Can Partial Horizontal Ownership Lessen Competition More Than a Monopoly?*

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Abstract

In this paper we investigate the anti-competitive effects of partial horizontal ownership in a setting where: (i) two cost-asymmetric firms compete à la Cournot; (ii) managers deal with eventual conflicting interests of the different shareholders by maximizing a weighted sum of the two firms' operating profits; and (iii) weights result from the corporate control structure of the firm they run. Within this theoretical structure, we find that if the manager of the more efficient firm weights the operating profit of the (inefficient) rival more than its own profit, then partial ownership will lessen competition more than a monopoly when both firms produce.

JEL Classification: L11, L12, L13, L41, L50

Keywords: Partial Horizontal Ownership, Common-Ownership, Cross-Ownership, Full Joint Ownership, Duopoly, Cost Asymmetry

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1 Introduction

Horizontal shareholding exists when shareholders own partial ownership stakes in several horizontal competitors in an industry. This may induce a conflict of objectives among the owners of a firm, since a shareholder who - for example - also holds a stake in a rival firm typically wants the firm to pursue a less aggressive strategy than the strategy desired by a shareholder which does not hold a stake in a rival firm. In order to model this feature, the literature typically considers the strategy x_j of firm j in such cases to be decided and executed by a manager, who weights the (eventual) conflicting objectives of the different shareholders according to the corporate control structure of the firm (which determines the influence of each of those owners over decision-making), as follows:

$$\max_{x_j} \pi_j + \sum\nolimits_{g \in \Im, g \neq j} w_{jg} \pi_g, \tag{1}$$

where $\Im$ denotes the set of existing firms in the industry, π_j denotes the operating profit of firm j, and $w_{jg} \geq 0$ denotes the weight that the manager of firm j assigns to the operating profit of each rival firm g, which is a function of the financial and control rights of the shareholders in the two firms.[1]

There are currently three alternative formulations for the weight that the manager of a firm assigns to the operating profits of rivals, due, respectively, to O'Brien and Salop (2000), Crawford *et al.* (2018) and Brito *et al.* (2018a).[2,3] However, independently of the exact

[1] While the financial rights have very clear empirical counterparts, the control rights do not. Azar (2016, 2017) and Brito *et al.* (2018a, 2018b) address this question by showing that O'Brien and Salop (2000) and Brito *et al.* (2018a)'s formulations can be microfounded through a probabilistic voting model in which shareholders vote to elect one of two candidates to the manager position, an incumbent and a challenger. In particular, they show that if the two candidates choose the strategy to the firm by maximizing the expected vote share within the firm, the control rights of shareholders can be endogenously measured by their holdings of voting stock. If, however, the two candidates maximize the probability of being elected, the control rights of shareholders can be endogenously measured by the Banzhaf (1965) power index that results from their holdings of voting stock.

[2] O'Brien and Salop (2000), rooted on Rotemberg (1984) and Bresnahan and Salop (1986), assumes, *the manager should decide the strategy of the firm so as to maximize a corporate control weighted sum of the firm's shareholders returns.* This yields that $w_{jg} = (\sum_{k \in \Theta_j} (\gamma_{kj} \phi_{kg}))/(\sum_{k \in \Theta_j} (\gamma_{kj} \phi_{kj}))$, where Θ_j denotes the set of shareholders that hold financial rights in firm j, ϕ_{kj} denotes the financial rights of shareholder k in firm j, and γ_{kj} denotes the control rights of shareholder k in firm j. This formulation has been critiqued for producing counter-intuitive weights when non-horizontal shareholders are highly dispersed (see, for example, Gramlich and Grundl, 2017). Recently, Crawford *et al.* (2018) and Brito *et al.* (2018a) proposed alternative formulations to avoid this issue. Under these alternative formulations, the *manager should decide the strategy of the firm so as to maximize a corporate control weighted sum of the shareholders relative returns.* They yield that $w_{jg} = \sum_{k \in \Theta_j} (\gamma_{kj} \phi_{kg} / (\sum_{h \in \Im} \phi_{kh}))$ and $w_{jg} = \sum_{k \in \Theta_j} (\gamma_{kj} \phi_{kg} / \phi_{kj})$, respectively.

[3] The different formulations can be extended to jointly capture horizontal shareholding by shareholders that can be external (common-ownership) and internal/rival firms (cross-ownership) to the industry. In those cases, the weights are computed using the *ultimate* financial and control rights, respectively, of *external* shareholders (see Brito *et al.*, 2018b).

formulation, the implication that, under partial ownership, managers would internalize the impact of their firm's strategy on the operating profits of rivals when their firm's controlling shareholders have financial rights in those rivals, is consistent with recent empirical work. Liang (2016) finds that in the presence of interlinks in ownership, firms compensate managers relatively more for rival's performance. Antón *et al.* (2018) finds that managerial wealth is more sensitive to own performance in the absence of such interlinks. Azar, Schmalz and Tecu (2018) find that such interlinks matter for how firms in the U.S. airline industry compete. Azar, Raina and Schmalz (2016) find the same relation in the U.S. banking industry. As a consequence, competition agencies have been taking an increased interest in assessing the anti-competitive effects of partial horizontal ownership acquisitions.

Since partial ownership does not completely and permanently eliminate competition among firms, we would expect, at first glance, prices in an industry characterized by partial ownership to be lower than in an industry characterized by a monopoly. However, the weights that managers assign to the operating profits of rivals (independently of the exact formulation) *are not necessarily bounded from above*, which implies that managers can assign more weight to the operating profit of rivals than to own-operating profit.[4,5] Backus, Conlon and Sinkinson (2018a) examine the weights (using O'Brien and Salop 2000's dominant formulation) that managers assign to rivals for all firm pairs in the S&P 500 between 1980 and 2017 and reported that the share of firm pairs with weights larger than one has been increasing over time, reaching over 10% in 2017 (see Figure 14 therein and related discussion). Further, weights larger than one are reminiscent of "tunneling", a term used to describe "the transfer of assets and profits out of firms for the benefit of those who control them" (Johnson *et al.*, 2000). La Porta *et al.* (2000) point out that tunneling comes in different forms: in addition to simply stealing the profits, diverting relevant opportunities away from the firm, or placing family members in overpaid managerial positions, managers may also sell the firm's output, assets, or additional securities to a rival firm at below market prices. Such sales only make sense if managers assign a weight larger than one to the operating profit of that specific rival firm.

Does this mean that prices in an industry characterized by partial ownership can be higher than in an industry characterized by a monopoly? To the best of our knowledge there is no article in the literature that examines this question. Nye (1992) and Foros, Kind and

[4]The weights that managers assign to the operating profits of rivals under the alternative formulation proposed by Brito *et al.* (2018a) are bounded above by one if control rights are measured by voting rights, but not if control rights are measured by the Banzhaf (1965) power index that results from the corresponding voting rights.

[5]This implies also that competition agencies may obtain concentration measures - using a modified/generalized Herfindahl-Hirschman index - above $10,000$.

Shaffer (2011) examine the related sub-question of whether prices in an oligopoly after a partial ownership acquisition can be higher than after a merger and show the answer can, in fact, be positive. Nye (1992) examines the 1989's Renault/Volvo joint venture in the heavy truck industry, which involved reciprocal partial ownership acquisitions by the two firms. As a consequence of this joint venture, the manager of Volvo assigned a weight of 0.55 to Renault's (heavy truck) operating profit while the manager of Renault assigned a weight of 0.505 to Volvo's (heavy truck) operating profit. Using data on market shares, Nye (1992) calibrates a Cournot homogenous-product oligopoly model with seven firms in which demand is assumed to be linear and each firm is assumed to have constant but asymmetric marginal cost and no capacity constraint. He then calculates that the joint venture would reduce industry total quantity by 1.91% while a merger would reduce it only by 1.71%. Foros, Kind and Shaffer (2011) examine a similar question under a Bertrand differentiated-product triopoly Salop model in which each firm is assumed to have identical costs of production and no capacity constraint. They compare the profitability of a partial ownership acquisition in which the acquiring firm, although acquiring less than 100% of the financial rights, obtains full control, with the profitability of a merger. They show that a necessary condition for a partial ownership acquisition to be more profitable than a merger is that the equilibrium price of the outside firm (not involved in the acquisition/merger) increases when the acquisition stake decreases, which yields that consumers in aggregate end up worse off than they would have been if the firms had merged.

The objective of this paper is to examine if prices in an industry characterized by partial ownership can be higher than in an industry characterized by a monopoly. For that purpose, we consider a Cournot homogenous-product duopoly model in which demand is assumed to be linear and each firm is assumed to have constant but asymmetric marginal cost and no capacity constraint. We consider also that the ownership structure is such that the manager of each firm weights the operating profit of the rival.[6] We show that if the manager of the more efficient firm weights the operating profit of the (inefficient) rival more than its own

[6] Naturally, in this setting, examining whether prices in an industry characterized by partial ownership can be higher than in an industry characterized by a monopoly is equivalent to examining whether prices after a partial ownership acquisition can be higher than after a merger as in Nye (1992). However, we must point out two major differences with respect to Nye (1992). First, he calibrates the demand and cost parameters so that the Cournot-Nash equilibrium shares of a market with seven firms mimic those of the heavy truck industry. He then simulates the effect of a joint venture (which involved reciprocal partial ownership acquisitions) and of a full merger showing that the former can reduce the industry total quantity more than a merger. However, he does not carry out any type of formal analysis. In contrast, we fully characterize the equilibria under the set of possible alternative partial ownership scenarios and identify the specific conditions that should be fulfilled in order for the market price after a partial ownership acquisition to be higher than after a merger. Second, Nye (1992) implicitly assumes that a unique interior equilibrium exists whereas we show that the set of possible equilibria is richer.

profit, then partial ownership *will* lessen competition more than a monopoly whenever both firms produce, regardless of the weight the manager of the inefficient firm assigns to the operating profit of the rival.

The remainder of the paper is organized as follows. Section 2 presents the theoretical model under which the Cournot-Nash industry equilibrium is derived, Section 3 discusses policy implications, and Section 4 concludes.

2 Theoretical Model

2.1 Setup

Consider a duopoly between firms j and g in a Cournot homogenous-product industry with no capacity constraint. Under this setting, we have that $x_j = q_j$, with price p being determined by the downward sloping inverse market demand function, $p(Q)$, where q_j denotes the quantity of firm j and $Q = q_j + q_g$ denotes the industry total quantity. The market demand function is assumed to be linear: $p(Q) = a - bQ$; and each firm is assumed to have constant marginal cost. In order to examine the impact of cost asymmetries, let c and λc denote the marginal cost of firm j and firm g, respectively, with $\lambda > 1$. Finally, let $a > \lambda c > c$.

2.2 Best-Response Functions

Assuming that the ownership structure is such that the manager of firm j places weight w_{jg} on firm g's operating profit and that the manager of firm g places weight w_{gj} on firm j's operating profit, the two managers solve, respectively:

$$\max_{q_j} \pi_j + w_{jg}\pi_g = (p - c)\, q_j + w_{jg}(p - \lambda c)\, q_g \tag{2}$$

$$\max_{q_g} \pi_g + w_{gj}\pi_j = (p - \lambda c)\, q_g + w_{gj}(p - c)\, q_j. \tag{3}$$

The first-order conditions for q_j and q_g imply the following best-response functions for the two firms:

$$\begin{aligned} BR_j &: q_j = \begin{cases} \frac{a-c}{2b} - \frac{1+w_{jg}}{2} q_g & \text{if } q_g < \frac{a-c}{(1+w_{jg})b} \\ 0 & \text{if } q_g \geq \frac{a-c}{(1+w_{jg})b} \end{cases} \\ BR_g &: q_g = \begin{cases} \frac{a-\lambda c}{2b} - \frac{1+w_{gj}}{2} q_j & \text{if } q_j < \frac{a-\lambda c}{(1+w_{gj})b} \\ 0 & \text{if } q_j \geq \frac{a-\lambda c}{(1+w_{gj})b} \end{cases} . \end{aligned} \tag{4}$$

The effects involved in the best-response functions are as follows. By producing one more unit, firm j (for example) receives the corresponding profit margin. However, by doing so, it decreases market price, which lowers the profit margin of firm j's inframarginal units and firm g's quantity. To the extent that the manager of firm j cares about the operating profit of firm g this effect is internalized (partially when $w_{jg} < 1$, fully when $w_{jg} = 1$ or "more than fully" when $w_{jg} > 1$). Thus, the higher the weight placed on the rival's operating profit, the lower the equilibrium quantity.

2.3 Industry Total Quantity Equilibria

Depending on where the best responses cross the horizontal and vertical axis, we can identify seven Cournot-Nash equilibria types. Let $\bar{w}_{jg} = \frac{a-(2-\lambda)c}{a-\lambda c} > 1$ and $\bar{w}_{gj} = \frac{a-(2\lambda-1)c}{a-c} < 1$. This implies that the best response of firm j crosses the vertical axis above the best response of firm g whenever $\frac{a-c}{(1+w_{jg})b} > \frac{a-\lambda c}{2b}$ or $w_{jg} < \bar{w}_{jg}$, while it crosses the horizontal axis to the right of the best response of firm g whenever $\frac{a-\lambda c}{(1+w_{gj})b} > \frac{a-c}{2b}$ or $w_{gj} < \bar{w}_{gj}$. In other words, $\bar{w}_{jg}$ denotes the cut-off for the weight that the manager of firm j places on firm g's operating profit above which firm j's operation in the market becomes blockaded. Likewise for $\overline{w}_{gj}$. Figure 1 depicts the seven equilibria types, which are formally characterized in Lemma 1.

Lemma 1

(a) If $w_{jg} < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, there is a unique Cournot-Nash interior equilibrium, given by:

$$q_j^{po} = \frac{(1-w_{jg})\,a - (2-\lambda\,(1+w_{jg}))\,c}{(3-w_{gj}-w_{jg}-w_{gj}w_{jg})\,b}$$
$$q_g^{po} = \frac{(1-w_{gj})\,a - (2\lambda-1-w_{gj})\,c}{(3-w_{gj}-w_{jg}-w_{gj}w_{jg})\,b}$$

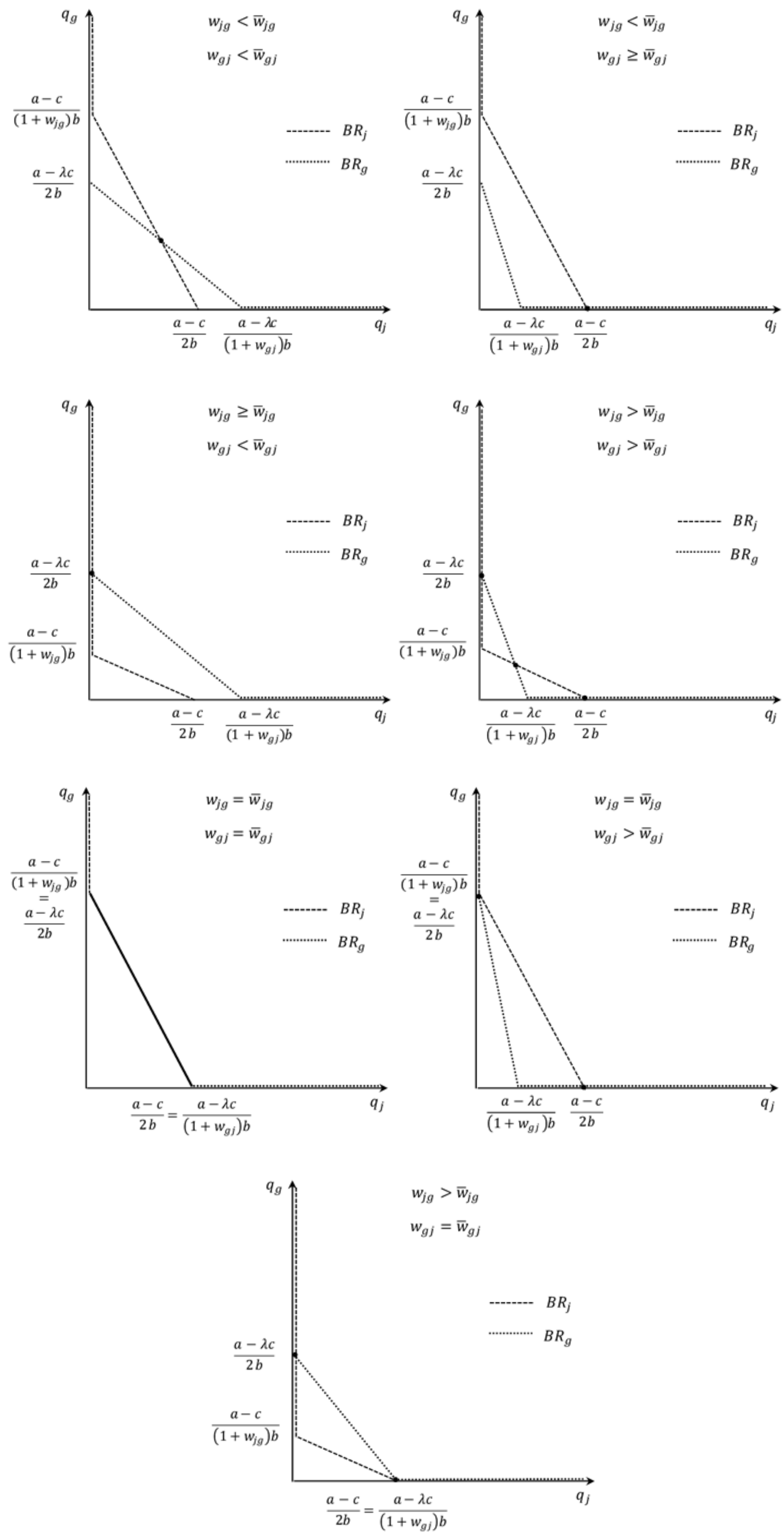
(b) If $w_{jg} < \bar{w}_{jg}$ and $w_{gj} \geq \bar{w}_{gj}$, there is a unique Cournot-Nash corner equilibrium, given by $q_j^{po} = \frac{a-c}{2b}$ and $q_g^{po} = 0$.

(c) If $w_{jg} \geq \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, there is a unique Cournot-Nash corner equilibrium, given by $q_j^{po} = 0$ and $q_g^{po} = \frac{a-\lambda c}{2b}$.

(d) If $w_{jg} > \bar{w}_{jg}$ and $w_{gj} > \bar{w}_{gj}$, there are three Cournot-Nash equilibria, given by the pairs of quantities described in (a) to (c).[7]

[7]The interior equilibrium described in part *(d)* is, however, not stable (see Tirole, 1988).

Figure 1
Cournot-Nash Equilibria Types



(e) *If* $w_{jg} = \bar{w}_{jg}$ *and* $w_{gj} = \bar{w}_{gj}$*, there are multiple Cournot-Nash interior and corner equilibria, given by any pair* q_j^{po}, q_g^{po} *such that* $q_g^{po} = \frac{a-\lambda c}{2b} - \frac{a-\lambda c}{a-c} q_j^{po}$.

(f) *If* ($w_{jg} = \bar{w}_{jg}$ *and* $w_{gj} > \bar{w}_{gj}$) *or* ($w_{jg} > \bar{w}_{jg}$ *and* $w_{gj} = \bar{w}_{gj}$)*, there are two Cournot-Nash corner equilibria, given by the pairs of quantities described in (b) and (c).*

Proof. The result follows directly from intersecting the best-response functions for the different weights values. ■

2.3.1 Monopoly

Under a monopoly, we have $w_{jg} = w_{gj} = 1$, which implies that the manager of each firm fully internalizes the impact of their firm's strategy on the rival firm operating profits. Since $\bar{w}_{jg} > 1$ and $\bar{w}_{gj} < 1$, this corresponds to part *(b)* of Lemma 1: $w_{jg} = 1 < \bar{w}_{jg}$ and $w_{gj} = 1 > \bar{w}_{gj}$. As a consequence, we have that the Cournot-Nash equilibrium is unique and given by $q_j^m = \frac{a-c}{2b}$ and $q_g^m = 0$, yielding that the industry total quantity is given by $Q^m = q_j^m + q_g^m = \frac{a-c}{2b}$. In other words, in a monopoly involving the two firms, managers assign production to the more efficient firm.

2.3.2 Partial Ownership *vs* Monopoly

Having established the Cournot-Nash equilibria for the two firms, we can now examine how the industry total quantity under partial ownership and monopoly, compares. We begin by addressing the corner equilibrium under partial ownership. In the equilibrium in which only firm j, the most efficient firm, produces, the industry total quantity under partial ownership is given by $Q^{po} = q_j^{po} + q_g^{po} = \frac{a-c}{2b} = Q^m$, which is the same as under monopoly. This equilibrium is sustainable for $w_{gj} \geq \bar{w}_{gj}$, regardless of w_{jg}, as depicted in Figure 2, Panel *(a)*.

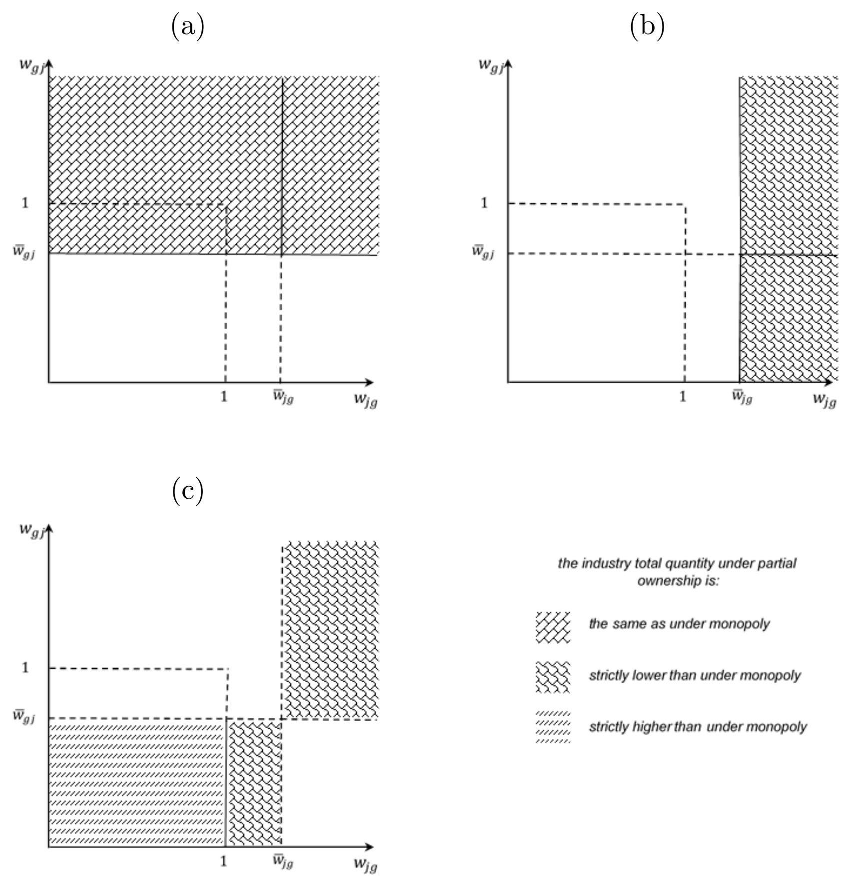
We now address the corner equilibrium in which only firm g, the inefficient firm, produces. The industry total quantity under partial ownership is given by $Q^{po} = q_j^{po} + q_g^{po} = \frac{a-\lambda c}{2b} < Q^m$, which is strictly lower than the industry total quantity under (an efficient) monopoly. This equilibrium is sustainable for $w_{jg} \geq \bar{w}_{jg}$, regardless of w_{gj}, as depicted in Figure 2, Panel *(b)*.

Finally, we address the interior equilibrium, which is characterized in Proposition 1 and depicted in Figure 2, Panel *(c)*.

Proposition 1 *In an interior equilibrium under partial ownership, the industry total quantity is:*

Figure 2

Partial Ownership vs Monopoly



(a) *strictly higher than under monopoly if* $w_{jg} < 1$ *and* $w_{gj} < \bar{w}_{gj}$.

(b) *the same as under monopoly if* $w_{jg} = 1$ *and* $w_{gj} < \bar{w}_{gj}$.

(c) *strictly lower than under monopoly if* ($1 < w_{jg} < \bar{w}_{jg}$ *and* $w_{gj} < \bar{w}_{gj}$) *or* ($1 < w_{jg} = \bar{w}_{jg}$ *and* $w_{gj} = \bar{w}_{gj}$) *or* ($w_{jg} > \bar{w}_{jg} > 1$ *and* $w_{gj} > \bar{w}_{gj}$).

Proof. See Appendix. ■

The intuition for the different cases is as follows. In the case of monopoly, the industry total quantity corresponds to the monopoly quantity by the most efficient firm, firm j, which is obviously the best response of firm j to zero output by firm g. In an interior equilibrium with partial ownership, firm g's quantity will be strictly positive. It is only possible that this leads to a strictly higher (or the same) industry total quantity than (as) the one under monopoly if the best response of firm j (to the increased quantity by firm g) is to lower its own output by *less* (or the same) than (as) firm g increased it. This means that the slope of firm j's best response function must be greater (or equal) than -1 and, for this to happen, the manager of firm j must weight firm g's operating profit less (or the same) than (as) its own, i.e. $w_{jg} \leq 1$.

The above implies that as soon as the manager of firm j weights firm g's operating profit more than its own, in an interior equilibrium with partial ownership, the industry total quantity will be strictly lower than under monopoly. In order to see why, consider a partial ownership setting with $1 = w_{jg} < \overline{w}_{jg}$ and $w_{gj} < \overline{w}_{gj}$ which yields an interior equilibrium that, as postulated by Proposition 1, leads to an industry total quantity that is the same as under monopoly. If an acquisition takes place such that $1 < w_{jg} < \overline{w}_{jg}$, firm j will contract its output since its manager cares relatively more about the operating profit of firm g. Although firm g will expand its output in response to firm j's contraction, the industry total quantity will fall since the slope of firm g's best response function is greater than -1.

Cost Asymmetry We now discuss the role played by cost asymmetry in the comparison discussed above. To do so, note that $\frac{\partial \bar{w}_{jg}}{\partial \lambda} = \frac{2c(a-c)}{(a-\lambda c)^2} > 0$ and $\frac{\partial \bar{w}_{gj}}{\partial \lambda} = \frac{-2c}{a-c} < 0$. This has several implications for the equilibria under partial ownership. First, an increase in the inefficiency level of firm g reduces the set of values for w_{jg} that sustain a *corner equilibrium* in which only firm g, the inefficient firm, produces, yielding an industry total quantity under partial ownership that is *strictly lower* than under (an efficient) monopoly. Second, an increase in the inefficiency level of firm g increases the set of values for w_{gj} that sustain a *corner equilibrium* in which only firm j, the most efficient firm, produces, yielding an industry total quantity under partial ownership that is the *same* as under monopoly. Third, an increase in the inefficiency level of firm g reduces the set of values for w_{gj} that sustain an *interior equilibrium* in which the industry total quantity under partial ownership is *strictly higher* than under monopoly. Fourth, an increase in the inefficiency level of firm g reduces the set of values for w_{gj} that sustain an *interior equilibrium* in which the industry total quantity under partial ownership is the *same* as under monopoly. Finally, an increase in the inefficiency level of firm g has an ambiguous effect on the set of values for w_{jg} and w_{gj} that sustain an *interior equilibrium* in which the industry total quantity under partial ownership is *strictly lower* than under monopoly.

3 Policy Implications

Proposition 2 summarizes both the corner and interior equilibria discussed in the previous section with respect to how the industry total quantity under partial ownership and monopoly, compares.

Proposition 2 *The equilibrium industry total quantity under partial ownership is:*

(a) strictly higher than or the same as under monopoly if $w_{jg} \leq 1$.

(b) strictly lower than or the same as under monopoly in a corner equilibrium if $w_{jg} > 1$.

(c) strictly lower than under monopoly in an interior equilibrium if $w_{jg} > 1$.

Proof. See Appendix. ■

This implies that if the manager of the more efficient firm does not weight the operating profit of the (inefficient) rival more than its own profit, then partial ownership *cannot* lessen competition more than a monopoly while if the manager of the more efficient firm weights the operating profit of the (inefficient) rival more than its own profit, then partial ownership *can* lessen competition more than a monopoly and *will*, in fact, lessen competition more than a monopoly whenever both firms produce. This occurs regardless of the weight the manager of the inefficient firm assigns to the operating profit of the rival. As a consequence, when assessing the anti-competitive effects of acquisitions that give raise to common- or cross-ownership, competition agencies should examine with increased interest the objective function of the manager of the most efficient firm in the industry.

4 Conclusions

We propose to examine whether prices in an industry characterized by partial ownership can be higher than in an industry characterized by a monopoly. To do so, we consider a Cournot duopoly model in which demand is assumed to be linear and each firm is assumed to have constant but asymmetric marginal cost and no capacity constraint. We consider also that the ownership structure is such that the manager of each firm weights the operating profit of the rival. We show that if the manager of the more efficient firm weights the operating profit of the rival more than its own profit, then partial ownership *will* lessen competition more than a monopoly whenever both firms produce. This article leaves many other settings yet to be explored. In particular, extensions that examine the value of the generalized Herfindahl-Hirschman index in equilibrium and/or consider settings with more than two firms constitute very interesting potential areas for future research. Hopefully, however, our contribution can be seen as a stepping stone in the direction of a more complete analysis.

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Appendix

In this appendix, we present the proofs of Propositions 1 and 2.

Proof of Proposition 1. Let $f(w_{gj}) = \frac{3-w_{gj}}{1+w_{gj}}$ with $\frac{\partial f(w_{gj})}{\partial w_{gj}} < 0$, $f(1) = 1$ and $f(\bar{w}_{gj}) = \bar{w}_{jg}$.

(a) If $w_{jg} < 1 < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, the industry total quantity under partial ownership is strictly higher than under monopoly if and only if $Q^{po} > Q^m$:

$$\frac{(2 - w_{gj} - w_{jg})\, a - (1 + \lambda - \lambda w_{jg} - w_{gj})\, c}{(3 - w_{gj} - w_{jg} - w_{gj} w_{jg})\, b} > \frac{a - c}{2b},$$

which is equivalent to:

$$\frac{(w_{jg} - 1)\,(w_{gj} - \bar{w}_{gj})}{f(w_{gj}) - w_{jg}} > 0.$$

Note that we have $(w_{gj} - \bar{w}_{gj}) < 0$ and $f(w_{gj}) > w_{jg}$ because $w_{gj} < \bar{w}_{gj}$ implies $f(w_{gj}) > f(\bar{w}_{gj}) = \bar{w}_{jg} > w_{jg}$. Then, $\frac{(w_{jg}-1)(w_{gj}-\bar{w}_{gj})}{f(w_{gj})-w_{jg}} > 0$ if $(w_{jg} - 1) < 0$, which is equivalent to $w_{jg} < 1$.

(b) If $w_{jg} = 1 < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, the industry total quantity under partial ownership is the same as under monopoly if and only if $Q^{po} = Q^m$, which - as discussed above - is equivalent to:

$$\frac{(w_{jg} - 1)(w_{gj} - \bar{w}_{gj})}{f(w_{gj}) - w_{jg}} = 0.$$

Note that we have $(w_{gj} - \bar{w}_{gj}) < 0$ and $f(w_{gj}) > w_{jg}$ because $w_{gj} < \bar{w}_{gj}$ implies $f(w_{gj}) > f(\bar{w}_{gj}) = \bar{w}_{jg} > w_{jg}$. Then, $\frac{(w_{jg}-1)(w_{gj}-\bar{w}_{gj})}{f(w_{gj})-w_{jg}} = 0$ if $(w_{jg} - 1) = 0$, which is equivalent to $w_{jg} = 1$.

(c) We need to evaluate three cases:

i. If $1 < w_{jg} < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, the industry total quantity under partial ownership is strictly lower than under monopoly if and only if $Q^{po} < Q^m$, which - as discussed above - is equivalent to:

$$\frac{(w_{jg} - 1)(w_{gj} - \bar{w}_{gj})}{f(w_{gj}) - w_{jg}} < 0.$$

Note that we have $(w_{gj} - \bar{w}_{gj}) < 0$ and $f(w_{gj}) > w_{jg}$ because $w_{gj} < \bar{w}_{gj}$ implies $f(w_{gj}) > f(\bar{w}_{gj}) = \bar{w}_{jg} > w_{jg}$. Then, $\frac{(w_{jg}-1)(w_{gj}-\bar{w}_{gj})}{f(w_{gj})-w_{jg}} > 0$ if $(w_{jg} - 1) > 0$, which is equivalent to $w_{jg} > 1$.

ii. If $w_{jg} = \bar{w}_{jg}$ and $w_{gj} = \bar{w}_{gj}$ and an interior equilibrium exists, it would be characterized by a pair $q_j^{po} > 0, q_g^{po} > 0$ such that $q_g^{po} = \frac{a-\lambda c}{2b} - \frac{a-\lambda c}{a-c} q_j^{po}$. Note that $\frac{a-\lambda c}{2b} > 0$ and $0 < \frac{a-\lambda c}{a-c} < 1$. This implies that the industry total quantity under partial ownership is strictly lower than under monopoly: $\frac{a-\lambda c}{2b} < Q^{po} < \frac{a-c}{2b} = Q^m$.

iii. If $w_{jg} > \bar{w}_{jg}$ and $w_{gj} > \bar{w}_{gj}$ and an interior equilibrium exists, the industry total quantity under partial ownership is strictly lower than under monopoly if and only if $Q^{po} < Q^m$, which - as discussed above - is equivalent to:

$$\frac{(w_{jg} - 1)(w_{gj} - \bar{w}_{gj})}{f(w_{gj}) - w_{jg}} < 0.$$

Note that we have $(w_{gj} - \bar{w}_{gj}) > 0$ and $f(w_{gj}) < w_{jg}$ because $w_{gj} > \bar{w}_{gj}$ implies $f(w_{gj}) < f(\bar{w}_{gj}) = \bar{w}_{jg} < w_{jg}$. Then, $\frac{(w_{jg}-1)(w_{gj}-\bar{w}_{gj})}{f(w_{gj})-w_{jg}} < 0$, which is equivalent to $(w_{jg} - 1) > 0$ which, in turn, is always true, as $w_{jg} > \bar{w}_{jg} > 1$.

Proof of Proposition 2.

(a) We need to evaluate three cases:

i. If $w_{jg} < 1 < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, there is, as established by part *(a)* of Lemma 1, an interior equilibrium in which the industry total quantity under partial ownership is, as established by part *(a)* of Proposition 1, strictly higher than under monopoly.

ii. If $w_{jg} = 1 < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, there is, as established by part *(a)* of Lemma 1, an interior equilibrium in which the industry total quantity under partial ownership is, as established by part *(b)* of Proposition 1, the same as under monopoly.

iii. If $w_{jg} \leq 1 < \bar{w}_{jg}$ and $w_{gj} \geq \bar{w}_{gj}$, there is, as established by part *(b)* of Lemma 1, a corner equilibrium in quantities in which only firm j, the most efficient firm, produces. As such, the industry industry total quantity under partial ownership is the same as under monopoly.

(b) We need to evaluate five cases:

i. If $1 < w_{jg} < \bar{w}_{jg}$ and $w_{gj} \geq \bar{w}_{gj}$, there is, as established by part *(b)* of Lemma 1, a corner equilibrium in quantities in which only firm j, the most efficient firm, produces. As such, the industry industry total quantity under partial ownership is the same as under monopoly.

ii. If $w_{jg} \geq \bar{w}_{jg} > 1$ and $w_{gj} < \bar{w}_{gj}$, there is, as established by part *(c)* of Lemma 1, a corner equilibrium in quantities in which only firm g, the inefficient firm, produces. As such, the industry industry total quantity under partial ownership is strictly lower than under (an efficient) monopoly.

iii. If $w_{jg} > \bar{w}_{jg} > 1$ and $w_{gj} > \bar{w}_{gj}$, there is, as established by part *(d)* of Lemma 1, two corner equilibria in quantities. A corner equilibrium in quantities in which only firm j, the most efficient firm, produces and, as such, the industry industry total quantity under partial ownership is the same as under monopoly. A corner equilibrium in quantities in which only firm g, the inefficient firm, produces and, as such, the industry industry total quantity under partial ownership is strictly lower than under (an efficient) monopoly.

iv. If $w_{jg} = \bar{w}_{jg} > 1$ and $w_{gj} = \bar{w}_{gj}$, there is, as established by part *(e)* of Lemma 1, multiple equilibria in quantities characterized by a pair q_j^{po}, q_g^{po} such that $q_g^{po} = \frac{a-\lambda c}{2b} - \frac{a-\lambda c}{a-c} q_j^{po}$. This yields two corner equilibria, as follows. A corner equilibrium in quantities in which only firm j, the most efficient firm, produces and, as such, the industry industry total quantity under partial ownership is the same as under monopoly. A corner equilibrium in quantities in which only firm g, the inefficient firm, produces and, as such, the industry industry total quantity under partial ownership is strictly lower than under (an efficient) monopoly.

v. If ($w_{jg} = \bar{w}_{jg} > 1$ and $w_{gj} > \bar{w}_{gj}$) or ($w_{jg} > \bar{w}_{jg} > 1$ and $w_{gj} = \bar{w}_{gj}$), there is, as established by part *(f)* of Lemma 1, two corner equilibria in quantities. A corner equilibrium in quantities in which only firm j, the most efficient firm, produces and, as such, the industry industry total quantity under partial ownership is the same as under monopoly. A corner equilibrium in quantities in which only firm g, the inefficient firm, produces and, as such, the industry industry total quantity under partial ownership is strictly lower than under (an efficient) monopoly.

(c) We need to evaluate three cases:

i. If $1 < w_{jg} < \bar{w}_{jg}$ and $w_{gj} < \bar{w}_{gj}$, there is, as established by part *(a)* of Lemma 1, an interior equilibrium in which the industry total quantity under partial ownership is, as established by part *(c)* of Proposition 1, strictly lower than under monopoly.

ii. If $w_{jg} > \bar{w}_{jg} > 1$ and $w_{gj} > \bar{w}_{gj}$, there is, as established by part *(d)* of Lemma 1, an interior equilibrium in quantities in which the industry total quantity under partial ownership is, as established by part *(c)* of Proposition 1, strictly lower than under monopoly.

iii. If $w_{jg} = \bar{w}_{jg} > 1$ and $w_{gj} = \bar{w}_{gj}$, there is, as established by part *(e)* of Lemma 1, multiple equilibria in quantities characterized by a pair q_j^{po}, q_g^{po} such that $q_g^{po} = \frac{a-\lambda c}{2b} - \frac{a-\lambda c}{a-c} q_j^{po}$. This yields a multiplicity of interior equilibria in which the industry total quantity under partial ownership is, as established by part *(c)* of Proposition 1, strictly lower than under monopoly.