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Overlapping ownership, pass-through, and product differentiation

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ABSTRACT

Overlapping ownership can lead firms to raise prices, but what determines the magnitude of this effect? I study how the price effect of overlapping ownership depends on demand and cost conditions and the degree of product differentiation in a Bertrand oligopoly. I do so by extending Weyl and Fabinger's (2013) conduct parameter approach which highlights the importance of pass-through.

1. Introduction

Overlapping ownership – in the form of cross-ownership by firms or common ownership by institutional investors – is a widespread and increasing phenomenon (e.g., Gilo et al., 2006; Backus et al., 2021a). It is well understood theoretically that such overlapping ownership can reduce firms' incentives to compete and thereby lead to higher prices. For example, this was shown in Cournot-type models by Bresnahan and Salop (1986) and Reynolds and Snapp (1986) and in Bertrand markets with homogeneous goods by Shelegia and Spiegel (2012) and Bayona et al. (2022).[1] On the empirical side, there is an ongoing debate about whether the rise of common ownership has affected competition, and, if so, through what channels (e.g., Azar et al., 2018; Backus et al., 2021b; Antón et al., 2023).

This paper studies the price effect of overlapping ownership in a theoretical model. In particular, I consider a Bertrand oligopoly with differentiated products and extend the conduct parameter approach of Weyl and Fabinger (2013) to overlapping ownership. This approach allows for a compact and intuitive treatment with general functional forms and clarifies the key role of *pass-through* in determining the magnitude of the price effect. I also examine how the price effect depends on demand and cost conditions and the level of product differentiation. The analysis contributes to the theoretical literature on overlapping ownership and may also be of relevance from a competition policy perspective (see Section 3 for further discussion).

2. Analysis

Consider a market with $n \geq 2$ firms. The firms have symmetric cost functions $C\left(q_i\right)$, for $i \in \{1,\ldots,n\}$, where $C(0) = 0$. I denote marginal costs by $c'\left(q_i\right) \triangleq \partial C/\partial q_i$, $\forall i$. The demand for the product of firm i is $q_i = D_i(\mathbf{p})$, where $\mathbf{p} \triangleq \left(p_1,\ldots,p_n\right)$ is a vector of prices. The demand system is symmetric. Moreover, I impose standard assumptions: The function D_i is smooth whenever positive, own-price effects are negative, $\partial D_i/\partial p_i < 0$, $\forall i$, cross-price effects are weakly positive, $\partial D_i/\partial p_k \geq 0$, $\forall i \neq k$, and own-price effects dominate cross-price effects, i.e., $\partial D_i/\partial p_i + \sum_k^{n-1} \partial D_i/\partial p_k < 0$.

The operating profit of firm i is $\pi_i = p_i D_i(\mathbf{p}) - C\left(D_i(\mathbf{p})\right)$. I consider a symmetric level of overlapping ownership (or symmetric "profit weights"), given by $\lambda \in [0,1)$. As shown by López and Vives (2019, pp. 2400–2402), λ can represent either common ownership or cross-ownership depending on the micro-foundation. For a given λ, the objective function of firm i is given by

$$\phi_i(\mathbf{p}) \triangleq p_i D_i(\mathbf{p}) - C\left(D_i(\mathbf{p})\right) + \lambda \sum_{k\neq i}^{n-1} \left[p_k D_k(\mathbf{p}) - C\left(D_k(\mathbf{p})\right)\right].$$

The firms set prices simultaneously and non-cooperatively. The first-order condition $\partial\phi_i/\partial p_i = 0$ is

$$D_i(\mathbf{p}) + \left(p_i - c'\left(D_i(\mathbf{p})\right)\right)\frac{\partial D_i(\mathbf{p})}{\partial p_i} + \lambda \sum_{k\neq i}^{n-1}\left[\left(p_k - c'\left(D_k(\mathbf{p})\right)\right)\frac{\partial D_k(\mathbf{p})}{\partial p_i}\right] = 0. \quad (1)$$

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[1] In addition, overlapping ownership can facilitate tacit collusion on prices (Gilo et al., 2006), and distort product positioning (Li et al., 2023). On the other hand, overlapping ownership may have pro-consumer effects, e.g., to raise product quality (Brito et al., 2020), stimulate technology licensing (Leonardos et al., 2021), and enhance product innovation (Stenbacka and Van Moer, 2023).

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The second-order conditions $\partial^2\phi_i/\partial p_i^2 < 0$ and $\partial^2\phi_i/\partial p_i^2 + (n-1)\,\partial^2\phi_i/\partial p_i\,\partial p_k < 0$ are assumed to hold globally. This ensures existence of a unique, symmetric Nash equilibrium in prices (López and Vives, 2019).

When all firms set a common price p, the per-firm demand is $Q(p) = D_i(p, \ldots, p)$. Due to demand symmetry, the slope of $Q(p)$ is

$$Q'(p) = \frac{\partial D_i}{\partial p_i} + \sum_{k \neq i}^{n-1} \frac{\partial D_i}{\partial p_k} = \frac{\partial D_i}{\partial p_i} + (n-1)\frac{\partial D_k}{\partial p_i} < 0,$$

where the inequality holds because own-price effects dominate cross-price effects.

Let

$$\alpha(p) \triangleq \frac{Q(p)}{-Q'(p)}$$

be the inverse semi-elasticity of $Q(p)$ and let

$$d(p) \triangleq \frac{(n-1)\frac{\partial D_k(p,\ldots,p)}{\partial p_i}}{-\frac{\partial D_i(p,\ldots,p)}{\partial p_i}}$$

be the aggregate diversion ratio at symmetric prices. Since $Q'(p) < 0$, we have $\alpha(p) > 0$ and $d(p) \in (0,1)$.

Let p^* be the symmetric equilibrium price, and denote the equilibrium price vector by $\mathbf{p}^* = (p^*, \ldots, p^*)$. At the equilibrium, (1) can be re-written as

$$Q(p^*) + \left(p^* - c'\left(Q(p^*)\right)\right)\left[\frac{\partial D_i(\mathbf{p}^*)}{\partial p_i} + \lambda(n-1)\frac{\partial D_k(\mathbf{p}^*)}{\partial p_i}\right] = 0. \tag{2}$$

In what follows, all functions are evaluated at the equilibrium point.

Proposition 1. *The firms' equilibrium mark-ups can be written as $p^* - c' = \alpha\theta$, where*

$$\theta \triangleq \frac{1-d}{1-\lambda d} \tag{3}$$

is the conduct parameter.[2] *Equivalently, $\left(p^* - c'\right)/p^* = \theta/\varepsilon$, where $\varepsilon = -(p^*/Q)\,Q'$.*

Proof. Starting from (2), we have

$$\begin{aligned} p^* - c' &= \frac{-Q}{\frac{\partial D_i}{\partial p_i} + \lambda(n-1)\frac{\partial D_k}{\partial p_i}} \\ &= \frac{-Q}{\frac{\frac{\partial D_i}{\partial p_i} + (n-1)\frac{\partial D_k}{\partial p_i}}{1 - \frac{(n-1)\frac{\partial D_k}{\partial p_i}}{-\frac{\partial D_i}{\partial p_i}}} + \lambda\frac{\frac{\partial D_i}{\partial p_i} + (n-1)\frac{\partial D_k}{\partial p_i}}{1 - \frac{-\frac{\partial D_i}{\partial p_i}}{(n-1)\frac{\partial D_k}{\partial p_i}}}} \\ &= \frac{-Q}{Q'\left(\frac{1}{1-d} - \lambda\frac{d}{1-d}\right)} \\ &= \frac{Q}{-Q'}\left(\frac{1-d}{1-\lambda d}\right) \\ &= \alpha\theta, \end{aligned}$$

where the third equality follows from the definitions of Q' and d, and the last from the definitions of α and θ. □

The conduct parameter (3) provides a compact and intuitive characterization of how overlapping ownership affects price competition when firms offer differentiated products. First, in the baseline where $\lambda = 0$, the conduct parameter is $\theta = 1-d$ as shown by Weyl and Fabinger (2013, p. 544). In this case, market conduct ranges from almost perfect competition ($\theta \to 0$) when goods are near perfect substitutes ($d \to 1$) to monopoly ($\theta = 1$) when goods are independent ($d = 0$). When we then introduce overlapping ownership ($\lambda > 0$), (3) gives $\theta > 1-d$, for any d. That is, overlapping ownership gives less competitive conduct and higher mark-ups, *ceteris paribus*. In the limit where $\lambda \to 1$ (i.e., a cartel or a full horizontal merger), we have $\theta \to 1$, $\forall d$, and market conduct becomes "monopoly-like."

2.1. Decomposition

Consider now the effect of a marginal increase in the level of overlapping ownership on the equilibrium price. Totally differentiating $p^* - c' = \alpha\theta$ with respect to λ yields

$$\frac{\partial p^*}{\partial \lambda} - c''Q'\frac{\partial p^*}{\partial \lambda} = \frac{\partial \alpha}{\partial p}\frac{\partial p^*}{\partial \lambda}\theta + \alpha\left(\frac{\partial \theta}{\partial p}\frac{\partial p^*}{\partial \lambda} + \frac{\partial \theta}{\partial \lambda}\right),$$

where $c'' \triangleq \partial c'/\partial q_i$. Solving this for $\partial p^*/\partial \lambda$, we obtain

$$\frac{\partial p^*}{\partial \lambda} = \underbrace{\frac{1}{\frac{1}{\alpha} - \frac{\theta}{\alpha}\frac{\partial \alpha}{\partial p} - \frac{\partial \theta}{\partial p} - \frac{Q'c''}{\alpha}}}_{\text{Pass-through coefficient}} \times \underbrace{\frac{\partial \theta}{\partial \lambda}}_{\text{Direct effect on conduct}}. \tag{4}$$

In general, a pass-through coefficient (or pass-through rate) measures the impact of a cost change on the equilibrium price. The pass-through coefficient expressed in (4) is strictly positive under the firms' second-order conditions (see the Appendix). Moreover, we have from (3) that the direct effect on the conduct parameter is

$$\frac{\partial \theta}{\partial \lambda} = \frac{(1-d)\,d}{(1-\lambda d)^2} > 0. \tag{5}$$

Hence, $\partial p^*/\partial \lambda > 0$.

The decomposition in (4) reflects a logic familiar from the literature on horizontal mergers (e.g., Farrell and Shapiro, 2010). Overlapping ownership can be seen as giving firm i an extra opportunity cost of cutting its price, since this will cannibalize sales from firms $k \neq i$ from which firm i receives a share of the profits. Consequently, overlapping ownership reduces the firms' incentives to compete. The actual effect on the equilibrium price in turn depends on the extent to which this opportunity cost is passed on to consumers. For a given direct effect on the conduct parameter, a higher pass-through rate means a larger price increase.

Building on this logic, it is useful to write the pass-through rate in terms of model primitives. First, let $\sigma \triangleq QQ''/\left(Q'\right)^2$ be the curvature of the (inverse) market demand function. Demand is convex (concave) when $\sigma > 0$ ($\sigma < 0$). It is then well known that

$$\frac{\partial \alpha}{\partial p} = \frac{Q'\left(-Q'\right) - Q\left(-Q''\right)}{(-Q')^2} = \sigma - 1.$$

Second, we have from (3) that

$$\frac{\partial \theta}{\partial p} = \frac{-d'(1-\lambda d) - (1-d)\left(-\lambda d'\right)}{(1-\lambda d)^2} = \frac{(\lambda - 1)\,d'}{(1-\lambda d)^2},$$

where $d' \triangleq \partial d/\partial p$.[3] Denoting the pass-through rate in (4) by ρ, we then obtain

$$\rho = \frac{\alpha}{1 + (1-\sigma)\theta - Q'c'' + \psi d'}, \tag{6}$$

where $\psi \triangleq \alpha(1-\lambda)/(1-\lambda d)^2 > 0$. Pass-through is thus higher for a more convex demand function (i.e., $\partial\rho/\partial\sigma > 0$), *ceteris paribus*. Similarly, pass-through is higher, *ceteris paribus*, for a more concave cost function and a faster decreasing diversion ratio.

It should be noted that the *ceteris paribus* clause here is demanding. As an example, consider two industries A and B where demand is more convex in A than B. For this to imply directly that the price effect of overlapping ownership as given by (5) and (6) is larger in A than B,

[2] Adachi and Bao (2024) derive an expression equivalent to (3). However, their approach is very different from mine (they study an aggregate industry model in the style of Chicago price theory), and they do not examine the equilibrium effects of changes in the ownership level.

[3] Weyl and Fabinger (2013, pp. 549–551) argue that $d' < 0$ is likely when demand is based on a discrete choice framework.

the industries would need to have the same initial level of ownership and the same demand and cost conditions (as given by α, Q', d, d', and c''). In practice, these conditions are likely to vary across different industries which could make it difficult to isolate the impact of one factor such as demand convexity. As argued by Ritz (2024), however, cross-industry differences in demand and cost conditions can to some extent be controlled for through econometric analysis.

Another important question is how the price effect of overlapping ownership depends on the level of product differentiation. Some insight on this can be gleaned from (5). First, the effect is small when products are very differentiated ($d \to 0$) because the opportunity cost then is negligible. The effect is also small when products are very close substitutes ($d \to 1$), as the conduct parameter then becomes unresponsive to ownership changes. This suggests that there will be a non-monotone relationship between the price effect and the level of product differentiation. I analyze this issue in the next section using a linear demand function.

In practice, changes in overlapping ownership will typically be discrete and hence one needs to integrate over the marginal effects (as given above). If the marginal effect had been constant, the effect of a discrete change would simply be the size of the change times the marginal effect. However, since the marginal effect is generally not constant, multiplying the marginal effect at the initial ownership level by the size of the change will lead to an over- or underestimation of the total effect depending on whether the marginal effect rises or falls as the ownership level increases. It is therefore important and useful to analyze explicitly the effect of discrete change in λ, which I also do in the linear demand case below.[4]

2.2. Linear demand

Following Shubik and Levitan (1980), suppose now that demand is given by

$$D_i(\mathbf{p}) = \frac{(b+(n-2)\gamma)\left(a-p_i\right) - \gamma \sum_{k\neq i}^{n-1}\left(a-p_k\right)}{(b-\gamma)(b+(n-1)\gamma)}, \tag{7}$$

where $b > \gamma \geq 0$. For simplicity, suppose also that marginal cost is constant and equal to $c \in (0, a)$. Given this, it is straightforward to show that the equilibrium price is

$$p^* = \frac{a(b-\gamma) + (b+(n-2)\gamma)c - \lambda(n-1)\gamma c}{2b + (n-3-\lambda(n-1))\gamma}. \tag{8}$$

Consider first the effect of a marginal increase in ownership and how it depends on product differentiation. In this example, the level of product differentiation is captured by the parameter γ. A higher value of γ means that products are closer substitutes (i.e., less differentiated).[5] Taking the derivative of p^* in (8) with respect to λ yields the following marginal effect on price:

$$\frac{\partial p^*}{\partial \lambda} = \frac{(n-1)(a-c)(b-\gamma)\gamma}{(2b+(n-3-\lambda(n-1))\gamma)^2} > 0. \tag{9}$$

Differentiating (9) with respect to γ then gives

$$\frac{\partial^2 p^*}{\partial \lambda \partial \gamma} = \underbrace{\frac{(n-1)(a-c)\gamma}{(2b+(n-3-\lambda(n-1))\gamma)^3}}_{>0}(2b-(1+\lambda+(1-\lambda)n)\gamma). \tag{10}$$

The impact of product substitutability on the price effect is thus determined by the sign of the last parentheses. We can state the following result.

Proposition 2. *When demand is given by (7) and marginal cost is constant, a higher level of product substitutability mitigates the price effect of overlapping ownership (i.e., $\partial^2 p^*/\partial\lambda\partial\gamma < 0$) if*

$$\gamma > \frac{2b}{1+\lambda+(1-\lambda)n} \tag{11}$$

and amplifies the price effect (i.e., $\partial^2 p^*/\partial\lambda\partial\gamma > 0$) if the converse holds.

This result is illustrated graphically in Fig. 1 (see the next page).

To interpret Fig. 1, consider first the two blue lines. We see that at $\gamma = .241$, $\partial^2 p^*/\partial\lambda\partial\gamma$ crosses the x-axis from above and $\partial p^*/\partial\lambda$ attains its maximum over $\gamma \in [0,1)$. To the right of this, i.e., for $\gamma > .241$, the price effect gradually diminishes if products become closer substitutes. Indeed, $\gamma > .241$ is exactly condition (11) from Proposition 2 given that $b = 1$, $\lambda = .1$, and $n = 8$. Thus, for these parameter values (11) is a fairly mild condition and $\partial^2 p^*/\partial\lambda\partial\gamma < 0$ holds for the majority of the permissible γ-values. However, as can be seen from the green lines, the strictness of the condition is sensitive to the choice of λ and n: When instead $\lambda = .2$ and $n = 2$ (while keeping a, b, and c the same), the price effect diminishes with γ only for $\gamma > .714$.[6]

Consider now the effect of a discrete change in overlapping ownership. Specifically, suppose that the amount of ownership jumps from some initial level λ up to $\lambda + \Delta$, where $0 < \Delta < 1 - \lambda$. Let p^*_{before} denote the price before the change (with level λ) and let p^*_{after} denote the price after the change (with level $\lambda + \Delta$). Then, using (8), we find that the relative change in price is

$$\frac{p^*_{\text{after}} - p^*_{\text{before}}}{p^*_{\text{before}}} \triangleq \eta = \frac{(n-1)(a-c)(b-\gamma)\gamma\Delta}{(a(b-\gamma)+c(b+(n-2-(n-1)\lambda)))\beta}, \tag{12}$$

where $\beta \triangleq 2b + \gamma(n-3-(n-1)(\lambda+\Delta)) > 0$.[7]

Formula (12) has the following properties. First, $\eta > 0$, so the increase in ownership always raises the price. This is natural since the marginal effect is always positive. Second, Δ enters both in the numerator and the denominator through β. All else equal, a greater jump Δ gives a larger price hike, which is also intuitive. Third, in addition to Δ, (12) depends on all the same parameters as (9), i.e., a, b, c, γ, λ and n. In this sense, the informational requirements of the two formulas are similar. Fourth, in the case where marginal cost is negligible (i.e., $c \to 0$), (12) has a particularly simple form:

$$\lim_{c\to 0} \eta = (n-1)\gamma\Delta\beta^{-1}.$$

Notably, the base demand parameter a does not enter in this expression. This is in contrast to the marginal effect (9) which depends on a also in the limit where $c \to 0$. In this case, calculating the effect of a discrete change in λ thus requires less information.

3. Discussion

There is an active debate about potential policy responses to overlapping ownership. A prominent proposal has been to strengthen the

[4] See Miklós-Thal and Shaffer (2021) for a related analysis of the difference between marginal and discrete changes in competitive conditions under nonlinear demand.

[5] More formally, γ is the cross-derivative $-\partial^2 U/\partial q_i \partial q_k$ of the underlying (quadratic) utility function U with respect to quantities q_i and q_k, $i \neq k$ (Choné and Linnemer, 2020).

[6] In previous work, O'Brien and Salop (1999, p. 611) and Brito et al. (2018, p. 153) have derived screening indicators for partial acquisitions. In these formulas, the upward pricing pressure from an increase in overlapping ownership is always greater the closer substitutes are the firms' products. However, those formulas measure the effect on *one* price from an ownership increase, holding the other prices fixed at the pre-acquisition level. By contrast, I consider the effect on the final equilibrium price when all prices can adjust and the pass-through rate (which in turn depends on substitutability) also matters. This latter effect may well be decreasing in the substitutability level.

[7] Note that in this example, the marginal effect (9) is increasing in λ (i.e., $\partial^2 p^*/\partial\lambda^2 > 0$). Thus, for a discrete change in λ, using the marginal effect at the "before" level (i.e., λ) would here lead to an underestimation of the total effect on price, whereas using the marginal effect at the "after" level (i.e., $\lambda + \Delta$) would lead to an overestimation. Formula (12) gives the correct (percentage) change in price as a function of the initial ownership level and the change Δ.

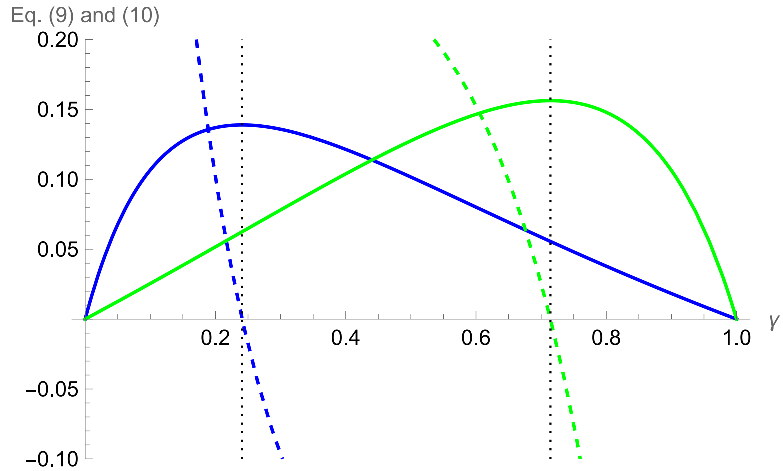

Fig. 1. The solid lines show $\partial p^*/\partial \lambda$ (i.e., (9)) and the dashed lines show $\partial^2 p^*/\partial \lambda \partial \gamma$ (i.e., (10)). Blue and green represent different parameter values. Blue: $a = b = 1$, $c = 0$, $\lambda = .1$, and $n = 8$. Green: $a = b = 1$, $c = 0$, $\lambda = .2$, and $n = 2$. The left vertical dotted line is at $\gamma = .241$ and the right vertical dotted line is at $\gamma = .714$.

enforcement of non-controlling minority shareholding within the framework of merger control (see, e.g., OECD, 2017). Such an approach would require competition authorities to assess on a case-by-case basis whether the anti-competitive effects of a given increase in ownership are large enough to warrant intervention.

My analysis helps to clarify what type of data would be useful for a competition authority trying to predict the price effect of a rise in overlapping ownership in an industry that can be represented by a model of differentiated-goods price competition. First, the effect depends on the number of firms and the initial level of ownership. These variables should be observable *ex ante*. Second, in merger analysis the authorities often rely on diversion ratios. These ratios can be obtained from customer survey data or by empirical estimation (see Conlon and Mortimer, 2021). Not surprisingly, diversion ratios are important also for the price effect of overlapping ownership. However, my analysis has shown that the relationship between the price effect and product differentiation is subtle, and that greater product substitutability may imply a smaller price increase. Moreover, the analysis has emphasized the importance of pass-through. A large empirical literature has estimated pass-through rates in many different industries (see, e.g., Miller et al., 2017). Focusing directly on pass-through may circumvent estimation of underlying variables such as demand curvature which has traditionally been seen as overly difficult (e.g., Farrell and Shapiro, 2010).[8]

A limitation of the analysis in this paper was the restriction to symmetric ownership. Studying the price effects of overlapping ownership in a model with general functional forms and *asymmetric* ownership is an interesting yet challenging avenue for future work. One way to approach this question could be to start with the duopoly case ($n = 2$) and assume that only one of the firms holds an ownership share in its rival.

Data availability

No data was used for the research described in the article.

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[8] See Reisinger and Zenger (2024) for a general discussion of predicting price effects of horizontal acquisitions based on observable variables.

Appendix

Positivity of the pass-through coefficient. Note first that $\partial \phi_i/\partial p_i = Q + (p^* - c)\,Q'/\theta$ in equilibrium. Thus:

$$\frac{\partial}{\partial p}\left[Q + \left(p^* - c'\right)\frac{Q'}{\theta}\right] = Q' + \left(1 - c''Q'\right)\frac{Q'}{\theta} + \left(p^* - c'\right)\frac{Q''\theta - Q'\frac{\partial\theta}{\partial p}}{\theta^2}.$$

Using $p^* - c = \alpha\theta$ and $\alpha = -Q/Q'$, the latter can be re-written as

$$Q' + \frac{Q'}{\theta} - \frac{QQ''}{Q'} + \frac{Q}{\theta}\frac{\partial\theta}{\partial p} - \frac{\left(Q'\right)^2 c''}{\theta}.$$

Strict concavity of the objective function then requires

$$\begin{aligned} Q' + \frac{Q'}{\theta} - \frac{QQ''}{Q'} + \frac{Q}{\theta}\frac{\partial\theta}{\partial p} - \frac{\left(Q'\right)^2 c''}{\theta} < 0 &\iff \\ 1 + \frac{1}{\theta} - \frac{QQ''}{\left(Q'\right)^2} + \frac{Q}{\theta Q'}\frac{\partial\theta}{\partial p} - \frac{Q'c''}{\theta} > 0 &\iff \\ 1 + \frac{1}{\theta} - \left(1 + \frac{\partial\alpha}{\partial p}\right) - \frac{\alpha}{\theta}\frac{\partial\theta}{\partial p} - \frac{Q'c''}{\theta} > 0 &\iff \\ \frac{1}{\alpha} - \frac{\theta}{\alpha}\frac{\partial\alpha}{\partial p} - \frac{\partial\theta}{\partial p} - \frac{Q'c''}{\alpha} > 0, & \end{aligned}$$

where the second line follows from multiplying through by $1/Q' < 0$, the third from using that $QQ''/\left(Q'\right)^2 = \sigma = 1 + \partial\alpha/\partial p$ and $Q/Q' = -\alpha$, and the fourth from gathering terms and multiplying through by θ/α. The last line implies that the pass-through coefficient in (4) is positive. □

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