

To this point, I have assumed only that $d < b$, which is what is required by the usual regularity conditions; this suffices to ensure that all relevant second-order conditions hold, that joint profits are concave in a common price, and that the best-response functions always have slope less than one as required by the usual stability conditions. It is useful to define an additional condition on the parameters in this demand system, which is used in some, but not all, of the analytical results of the following sections. This is intended to bound d away from b, because the model exhibits peculiar behavior near extreme values of d approaching b. Consider for example the expressions for $p_i^*(w)$ and $\widetilde{p}_i^*(w)$ given just above–the expressions for downstream equilibrium prices without and with price-matching policies, respectively. Comparing these expressions, one can see immediately that they yield identical downstream prices with and without price-matching for $d = 0$. This is entirely logical, as price-matching policies clearly play no role across products with independent demands. Comparing these expressions in the limit as $b \to d$, one can see that $p_i^*(w) \longrightarrow w + a/b$, while $\widetilde{p}_i^*(w) \to \infty$, increasing without bound as price-matching allows collusive pricing in the face of perfectly inelastic aggregate demand. Therefore, in some of the analysis it proves useful to bound d away from b, ensuring that the products are not perfect substitutes. The need for this condition (in order to simplify results) arises only in one particular model of upstream competition, and the condition I employ is most easily motivated by features of that model. I therefore wait to define this specific condition bounding d away from b until the appropriate section.

3 The Effect of Price-Matching on Equilibrium Prices

This section proceeds in four steps, building on the analysis of the pricing subgame laid out above, which applies to all upstream market structures considered. The first subsection lays out results based on the analysis of the pricing subgame, which therefore hold for all upstream models. Each of the subsequent three subsections posits a particular upstream market structure and derives equilibrium upstream (wholesale) and downstream (retail) prices with and without price-matching policies. The regimes considered are: the standard model of a competitive upstream market with exogenous prices (at the upstream marginal cost); a monopolized upstream market with a single firm serving both downstream firms; and a "vertical monopoly" upstream market structure in which each downstream firm faces a single (but different) upstream supplier.

3.1 Effects of Price-Matching on Downstream Pricing

Two important results follow immediately from the analysis of the downstream pricing subgame. These results follow directly from analysis of the expressions derived above for $p_i^*(w)$ and $\widetilde{p}_i^*(w)$.

Proposition 1 *For given upstream prices w, price-matching raises downstream margins and prices ($\widetilde{p}_i^*(w) > p_i^*(w)$, for all i, w).*

Proposition 2 *Price-matching decreases the rate of downstream pass-through of upstream prices, both for industry-wide changes ($\frac{\partial \widetilde{p}_i^*(w)}{\partial w_0} < \frac{\partial p_i^*(w)}{\partial w_0}$, where $w_i = w_j = w_0$) and for firm-specific changes ($\frac{\partial \widetilde{p}_i^*(w)}{\partial w_i} < \frac{\partial p_i^*(w)}{\partial w_i}$).*

The first of these results follows directly from the traditional arguments about the tendency of price-matching to raise prices. By reducing the ability of firms to gain sales through price-cutting, price-matching reduces the elasticity of firm-level demand. This raises best-response prices, shifting out best-response curves and leading to higher equilibrium prices. The second of these results follows from a related logic. When a downstream firm experiences an increase in marginal cost (through an increase in the upstream price), it suffers a loss in volume if the firm holds its margin constant. This upsets the margin-volume tradeoff embodied in the first-order condition, creating an incentive to cut margins to regain volume and restore that optimal balance. Because price-matching reduces the elasticity of demand, the firm needs to reduce its margins by a greater amount to restore that balance for any given increase in wholesale prices, meaning that the margin reduction offsets a larger fraction of the wholesale price increase. As a result, the final price (wholesale price plus margin) rises less quickly with increases in wholesale price. These two effects of price-matching on the downstream pricing subgame–higher margins and lower pass-through–together form the foundation for the results that follow, in which this game is embedded in a broader game that endogenizes upstream price-setting.

3.2 Competitive upstream market structure

This subsection restates the main result in the existing literature in terms of the present model for purposes of subsequent price comparisons. The existing price-matching literature maintains the assumption that firms engaged in price-matching face exogenous marginal costs, consistent with a competitive upstream market. Recalling that the upstream marginal cost is also assumed to be zero, the wholesale prices will also be zero in this case: $w_i = w_j = 0$. It is straightforward to apply the results above to determine the downstream prices that prevail in this case, with and without price-matching:

$$p_i^* = p_j^* = \frac{a}{2b-d}, \text{ and}$$

$$\widetilde{p}_i^* = \widetilde{p}_j^* = \frac{a}{2(b-d)}.$$

It is straightforward to verify that $\widetilde{p}_i^* = \widetilde{p}_j^* > p_i^* = p_j^*$ for any $d > 0$. In this model, the wholesale price is fixed at 0 by the assumption of a competitive upstream market. Price-matching, in accordance with Proposition 1, raises downstream margins and prices. This yields the next proposition, which restates the results of the traditional price-matching literature..

Proposition 3 *Assume the upstream market is competitive. Then price-matching has no effect on upstream prices and raises downstream margins and prices.*

3.3 Monopoly upstream market structure

A single upstream firm selling to the two downstream firms sets a single price–without loss of generality, given the model's symmetry–to maximize its profit from the sum of the sales to both downstream firms.

Because the symmetric downstream firms will set symmetric prices in the third stage, the first-order condition determining this wholesale price reduces to a simple expression. The upstream firm maximizes the sum over two downstream firms of its margin (w) times the quantity demanded at the relevant third-stage price derived above: $2w[a + (b - d)p^*(w)]$, where $p^*(w)$ may or may not have a tilde depending on whether one is considering the case of price-matching.

Without price-matching, at a symmetric $w_i = w_j = w$, the third-stage price simplifies to $p^*(w) = \frac{a+bw}{2b-d}$, and therefore the profit function simplifies to $2w(a + bw)/(2b - d)$. It is straightforward to determine from the first-order condition that the upstream firm's profit is maximized at

$$w^* = \frac{a}{2(b-d)},$$

which implies a downstream price of

$$p_i^* = p_j^* = \frac{(3b-2d)a}{2(b-d)(2b-d)}.$$

With price-matching, at a symmetric $w_i = w_j = w$, the third-stage profit function simplifies to $w[a - (b - d)w]$. It is straightforward to determine from the first-order condition that the upstream firm's profit is maximized at

$$\widetilde{w}^* = \frac{a}{2(b-d)},$$

which implies a downstream price of

$$\widetilde{p}_i^* = \widetilde{p}_j^* = \frac{3a}{4(b-d)}.$$

As shown in Proposition 1, price-matching raises downstream margins in this model for any given upstream prices. In this model, the upstream monopolist can respond to these higher anticipated margins when it chooses its wholesale price, making the net effect on final downstream prices ambiguous in principle. This feature of the model, which also applies to the model of vertical monopolies considered later, is a new feature not previously contemplated in the literature.

There are two competing forces at work in price-matching's effect on the upstream monopolist's choice of price. On one hand, Proposition 1's higher downstream margin (and therefore higher downstream price) at any given w reduces quantity and tips the margin-volume tradeoff in favor of *lowering* wholesale price in order to generate additional sales. On the other hand, Proposition 2's lower pass-through rate makes raising wholesale price less costly in terms of lost sales, which favors *raising* wholesale price. How these incentives net out will depend in general on the precise features of the model and the demand system. From inspection of w^* and $\widetilde{w}^*$ above, one can see that in this particular linear demand system these effects precisely balance each other out, and the upstream monopolist in fact does not adjust its wholesale price in response to downstream price-matching. It is straightforward to verify that $w^* = \widetilde{w}^*$, and that $\widetilde{p}_i^* = \widetilde{p}_j^* > p_i^* = p_j^*$ for any $d > 0$.

Proposition 4 *Assume the upstream market consists of a monopolist that serves both downstream firms. Then price-matching has no effect on upstream prices and raises downstream margins and prices.*

3.4 Vertical monopoly upstream market structure

When each downstream firm may buy from only its associated upstream firm, the upstream pricing game is again a simultaneous price-setting game. Each upstream firm sets its w_i to maximize its profits, which is the product of its margin (w_i) and the quantity demanded of the firm that it supplies, since downstream outputs translate one-for-one into inputs purchased from the designated upstream firm, at the pair of prices arrived at in the third stage downstream pricing subgame. Thus, each upstream firm i maximizes $w_i[a + bp_i^*(w) - dp_j^*(w)]$, where the $p^*(w)$ may have a tilde depending on whether one is considering the case with price-matching.

Without price-matching, it is easy to derive the upstream best-response function $w_i^{BR} = [(2b + d)a + bdw_j]/[2(2b^2 - d^2)]$, which can be solved for the upstream equilibrium wholesale price

$$w_i^* = w_j^* = \frac{a(2b + d)}{4b^2 - bd - 2d^2}.$$

This, in turn, implies third-stage downstream prices of

$$p_i^* = p_j^* = \frac{2a}{2b - d} \frac{3b^2 - d^2}{4b^2 - bd - 2d^2}.$$

With price-matching, each upstream firm chooses w_i to maximize its profits, recognizing that its associated downstream firm determines the effective downstream price only if it is the lower-priced firm, which is in turn true only if the upstream supplier is the lower-priced supplier. Given the model's symmetry and the equilibrium refinement described earlier, the equilibrium upstream prices in this game are obtained by maximizing each upstream firm's profits along the $w_i = w_j$ 45-degree line without regard to the other upstream firm's price (that is, assuming that the effective price for both firms is determined by one's own price together with the price-matching policy): $w_i = \arg\max_{w_i} w_i[a - (b - d)p^*(w_i, w_i)]$. This yields an equilibrium upstream price of

$$\widetilde{w}_i^* = \widetilde{w}_j^* = \frac{a}{2(b - d)},$$

which in turn implies a downstream equilibrium price of

$$\widetilde{p}_i^* = \widetilde{p}_j^* = \frac{3a}{4(b - d)}.$$

As for all of these upstream market structure models, price-matching raises downstream margins by Proposition 1. As in the model with an upstream monopolist, the upstream vertical structure monopolist in this third model can respond to these higher anticipated margins when choosing wholesale prices. Again, this makes the net effect of price-matching on final downstream prices ambiguous in principle.

Absent price-matching, when an upstream firm cuts its wholesale price its affiliated downstream firm also reduces its downstream price, leading to an increase in quantity sold, some of which represents an increase in market share, since its downstream price falls relative to the rival downstream's firm price. How aggressively each upstream firm wants to pursue such wholesale price-cutting depends on the rate of pass-through (higher pass-through makes price-cutting more appealing because a greater quantity increase results from a given price cut) and on the ability to capture market share by inducing a relative price difference in the downstream market.

Introducing price-matching into the downstream market has three effects on upstream pricing incentives. First, as with the single upstream monopolist model, price-matching increases downstream margins, reducing quantities at any given upstream prices, and favoring lower prices to restore the optimal volume-margin tradeoff. Second, price-matching eliminates the ability to capture an increase in market share. Since downstream price-matching ensures equal prices and thus (by symmetry of demand) equal quantities, each upstream firm is guaranteed to supply the inputs for 50% of the final market sales. Third, price-matching reduces the rate of pass-through of upstream price changes. The second and third of these effects powerfully undermine the incentive to engage in upstream price-cutting. In fact, comparison of the expressions for $\widetilde{w}_i^*$ in this model and the prior model reveal that downstream price-matching induces upstream pricing at the collusive level–that is, at the same level chosen in the prior model in which a single upstream monopolist supplied both downstream firms in the price-matching regime. Moreover, because in this model the competing upstream firms have incentives to engage in upstream price-cutting absent price-matching, the effect of price-matching policies is to raise upstream prices from a lower, more competitive level to a collusive level. As a result, the upstream equilibrium response to downstream price-matching is to raise upstream prices. This is easily verified by manipulation of the above expressions, which yields $\widetilde{w}_i^* = \widetilde{w}_j^* > w_i^* = w_j^*$. Since price-matching also raises downstream margins, it follows immediately (and can be verified algebraically) that price-matching increases downstream prices: $\widetilde{p}_i^* = \widetilde{p}_j^* > p_i^* = p_j^*$.

Proposition 5 *Assume the upstream market consists of two firms, one serving each downstream firm. Then price-matching induces equilibrium upstream prices equal to collusive upstream prices.*

Proposition 6 *Assume the upstream market consists of two firms, one serving each downstream firm. Then price-matching raises upstream prices, downstream margins, and downstream prices.*

4 The Effects of Price-Matching on Profits and Total Welfare

This section reinterprets the pricing results above in terms of the effects of price-matching on profits and total welfare. The analysis of total welfare is a straightforward exercise because total welfare is fully determined, given the simplicity and symmetry of the demand model, by the downstream prices. I present these summary results for each of the three upstream market structures previously considered.

4.1 Competitive upstream market

Proposition 7 *With a competitive upstream market, price-matching lowers total welfare, does not change upstream profits, and raises downstream profits..*

In this model upstream profits are zero with or without price-matching, by the assumption of a competitive upstream market. As demonstrated in proposition 3, downstream prices rise with price-matching, implying a decline in total welfare. It is easy to check algebraically that the prices found in the analysis above imply a higher profit with price-matching than without in this model. In fact, it is easy to see from that analysis that downstream prices under price-matching in this structure maximize joint profits of all firms, implying that downstream profits rise with price matching since the upstream shares continue to capture no profit. This restates the results of the traditional price-matching literature. Downstream firms have an incentive to engage in price-matching because it raises their margins and, with fixed upstream pricing, their profits.

4.2 Single upstream monopolist

Proposition 8 *With a single upstream monopolist, price-matching lowers total welfare, reduces upstream profits, and raises downstream profits.*

In this model the upstream price does not change with price-matching, but the downstream price increases per Proposition 4. This immediately implies a reduction in total welfare. Since higher downstream prices also imply a reduction in quantity at a fixed upstream price, upstream profits must fall as well. It is easy to verify that the downstream profits increase. In fact, downstream prices under price-matching maximize joint downstream profits conditional on the (unchanging) upstream price; thus, profits under price-matching must be strictly higher than at the strictly lower no-price-matching prices. Here, despite the fact that the upstream firm anticipates a different pricing regime and different equilibrium markups in downstream competition, it does not respond by raising or lowering its upstream price.

The fact that the upstream price stays exactly the same seems likely to be specific to this linear demand system. However, there remains the more general finding that there are competing effects with an ambiguous net impact: on one hand, lower final quantities would favor cutting upstream prices; on the other hand, lower rates of pass-through favor raising upstream prices. This result also suggests that monopoly upstream suppliers are unlikely to encourage downstream adoption of price-matching policies unless they have a means of extracting some of the increases in downstream profits through non-linear pricing such as two-part tariffs.

4.3 Vertical monopoly market structure

Proposition 9 *With upstream vertical structure monopolists, price-matching lowers total welfare. Defining* $d = \alpha b$*, profit effects depend on* α *as follows: for* $\alpha < 0.85$*, price-matching lowers both upstream and downstream profits; for* α *such that* $0.85 < \alpha < 0.95$*, price-matching raises downstream profits and lowers upstream profits; for* $\alpha > 0.95$*, price-matching raises both upstream and downstream profits. (All numerical thresholds are approximations of analytical solutions, as described in the text.)*

Since the analysis showed that in this model price-matching raises downstream prices due to higher margins on higher upstream prices, it follows immediately that total welfare falls. The analysis of profit levels is proved by algebraic manipulation of the expressions obtained by substituting closed-form solutions for w and p into the relevant profit functions. This is a long and involved algebraic exercise; however, in the end the analysis demonstrates that downstream profits rise with price-matching, defining $d = \alpha b$, if and only if $-4\alpha^5 - 4\alpha^4 + 31\alpha^3 - 4\alpha^2 - 52\alpha + 32 > 0$. Numerically, this is satisfied if and only if $\alpha > 0.85$, approximately. Using the same method, the comparison of upstream profit functions can be manipulated to demonstrate that upstream profits increase with price-matching if and only if $4\alpha^4 + 4\alpha^3 - 17\alpha^2 - 8\alpha + 16 > 0$. Numerically, this is satisfied if and only if $\alpha > 0.95$, approximately.

The analysis of earlier sections showed that in this vertical market structure price-matching causes both upstream and downstream firms to raise margins, leading to a higher final downstream price. This in turn implies that both upstream and downstream firms sell a lower quantity at a higher margin, which is insufficient on its own to identify changes in either upstream or downstream profits. However, we know from the earlier analysis that price-matching in this vertical market structure induces collusive prices both downstream, conditional on upstream prices, and upstream, conditional on the anticipated pricing game. For the upstream firms this means avoiding competition in upstream prices (good for their profits) but selling into a higher-margin downstream market (bad for their profits). For the downstream firms this means achieving higher margins conditional on upstream prices (good for their profits), but being faced with potentially much higher upstream prices (bad for their profits). The algebra demonstrates that in fact the negative side of the tradeoff prevails over a wide range of the parameter values (and for the parameter values for which the model is more well-behaved). Understanding this result is facilitated by restricting attention to an intuitively derived subset of the parameter space in which results are unambiguous. As described in section 2.3, this restriction bounds d away from b.

Definition 10 *Demand is "substantially differentiated" if downstream equilibrium prices under the vertical monopoly market structure without price-matching exceed the downstream prices that maximize total industry profits (aggregated across all upstream and downstream firms). Numerically, this approximately equivalent to the condition that $d < 0.65b$.*

In effect, when this condition holds, the market is sufficiently uncompetitive–i.e., there is a sufficiently high level of product differentiation–that the double marginalization of normal competition (without price-matching policies) already leads to prices higher than the joint profit-maximizing level. The numerical approximation is derived through algebraic comparison of the above expressions for $p_i^*(w)$ with the joint profit-maximizing price $\overline{p} = \frac{a}{2(b-d)}$. With significant manipulation, this yields the result that final downstream prices exceed those that maximize total industry profits (aggregated across both firms at both levels) if and only if $2\alpha^3 - \alpha^2 - 6\alpha + 4 > 0$. Numerically, this holds if and only if $\alpha < 0.65$, approximately. Per the prior proposition, this range of α lies wholly within the range of α in which price-matching unambiguously lowers profits for both upstream and downstream firms. This yields a simplified result.

Proposition 11 *With upstream vertical structure monopolists, if demand is substantially differentiated then price-matching lowers total welfare and both upstream and downstream profits.*

The intuition for how price-matching decreases downstream profits can be described simply, aggregating results of the paper, when one restricts attention to these moderate values of d relative to b. First, in these circumstances, in the no-price-matching version of the vertical structure monopolies game, there is already significant double marginalization. Upstream and downstream firms both set price above marginal cost in order to maximize their profits given the imperfect substitutability of the two final products. For these values of d, this double marginalization results in a final downstream price without price-matching that is already above the joint profit-maximizing price (aggregating profits of both firms at both levels). Second, price-matching both allows collusive pricing conditional on w and reduces pass-through of increases in w to downstream prices p. As a result, price-matching causes upstream firms to raise upstream prices to collusive levels as well, which are marked up downstream with even greater margins than absent price-matching. Double-marginalization, which already led to prices about the joint profit-maximizing level, is thus exacerbated by price-matching, resulting in lower aggregate industry profits. Unless the relative shares of profits changes dramatically, which does not happen in this model, this leads to lower profits for both firms at both levels of the industry. This is the core intuition and core result of the paper.

For completeness, it is important to consider also the intuition for why it is that, for d nearer to its upper limit of b, it is possible for downstream firms (and in the extreme, even upstream firms) to benefit from price-matching. This results from two features of the model. First, as d approaches b, products become very close substitutes, and price competition absent price-matching is intense. Second, at the same time, aggregate demand becomes very inelastic, and the collusive prices sustained by price-matching increase rapidly and without bound (in the limit). Thus, the gap between the no-price-matching/competitive and with-price-matching/collusive prices widens dramatically as d approaches b, leaving more room for price-matching to increase profits. In particular, for d large relative to b, the no-price-matching downstream equilibrium may be so low that it lies below the joint industry profit-maximizing price, meaning that an increase in downstream price resulting from exacerbated double-marginalization actually works to increase aggregate industry profits. However, these effects arise for relatively extreme parameter values.

5 Conclusion

The central message of this paper is that one cannot ignore vertically related industries when assessing the effects of price-matching policies in a particular market. In particular, price-matching policies tend, in addition to raising markups for the adopting firms, to reduce the pass-through of upstream price increases. If the upstream firms have market power, this will generally lead them to raise their upstream prices, further exacerbating the price-increasing effect of price-matching policies, but also potentially undermining the profitability of these policies for the downstream firms.

The introduction discussed the contribution of this paper relative to the literature on price-matching policies. This paper also relates to another literature that considers a different kind of contingent pricing scheme. While the pricing policies are different, the models share similarities in the underlying theoretical logic at work. Boik and Corts (2016) study "platform most-favored nation (PMFN)" clauses in which a seller commits to each of several platforms not to sell through any rival platform at a lower price (e.g., an airline commits to several online booking sites not to offer cheaper fares on one particular site than on any other). These are fundamentally different kinds of policies because the commitment is about different prices set by one seller, rather than about the relationship of prices across sellers, but a common thread appears in that literature and in this paper. In the PMFN literature, the PMFN commitment creates incentives for each platform to raise its fee to the seller because the seller is constrained in its ability to pass that fee increase through in its price on that platform. Instead, the seller must maintain a common price across platforms, which makes it more costly to pass through the fee increase of any one platform. Thus, PMFN policies decrease final-price pass-through of price increases for "inputs" (in the PMFN literature, a sales channel fee), leading to higher equilibrium fees. This is highly similar to the logic at work in this paper, although the nature of the pricing policy and market structures are completely different.

This paper does not consider the endogenous adoption of price-matching policies. This subject is treated extensively in the literature. The lesson from the literature is that in models such as this one (that do not emphasize heterogeneity in consumers or firms) price-matching policies generally are adopted in equilibrium if circumstances are such that their widespread or universal adoption would raise seller profits. In essence, adopting a price-matching policy in such circumstances is a weakly dominant strategy: if others do not adopt, there may be little or no effect of a single policy, but if others do adopt then all sellers stand to benefit. The results of this paper then, which suggest that in many circumstances with upstream market power downstream firms may not benefit from price-matching policies, may be interpreted as suggestive that price-matching policies are less likely to be adopted in such industries. At the same time, when adopted in these circumstances, such policies are welfare-reducing and, according to the results of this paper, this effect is typically exacerbated by the presence of market power upstream. These insights may help competition authorities assess more carefully the relevant competitive environment when evaluating the effects of price-matching policies.

6 References

Aguzzoni, L. et al., 2012, "Can 'Fair' Prices Be Unfair? A Review of Price Relationship Agreements," *UK Office of Fair Trading report 1438, http://www.learlab.com/publication/1145/.*

Boik, A., and K. Corts, 2016, "The Effects of Platform MFNs on Competition and Entry," *Journal of Law and Economics* 59, 105-134.

Corts, K., 1997, "On the Competitive Effects of Price-Matching Policies," *International Journal of Industrial Organization* 15, 283-299.

Hviid, M., 2010, "Summary of the Literature on Price Guarantees," University of East Anglia working paper, https://www.ofcom.org.uk/__data/assets/pdf_file/0037/67978/paper.pdf.

Hviid, M. and G. Shaffer, 1999, "Hassle-Costs, The Achilles Heel of Price-Matching Guarantees," *Journal of Economics and Management Strategy* 8, 489-521.

Mao, W., 2005, "Price-Matching Policy with Imperfect Information," *Managerial and Decision Economics* 26, 367-372.

Moorthy, S. and R. Winter, 2006, "Price-matching guarantees," *The RAND Journal of Economics* 37, 449-465.

Salop, S., 1986, "Practices that (Credibly) Facilitate Oligopoly Coordination", in: J. Stiglitz and F. Mathewson, eds., *New Developments in the Analysis of Market Structure*, MIT Press, Cambridge, MA.

Yankelevich, A. and B. Vaughan, 2016, "Price-Match Announcements in a Consumer Search Duopoly," *Southern Economic Journal* 82, 417-421.