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Abstract

This paper considers the effects of common ownership on advance purchase markets featuring intertemporal price discrimination (e.g. airline tickets). Common ownership increases advance prices, while spot prices can decrease. We show that common ownership is anti-competitive but the increase in average transacted prices is smaller than under uniform pricing, although consumers shift towards more informed, more expensive purchases. Common ownership is less detrimental for consumers than under uniform pricing and can even benefit consumers when consumers are sufficiently uninformed about their preferences in advance.

JEL classification: D43, D82, L13, L41.

Keywords: Common ownership; intertemporal price discrimination; advance selling; consumer learning.

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1 Introduction

Increasing degrees of cross- and common-ownership in a broad variety of markets (Backus, Conlon, and Sinkinson 2021) have generated a debate about whether overlapping investors soften competition and raise prices, with airline markets providing the most prominent empirical setting (Azar, Schmalz, and Tecu 2018; Dennis, Gerardi, and Schenone 2022). However, in advance-purchase markets—such as the market for airline tickets—average transaction prices depend on both, the firms' price schedule, and the consumers' endogenous timing of purchases. In particular, a reduction in the number of advance customers may contribute to an increase in average expenditure by shifting sales towards higher spot prices. This paper sheds light on the mechanism that makes common ownership anticompetitive in advance purchase markets.

We introduce symmetric internalization of rival profits into the advance-purchase duopoly of Möller and Watanabe (2016). Consumers initially receive imperfect information about their preferred product. They can buy in advance at a discount or wait until their preferences are known and pay the spot price. We assume that firms commit to both prices and that the market is fully covered, holding total sales fixed to isolate the effects of ownership on purchase timing.

We show that common ownership raises advance prices, reduces advance-purchase discounts, and shifts purchases toward the spot market. Spot prices can fall with an increase in common ownership and this happens if and only if consumers' advance information is sufficiently imprecise. Nevertheless, average payments increase throughout the equilibrium domain considered, i.e. our theory predicts common ownership to be *anti-competitive*.

Our model's main contribution is to allow for an evaluation of the effects of common ownership relative to markets where intertemporal price discrimination is absent. We show that, in spite of the fact that a shift towards later, more expensive purchases contributes positively to average expenditure, the anti-competitive effect of common ownership is *weaker* than under uniform pricing—both in terms of absolute and proportional price responses. Our theory therefore suggests that, in uniform-pricing settings, the anticompetitive effects of common ownership might be stronger than predicted by the empirical evidence from airline markets. In light of the recent debate about the effects of common ownership, an alternative interpretation of this result is that, in airline markets, a potentially anti-competitive effect is harder to

detect than in markets with uniform pricing.

A second contribution of our analysis is the insight that an increase in average transaction price due to common ownership can go hand in hand with an increase in consumer surplus. The reason is that a shift towards later, more informed purchases allows consumers to better satisfy their needs. More precisely, we show that a marginal increase in common ownership raises consumer surplus if and only if the sales-weighted sum of the changes in price levels is negative, or equivalently when the increase in the advance price level is smaller than the decrease in the spot price level, both weighted by the number of consumers who purchase in each period. The reason is that, the increase in the average transacted price that is due to the raised number of consumers who postpone their purchases until the spot market, is exactly offset by the corresponding improvement in consumption value.

This insight allows for a particularly strong conclusion in the limit, where preference uncertainty is strong. We show that in this limit, small degrees of common ownership are always beneficial for consumers, because the reduction in the spot price level necessarily outweighs the increase in the advance price level. The reason is that when preference uncertainty is strong, products appear as approximately homogeneous in the advance market, inducing firms to charge prices close to marginal costs *independently* of the degree of common ownership. Hence, in the limit, consumers benefit from a decrease in spot prices while advance prices stay largely unchanged. More generally, we can show that the effect of common ownership on consumers is less detrimental than in the uniform pricing benchmark where consumer surplus is always decreasing with common ownership.

Regarding the recent policy debate about the potentially adverse effects of common ownership, our results thus provide arguments to both, proponents and opponents: They indicate that in markets where intertemporal price discrimination is absent, common ownership might have a more anti-competitive effect on prices than suggested by the empirical evidence from airline markets, while in the specific setting of an advance purchase market consumers might even benefit from common ownership.

Related literature. Regarding the empirical investigation of the potentially anti-competitive effects of common ownership, airline ticket pricing has been a prominent empirical setting.[1]Azar, Schmalz, and Tecu (2018) report that

1. A notable exception is Azar, Raina, and Schmalz (2022) who document price increases

common ownership increases average prices in US origin-destination markets by combining quarterly ticket-fare data from the publicly available US Department of Transportation's DB1B database, with ownership data based on the Thomson-Reuters Ownership data-set originating from 13F filings. They estimate that common ownership increases average prices by 3-7% using a fixed-effects panel regression. Backus, Conlon, and Sinkinson (2021) provide evidence that large degrees of common ownership are driven by investor concentration. This resonates well with Azar, Schmalz, and Tecu (2018) who find larger effects in the range of 10-12 % using a difference-in-differences analysis based on BlackRock's acquisition of Barclays Global Investors in 2009. Yet, the empirical relationship between common ownership and airline fares remains contested, as Dennis, Gerardi, and Schenone (2022) challenge the identification and robustness of these findings by arguing that a positive correlation between prices and ownership-adjusted concentration indices might be driven by their market share component. Our analysis contributes to this literature by identifying the separate channels through which common ownership influences the average transacted price in a setting where market shares are fixed. The predictions of our theory motivate joint tests of price schedules and purchase timing using independently identified ownership variation. They complement the existing debate over causal identification by specifying how common ownership should manifest itself across multiple outcomes.

From a modeling perspective, our analysis is closely related to the duopoly models of Möller and Watanabe (2016) and Ceschi and Möller (2023). We differ from these studies by allowing for common ownership and by considering the question whether common ownership has a positive effect on the average price paid and how this effect compares to the uniform-pricing benchmark. Möller and Watanabe (2016) show that competition reduces average transacted price by comparing duopoly with monopoly but they do not relate this finding to the uniform pricing benchmark. Ceschi and Möller (2023) show that in a duopoly, intertemporal price discrimination reduces average price relative to uniform pricing, but they do not compare the effect with the corresponding price reduction under monopoly. Hence, our main contribution is to address a new issue arising from a recent empirical debate by explaining why common ownership has an anti-competitive effect in advance purchase markets and why this effect can be expected to be less pronounced than in markets where intertemporal price discrimination is absent. Moreover,

due to common ownership in the US banking industry.

while Möller and Watanabe (2016) have argued that a move from duopoly to monopoly can benefit consumers, our model delivers the insight that a small reduction in competition, via common ownership, *always* increases consumer surplus if consumers are sufficiently uninformed. A basic insight of our model is that separating the effects of common ownership on early and late purchasers is necessary for understanding the overall effect of common ownership on consumers. This resonates well with Williams (2022) whose estimation of the welfare effects of dynamic airline pricing in a related but different setting—with demand shocks, limited capacity, and intertemporal changes in willingness to pay—highlights the importance of distinguishing the effects on early and late purchasers.

Finally, the seminal analysis of partial equity interests in oligopolistic markets *without* advance purchase is due to Rotemberg (1984) and Reynolds and Snapp (1986) who assume that firms compete in quantities. Bresnahan and Salop (1986) and Farrell and Shapiro (1990) extend their analysis by allowing for asymmetric firms. More related are recent contributions that share our assumption that firms compete in price, such as Shelegia and Spiegel (2012), Bayona, López, and Manganelli (2022), and Lømo (2024). A detailed overview of the theory of common ownership can be found in Schmalz (2021). We differ from these theoretical contributions through our focus on advance purchase markets, thereby bridging the gap to the empirical studies of common ownership in the airline industry.[2] What we share with these studies is our interpretation of common ownership as a motivation for the internalization of rival profits. This sets us apart from Antón et al. (2023) who identify managerial incentives as a channel through which common ownership affects product-market outcomes by altering productivity and costs rather than by modifying profit maximization.

2. Li and Zhang (2025) analyze overlapping ownership when firms discriminate between repeat and new customers. They show that ownership can alter customer retention and make behavior-based pricing more profitable and less favorable to consumers than uniform pricing. Our model concerns a different source of intertemporal discrimination: each consumer purchases once and chooses between buying before or after learning the preferred product. The relevant allocation margin is therefore purchase timing rather than repeat purchasing.

2 Model

We introduce symmetric common ownership into the duopoly model of intertemporal price-discrimination by Möller and Watanabe (2016). More specifically, we assume that the manager of firm $i \in \{A, B\}$ maximizes the weighted sum of the two firms' profits with firm i receiving a weight normalized to one and firm j receiving a smaller weight $\lambda \in (0, 1)$. We will interpret an increase in the parameter λ as an increase in (symmetric) common ownership. Our objective is to understand the effect of common ownership on pricing and the intertemporal allocation of sales and to derive implications for consumer surplus.

To be more specific, consider a market where two firms each sell one differentiated product $i \in \{A, B\}$ during two periods; an advance purchase period 1 and a consumption period 2. Firms can commit to a price schedule $(p_{1,i},\, p_{2,i}) \in \mathbb{R}^2_+$ where $p_{1,i}$ and $p_{2,i}$ denote the prices of product i in periods 1 and 2, respectively. The unit cost of production is assumed to be constant and identical across products. For simplicity, we normalize unit costs to zero and abstract from discounting.

There is a continuum of consumers with mass 1. Consumers have unit demands. A consumer of type $\sigma \in [0, 1]$ obtains the value $s + \frac{t}{2}\sigma$ from consuming his preferred product and $s - \frac{t}{2}\sigma$ from consuming his non-preferred product. The parameter $s > 0$ denotes a consumer's average consumption value and is assumed to be identical across consumers. The parameter $t > 0$ measures the general degree of product differentiation. Consumers differ only in their choosiness, σ, which constitutes their private information. In the eyes of more choosy consumers, differences in the products' characteristics weigh more heavily. We assume σ is distributed uniformly in $[0, 1]$ which allows us to solve the model explicitly. Further, to keep the model symmetric, we assume that, for any σ, the mass of consumers whose preferred product is A is the same as the mass of consumers whose preferred product is B.

In the consumption period, consumers know their preferred product, but in the advance purchase period they face uncertainty about their individual preferences. More specifically, in period 1, each consumer receives a (private) signal $S \in \{A, B\}$ about the identity of his preferred product. Following Möller and Watanabe (2016), we denote the product indicated by signal S as the consumer's favorite product to distinguish it from his (potentially different) preferred product. The signal's precision, that is, the probability with which the consumer's favorite product turns out to be his preferred

product, is identical across consumers and given by $\gamma \in (\frac{1}{2}, 1)$. Note that for $\gamma \to \frac{1}{2}$ the consumers' signal is completely uninformative, whereas for $\gamma \to 1$ consumers face no uncertainty.

We assume that each consumer can purchase at most one product. This rules out the possibility that consumers purchase both products in advance or switch product after purchasing the wrong product. Further, we choose the consumers' outside option to make those consumers who purchase in advance find it optimal to consume even when they turn out to have purchased their non-preferred product.

2.1 Benchmark: Uniform pricing

Consider as a benchmark a situation where firms cannot price discriminate intertemporally, i.e. where we require that $p_{1,i} = p_{2,i} = p_i$ for $i \in \{A, B\}$.

To determine a uniform-pricing equilibrium $p_A = p_B = p^u$, first note that in the absence of a discount for purchasing in advance, all consumers postpone their purchase until period 2. Suppose that firm B charges the equilibrium price p^u and consider a deviation of the manager of firm A to a lower price $p_A < p^u$. The consumer-type who is indifferent between his preferred product and the cheaper product is given by

$$\bar{\sigma}^u = \frac{p^u - p_A}{t}.$$

In an equilibrium, p_A has to maximize the manager's objective given by:

$$V^u = \frac{1}{2} p_A (1 + \frac{p^u - p_A}{t}) + \frac{1}{2} \lambda p^u (1 - \frac{p^u - p_A}{t}).$$

Substituting $p_A = p^u$ into the corresponding first-order condition gives

$$p_2^u = \frac{t}{1 - \lambda}.$$

Note that we have derived this equilibrium under the implicit assumption that the market is fully covered. As standard in models of differentiated price-competition, this assumption translates into a lower bound on the consumers' (average) consumption value s, or an upper bound on the level of product-differentiation t, i.e. existence of the above equilibrium requires that

$$\frac{s}{t} \geq \frac{1}{1 - \lambda}. \tag{1}$$

Note that this restriction becomes exceedingly demanding for higher levels of common ownership λ.

3 Equilibrium

In this section we derive the unique candidate for a symmetric price discrimination equilibrium $(p_{1,A}, p_{2,A}) = (p_{1,B}, p_{2,B}) = (p_1^*, p_2^*)$, in which firms make positive sales at two distinct prices $p_1^* \neq p_2^*$.[3] We prove the existence and uniqueness of such an equilibrium in the Appendix. When the market is fully covered in equilibrium, an advance purchase discount $\Delta p^* = p_2^* - p_1^* > 0$ induces an intertemporal segmentation of consumers. Consumers with low degrees of choosiness buy their favorite product in period 1, whereas consumers with high choosiness wait until period 2 to purchase their preferred product. Our focus on the case where the market is fully covered implies a lower bound on the ratio $\frac{s}{t}$ comparable to (1) in the uniform pricing benchmark. To prove existence of equilibrium, we assume a more restrictive bound on $\frac{s}{t}$ and we also set an upper bound on γ, i.e. we require that the consumers' information in the advance purchase period is sufficiently imprecise. The upper bound on γ becomes relaxed for lower degrees of common ownership and vanishes in the limit where $\lambda \to 0$.

To derive the equilibrium candidate, suppose that firm B adopts the equilibrium price schedule (p_1^*, p_2^*) and consider a deviation by the manager of firm A to a price schedule $(p_{1,A}, p_{2,A}) \neq (p_1^*, p_2^*)$. For a consumer whose favorite is $S = A$, purchasing A in advance gives (expected) utility

$$U(\sigma, A \mid 1, A) = s + \gamma \frac{t}{2}\sigma - (1-\gamma)\frac{t}{2}\sigma - p_{1,A}.$$

Any consumer who postpones his purchase must condition his product choice in period 2 on the identity of his preferred product. Otherwise, he could have purchased the product he buys in period 2 already in period 1, at a lower price. Waiting until period 2, therefore, gives the (expected) utility

$$U(\sigma, A \mid 2) = s + \frac{t}{2}\sigma - \gamma p_{2,A} - (1-\gamma)p_2^*.$$

Waiting is preferable if and only if the (expected) gain in consumption value exceeds the (expected) price premium

$$\sigma > \sigma_{W,A} \equiv \frac{(1-\gamma)p_2^* + \gamma p_{2,A} - p_{1,A}}{t(1-\gamma)}.$$

3. Using similar arguments as Möller and Watanabe (2016), we can rule out the existence of a symmetric equilibrium in which $p_1^* = p_2^*$.

Analogously, for a consumer whose favorite product is $S = B$ waiting is preferable if and only if

$$\sigma > \sigma_{W,B} \equiv \frac{\gamma p_2^* + (1-\gamma)p_{2,A} - p_1^*}{t(1-\gamma)}.$$

Finally, if $p_{1,A} > p_1^*$, an advance customer with $S = A$ prefers the more expensive but favored product A over the less expensive non-favored product B if and only if

$$\sigma > \bar{\sigma} \equiv \frac{p_{1,A} - p_1^*}{t(2\gamma - 1)}.$$

For (p_1^*, p_2^*) to be an equilibrium, $(p_{1,A}, p_{2,A}) = (p_1^*, p_2^*)$ has to maximize the objective of firm A's manager given by

$$\begin{aligned} V_A &= \frac{1}{2}p_{1,A}\left(\sigma_{W,A} - \bar{\sigma}\right) + \frac{1}{2}p_{2,A}\left[\gamma(1-\sigma_{W,A}) + (1-\gamma)(1-\sigma_{W,B})\right] \quad (2) \\ &+ \lambda\left\{\frac{1}{2}p_1^*\left(\sigma_{W,B} + \bar{\sigma}\right) + \frac{1}{2}p_2^*\left[\gamma(1-\sigma_{W,B}) + (1-\gamma)(1-\sigma_{W,A})\right]\right\}. \end{aligned}$$

Substitution of $(p_{1,A}, p_{2,A}) = (p_1^*, p_2^*)$ into the corresponding first order conditions leads to a system of linear equations whose unique solution constitutes the equilibrium price-schedule:

$$p_1^* = \frac{t(2\gamma-1)[1+\gamma+\lambda(1-\gamma)]}{\Omega(\lambda,\gamma)}, \quad (3)$$

$$p_2^* = \frac{t(2\gamma-1)[1+\gamma+\lambda(1-\gamma)] + 2t\gamma(1-\gamma)(1-\lambda)}{\Omega(\lambda,\gamma)} \quad (4)$$

where we have abbreviated notation by defining

$$\Omega(\lambda,\gamma) \equiv (1-\lambda)[2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)] > 0.$$

In the Appendix we prove the following:

Proposition 1. *Given the degree of common ownership $\lambda \in (0,1)$, suppose*

$$\gamma < \frac{1}{2} + \frac{1-\lambda}{2(1+3\lambda)} \equiv \gamma_e(\lambda) \quad (5)$$

and

$$\frac{s}{t} > \frac{1}{2} + \frac{3\gamma - 1 - \lambda(1-\gamma)}{(1-\lambda)\left[2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)\right]}. \tag{6}$$

Then the prices (p_1^*, p_2^*) in (3) and (4) constitute the unique symmetric equilibrium. In this equilibrium, firms offer advance purchase discounts

$$\Delta p^* = p_2^* - p_1^* = \frac{2t\gamma(1-\gamma)}{2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)} > 0,$$

and a fraction

$$\sigma_W^* = \frac{\Delta p^*}{t(1-\gamma)} = \frac{2\gamma}{2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)} \in (0,1) \tag{7}$$

of consumers is induced to purchase in advance.

At parameter values satisfying the strict inequalities in Proposition 1, small changes in the common ownership parameter λ preserve the conditions, permitting us to perform local comparative statics on the basis of the equilibrium defined by (3) and (4). Comparisons over larger parameter intervals require the sufficient conditions to hold throughout the interval.

4 The anti-competitive effect

We are now ready to consider the effect that common ownership has on pricing. We will decompose this effect into a level-effect and an allocation-effect and show that the overall effect of common ownership is anti-competitive, in that it leads to an increase in the average transacted price. We then compare with the uniform-pricing benchmark to understand whether the anti-competitive effect of common ownership is enhanced or mitigated by firms' ability to price-discriminate intertemporally. The results in this section help to relate the recent empirical studies of common ownership for industries with price-discrimination (e.g. airlines) to those for industries where pricing is uniform. Our main result shows that the increase in average transacted price due to common ownership is less pronounced when firms can price discriminate intertemporally, suggesting that the empirical estimates from the airline industry might be interpreted as a lower bound.

We start by considering the effects of common ownership on the price-discrimination equilibrium (p_1^*, p_2^*) characterized in Proposition 1:

Proposition 2. *Suppose that (5) and (6) hold. Common ownership has an anti-competitive effect on the average transacted price* $\bar{p}^* = \sigma_W^* p_1^* + (1-\sigma_W^*)p_2^*$*:*

$$\frac{d\bar{p}^*}{d\lambda} = \underbrace{\sigma_W^* \frac{dp_1^*}{d\lambda} + (1-\sigma_W^*)\frac{dp_2^*}{d\lambda}}_{\text{level effect (+/-)}} \quad \underbrace{-\Delta p^* \frac{d\sigma_W^*}{d\lambda}}_{\text{allocation effect (+)}} > 0. \tag{8}$$

Common ownership acts through two channels:

1. *Level-Effect: An increase in* λ *raises the advance purchase price* p_1^**. An increase in* λ *raises the spot price* p_2^* *if* $\gamma > \gamma_p(\lambda)$ *but decreases it if* $\gamma < \gamma_p(\lambda)$*. The threshold* $\gamma_p(\lambda)$ *satisfies* $\frac{1}{2} < \gamma_p(\lambda) < \gamma_e(\lambda)$ *for all* λ*.*

2. *Allocation-Effect: An increase in* λ *reduces firms' advance purchase discounts* Δp^* *and thus decreases the number of consumers* σ_W^* *who purchase at a discount.*

The sales-weighted level-effect of common ownership is negative if consumers are sufficiently uninformed in the advance market, i.e.

$$\lim_{\gamma \to \frac{1}{2}} \left[\sigma_W^* \frac{dp_1^*}{d\lambda} + (1-\sigma_W^*)\frac{dp_2^*}{d\lambda} \right] < 0 \quad \textit{for all} \quad \lambda.$$

Proposition 2 shows that, in the presence of intertemporal price discrimination, the anti-competitive effect of common ownership on average transacted price can be decomposed into a sales-weighted level-effect and an allocation-effect. To see why this is the case, write the average transacted price $\bar{p}^*$ as the difference between the spot price and the aggregate discount, $\bar{p}^* = p_2^* - \Delta p^* \sigma_W^*$ and differentiate with respect to λ to obtain (8). From Proposition 2 we know that an increase in common ownership raises the advance purchase price p_1^*, but the effect on the spot price p_2^* can go either way. In particular, an increase in common ownership can reduce spot prices and this happens when consumers' preferences are sufficiently uncertain. Proposition 2 also shows that there exists an additional, allocational effect, that is positive and when this effect is taken into account, the overall effect of common ownership on the average transacted price is anti-competitive.

Finally, Proposition 2 reveals that, in the limit, where the consumers' signals become fully uninformative, the sales-weighted price level effect becomes negative. To understand this result, note that, in this limit, products appear as homogeneous to consumers in the advance market. This means

that competition becomes Bertrand style, so that advance prices converge to marginal costs, *independently* of the degree of common ownership. In this limit, common ownership thus ceases to affect advance prices while leading to a decrease in spot price as stated in Proposition 2, inducing the level-effect of common ownership to be negative. This means that, in this limit, the allocational effect becomes decisive in that it gives the overall effect a positive sign, thereby making common ownership anti-competitive. Proposition 2 thus underlines the importance of allocational effects for our understanding of the anti-competitiveness of common ownership.

In markets with intertemporal price discrimination, such as the airline industry, part of the increase in average transacted price in response to common ownership is therefore due to changes in the timing of consumer purchases. By mitigating competition, common ownership induces firms to compete for advance customers less aggressively resulting in fewer customers who claim a discount. Given the absence of this allocational channel in a setting with uniform pricing, an immediate question is whether common ownership is more, or less anti-competitive when firms can price-discriminate intertemporally. We provide an answer to this question in form of the following:

Proposition 3. *Suppose that (1), (5), and (6) are satisfied, so that* p^u *and* (p_1^*, p_2^*) *constitute the unique equilibrium under uniform pricing and price-discrimination, respectively. Then it holds that*

$$\bar{p}^* < p^u, \quad 0 < \frac{d\bar{p}^*}{d\lambda} < \frac{dp^u}{d\lambda} = \frac{t}{(1-\lambda)^2}, \quad 0 < \frac{d\log\bar{p}^*}{d\lambda} < \frac{d\log p^u}{d\lambda} = \frac{1}{1-\lambda}.$$

Proposition 3 shows that intertemporal price discrimination reduces both the average transacted price and its sensitivity to common ownership, whether measured in absolute or proportional terms. Given that common-ownership acts anti-competitively in the presence of price-discrimination (Proposition 2), this means that increases in average transacted price due to common ownership can be expected to be less pronounced when firms are able to price-discriminate intertemporally. Proposition 3 thus provides us with an argument for why the evidence of the anti-competitive effects of common ownership on airline pricing might be understood as a lower bound. In generic markets, where firms' ability to price-discriminate might be restricted, the effects of common ownership on pricing can be expected to be stronger.

5 Consumer surplus

The decomposition of price effects into a level effect and an allocational effect in Proposition 2 suggests that, in advance purchase markets, the anti-competitive effect of common ownership on the average transacted price might go hand in hand with an increase in consumer surplus. This is because the allocational effect of common ownership is accompanied by an improvement of the match between consumer preferences and product characteristics. By inducing more consumers to postpone their purchases until their preference uncertainty has been resolved, common ownership raises the utility consumers derive from their purchased products in expectation.[4] From the consumers' perspective, we thus have to account for the improvement in consumption value to decide whether common ownership is indeed detrimental.

In this section, we first show that the effect of common ownership on consumer surplus is negative if and only if the sales-weighted level effect in (8) is positive. Hence, an immediate implication of Proposition 2 is that, in the limit, where consumers' signals become uninformative, consumer surplus is increasing with common ownership. Finally, we compare with the uniform pricing benchmark, to establish that, even when consumer surplus is decreasing, common ownership is less detrimental for consumers than under uniform pricing.

To determine the overall effect of common ownership on consumers, consider aggregate consumer surplus:

$$\begin{aligned} CS^* &= \int_0^{\sigma_W^*} \left(s + \gamma \frac{t}{2}\sigma - (1-\gamma)\frac{t}{2}\sigma - p_1^* \right) d\sigma + \int_{\sigma_W^*}^1 \left(s + \frac{t}{2}\sigma - p_2^* \right) d\sigma \\ &= s + \frac{t}{4} - \bar{p}^* - \frac{t(1-\gamma)}{2}(\sigma_W^*)^2. \end{aligned}$$

Differentiating and using $\Delta p^* = t(1-\gamma)\sigma_W^*$, we obtain

$$\frac{dCS^*}{d\lambda} = -\frac{d\bar{p}^*}{d\lambda} - t(1-\gamma)\sigma_W^* \frac{d\sigma_W^*}{d\lambda} = -\left[\sigma_W^* \frac{dp_1^*}{d\lambda} + (1-\sigma_W^*)\frac{dp_2^*}{d\lambda} \right]. \tag{9}$$

4. For the same reason, welfare is increasing with common ownership in our model. This result resonates well with the finding of Möller and Watanabe (2016) that welfare in a duopoly without common ownership ($\lambda = 0$) is lower than in the monopoly benchmark. Due to the absence of quantity-effects, a full welfare analysis is beyond our model's scope but the model serves to highlight one particular way in which common ownership can be welfare improving.

Thus, the effect on consumer surplus is exactly the negative of the level effect defined in (8). The allocation terms cancel because consumers at the purchase-timing cutoff are indifferent between buying early and waiting. For these marginal consumers, the improvement in expected consumption value exactly offsets the additional payment associated with purchasing later.

Since the advance price increases with common ownership, a decline in the spot price is necessary for consumers to benefit. It is not sufficient: the benefit to late purchasers must exceed the higher advance price paid by early purchasers. Combining (9) and Proposition 2, we have thus shown the following:

Proposition 4. *Suppose that (5) and (6) hold. An increase in common ownership raises consumer surplus if and only if*

$$-\frac{dp_2^*}{d\lambda} > \frac{\sigma_W^*}{1-\sigma_W^*}\frac{dp_1^*}{d\lambda}.$$

For $\gamma \to \frac{1}{2}$ this condition holds, i.e. an increase in common ownership raises consumer surplus when consumers are sufficiently uninformed.

The indifference argument underlying (9) and the reasoning we applied to conclude that the sales-weighted level effect becomes negative for $\gamma \to \frac{1}{2}$ extend to other continuous distributions of consumer types, with the corresponding advance and spot sales shares as weights. In the limit, the only effect of common ownership is a reduction in spot prices, and hence consumers must be better off. Intuitively, common ownership reduces firms' incentives to sell in advance, and given the optimality of marginal-cost pricing in the advance market, the only way to achieve this, is to lower their prices in the spot market. This gives us confidence to claim that Proposition 4 extends to non-uniform distributions of consumer types.

Finally, consider consumer surplus in the uniform pricing benchmark. Because all consumers purchase their preferred product in period 2, consumer surplus under uniform pricing is

$$CS^u = \int_0^1 \left(s + \frac{t}{2}\sigma - p_2^u\right) d\sigma = s + \frac{t}{4} - p^u.$$

Note that it follows from

$$p^u - p_2^* = \frac{4t\gamma(1-\gamma)(1+\lambda)}{\Omega(\lambda,\gamma)} > 0$$

that consumer surplus under price-discrimination is larger than under uniform pricing, i.e.

$$CS^* - CS^u = p^u - \bar{p}^* - \frac{t(1-\gamma)}{2}(\sigma_W^*)^2 = p^u - p_2^* + \frac{t(1-\gamma)}{2}(\sigma_W^*)^2 > 0.$$

Intuitively, because the price consumers pay by waiting for their preference uncertainty to be resolved is smaller than the price they pay under uniform pricing, consumers can only benefit from the additional option to purchase in advance at a still smaller price. More importantly, we find that

$$\frac{dCS^*}{d\lambda} - \frac{dCS^u}{d\lambda} = \frac{dp^u}{d\lambda} - \frac{d\bar{p}^*}{d\lambda} - t(1-\gamma)\sigma_W^* \frac{d\sigma_W^*}{d\lambda}.$$

Because Propositions 2 and 3 have shown that $\frac{dp^u}{d\lambda} > \frac{d\bar{p}^*}{d\lambda}$ and $\frac{d\sigma_W^*}{d\lambda} < 0$ we have therefore proven the following:

Proposition 5. *Suppose that (1), (5) and (6) hold. Then*

$$\frac{dCS^*}{d\lambda} - \frac{dCS^u}{d\lambda} > 0,$$

i.e. in the presence of intertemporal price-discrimination, an increase in common ownership is less detrimental for consumers than under uniform pricing.

In combination, Propositions 4 and 5 establish that policy makers concerned with the recent rise in common ownership should be less worried about consumers in markets characterized by intertemporal price-discrimination. In particular, in advance purchase markets such as the market for airline tickets, the detrimental effect of common ownership on consumers is mitigated for two reasons. First, the anti-competitive effect of common ownership on average transacted price is reduced. Second, common ownership raises the number of consumers who are induced to make informed purchases, thereby benefiting consumers. This latter effect can even cause consumer surplus to increase with common ownership, which happens in our model when consumers are sufficiently uninformed.

6 Conclusion

This article is motivated by an empirical literature estimating the anti-competitive effects of common ownership with data from the airline industry.

Our model features firms that engage in intertemporal price-discrimination, a practice that is ubiquitous in airline-ticket pricing. Our model shows that common ownership has an anti-competitive effect on advance prices but might be pro-competitive in the spot market. The overall effect on average transacted price is positive, but smaller than when pricing is uniform. While these findings suggest that generically common ownership might be more anticompetitive than suggested by existing empirical evidence, our theory also shows that in advance purchase markets common ownership is less detrimental for consumers than in the absence of intertemporal price discrimination and can even benefit consumers when preference uncertainty is sufficiently strong. It is our hope that the model's predictions about the effects of common ownership on pricing and the intertemporal allocation of sales motivate further empirical research in advance selling markets.

Appendix A - Proofs

Proof Proposition 1. The proof proceeds with the following six steps. Step 1 considers deviations that preserve the interior demand configuration used in the main text and shows that the candidate prices uniquely maximize the corresponding quadratic objective function. Steps 2 and 3 consider deviations under which only the deviating firm sells in advance. Steps 4 and 5 consider deviations under which all consumers receiving one of the two signals purchase early. Step 6 treats the remaining cases. Together, Steps 1–6 establish that the candidate is an equilibrium and that it is unique.

We begin with some properties of the candidate prices. First note that they satisfy

$$0 < p_1^* < p_2^*, \qquad \sigma_W^* = \frac{p_2^* - p_1^*}{t(1-\gamma)} = \frac{2\gamma}{2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)} \in (0,1),$$

which means that they constitute a *price-discrimination equilibrium* according to our definition. Moreover, (5) implies

$$\gamma p_2^* - p_1^* = \frac{t(1-\gamma)[1-\gamma-\lambda(3\gamma-1)]}{(1-\lambda)[2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)]} > 0.$$

As we will see below, this inequality guarantees that no deviation by firm A can induce all signal B consumers to postpone their purchase. Combining

this inequality with $p_2^* - p_1^* = t(1-\gamma)\sigma_W^*$ gives $p_2^* < t\sigma_W^* < t$. Condition (6) therefore implies that

$$s - \frac{t\sigma}{2} - p_2^* \geq s - \frac{t}{2} - p_2^* > 0 \qquad \text{for every } \sigma \in [0,1],$$

which guarantees that after any unilateral deviation by firm A, a waiting consumer can obtain positive utility by purchasing from B, even when B is non-preferred, i.e. waiting never leads to non-participation. This justifies comparing the three alternatives used throughout the proof: purchasing A in advance, purchasing B in advance, and waiting to purchase the realized preferred product. Recall that no consumer will ever choose the non-preferred product over the preferred product in period 2 because buying that product in advance would then have yielded still higher expected utility.

Now, fix firm B's prices at (p_1^*, p_2^*), and consider any deviation by firm A to $(p_{1,A}, p_{2,A})$. If $p_{1,A} > p_{2,A}$, purchasing A early is dominated by waiting and purchasing it at $p_{2,A}$. Replacing $p_{1,A}$ by $p_{2,A}$ leaves both firms' revenues unchanged. We can therefore restrict attention to

$$0 \leq p_{1,A} \leq p_{2,A}.$$

Retain the cutoffs from the main text:

$$\sigma_{W,A} = \frac{\gamma p_{2,A} + (1-\gamma)p_2^* - p_{1,A}}{t(1-\gamma)},$$

$$\sigma_{W,B} = \frac{(1-\gamma)p_{2,A} + \gamma p_2^* - p_1^*}{t(1-\gamma)}, \qquad \bar{\sigma} = \frac{p_{1,A} - p_1^*}{t(2\gamma - 1)}.$$

Here $\bar{\sigma}$ is interpreted as a signed price difference: it is negative when firm A charges the lower advance price. Notice that $\sigma_{W,B} > 0$ for every nonnegative $p_{2,A}$, because $\gamma p_2^* > p_1^*$.

Step 1. For deviations that preserve the interior demand configuration used in the main text, the candidate prices uniquely maximize the corresponding quadratic objective function.

Proof of Step 1. Suppose that

$$0 \leq \sigma_{W,A}, \sigma_{W,B} \leq 1, \qquad -\sigma_{W,B} \leq \bar{\sigma} \leq \sigma_{W,A}.$$

Advance demand for firm A is $(\sigma_{W,A} - \bar{\sigma})/2$, while advance demand for firm B is $(\sigma_{W,B} + \bar{\sigma})/2$. Their late demands are, respectively,

$$\frac{\gamma(1-\sigma_{W,A}) + (1-\gamma)(1-\sigma_{W,B})}{2}$$

and

$$\frac{(1-\gamma)(1-\sigma_{W,A}) + \gamma(1-\sigma_{W,B})}{2}.$$

The managerial objective therefore takes the form in (2). Its first-order derivatives are

$$2t\frac{\partial V_A}{\partial p_{1,A}} = -\frac{2\gamma p_{1,A}}{(1-\gamma)(2\gamma-1)} + \frac{(1+\lambda)p_1^*}{2\gamma-1} + \frac{2\gamma p_{2,A}}{1-\gamma} + (1+\lambda)p_2^*,$$

and

$$2t\frac{\partial V_A}{\partial p_{2,A}} = t + \frac{2\gamma p_{1,A}}{1-\gamma} + (1+\lambda)p_1^* - \frac{2[\gamma^2 + (1-\gamma)^2]p_{2,A}}{1-\gamma} - 2\gamma(1+\lambda)p_2^*.$$

The Hessian is

$$\frac{1}{t}\begin{pmatrix} -\dfrac{\gamma}{(1-\gamma)(2\gamma-1)} & \dfrac{\gamma}{1-\gamma} \\ \dfrac{\gamma}{1-\gamma} & -\dfrac{\gamma^2+(1-\gamma)^2}{1-\gamma} \end{pmatrix}.$$

Its first diagonal element is negative, and its determinant is

$$\frac{\gamma}{t^2(1-\gamma)(2\gamma-1)} > 0.$$

Hence the quadratic expression in (2), extended to the entire price plane, is strictly concave. Substitution of the candidate prices makes both first-order derivatives zero. The candidate therefore uniquely maximizes this quadratic expression. Since $\sigma_{W,A} = \sigma_{W,B} = \sigma_W^* \in (0,1)$ and $\bar{\sigma} = 0$ at the candidate, it lies strictly inside the demand region considered here. No deviation in this region is profitable.

It remains to consider deviations to prices $(p_{1,A}, p_{2,A})$ for which demand functions differ from the interior configuration used in (2). The following steps rule out the existence of a profitable deviation for all such possible cases.

Step 2. A deviation inducing only the deviating firm A to sell in advance, and both signal groups to contain consumers who wait cannot be profitable.

Proof of Step 2. When no consumer purchases B early, signal-A consumers purchase A early below $\sigma_{W,A}$. Signal-B consumers purchase A early below

$$\frac{\gamma p_2^* + (1-\gamma)p_{2,A} - p_{1,A}}{\gamma t}.$$

Both cutoffs lie below one. The manager's objective now differs from (2):

$$V_A = \frac{1}{2}\Bigg\{ p_{1,A}\left[\sigma_{W,A} + \frac{\gamma p_2^* + (1-\gamma)p_{2,A} - p_{1,A}}{\gamma t}\right] + \left[\gamma p_{2,A} + \lambda(1-\gamma)p_2^*\right](1-\sigma_{W,A}) \\ + \left[(1-\gamma)p_{2,A} + \lambda\gamma p_2^*\right]\left[1 - \frac{\gamma p_2^* + (1-\gamma)p_{2,A} - p_{1,A}}{\gamma t}\right]\Bigg\}.$$

Differentiation gives

$$t\gamma(1-\gamma)\frac{\partial V_A}{\partial p_{1,A}} = -p_{1,A} + (1+\lambda)\gamma(1-\gamma)p_2^* + \left[\gamma^2 + (1-\gamma)^2\right]p_{2,A}.$$

As we consider deviations for which there are no advance sales by B we have

$$p_{1,A} \leq \frac{\gamma p_1^* - (2\gamma - 1)[\gamma p_2^* + (1-\gamma)p_{2,A}]}{1-\gamma}.$$

Combining this inequality with $p_{1,A} \leq p_{2,A}$ yields

$$t\gamma(1-\gamma)\frac{\partial V_A}{\partial p_{1,A}} \geq \gamma\left([\gamma + \lambda(1-\gamma)]p_2^* - p_1^*\right) = \frac{t\gamma(1-\gamma)^2(1+\lambda)}{2\gamma + (1+\lambda)(1-\gamma)(4\gamma-1)} > 0.$$

To obtain the lower bound, substitute the smaller of the two upper bounds on $p_{1,A}$. The resulting expression is minimized where those bounds coincide.

Increasing $p_{1,A}$ therefore raises the objective until the deviation reaches the region in Step 1, unless it first reaches $p_{1,A} = p_{2,A}$. In that event, increase both prices along the diagonal. The derivative along this diagonal is

$$\frac{dV_A(p_{1,A}, p_{1,A})}{dp_{1,A}} = \frac{t + (1+\lambda)p_2^* - 2p_{1,A}}{2t}.$$

Diagonal points in the present region satisfy

$$p_{1,A} \leq \frac{p_1^* - (2\gamma - 1)p_2^*}{2(1-\gamma)}.$$

Consequently,

$$\frac{dV_A(p_{1,A}, p_{1,A})}{dp_{1,A}} \geq \frac{t(1-\gamma) + [\gamma + \lambda(1-\gamma)]p_2^* - p_1^*}{2t(1-\gamma)} > 0.$$

This movement reaches the region in Step 1 with a higher objective. Therefore, no deviation considered in this step is profitable.

Step 3. A deviation inducing only the deviating firm A to sell in advance and all signal-A consumers to purchase early cannot be profitable.

Proof of Step 3. Suppose that $\sigma_{W,A} \geq 1$, while the signal-B cutoff between purchasing A early and waiting lies strictly between zero and one. The objective becomes

$$V_A = \frac{1}{2}\Bigg\{ p_{1,A}\left[1 + \frac{\gamma p_2^* + (1-\gamma)p_{2,A} - p_{1,A}}{\gamma t}\right] + \left[(1-\gamma)p_{2,A} + \lambda\gamma p_2^*\right]\left[1 - \frac{\gamma p_2^* + (1-\gamma)p_{2,A} - p_{1,A}}{\gamma t}\right]\Bigg\}.$$

Its derivative with respect to the advance price is

$$\frac{\partial V_A}{\partial p_{1,A}} = \frac{\gamma t - 2p_{1,A} + (1+\lambda)\gamma p_2^* + 2(1-\gamma)p_{2,A}}{2\gamma t}.$$

The conditions defining this case imply

$$p_{1,A} \leq \min\left\{\gamma p_{2,A} + (1-\gamma)p_2^* - t(1-\gamma), \frac{\gamma p_1^* - (2\gamma - 1)[\gamma p_2^* + (1-\gamma)p_{2,A}]}{1-\gamma}\right\}.$$

Substitute this upper bound into the derivative. Along the first affine bound, the resulting numerator decreases with $p_{2,A}$; along the second, it increases. Its minimum therefore occurs at their intersection. Substitution of the prices $(p_{1,A}, p_{2,A})$ defining this intersection, together with the expressions for the candidate equilibrium (p_1^*, p_2^*) gives:

$$\frac{\partial V_A}{\partial p_{1,A}} \geq \frac{2\gamma^2 + (1+\lambda)(1-\gamma)(2\gamma^2 + 3\gamma - 1)}{(3\gamma - 1)[2\gamma + (1+\lambda)(1-\gamma)(4\gamma - 1)]} > 0.$$

Increasing $p_{1,A}$ thus reaches the region in Step 2 or Step 4 with a higher objective. The diagonal cannot obstruct this increase: $p_{1,A} = p_{2,A}$ and $\sigma_{W,A} \geq 1$ would imply

$$p_{2,A} \leq p_2^* - t < 0.$$

If all signal-B consumers also purchase early, the deviation belongs to the all-early case treated in Step 6. We therefore conclude that no deviation considered in this step is profitable.

Step 4. A deviation inducing both firms to sell in advance, all signal-A consumers to purchase early, and some signal-B consumers to wait cannot be profitable.

Proof of Step 4. Here $\sigma_{W,A} \geq 1$ and $\sigma_{W,B} \leq 1$. The objective is

$$V_A = \frac{1}{2}\Big\{p_{1,A}(1-\bar{\sigma}) + (1-\gamma)p_{2,A}(1-\sigma_{W,B}) + \lambda\big[p_1^*(\sigma_{W,B}+\bar{\sigma}) + \gamma p_2^*(1-\sigma_{W,B})\big]\Big\}.$$

The objective is strictly concave, since

$$\frac{\partial^2 V_A}{\partial p_{1,A}^2} = -\frac{1}{t(2\gamma-1)}, \qquad \frac{\partial^2 V_A}{\partial p_{2,A}^2} = -\frac{1-\gamma}{t}, \qquad \frac{\partial^2 V_A}{\partial p_{1,A}\partial p_{2,A}} = 0.$$

The unconstrained maximizer has coordinates

$$\left(\frac{t(2\gamma-1)+(1+\lambda)p_1^*}{2}, \quad \frac{t(1-\gamma)+(1+\lambda)(p_1^*-\gamma p_2^*)}{2(1-\gamma)}\right).$$

At this point,

$$\sigma_{W,A} - 1 = -\frac{(1+\lambda)\gamma[\gamma^2+(1-\gamma)^2]}{(1-\gamma)[2\gamma+(1+\lambda)(1-\gamma)(4\gamma-1)]} < 0.$$

Therefore the maximum of this quadratic over the set of prices where $\sigma_{W,A} \geq 1$ lies on the boundary where $\sigma_{W,A} = 1$. On that boundary, the quadratic expression coincides with (2). Step 1 shows that (2) is uniquely maximized at the candidate, where $\sigma_{W,A} = \sigma_W^* < 1$. Its maximum on $\sigma_{W,A} = 1$ is consequently strictly below the candidate objective. Every deviation considered in this step is therefore unprofitable.

Step 5. A deviation inducing both firms to sell in advance, all signal-B consumers to purchase early, and some signal-A consumers to wait cannot be profitable.

Proof of Step 5. Here $\sigma_{W,B} \geq 1$ and $\sigma_{W,A} \leq 1$. The objective is

$$V_A = \frac{1}{2}\Big\{p_{1,A}(\sigma_{W,A}-\bar{\sigma}) + \gamma p_{2,A}(1-\sigma_{W,A}) + \lambda\big[p_1^*(1+\bar{\sigma}) + (1-\gamma)p_2^*(1-\sigma_{W,A})\big]\Big\}.$$

Its Hessian is

$$\frac{1}{t}\begin{pmatrix} -\dfrac{\gamma}{(1-\gamma)(2\gamma-1)} & \dfrac{\gamma}{1-\gamma} \\ \dfrac{\gamma}{1-\gamma} & -\dfrac{\gamma^2}{1-\gamma} \end{pmatrix}.$$

The first diagonal element is negative, and the determinant equals

$$\frac{\gamma^2}{t^2(1-\gamma)(2\gamma-1)} > 0.$$

Thus the objective is strictly concave. Its maximizer has coordinates

$$\left(\frac{t(2\gamma-1)+(1+\lambda)p_1^*}{2}, \quad \frac{t\gamma+(1+\lambda)[p_1^*-(1-\gamma)p_2^*]}{2\gamma}\right).$$

At this point,

$$\sigma_{W,B} - 1 = -\frac{2(1+\lambda)\gamma(1-\gamma)}{2\gamma+(1+\lambda)(1-\gamma)(4\gamma-1)} < 0.$$

Therefore, the maximum over $\sigma_{W,B} \geq 1$ lies on $\sigma_{W,B} = 1$. On this boundary, the expression coincides with (2), whose unique maximizer satisfies $\sigma_{W,B} = \sigma_W^* < 1$. Every deviation considered here consequently yields an objective strictly below the candidate's.

Step 6. Neither a deviation inducing all consumers to buy in advance nor a deviation inducing only the non-deviating firm B to sell early can be profitable.

Proof of Step 6. First consider deviations under which everyone purchases early. When both firms have positive demand, the objective is

$$\frac{p_{1,A}+\lambda p_1^*}{2} + \frac{(\lambda p_1^* - p_{1,A})(p_{1,A}-p_1^*)}{2t(2\gamma-1)}.$$

Its unconstrained maximum is

$$\frac{t(2\gamma-1)}{8} + \frac{(1+3\lambda)p_1^*}{4} + \frac{(1-\lambda)^2(p_1^*)^2}{8t(2\gamma-1)}.$$

This also bounds the objective when demand is concentrated entirely on one firm. If everyone purchases A, the objective is $p_{1,A}$, with $p_{1,A} \leq p_1^* - t(2\gamma-1)$.

If everyone purchases B, the objective is λp_1^*. Both values are bounded by the same maximum.

At the candidate, the objective equals

$$\frac{1+\lambda}{2}\left[p_2^* - t(1-\gamma)(\sigma_W^*)^2\right].$$

Subtracting the preceding upper bound from this value gives

$$\frac{t(1-\gamma)^2(1+\lambda)^2}{2[2\gamma+(1+\lambda)(1-\gamma)(4\gamma-1)]^2}\left[1+3(2\gamma-1)+2(2\gamma-1)^2-(2\gamma-1)^3\right]>0.$$

Thus no all-early deviation is profitable.

Next suppose that only firm B sells in advance. Necessarily $p_{1,A} \geq p_1^*$. The signal-A cutoff between purchasing B early and waiting is

$$\frac{\gamma p_{2,A} + (1-\gamma)p_2^* - p_1^*}{\gamma t} > 0.$$

If this cutoff is at least one, everyone purchases B early, a case already considered. Otherwise, reduce $p_{1,A}$ to

$$\frac{(1-\gamma)p_1^* + (2\gamma-1)[\gamma p_{2,A} + (1-\gamma)p_2^*]}{\gamma}.$$

Consumer choices and both firms' revenues remain unchanged. At the resulting prices,

$$\bar{\sigma} = \sigma_{W,A} = \frac{\gamma p_{2,A} + (1-\gamma)p_2^* - p_1^*}{\gamma t} < 1.$$

The modified deviation therefore lies on a boundary considered in Step 1 or Step 5 and cannot be profitable.

Finally, to confirm that Steps 1-6 cover all possible deviations, suppose first that both firms sell early. Capping each waiting cutoff at one gives precisely the cases in Step 1, Step 4, Step 5, and Step 6. If only firm A sells early, the signal-A cutoff is at least the signal-B cutoff, because their difference equals

$$\frac{(2\gamma-1)(p_{2,A}-p_{1,A})}{\gamma t(1-\gamma)} \geq 0.$$

The possibilities are therefore those in Step 2, Step 3, and Step 6. If only B sells early, the reduction just described applies. Finally, $\sigma_{W,B} > 0$ rules out the possibility that no firm sells in advance.

Thus every unilateral deviation has been considered. Neither firm can profitably deviate from (p_1^*, p_2^*).

□

Proof Proposition 2. This proof determines the effect of a marginal increase in common ownership λ on advance price p_1^*, spot price p_2^*, advance purchase discount Δp^*, and average transacted price $\overline{p}^*$, before considering the limit $\gamma \to \frac{1}{2}$ where signals cease to be informative. We assume throughout, that the parametric requirements for equilibrium existence are satisfied.

Advance price. The effect of common ownership on p_1^* is

$$\frac{dp_1^*}{d\lambda} = \frac{2t\left(\gamma - \frac{1}{2}\right) A(\lambda, \gamma)}{\Omega^2} > 0,$$

whose sign is determined by

$$A(\lambda, \gamma) = 4(\lambda - 1)^2\gamma^3 - \left(9 - 2\lambda + 9\lambda^2\right)\gamma^2 + \left(10 + 8\lambda + 6\lambda^2\right)\gamma - (\lambda + 1)^2.$$

The derivative

$$\frac{d^3A}{d\lambda^2 d\gamma} = 12(1 - \gamma)(1 - 2\gamma) < 0,$$

implies that

$$\frac{d^2A}{d\lambda^2} = 12\gamma - 2 - 18\gamma^2 + 8\gamma^3 > \frac{d^2A}{d\lambda^2}|_{\gamma=1} = 0.$$

Hence, we know that

$$\begin{aligned} \frac{dA}{d\lambda} &= 8\gamma - 2 + (12\gamma - 2)\lambda - (18\lambda - 2)\gamma^2 - 8(1 - \lambda)\gamma^3 > \frac{dA}{d\lambda}|_{\lambda=0} \\ &= (1 - \gamma)(8\gamma^2 + 6\gamma - 2) > 0. \end{aligned}$$

Hence,

$$A > A|_{\lambda=0} = 4\gamma^3 - 9\gamma^2 + 10\gamma - 1 > 4\gamma^3 + \gamma - 1 = (2\gamma - 1)(2\gamma^2 + \gamma + 1) > 0.$$

Spot price. From condition (5) of Proposition 1, the upper bound on signal precision is

$$\gamma_e(\lambda) = \frac{1+\lambda}{1+3\lambda} = \frac{1}{2} + \frac{1-\lambda}{2(1+3\lambda)}.$$

Thus, the relevant parameter domain is $\frac{1}{2} < \gamma < \gamma_e(\lambda)$. Consider the derivative of the spot price with respect to λ,

$$\frac{\partial p_2^*}{\partial \lambda} = \frac{tB(\lambda,\gamma)}{\Omega(\lambda,\gamma)^2},$$

whose sign is determined by

$$B(\lambda,\gamma) = -4(1+6\lambda+\lambda^2)\gamma^3 + (17+38\lambda+9\lambda^2)\gamma^2 - (10+16\lambda+6\lambda^2)\gamma + (1+\lambda)^2,$$

Define the critical value $\gamma_p(\lambda)$ by $B(\lambda, \gamma_p(\lambda)) = 0$. We now prove that $\frac{1}{2} < \gamma_p(\lambda) < \gamma_e(\lambda)$ for all $\lambda \in [0,1)$. To see this first evaluate B at $\gamma = 1/2$. Substituting and simplifying gives

$$B\left(\lambda, \frac{1}{2}\right) = -\frac{(1-\lambda)^2}{4} < 0$$

for every $\lambda \in [0,1)$. Second, evaluate B at the threshold given by (5). Substituting $\gamma_e(\lambda) = \frac{1+\lambda}{1+3\lambda}$ into B and simplifying yields

$$B\left(\lambda, \gamma_e(\lambda)\right) = \frac{4(1-\lambda)(1+\lambda)^4}{(1+3\lambda)^3} > 0.$$

We have therefore established that $B\left(\lambda, \frac{1}{2}\right) < 0 < B\left(\lambda, \gamma_e(\lambda)\right)$. By continuity, there must be at least one critical value $\frac{1}{2} < \gamma_p(\lambda) < \gamma_e(\lambda)$ satisfying $B(\lambda, \gamma_p(\lambda)) = 0$. To establish uniqueness consider

$$\frac{\partial B}{\partial \gamma} = -12(1+6\lambda+\lambda^2)\gamma^2 + 2(17+38\lambda+9\lambda^2)\gamma - (10+16\lambda+6\lambda^2).$$

Notice that this derivative is a strictly concave quadratic function of γ, because

$$\frac{\partial^3 B}{\partial \gamma^3} = -24(1+6\lambda+\lambda^2) < 0.$$

Evaluating the derivative at the endpoints of the interval $[1/2, 1]$, we obtain

$$\left.\frac{\partial B}{\partial \gamma}\right|_{\gamma=1/2} = 4(1+\lambda) > 0$$

and

$$\left.\frac{\partial B}{\partial \gamma}\right|_{\gamma=1} = 12(1-\lambda) > 0.$$

Since $\partial B/\partial\gamma$ is strictly concave in γ and positive at the extremes $\frac{\partial B}{\partial \gamma} > 0$ for all $\gamma \in \left[\frac{1}{2}, 1\right]$ and $\lambda \in [0,1)$. Thus, $B(\lambda,\gamma)$ is strictly increasing in γ. establishing that B has exactly one zero in the interval $(1/2, \gamma_e(\lambda))$. We have thus shown that, for every $\lambda \in [0,1)$, there exists a unique critical signal precision $\gamma_p(\lambda) \in (\frac{1}{2}, \gamma_e(\lambda))$ such that $\frac{\partial p_2^*}{\partial \lambda} < 0$ if and only if $\gamma < \gamma_p(\lambda)$.

Discounts. The effect of common ownership on Δp^* is

$$\frac{d\Delta p^*}{d\lambda} = -\frac{8t\left(\gamma-\frac{1}{4}\right)(1-\lambda)^2(1-\gamma)^2\gamma}{\Omega^2} < 0$$

which also proves that an increase in λ decreases $\sigma_W^* = \frac{\Delta p^*}{t(1-\gamma)}$.

Average transacted price. Using $\bar{p}^* = p_2^* - \sigma_W^* \Delta p^* = p_2 - \frac{(\Delta p^*)^2}{t(1-\gamma)}$ the effect of common ownership on $\bar{p}^*$ can be written as

$$\begin{aligned}\frac{d\bar{p}^*}{d\lambda} &= \frac{dp_2^*}{d\lambda} - \frac{2\Delta p^*}{t(1-\gamma)}\frac{d\Delta p^*}{d\lambda} = \frac{dp_2^*}{d\lambda} - \frac{dp_1^*}{d\lambda} - \frac{2\Delta p^*}{t(1-\gamma)}\frac{d\Delta p^*}{d\lambda} + \frac{dp_1^*}{d\lambda} \\ &= [1-2\sigma_W^*]\frac{d\Delta p^*}{d\lambda} + \frac{dp_1^*}{d\lambda}.\end{aligned}$$

$\frac{d\bar{p}^*}{d\lambda} > 0$ then follows from the signs of the derivatives established above and the fact that $\sigma_W^* > \frac{1}{2}$ which holds because the second term in the denominator in (7) satisfies

$$(1+\lambda)(1-\gamma)(4\gamma-1) < 2(1-\gamma)(4\gamma-1) = 2\gamma - 2(2\gamma-1)^2 < 2\gamma.$$

Finally, in the limit, where consumers are completely uninformed, products become homogeneous in the advance market and advance purchase price converges to marginal costs, i.e. $\lim_{\gamma\to\frac{1}{2}} p_1^* = 0$. Hence, $\lim_{\gamma\to\frac{1}{2}} \frac{dp_1^*}{d\lambda} = 0$ independently of λ and

$$\lim_{\gamma\to\frac{1}{2}}\left[\sigma_W^*\frac{dp_1^*}{d\lambda} + (1-\sigma_W^*)\frac{dp_2^*}{d\lambda}\right] = \lim_{\gamma\to\frac{1}{2}}(1-\sigma_W^*)\frac{dp_2^*}{d\lambda} = -\frac{(1+\lambda)t}{(3+\lambda)^3} < 0.$$

□

Proof Proposition 3. Use $\bar{p}^* = p_2^* - t(1-\gamma)(\sigma_W^*)^2$ and $p^u = \frac{t}{1-\lambda}$ to get

$$p^u - \bar{p}^* = 4t\gamma(1-\gamma)\left[\frac{1+\lambda}{\Omega} + \frac{\gamma(1-\lambda)^2}{\Omega^2}\right] > 0.$$

Differentiating yields

$$\frac{d(p^u - \bar{p}^*)}{d\lambda} = \frac{4t\gamma(1-\gamma)(1-\lambda)}{\Omega^3}\Big[8\gamma^2 + 4\gamma(1-\gamma)(4\gamma-1)(1+3\lambda) + (1-\gamma)^2(4\gamma-1)^2(1+\lambda)^3\Big] > 0.$$

Together with $d\bar{p}^*/d\lambda > 0$, this establishes

$$0 < \frac{d\bar{p}^*}{d\lambda} < \frac{dp^u}{d\lambda} = \frac{t}{(1-\lambda)^2}.$$

The same ordering holds for proportional price responses. In particular,

$$\frac{d}{d\lambda}\left(\frac{\bar{p}^*}{p^u}\right) = -\frac{4\gamma^2(1-\gamma)(1-\lambda)^3}{\Omega^3}\left[2\gamma + (3\lambda-1)(1-\gamma)(4\gamma-1)\right] < 0.$$

The inequality follows because, for $\lambda \geq 0$,

$$\begin{aligned} 2\gamma + (3\lambda-1)(1-\gamma)(4\gamma-1) &\geq 2\gamma - (1-\gamma)(4\gamma-1) \\ &= 4\gamma^2 - 3\gamma + 1 > 0. \end{aligned}$$

Consequently,

$$0 < \frac{d\log\bar{p}^*}{d\lambda} < \frac{d\log p^u}{d\lambda} = \frac{1}{1-\lambda}.$$

Thus, whenever both equilibria exist, the price response to common ownership is smaller under intertemporal price discrimination, whether measured in absolute or proportional terms. □

Declaration of generative AI in the manuscript preparation process

During the preparation of this work the authors used ChatGPT to check the manuscript for consistency and to simplify the algebra of the proofs. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article

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References

Antón, Miguel, Florian Ederer, Mireia Giné, and Martin Schmalz. 2023. "Common Ownership, Competition, and Top Management Incentives." *Journal of Political Economy* 131 (5): 1294–1355.

Azar, José, Sahil Raina, and Martin Schmalz. 2022. "Ultimate Ownership and Bank Competition." *Financial Management* 51 (1): 227–269.

Azar, José, Martin C. Schmalz, and Isabel Tecu. 2018. "Anticompetitive Effects of Common Ownership." *Journal of Finance* 73 (4): 1513–1565.

Backus, Matthew, Christopher Conlon, and Michael Sinkinson. 2021. "Common ownership in America: 1980–2017." *American Economic Journal: Microeconomics* 13 (3): 273–308.

Bayona, Anna, Ángel L López, and Anton-Giulio Manganelli. 2022. "Common ownership, corporate control and price competition." *Journal of Economic Behavior & Organization* 200:1066–1075.

Bresnahan, Timothy, and Steven C. Salop. 1986. "Quantifying the competitive effects of production joint ventures." *International Journal of Industrial Organization* 4 (2): 155–175.

Ceschi, Nadia, and Marc Möller. 2023. "Advance selling in the wake of entry." *The Journal of Industrial Economics* 71 (4): 1072–1089.

Dennis, Patrick, Kristopher Gerardi, and Carola Schenone. 2022. "Common ownership does not have anticompetitive effects in the airline industry." *The Journal of Finance* 77 (5): 2765–2798.

Farrell, Joseph, and Carl Shapiro. 1990. "Asset Ownership and Market Structure in Oligopoly." *The RAND Journal of Economics* 21 (2): 275–292.

Li, Changying, and Jianhu Zhang. 2025. "Behaviour-Based Pricing with Overlapping Ownership." *Canadian Journal of Economics* 58 (1): 136–168.

Lømo, Teis Lunde. 2024. "Overlapping ownership and input prices." *International Journal of Industrial Organization* 94:103067.

Möller, Marc, and Makoto Watanabe. 2016. "Competition in the presence of individual demand uncertainty." *The RAND Journal of Economics* 47 (2): 273–292.

Reynolds, Robert J., and Bruce R. Snapp. 1986. "The competitive effects of partial equity interests and joint ventures." *International Journal of Industrial Organization* 4 (2): 141–153.

Rotemberg, Julio. 1984. "Financial transaction costs and industrial performance." *Sloan School of Management Working Paper* 1554-84.

Schmalz, Martin C. 2021. "Recent Studies on Common Ownership, Firm Behavior, and Market Outcomes." *The Antitrust Bulletin* 66 (March): 12–38.

Shelegia, Sandro, and Yossi Spiegel. 2012. "Bertrand competition when firms hold passive ownership stakes in one another." *Economics Letters* 114 (January): 136–138.

Williams, Kevin R. 2022. "The Welfare Effects of Dynamic Pricing: Evidence from Airline Markets." *Econometrica* 90 (2): 831–858.