THE COMPETITIVE EFFECTS OF COMMON OWNERSHIP: WE KNOW LESS THAN WE THINK

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Recent empirical research claims to show that the common ownership of competing firms by institutional investors has anticompetitive effects even when all financial interests are minority shareholdings.[1] This line of empirical research, which is still in its infancy, has received a great deal of attention.[2] Antitrust authorities in the United States have opened investigations in "more than one industry" based on the claims in these papers.[3] Competition authorities in Europe have incorporated common-ownership effects into concentra-

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[1] *See* José Azar, Martin C. Schmalz & Isabel Tecu, *Anti-Competitive Effects of Common Ownership* (Ross Sch. of Bus., Working Paper No. 1235, 2016) (on file with authors) [hereinafter Azar, Schmalz & Tecu 2016]; José Azar, Sahil Raina & Martin Schmalz, Ultimate Ownership and Bank Competition (2016) (unpublished manuscript), papers.ssrn.com/sol3/papers.cfm?abstract_id=2710252. Azar, Schmalz, and Tecu have revised their July 2016 working paper *Anti-Competitive Effects of Common Ownership* several times and have posted revisions on SSRN. This article responds primarily to the July 2016 version of the paper, although their revisions do not materially affect the analysis in this article. *See infra* note 61.

[2] A prominent Harvard law professor calls the findings "an economic blockbuster." Einer Elhauge, *Horizontal Shareholding*, 129 HARV. L. REV. 1267, 1267 (2016). One of the papers in this literature (the airline paper) is the second most downloaded paper in SSRN history in the JEL category L41, which is "Monopolization; Horizontal Anticompetitive Practices." An op-ed in *The New York Times* discusses common ownership of companies in concentrated markets. Eric Posner, Fiona Scott Morton & Glen Weyl, Opinion, *A Monopoly Trump Can Pop*, N.Y. TIMES, Dec. 7, 2016, at A29; see also Eric Posner, Fiona Scott Morton & E. Glen Weyl, *A Proposal to Limit the Anticompetitive Power of Institutional Investors*, *supra* this issue, 81 ANTITRUST L.J. 669 (2017) [hereinafter Posner et al., *A Proposal to Limit*].

[3] *Oversight of the Enforcement of the Antitrust Laws: Hearing Before the S. Subcomm. on Antitrust, Competition Policy, and Consumer Rights of the S. Comm. on the Judiciary*, 114th Cong. (2016) (statement of Bill Baer, Assistant Att'y Gen., Antitrust Div., Dep't of Justice).

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tion measures used in merger analyses.[4] An antitrust complaint cites to this literature as support for the allegations contained therein.[5] Based on this research, some economists and lawyers have called for more vigorous antitrust enforcement against minority shareholdings of institutional investors.[6]

The purpose of this article is to examine the early papers in this emerging line of empirical research and to offer an economic perspective on their implications for antitrust and regulatory policy.[7] Although there are valid reasons why common ownership can raise competitive concerns in specific circumstances, and without pre-judging what additional analyses of this question will find, our analysis leads us to conclude that both researchers and policy authorities are getting well ahead of themselves in calling for and implementing policy changes based on this research. While the correlations identified in the research to date might seem to suggest that an increase in common ownership has anticompetitive effects, our analysis shows that this is not a valid inference. That is, the emerging research at present does not scientifically establish that an increase in common ownership involving minority shareholdings causes higher prices in the industries examined.

The policy issues at stake are significant. For perspective, imagine that an institutional investor currently owns 5 percent of firm A but has no shares of competing firm B, and that A and B compete in a moderately or highly concentrated market (e.g., the typical airline or banking market). The claim in this research is that if the investor purchases, say, 5 percent of the shares of firm B and becomes a "common owner" of these firms, then the prices charged by firms A and B will rise. Prices rise, according to the claim, even though the investor's financial interests are relatively small and by all appearances are noncontrolling. José Azar, Isabel Tecu, and Martin Schmalz (hereinafter the "airline paper") and Azar, Sahil Raina, and Schmalz (hereinafter the "banking paper") claim to find empirical support for this effect in the airline and banking industries, respectively.[8] The airline paper also claims that the magnitude of the price effect associated with common ownership is consistent with pre-

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[4] In a recent Statement of Objections to a merger, the European Commission presented a modified Herfindahl-Hirschman index (MHHI) analysis to account for the effects of common shareholding by institutional investors. *See* Case M.7932—Dow/DuPont, Comm'n Decision (Mar. 3, 2017), ec.europa.eu/competition/mergers/cases/decisions/m7932_13668_3.pdf (declaring a concentration to be compatible with the internal market and the EEA Agreement).

[5] Consolidated Amended Class Action Complaint at 13–15, *In re* Domestic Airline Travel Antitrust Litig., MDL Docket No. 2656, Misc. No. 15-1404 (CKK) (D.D.C. Mar. 25, 2016).

[6] *See* Posner et al., *A Proposal to Limit*, *supra* note 2.

[7] Given the early stages of this research (the airline, banking, and compensation papers have not been published at the time of this writing), it is somewhat unusual to write a detailed commentary on it. However, the results reported by these papers are having a policy impact well before they have been carefully vetted by scholars and policy makers. Given the attention this research has already received in policy circles, our attention to it at this time is appropriate.

[8] Azar, Schmalz & Tecu 2016, *supra* note 1; Azar, Raina & Schmalz, *supra* note 1.

dictions of the economic theory of partial ownership, from which the authors draw their key explanatory variable (the modified Herfindahl-Hirschman Index, or MHHI).[9]

Miguel Antón, Florian Ederer, Mireia Giné, and Schmalz (hereinafter the "compensation paper") claim to find that as common ownership increases, executive compensation in American industry skews away from rewarding managers based on own-firm profits and more toward rewarding them based on industry profits.[10] This finding appears to be consistent with the claims in the other papers that common ownership leads to higher prices, as the finding might be interpreted to suggest that compensation gives managers incentives to pursue anticompetitive strategies that raise industry profits.

While it is widely accepted that common ownership can have anticompetitive effects when the owners control at least one of the firms in which they own shares (a complete merger is a special case), antitrust authorities historically have taken little interest in common ownership by minority shareholders whose influence over corporate management seems limited to voting rights. Thus, if the empirical findings and conclusions in the emerging research are correct and robust, they could have dramatic implications for the antitrust analysis of mergers and acquisitions. The findings could be interpreted to suggest that antitrust authorities should scrutinize not only situations in which a common owner of competing firms controls at least one of the entities in which it owns shares, but also situations in which *all* of the common owner's shareholdings are small minority positions. As we noted earlier in this article, such a policy shift is already occurring.

Institutional investors (e.g., mutual funds) frequently take positions in multiple firms in an industry to offer diversified portfolios to retail investors at low transaction costs. A change in antitrust or regulatory policy toward these investments could have significant negative implications for the types of investments currently available to retail investors. In particular, a recent propo-

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[9] The theory of "partial ownership" from which the airline, banking, and compensation papers draw their key explanatory variable was developed in two articles that examine the roles of financial interest and corporate control in determining a firm's pricing incentives. Timothy F. Bresnahan & Steven C. Salop, *Quantifying the Competitive Effects of Production Joint Ventures*, 4 INT'L J. INDUS. ORG. 155 (1986); Daniel P. O'Brien & Steven C. Salop, *Competitive Effects of Partial Ownership: Financial Interest and Corporate Control*, 67 ANTITRUST L.J. 559 (2000). (Author O'Brien is one of the authors of this article.) The theory of partial ownership developed in these papers encompasses what this line of research calls "common ownership" as a case where two or more firms have a common owner that partially owns each of them. Complete mergers also arise as a special case where the merging firms have the same set of owners after the merger.

[10] Miguel Antón, Florian Ederer, Mireia Giné & Martin Schmalz, *Common Ownership, Competition, and Top Management Incentives* (Cowles Found., Discussion Paper No. 2046, 2016).

sal[11] to step up antitrust enforcement in this area would seem to require significant changes to the size or composition of many investment funds.

Given the potential policy implications of this research and the less than obvious connections between small minority ownership interests and anticompetitive price effects, it is important to be particularly confident in the analysis and empirical findings before drawing strong policy conclusions. In our view, achieving such confidence requires a valid empirical test that permits causal inferences about the effects of common ownership on price. In addition, the empirical findings and their interpretation should be consistent with the observed behavior of firms and investors in the economic and legal environments in which they operate.

We find that the airline, banking, and compensation papers fall short of these criteria. Thus, at this early stage of the research on common ownership, the conclusions about the effects of common ownership are premature. The papers in this literature are interesting and worthy of attention, but not sufficiently conclusive to warrant the kinds of policy proposals and changes that have arisen.

Our analysis brings to light the following issues with this emerging line of research:

- The regression equations in the emerging research are mis-specified, and the particular mis-specifications are likely to lead to a correlation between price and the measure of common ownership employed even if common ownership has no causal effect on price. Thus, these correlations do not establish that common ownership through minority shareholdings raises prices.
    - Specifically, the key explanatory variable in this research—the modified HHI (MHHI)—depends on market shares, which depend on the same underlying factors that drive prices. In econometric terms, market shares and the MHHI are endogenous. Because market shares and the MHHI are likely to be related to factors that affect price that are not included as explanatory variables in the regression equations, the regression estimates from the specifications employed are likely to yield a relationship between the MHHI and price. Under plausible conditions, this relationship will be positive for reasons not related to common ownership. That is, an estimate of this relationship could erroneously suggest a positive relationship between price and common ownership when none exists.
    - In addition to market shares, the MHHI depends on the financial shares of investors, which may also be endogenous. That is, some

[11] Posner et al., *A Proposal to Limit*, *supra* note 2.

factors that drive prices may also affect institutional investors' stock purchasing decisions. The emerging research uses various instrumental-variable techniques to attempt to correct for both sources of endogeneity, but in our view, these strategies fall short.

- The empirical specifications in this research are not consistent with the economic theory of partial ownership that motivates the research. This inconsistency would create a problem for interpreting the empirical results even if the endogeneity issues were resolved. In particular, the MHHI may rise or fall with an increase in common ownership that is asserted to affect price. Therefore, a positive relationship between the MHHI and price does not necessarily imply a positive relationship between common ownership and price.

- While others disagree,[12] we believe that there are a number of reasons to doubt that common ownership involving small minority shareholdings would have a significant effect on competition:
  - A manager's incentives likely depend on how the manager is compensated. Under the proportional control assumption employed in the emerging research, managers take actions that increase industry profits at the expense of their own firm's profits. However, managerial compensation in the corporate world generally takes the form of a fixed salary plus incentives that depend in some way on the profits of the firm (e.g., options in the firm's stock). This form of compensation gives a manager an incentive to choose price to maximize the profits of the firm, and it does not give the manager an incentive to choose price in a way that increases industry profits at the expense of own-firm profits. While it is possible that other forms of compensation (e.g., terminating a manager for nonperformance) could provide incentives to put some positive weight on rival firms' profits and thus to fail to maximize own-firm profits, the emerging literature on common ownership has not empirically established that this occurs.
  - Einer Elhauge argues that executive compensation with stock options, which are "70% driven by general market profitability and only 30% driven by individual corporate performance," would cause managers to favor industry profits over own-firm profits and compete less aggressively, consistent with the empirical findings purporting to establish that common ownership leads to higher prices.[13] This argument conflates the natural correlation between a firm's profits and industry profits with the incentives created by a manager's contract. Compensation based on stock options gives managers incen-

[12] *Id.*; Elhauge, *supra* note 2.

[13] Elhauge, *supra* note 2, at 1278.

tives to choose prices that increase the profits of the firms they manage, not the profits of rival firms. It is a mistake to claim that managers will make choices that reduce own-firm profits to increase the profits of rival firms simply because a firm's profits are correlated with industry profits.

- Laws on fiduciary obligation require a corporation's directors and officers to "serve as trustees for the stockholders with respect to the interests of the stockholders in the corporation."[14] The emerging literature on common ownership, however, assumes that corporate managers act to benefit stockholders through their shareholdings outside the corporation. Although it may be difficult for minority shareholders to enforce fiduciary-obligation laws with respect to decisions like pricing and managerial compensation, the law is clear that the obligation of each director and officer is to the company. Behavior consistent with fiduciary obligation is not consistent with how managers are assumed to behave under the control assumptions made in the emerging literature on common ownership.

In summary, our analysis shows that the emerging literature has identified correlations between endogenous variables—in particular, between prices and measures of concentration modified to take into account the effects of common ownership. While more research to understand the implications of these correlations is in order, the correlations have no clear implication for the effects of common ownership on prices and do not form a reasonable basis for policy, let alone the major changes in policy that some have proposed.[15] More research is needed. We believe this research should (1) develop empirical specifications consistent with economic predictions of how common ownership can affect price; and (2) measure the extent to which financial interests involving minority shareholdings translate into control or influence over managers, a critical element in assessing the competitive effects of common ownership.

The remainder of this article is organized as follows. Part II explains the theory of partial ownership that produced the MHHI used in the emerging research to explain prices. Part III discusses the disconnect between this theory and the emerging research to date and discusses the implications of this disconnect for interpreting the empirical results. Part IV explains why, based

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[14] William M. Lafferty, Lisa A. Schmidt & Donald J. Wolfe, Jr., *A Brief Introduction to the Fiduciary Duties of Directors Under Delaware Law*, 116 PENN ST. L. REV. 837, 841 (2012) (citation omitted).

[15] Posner, Scott Morton, and Weyl propose that "no institutional investor invested in more than a single (effective) firm in an oligopoly may own more than 1 percent of the industry or communicate with its managers." Posner et al., *A Proposal to Limit*, *supra* note 2, at 724.

on the correlations identified in the emerging research to date, it is not possible to conclude that more common ownership causes higher prices. Part V offers ideas on how to test for the competitive effects of common ownership. Part VI discusses the mechanism through which common ownership could affect competition—compensation—and the role of fiduciary obligation. Part VII discusses the role of the MHHI in assessing the effects of common ownership.

I. THE THEORY OF PARTIAL OWNERSHIP

The emerging research on common ownership draws on the theory of partial ownership developed by Timothy Bresnahan and Steven Salop and Daniel O'Brien and Steven Salop[16] for its key explanatory variable—the MHHI. To evaluate the empirical findings in this research, it helps first to understand the motivation for this theory and what the theory actually predicts about the relationship between price and common ownership.

A. MOTIVATION FOR THE THEORY[17]

Imagine five equally sized firms competing in a market. By conventional measures, the industry is moderately concentrated, with an HHI of 2000. By conventional reasoning, we expect some degree of competition between the firms to act as a constraint on prices.[18] But imagine that the five firms have some common owners.[19] Does this alter the conclusion?

Consider an analogy with mergers. A merger between two of the firms would increase concentration significantly (HHI delta of 800) and create a highly concentrated market (HHI of 2500).[20] Absent easy entry or sufficient merger-specific efficiencies, we expect less competition than before the merger. Such a *complete* acquisition of one of the firms by another generates

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[16] Bresnahan & Salop, *supra* note 9; O'Brien & Salop, *supra* note 9.

[17] This section borrows from Daniel P. O'Brien, *Anticompetitive Effects of Common Ownership: Overview of the Theory, and Review of the Empirical Findings of Azar, et al.*, TRANSP., ENERGY & ANTITRUST, Fall 2015, at 3 (ABA Section of Antitrust Law Transportation and Energy Industries Committee Newsletter.).

[18] How well competition actually works depends on the nature of price competition and details relating to demand and cost.

[19] We follow the authors in using the term "common ownership" to refer to an owner holding shares in two or more entities that compete with each other in a market. It is understood that common ownership may involve partial ownership interests by common shareholders in more than one firm.

[20] The reason the HHI delta of 800 ($= 2 \times 20 \times 20$) does not equal the difference between the post-merger and pre-merger HHIs, which is 500, is that the HHI delta is calculated using pre-merger shares. After the merger, these shares change in Cournot equilibrium, so the true delta is 500 in this example. For a discussion of the relationship between the HHI delta and the equilibrium effects of mergers, see Joseph Farrell & Carl Shapiro, *Horizontal Mergers: An Equilibrium Analysis*, 80 AM. ECON. REV. 107 (1990).

an extreme case of common ownership—the acquiring firm's shareholders own 100 percent of the acquired firm after the merger. Thus, it seems clear that *some* amount of common ownership (here 100 percent) is likely to reduce competition, absent offsetting factors. But suppose that a shareholder of one firm acquires less than 100 percent of another firm. How much common ownership is too much?

Starting in the mid-1980s, economists began examining this issue rigorously.[21] The early analysis considered joint ventures and firms acquiring shares of their rivals. As an example, suppose firm 1 acquires 20 percent of firm 2. After the acquisition, firm 2 is much like a joint venture owned partly by firm 1 and partly by previous owner(s) of firm 2.[22] The theory of joint ventures predicts that competition is likely to be less intense post- than it was pre-acquisition even though the acquisition does not directly affect the firms' market shares.[23] There are two reasons. One reason is that the acquisition gives firm 1 an incentive to pull its competitive punches to some degree, because any benefit to firm 1 from more aggressive competitive behavior is attenuated by the negative impact this behavior would have on firm 1's 20 percent share of firm 2's profit.[24] This effect on competition arises solely from firm 1's *financial interest* in firm 2. A second reason the acquisition might diminish competition arises if the acquisition gives firm 1 some degree of *control* over the management of firm 2. Firm 1 would like firm 2 to pull its competitive punches because this would increase firm 1's profit. If corporate

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[21] Robert J. Reynolds & Bruce R. Snapp, *The Competitive Effects of Partial Equity Interests and Joint Ventures*, 4 INT'L J. INDUS. ORG. 141 (1986); Bresnahan & Salop, *supra* note 9; David Flath, *When Is It Rational for Firms to Acquire Silent Interests in Rivals?* 9 INT'L J. INDUS. ORG. 573 (1991); David Flath, *Horizontal Shareholding Interlocks*, 13 MANAGERIAL & DECISION ECON. 75 (1992); William Nye, *Can a Joint Venture Lessen Competition More than a Merger?*, 40 ECON. LETTERS 487 (1992); David A. Malueg, *Collusive Behavior and Partial Ownership of Rivals*, 10 INT'L J. INDUS. ORG. 27 (1992); David Reitman, *Partial Ownership Arrangements and the Potential for Collusion*, 42 J. INDUS. ECON. 313 (1994); O'Brien & Salop, *supra* note 9; Patrick Greenlee & Keith Waehrer, The Effect of Profit Sharing on Auction Markets (2004) (unpublished manuscript), papers.ssrn.com/sol3/papers.cfm?abstract_id=500083; David Gilo, Yossi Moshe & Yossi Spiegel, *Partial Cross Ownership and Tacit Collusion*, 37 RAND J. ECON. 81 (2006); Øystein Foros, Hans Jarle Kind & Greg Shaffer, *Mergers and Partial Ownership*, 55 EUR. ECON. REV. 916 (2011); Ángel L. López & Xavier Vives, *Cross-Ownership, R&D Spillovers, and Antitrust Policy* (CESifo, Working Paper No. 5935, 2016); José Azar, Portfolio Diversification, Market Power, and the Theory of the Firm (Sept. 3, 2017) (unpublished manuscript), papers.ssrn.com/sol3/papers.cfm?abstract_id=2811221.

[22] The combination is not literally a joint venture, but the analysis of economic incentives is similar. In many joint ventures, the owners also own separate production units that may compete with the joint venture. In the analogy here, the pre-venture owners of firm 2, whose shares are not acquired, do not operate a competing entity.

[23] In all of the hypothetical acquisitions in this article, we assume that the acquisition has no efficiency benefits.

[24] Reynolds and Snapp provided the first rigorous analysis of this effect under the assumption that a single owner controls each firm. Reynolds & Snapp, *supra* note 21.

governance provisions or other factors give firm 1 enough control over firm 2 to make this happen, competition is likely to diminish further.[25]

The preceding example shows that the competitive effects of a joint venture depend on both the size of the financial interests *and* the degree of corporate control that those interests confer. Bresnahan and Salop[26] proposed a metric that concisely summarizes these factors in the context of joint ventures—a modified HHI that adjusts the standard HHI to account for the effects of the competing firms' financial interests in the joint venture. The MHHI has the same interpretation as the HHI, the difference being that it accounts for the effects of common ownership.[27] Bresnahan and Salop used this framework to examine the effects of joint ventures on concentration under a range of specific assumptions about which owner or set of owners controls the joint venture.

In practice, common ownership arises in more and varied contexts than in joint ventures and transactions in which firms acquire shares of their rivals. It is common, for example, to see both individual and institutional investors—not only the competing firms themselves—acquire shares of multiple firms in the same industry.[28] The emerging research on common ownership is motivated in part by the observation that, when account is taken of the activities of institutional investors, common ownership is prevalent in many industries, including the airline and banking industries studied in the airline and banking papers.

Building on Bresnahan and Salop, O'Brien and Salop[29] generalized the framework for assessing the effects of partial ownership to cover cases where third-party investors acquire multiple firms in the same industry. O'Brien and Salop also proposed a way to quantify how a shareholder's fractional financial interest in a firm translates into control over the firm's managers. In particular, O'Brien and Salop define a shareholder's "control weight" as the weight the manager assigns in its objective function to the shareholder's financial

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[25] An additional potential effect of firm 1's ownership of firm 2 is an increased likelihood of coordination. For example, firm 1's ownership might provide a conduit for information sharing that makes coordination with firm 2 easier.

[26] Bresnahan & Salop, *supra* note 9.

[27] Both indices can be formally defined as the share-weighted average margin multiplied by the market elasticity of demand in a market characterized by (homogeneous) Cournot competition. *See* Keith Cowling & Michael Waterson, *Price-Cost Margins and Market Structure*, 43 ECONOMICA 267 (1976); O'Brien & Salop, *supra* note 9.

[28] This is common in the cable TV industry, for example. Mergers in the cable industry motivated the development of the MHHI in O'Brien and Salop. O'Brien & Salop, *supra* note 9; *see also* Stanley M. Besen et al., *Vertical and Horizontal Ownership in Cable TV: Time-Warner-Turner (1986)*, *in* THE ANTITRUST REVOLUTION: THE ROLE OF ECONOMICS 452 (John E. Kwoka, Jr. & Lawrence J. White eds., 3d ed. 1999).

[29] O'Brien & Salop, *supra* note 9.

benefit from all of its ownership interests in the same market. The theory accommodates complete mergers, controlling partial investments, and non-controlling partial investments as special cases. Differences between the cases arise from differences in the size of financial interests and how the financial interests translate into control.

O'Brien and Salop use their framework to generalize the MHHI concentration measure proposed by Bresnahan and Salop and to propose a price-pressure index that is a partial-ownership analog of the gross upward pricing pressure index used in the analysis of differentiated-product mergers. In deriving these measures, O'Brien and Salop identified the key variables that determine how common ownership affects incentives and competition, as discussed next.

B. Implications of Common Ownership for Pricing

For ease of exposition, we will employ a somewhat simplified example. The principles that emerge from this example generalize to more complicated situations.

We imagine a market with three competing firms and many investors, one of which may own shares in more than one firm. Firm j is initially owned by I_j different investors that own equal shares of firm j and no financial interests in firm j's rivals. Suppose that another investor becomes a common owner by acquiring fractional financial interests F_1, F_2, and F_3 in firms 1 through 3, respectively. Given the common owner's investments, the original owners of each firm and the common owner have divergent interests. In particular, each original owner cares only about the profits of the particular firm it owns, whereas the common owner cares about its earnings from all three firms.

The theory of partial ownership in O'Brien and Salop captures the owners' divergent interests quantitatively as follows. Denote the profits of firms 1 through 3 as Π_1, Π_2, and Π_3, respectively. The profit that accrues to each original owner of firm 1 is its share of firm 1's profit:

$$\text{Profit of an Original Owner of Firm 1} = \frac{(1 - F_1)}{I_1} \times \Pi_1. \quad (1)$$

The profit that accrues to the common owner is its share of the profits of all of the firms it owns:

$$\text{Profit of Common Owner} = (F_1 \times \Pi_1) + (F_2 \times \Pi_2) + (F_3 \times \Pi_3). \quad (2)$$

The manager of each firm chooses its strategies (e.g., prices, quantities, investment decisions) to maximize an objective (described shortly) that depends on the owners' financial returns. Because the firms compete, the strate-

gies chosen by the manager of each firm affect not only the profits of the firm it manages, but also the profits of rival firms. Given the disparate interests of the owners, as reflected in (1) and (2), the question becomes how the manager of each firm accounts for these disparate interests in its decision making.

In general, the answer may depend on corporate-governance provisions, the law (e.g., fiduciary obligations), and how collective decision making works, given these factors, to determine managerial compensation. In most economic analyses of competition among firms, researchers cut through these issues by making a simple assumption: the manager of each firm maximizes the profits of the firm it manages. This is the assumption that most economic analyses made before the literature on joint ventures and partial ownership developed.[30] Under this assumption, the manager of firm 1 chooses to maximize the profit Π_1 irrespective of the degree of common ownership. In this case, common ownership has no effect on firms' strategies.

O'Brien and Salop[31] introduce a generalized assumption regarding the manner in which each firm's manager weighs the interests of the firm's owners. In particular, they assume that each firm's manager maximizes a weighted sum of the owners' financial returns, which include the owners' earnings through their financial interests in other firms in the same market. The weight that a manager assigns to each owner's profit can be interpreted as a measure of the degree of control or influence the owner has over firm management. By adjusting these "control weights," an analyst can employ this approach to capture virtually any control scenario. The effects of mergers and partial acquisitions are analyzed in this framework by altering owners' financial positions and the control weights in ways that reflect the nature of the acquisition.

For example, the standard assumption that managers maximize the profits of the firm arises when positive control weights are placed only on owners that do not hold positions in rival firms.[32] A complete merger arises as a special case in which one or more common owners hold 100 percent of two of the firms and all the control weight is placed on these owners. Intermediate cases, e.g., the proportional-control assumption made in the airline, banking, and compensation papers, arise when owners with different objectives each

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[30] The usual justification for this assumption is the Fisher separation theorem. IRVING FISHER, THE THEORY OF INTEREST (1930); Harry DeAngelo, *Competition and Unanimity*, 71 AM. ECON. REV. 18 (1981); Frank Milne, *The Firm's Objective Function as a Collective Choice Problem*, 37 PUB. CHOICE 473 (1981). The theorem implies that in perfectly competitive markets with a complete set of tradable securities, a firm's owners unanimously agree that the firm's objective should be to maximize the profits of the firm. The separation theorem breaks down under common ownership among imperfectly competitive firms.

[31] O'Brien & Salop, *supra* note 9.

[32] It does not matter how control is allocated among owners that do not have common-ownership interests, as they all wish to pursue the same objective.

receive some positive control weight that may relate to their financial interests in some way.

Continuing with our three-firm example, suppose the common owner's control weights are W_1, W_2, and W_3 for its financial interests in firms 1, 2, and 3, respectively. The profit objective of firm 1's manager is then:

$$\text{Manager of Firm 1's Objective} = W_1 \times [\text{Profit of Common Owner}] + \frac{(1 - W_1)}{I_1} \times [\text{Profit of an Original Owner}] \times I_1. \quad (3)$$

The objectives of the other firms' managers are similar, replacing the common owner's control weight for firm 1 with its control weights for firms 2 and 3, respectively.

Given the ownership positions and control weights, it is possible to express each manager's objective in terms of what we will call the *common-ownership incentive terms.* We do this by substituting the expressions for the owners' profits in (1) and (2) into the expression for the manager's objective in (3). As the detailed derivation in the Appendix demonstrates, if we make these substitutions for each manager, we obtain the following objectives:

$$\text{Manager of Firm 1's Objective: } \Pi_1 + (C_{12} \times \Pi_2) + (C_{13} \times \Pi_3) \quad (4a)$$

$$\text{Manager of Firm 2's Objective: } \Pi_2 + (C_{21} \times \Pi_1) + (C_{23} \times \Pi_3) \quad (4b)$$

$$\text{Manager of Firm 3's Objective: } \Pi_3 + (C_{31} \times \Pi_1) + (C_{32} \times \Pi_2) \quad (4c)$$

where

$$C_{12} = \frac{W_1 F_2}{W_1 F_1 + \frac{(1 - W_1)(1 - F_1)}{I_1}} \quad (5)$$

is the common-ownership incentive term for investments in firm 2 by common owners of firm 1,[33] and the other subscripted C terms have analogous definitions.[34] Thus, the objective of each firm's manager is to maximize the

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[33] The analysis here is simplified by the assumptions that each firm is held by a single common owner and I other owners that each have the same share of the firm. In general, the common-ownership incentive terms depend on the financial interests and control weights of all owners of all firms in the market. That is, $C_{jk} = \frac{\sum_i W_{ij} F_{ik}}{\sum_i W_{ij} F_{ij}}$ is the incentive term that reflects ownership of firm k by owners that have control over firm j, where F_{ik} is fraction of firm k owned by owner i, W_{ij} is the control weight of owner i for its financial position in firm j, and the sums are taken over all owners in the industry.

[34] The managers' objectives in in (4a) through (4c) are technically proportional to rather than equal to the expressions on the right-hand side of these equations. *See infra* Appendix. However,

profits of the firm it manages plus a sum of rival firms' profits weighted by the common-ownership incentive terms, which themselves depend on the financial interests and control weights. In all, there are six common-ownership incentive terms in the three-firm case: C_{12}, C_{13}, C_{21}, C_{23}, C_{31}, and C_{32}. More generally, when N firms compete in a market, there are $N \times (N-1)$ common-ownership incentive terms with definitions analogous to the definition of C_{12}, above.

The expression for the common-ownership incentive term C_{12} may appear inscrutable, but it has a natural interpretation. Looking first at the numerator of (5), if the common owner's financial interest in firm 2 is zero ($F_2 = 0$), or if its financial interest in firm 2 is positive but its degree of control over firm 1's manager is zero ($W_1 = 0$), then the incentive term C_{12} is zero. This means that the manager of firm 1 places no weight on firm 2's profit in its objective. This makes sense—if the common owner does not own shares in firm 2, or if it owns shares in 2 but has no control over firm 1's decision making, then its financial position in firm 2 should have no effect on firm 1's decisions. On the other hand, if the common owner has both a positive financial interest in firm 2 ($F_2 > 0$) and some control or influence over firm 1's decisions ($W_1 > 0$), then the common-ownership term C_{12} is positive, and the manager of firm 1 will take into account firm 2's profits in its decision making in accordance with conditions (4a) and (5).

The denominator of (5) is a measure of the concentration of ownership and control of firm 1. As the number of non-common owners becomes larger (as I_1 becomes larger), the incentive term C_{12} grows. This captures the idea that a common owner's influence over the manager rises as the other owners' shareholdings become more diffuse.[35]

The determination of prices (or quantities, or other relevant strategic variables) under common ownership is similar to their determination when common ownership is absent, except that the managers' profit objectives are adjusted to account for common ownership. Antitrust economists generally assume that the firms (through their managers) are players in an oligopoly game, typically either Cournot or Bertrand oligopoly. The prices that emerge

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we can associate these expressions with the managers' objectives because a strategy that maximizes an objective X is the same as the strategy that maximizes Y if X differs from Y only by a constant factor of proportionality.

[35] More generally, the numerator of $C_{jk} = \frac{\sum_i W_{ij} F_{ik}}{\sum_i W_{ij} F_{ij}}$ reflects the control of firm j by owners with financial interests in rival firm k. The denominator is a measure of the concentration of ownership and control within firm j. Under proportional control ($W_{ij} = F_{ij}$), for example, the denominator is the HHI based on the ownership shares of firm j. The more firm j is owned and controlled by owners that have higher financial stakes in firm k, and the less concentrated the ownership of firm j, the more the manager of firm j will account for the effects of its decisions on firm k's profit (under the assumption of proportional control). *See* O'Brien & Salop, *supra* note 9, at 611–14 (providing details).

depend on factors that affect the managers' objectives. When common ownership is absent, the prices that emerge depend on cost and demand factors that are implicit in the profit terms in managers' objectives. When common ownership exists, the prices that emerge depend on the common-ownership incentive terms in addition to cost and demand factors. The equilibrium price(s) generally depend on all of the cost and demand factors and all of the common-ownership incentive terms.[36]

Whether and how common ownership affects prices depends on the financial interests and control weights that determine the incentive terms. If all common ownership involves no control, the control weights and incentive terms are all zero (i.e., the *W* values in terms of the form (5) are zero, making the common-ownership incentive terms zero). In this case, common ownership has no effect on competition and prices. If common ownership involves control or influence over managers, the effects on prices generally depend on both the size of the financial interests and the degree of control or influence associated with each financial interest. The effects of financial interest and control are subsumed in the common-ownership incentive terms.

C. THE MHHI AND MHHI DELTA

Antitrust authorities use concentration indices to provide a rough gauge of the likelihood that a complete merger will harm competition. Although economic theory does not yield a direct relationship between concentration and price, and the merger guidelines in most jurisdictions recognize the limitations of concentration analysis, merger authorities have found concentration indices (including the HHI) useful in defining safe harbors that provide the business community guidance about which transactions the authorities are unlikely to challenge.[37]

The theory of partial ownership in Bresnahan and Salop and O'Brien and Salop[38] produced a generalization of the HHI that takes into account partial ownership. This is the MHHI (i.e., the modified HHI), which is equal to the HHI plus a term known as the MHHI delta:

$$\text{MHHI} = \text{HHI} + \text{MHHI delta}.$$

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[36] More formally, each manager chooses its strategy (price, quantity, etc.) to maximize its objective in (4). Under assumptions that allow application of the implicit function theorem, the equilibrium strategies can be defined as functions of cost and demand factors and the common-ownership incentive terms.

[37] *See, e.g.*, U.S. Dep't of Justice & Fed. Trade Comm'n, Horizontal Merger Guidelines § 5.3, at 19 (2010), ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf; Eur. Comm'n, Guidelines on the Assessment of Horizontal Mergers under the Council Regulation on the Control of Concentration Between Undertakings, 2004 O.J. (C 31) 5.

[38] Bresnahan & Salop, *supra* note 9; O'Brien & Salop, *supra* note 9.

The MHHI delta measures the additional concentration that arises because of common ownership. In our three-firm example with a single common owner, the MHHI delta is

$$\text{MHHI delta} = (C_{12} + C_{21})s_1s_2 + (C_{13} + C_{31})\ s_1s_3 + (C_{23} + C_{32})s_2s_3, \qquad (6)$$

where s_j is the market share of firm j and the common-ownership incentive terms depend on ownership and control weights as described previously.[39]

The expression for the MHHI delta may seem inscrutable, but it is straightforward to see how it generalizes the HHI. For example, suppose that the common owner purchases 100 percent of firms 1 and 2 and fully controls both, but holds no position in firm 3. In this case, $F_1 = F_2 = W_1 = W_2 = 1$, and the other financial interest and control weights are zero. The common-ownership incentive terms are then $C_{12} = C_{21} = 1$ for common ownership involving firms 1 and 2 and zero for common ownership involving firm 3. The MHHI delta is then $2s_1s_2$ [$= (C_{12} + C_{21})s_1s_2$], which is the familiar formula for the change in the HHI from a complete merger. In other words, if an investor initially holds no shares of firms 1 and 2, and then acquires all shares and gains control of both firms, then the change in the MHHI from the change in common ownership (a complete merger) is the same as the change in the HHI from a complete merger. This illustrates one way that the MHHI generalizes the HHI as a measure of concentration.

While the MHHI has a similar motivation and interpretation as the HHI,[40] it also shares the HHI's flaws. For example, a reduction in one competitor's cost that leads to lower prices may be associated with an increase in the HHI and MHHI.[41] These indices are concentration measures, and they do not directly measure competitive effects.[42] This likely explains why merger guidelines in most jurisdictions limit their use to the provision of safe harbors.

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[39] In more general cases with multiple owners and a different number of firms, the MHHI delta equals $\sum_j \sum_{k \neq j} C_{jk} s_j s_k = \sum_j \sum_{k \neq j} \frac{\sum_i W_{ij} F_{ik}}{\sum_i W_{ij} F_{ij}} s_j s_k$, where s_j and s_k are the market shares of firms j and k and the sums are taken across all firms and all owners in the market. *See* O'Brien & Salop, *supra* note 9, at 611–14.

[40] Under Cournot oligopoly, the HHI equals the share-weighted average margin in the industry times the elasticity of demand. *See* Cowling & Waterson, *supra* note 27. The MHHI is constructed the same way except that it takes into account partial ownership under specific control assumptions.

[41] For a discussion of weaknesses of the HHI, see Joseph Farrell & Carl Shapiro, *Asset Ownership and Market Structure in Oligopoly*, 21 RAND J. ECON. 275 (1990).

[42] Although concentration measures provide a rough gauge of the competitiveness of markets, the industrial organization literature has long recognized problems with using concentration as an explanatory variable. *See, e.g.*, Joe S. Bain, *Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936–1940*, 65 Q.J. ECON. 293, 294 (1951); Harold Demsetz, *Industry Structure, Market Rivalry, and Public Policy*, 16 J.L. & ECON. 1 (1973); Timothy F. Bresnahan, *Empirical Studies of Industries with Market Power*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZA-

II. THE DISCONNECT BETWEEN THE EMERGING LITERATURE AND THE THEORY OF PARTIAL OWNERSHIP

We have established that the theory of partial ownership used in the emerging literature on common ownership for its key explanatory variable yields a particular relationship between prices and common ownership. Specifically, in the equilibrium of an oligopolistic market, prices depend on (1) cost and demand factors (as in virtually any economic theory), and (2) a set of common-ownership incentive terms that reflect the extent to which owners that control each firm have ownership interests in rival firms.

However, this relationship is not the relationship estimated in the airline and banking papers. Instead, those papers estimate regression equations that express price (or compensation) as a function of concentration indices (the HHI and MHHI delta in the airline and compensation papers, and the MHHI in banking paper). This disconnect between the predictions of the theory of partial ownership and the regression equations creates serious problems of interpretation.

All three concentration measures are endogenous variables that depend on the same exogenous factors that affect equilibrium prices. It is well known that changes in exogenous factors that reduce concentration can raise price, and changes in costs that raise concentration can reduce price. One well-known example is a marginal cost reduction of a single firm in a symmetric oligopoly. Such a cost reduction increases the market share of the firm that experiences the cost reduction and *increases* the HHI. However, the cost reduction typically *reduces* price. Unfortunately, changes in common ownership raise a similar issue. In particular, a change in common ownership that raises the MHHI may reduce price, and a change in common ownership that lowers the MHHI *may* increase price. Therefore, the MHHI does not provide a reliable prediction of the effects of common ownership on price.[43]

We illustrate this problem with an example that conveys the larger principle. Imagine a market for a product in which a dominant firm (labeled firm 1) that has relatively flexible capacity competes against a fringe of small firms

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TION 1011, 1043–44 (Richard Schmalensee & Robert D. Willig eds., 1989); Farrell & Shapiro, *supra* note 41, at 290; Michael D. Whinston, *Antitrust Policy Toward Horizontal Mergers*, in 3 HANDBOOK OF INDUSTRIAL ORGANIZATION 2369, 2412–14 (Mark Armstrong & Robert Porter eds., 2007); Peter C. Reiss & Frank A. Wolak, *Structural Econometric Modeling: Rationales and Examples from Industrial Organization*, *in* 6A HANDBOOK OF ECONOMETRICS 4277 (James J. Heckman & Edward E. Leamer eds., 2007). For a summary of the points in these articles, see Daniel P. O'Brien, Price-Concentration Analysis: Ending the Myth, and Moving Forward (July 2017) (unpublished manuscript), papers.ssrn.com/sol3/papers.cfm?abstract_id=3008326.

[43] Formally, it is generally not possible to express equilibrium prices as a function of exogenous cost and demand factors and the MHHI. For a general analysis and statement and proof of this impossibility theorem, see O'Brien, *supra* note 42.

that have relatively inflexible capacities. To keep the example simple, suppose that the fringe firms are all the same size and that their quantities are fixed. Firm 1 has a controlling owner that takes a financial interest F that carries no control in each of the other firms in the market. The remaining shareholders of each firm do not hold positions in rival firms.

If the fringe firms are very small, the HHI in this market is approximately the square of the dominant firm's share: $HHI = s_1^2$. If there are a total of N firms in the market, the MHHI delta is

$$\text{MHHI delta} = \sum_{k=2}^{N} Cs_1 s_k = (N-1)Cs_1 \frac{1-s_1}{(N-1)} = Cs_1(1-s_1),$$

where s_k is the share of a single fringe firm and the common-ownership incentive term C is firm 1's financial interest in each fringe firm.[44] The MHHI (the sum of the HHI and the MHHI delta) is therefore approximately

$$\text{MHHI} \approx s_1^2 + Cs_1(1-s_1).$$

Now consider the effects of an increase in common ownership (as measured by an increase in the common-ownership incentive term C) on price, the HHI, the MHHI delta, and the MHHI. Under most assumptions, the dominant firm will respond to an increase in C by increasing price. This occurs because the dominant firm's manager places greater weight on the profits of fringe firms as the common owner's financial positions in fringe firms increase.[45] At the same time, the increase in price is associated with a reduction in firm 1's quantity and market share, and because the HHI is positively related to the dominant firm's market share, the HHI also falls. Thus, an increase in common ownership that raises price reduces concentration as measured by the HHI. This shows the HHI is not a good measure of the competitive effects of common ownership in this example, but that may not be surprising, as the HHI depends only on market shares and does not depend explicitly on common ownership.

What is more surprising is that the MHHI delta and the MHHI may rise or fall with an increase in common ownership. Focus first on the MHHI delta, $Cs_1(1-s_1)$. For any given market share of the dominant firm, an increase in common ownership (increase in C) raises the MHHI delta. However, an increase in common ownership leads to a reduction in firm 1's share, which reduces the factor $s_1(1-s_1)$ if $s_1 < 0.5$. For sufficiently small values of the dominant firm's share, an increase in common ownership in this example can

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[44] The common-ownership incentive term corresponding to the common owner's non-controlling interest in a fringe firm equals the owner's financial interest in that firm.

[45] The Appendix shows that this is true for this example under linear demand and constant marginal cost.

reduce the MHHI delta after accounting for both the increase in C and decrease in s_1. Even when the increase in common ownership increases the MHHI delta, this increase may be less than the decrease in the HHI. In this case, an increase in common ownership decreases the MHHI.

Figure 1 shows how price, the HHI, and the MHHI vary with common ownership in a specific example of a market with linear demand and constant marginal cost.[46] In this example, the MHHI increases with common ownership if $C < 0.33$ and falls with common ownership for higher values of C. Because price rises with common ownership, this means that a given value of the MHHI may arise for two different levels of common ownership that are associated with different prices. Thus, the value of the MHHI does not predict price. More generally, we observe that

- Changes in common ownership that raise the MHHI may raise or lower price; and
- Changes in common ownership that reduce the MHHI may raise or lower price.

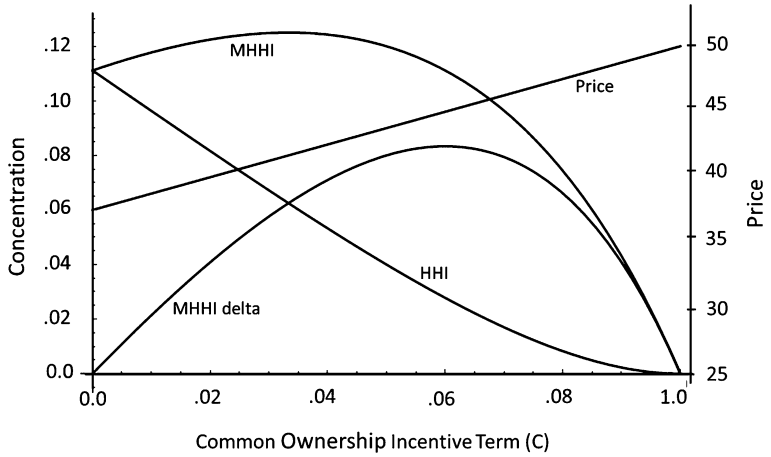

FIGURE 1: CONCENTRATION MAY INCREASE OR DECREASE WITH COMMON OWNERSHIP

This example shows that it is not possible to infer from concentration alone the effects of common ownership on price. The crux of the problem is that concentration measures are functions of market shares, and the concentration measures may increase or decrease with changes in common ownership that increase price.

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[46] See the Appendix for details of the derivation. In this example, the industry inverse demand is $P = 100 - Q$, marginal costs are zero, and fringe supply is fixed at 50.

This example also shows that the relationship between price and the MHHI as common ownership varies can be highly nonlinear. This means that the magnitude of the price change associated with a given change in the MHHI depends critically on the initial level of common ownership. In the example, the MHHI curve is fairly flat when C is near 0.33, while the price curve has constant slope. In a market where C varied by a small amount over a region near 0.33, a regression of price on the MHHI would yield a very high estimate of the effect of the MHHI on price, one that would obviously misrepresent the effects of a change in common ownership on price.

A possible criticism of this example is that it relies on specific assumptions about market structure (a dominant firm and fringe of small competitors) and common ownership (the dominant firm takes a position in every rival). Under different assumptions about market structure and the nature of common ownership, there could be a consistently positive relationship between price and the MHHI as common ownership varies. For example, if firms are symmetric oligopolists with the same market shares, then an increase in common ownership that carries control and preserves symmetry typically increases both price and the MHHI, generating a positive relationship between price and the MHHI as common ownership (with control) varies.

The point of the example, however, is that the relationship between price and the MHHI by itself does not reliably indicate the magnitude or even the direction of the effects of common ownership on price. More information is required to make this assessment, including an understanding of how the MHHI (an endogenous variable) varies with common ownership.

The example we presented is particularly simple, as common ownership takes a form that leads to a single common-ownership incentive term. Even in this case, the same MHHI may arise from two different levels of common ownership that lead to different prices, which means that the MHHI itself does not predict price. In more complex cases with multiple owners taking financial positions in more than one competitor, there are multiple common-ownership incentive terms. In this case, even if the MHHI is positively related to each common-ownership incentive term, there are generally multiple common-ownership scenarios that yield the same MHHI, and the different scenarios generally involve different prices. Again, the effect of common ownership on price cannot be determined from the MHHI.

As a simple example of the complexities that arise when common ownership has higher dimension, consider a two-firm market in which firms initially have the same shares, but one firm has higher costs than the other. A simple way to capture this asymmetry is by assuming that one firm is tightly capacity constrained while the other is not. The point of the example arises for other types of cost differences, but the assumption of a rigid capacity constraint that

applies to one firm but not the other simplifies the explanation. Consider two ownership scenarios. In the first scenario, a common owner takes a controlling position in the constrained firm and a small, non-controlling interest x in the flexible firm. This purchase will not affect prices because the capacity-constrained firm will still want to produce at capacity if the controlling common owner's investment in the flexible firm is small. The reason is that if the capacity constraint is tight, a small investment does not change the constrained firm's incentives enough to overcome its pre-investment desire to sell more. In the second scenario, a common owner purchases 100 percent of the flexible firm and a small, noncontrolling interest y in the constrained firm. In this case, the purchase will raise price because the owner of the flexible firm has an incentive to pull its competitive punches to raise price and increase profits of the constrained firm. In both scenarios, the MHHI increases. There is some investment level y' in scenario 2 that yields the same post-transaction MHHI as scenario 1. However, price rises in the second scenario, but does not rise in the first. In both scenarios, there are two common-ownership incentive terms, and they differ both within and across scenarios in ways that yield the same MHHI in each scenario. However, the scenarios still yield different price increases. Thus, the relationship between price and the MHHI (no relationship across the two scenarios) does not predict price. The problem is that a single-dimensional measure like the MHHI is not rich enough to capture a multi-dimensional change in common ownership.

We should point out that we are not arguing that there is no role for concentration indices in merger analysis. Although concentration has well-known problems predicting merger effects,[47] that does not mean that it has no role, e.g., in the provision of safe harbors. Using concentration (e.g., the HHI) as a rough indicator of a merger's anticompetitive potential, however, is vastly different from concluding that a positive correlation between price and the MHHI in data establishes that common ownership affects price.

III. THE EMPIRICAL ANALYSIS IN THE AIRLINE AND BANKING PAPERS

The airline and banking papers use regression analysis to relate prices to the MHHI or its components, the HHI and MHHI delta, under the assumption of proportional control, which implies that common ownership yields a positive MHHI delta whenever the commonly owned firms have positive market

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[47] Summarizing the use of concentration in merger analysis, Farrell and Shapiro state: "Although our analysis reveals that conventional policy, which aims to avert increases in measured concentration, lacks an explicit theoretical foundation, our inquiry has as yet furnished no clear alternative." Farrell & Shapiro, *supra* note 41, at 290.

shares.[48] The airline paper employs the HHI and MHHI delta as separate explanatory variables in their analysis of airline ticket pricing; the banking paper uses the MHHI (the sum of the HHI and MHHI delta) as the key explanatory variable in the analysis of banking prices. These regressions constitute the statistical analysis on which these papers base their conclusion that common ownership involving minority shareholdings has anticompetitive effects.

As explained Part III, the MHHI and MHHI delta do not reliably predict the price effects of common ownership as a matter of theory even ignoring statistical issues. In this Part, we explain why we would expect to find a relationship between these measures of concentration and price even in settings where common ownership has no effect on price.

A. THE AIRLINE AND BANKING PAPER REGRESSIONS

The airline paper estimates a regression of the form

$$\text{Airline Price-Concentration Relation: } P = \alpha_0 X + \alpha_1 H + \alpha_2 M_D + u, \quad (7a)$$

where P is the log of the airline ticket price; H is the HHI; M_D is the MHHI delta; X represents other factors that affect price that are observed by both the firms and the researcher; u is a random error reflecting factors that affect price other than H, M_D, and X; and α_0, α_1, and α_2 are coefficients to be estimated. The data are assembled quarterly, by carrier, and by city-pair market. (To economize on notation, we omit subscripts from variables that indicate the unit of observation.) In one analysis, prices vary by carrier; in another, the price measure is the average price in each city-pair market in each quarter.

The airline paper estimates equation (7a) using both least squares (panel regressions)[49] and an instrumental variables technique (panel-IV analysis). The panel regressions do not take into account the endogeneity of the concentration variables. The panel regressions that treat each carrier's price as an observation include fixed effects for the year-quarter and for the market-carrier. The panel regressions based on the average price in each market include fixed effects for the year-quarter and for the market. Both panel regressions also include other explanatory variables related to airline cost and demand. The panel-IV regressions are similar to the panel regressions but use an instrumental variables technique (discussed below) to address the endogeneity of the MHHI delta. The estimates of α_1 and α_2 represent the sensitivities of price to changes in the HHI and the MHHI delta in the data. The variables H and

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[48] More specifically, an institutional owner's control weight for firm j equals the number of voting shares of firm j held by the owner divided by the total number of shares (voting and nonvoting) outstanding for firm j. The papers are not clear on the treatment of control for noninstitutional shareholders, but that issue is not important for the analysis in this part.

[49] By "least squares," we mean ordinary or generalized least squares procedures that do not correct for the presence of endogenous explanatory variables.

M_D are scaled between 0 and 1 rather than between 0 and 10,000. Thus, the estimate of 0.201 for α_2 in the first panel regression reported in the airline paper means that an increase in the MHHI delta from 0 to 2200 (2200 is the average MHHI delta in the sample) raises the log of the price by 0.044 (= 0.201×0.22l). This works out to 4.9 percent increase in the airline ticket price, perhaps suggesting that an increase in common ownership from zero to the average level in the industry has raised prices by 4.9 percent.

The banking paper estimates a similar regression relating prices and other performance measures for banking services to the MHHI in banking:

$$\text{Banking Price-Concentration Relation: } P = \alpha_0 X + \alpha_3 M + u, \qquad (7b)$$

where $M = H + M_D$ is the MHHI.[50] This regression relation is conceptually the same as that in the airline relation (7a) but with the restriction that the HHI and MHHI delta have the same effect on price, i.e., $\alpha_3 = \alpha_1 = \alpha_2$. The banking paper estimates (7b) using different measures for price and using both least squares (panel regressions, with fixed effects for year and bank branch) and instrumental variables (panel-IV analysis to address the endogeneity of the MHHI). This paper also reports a positive relationship between the MHHI and price. For example, it reports that a 1 standard deviation increase in the MHHI yields a 2.1 percent increase in money market account maintenance fees.

B. Statistical Relationship Implied by the Theory

Under the theory of partial ownership used to generate the MHHI, the relationship between price and common ownership is different than the relationship posited in equations (7a) and (7b), as explained in Part II. Suppose, for example, that three airlines compete in a market. The managers' objectives are given in (4a) through (4c) in Part II. The standard assumption is that each manager chooses its strategy (price, output, or investment) to maximize its objective, and when all three managers do this simultaneously, the solution is a Nash equilibrium. Both the optimizing conditions (the first-order conditions) and the equilibrium solution depend on cost and demand variables and the common-ownership incentive terms.

There are two general strategies for assessing the effects of common ownership empirically. One strategy would be to use each manager's optimizing condition (the first-order condition to its maximization problem) along with

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[50] The banking paper replaces the MHHI with what the authors define as the "GHHI," which assigns ownership to "ultimate" owners when firms rather than their owners purchase shares in rival firms. For example, if owner 1 holds 10% of firm A and firm A purchases 30% of firm B, then owner 1 will hold 3% (= 0.1×0.3) of firm B. Apart from specific examples, O'Brien and Salop do not specify whether the ownership shares and control weights correspond to ultimate or intermediate owners, although this clearly affects the analysis. O'Brien & Salop, *supra* note 9.

assumptions about the form of the cost and demand functions to derive a set of structural equations (the first-order conditions) for estimation using a systems-estimation technique. This is known as "structural modelling" in industrial organization.[51] Alternatively, one could use the pricing equations generated by the managers' optimizing behavior to derive a reduced-form relationship that expresses equilibrium prices in terms of exogenous factors.[52] In the common-ownership context, these factors would include cost and demand variables and, if financial interests are exogenous, the common-ownership incentive terms. If the common-ownership incentive terms are endogenous, a systems-estimation technique would be required to estimate the "semi-reduced" form that expresses prices as functions of cost and demand factors and the common-ownership incentive terms.[53]

The estimating equations in the airline and banking papers are clearly more in line with the reduced-form approach, as that research generally does not specify the nature of the cost and demand relationships. Thus, to compare the predictions of the theory of partial ownership with the findings in the literature, we focus on the implications of the theory for reduced-form analysis.

If we assume that the relationship between price and other factors is linear, then the relationship implied by the theory of partial ownership (TPO) would be

$$\text{TPO Relation: } P = \alpha_0 X + \alpha_{12} C_{12} + \alpha_{13} C_{13} + \alpha_{21} C_{21} + \alpha_{23} C_{23} + \alpha_{31} C_{31} + \alpha_{32} C_{32} + u, \quad (8)$$

where the subscripted C values are the common-ownership incentive terms in a three-firm market as defined in Equation (5), and the subscripted α values are parameters to be estimated.[54] Comparing (8) to (7a) and (7b), we see that under the assumption that the relationship is linear, the airline and banking papers replace the common-ownership incentive terms with the components of the MHHI, which are H and M_D.

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[51] Classic examples, providing surveys of these techniques, include Jonathan B. Baker & Timothy F. Bresnahan, *The Gains from Merger or Collusion in Product-Differentiated Industries*, 33 J. INDUS. ECON. 427 (1985); Steven Berry, James Levinsohn & Ariel Pakes, *Automobile Prices in Market Equilibrium*, 63 ECONOMETRICA 841 (1995); Reiss & Wolak, *supra* note 42.

[52] A variable is exogenous in a regression model if it is uncorrelated with the error term in the regression. *See* JEFFREY M. WOOLDRIDGE, ECONOMETRIC ANALYSIS OF CROSS SECTION AND PANEL DATA 54 (2d ed. 2010).

[53] A variable is endogenous in a regression model if it is correlated with the error term in the regression. *Id.* When an endogenous variable is used as an explanatory variable in a regression, bias occurs unless a technique like instrumental variables is used to correct the problem. *Id.*

[54] In reality, the price/common ownership relationship is non-linear except in special cases (such as the example considered below). Thus, the linear relationships in the price/common ownership relation (8) and in the airline and banking regressions (7a–b) are best viewed as approximations.

C. Problems with the Empirical Analysis

To understand the statistical issues with estimating (7a–b) when the true relationship is (8), it helps to make two additional simplifications. First, abstract from explanatory variables in (7a–b) other than the concentration variables.[55] Second, suppose that common ownership takes a form that can be summarized with a single common-ownership incentive term C. These assumptions are abstractions that simplify the analysis and do not alter our central points. Under these assumptions, the relations in (7a–b) and (8) become

$$\text{Airline Price-Concentration Relation (Simplified): } P = \alpha_1 H + \alpha_2 M_D + u \quad (9a)$$

$$\text{Banking Price-Concentration Relation (Simplified): } P = \alpha_3 M + u \quad (9b)$$

$$\text{TPO Relation (Simplified): } P = \alpha C + u. \quad (10)$$

To simplify the statistical discussion, we assume that all variables (9a–b) and (10) are measured as differences from means.

1. *Spurious Correlation 1: Endogenous Explanatory Variables*

Suppose that common ownership has no effect on competition and price. This is true if the control weight W equals zero rather than the common owner's financial interest as under the proportional control scenario assumed in these papers. Because it is possible that minority shareholdings do not cause common owners to influence managers in ways that lead them to take actions against the interests of non-common owners, any empirical analysis of the effects of common ownership should allow for (and test for) this possibility.

However, under the assumption of proportional control made in these papers, the expected values of least-squares estimates of the coefficients in (9a–b) are generally not zero even when the true common-ownership effect is zero. In fact, the same is true under any positive control assumption.

To see this formally, we describe the least-squares estimates of the coefficients in (9a–b) in terms of correlations. Consider first the regression (9b), which imposes the restriction that the HHI and MHHI delta affect price in the same way. If common ownership does not affect price, then $\alpha = 0$ in (10), and $P = u$. In this case, the regression estimate of the MHHI effect in (9b) is

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[55] If X is uncorrelated with the other variables, then excluding it does not affect the estimates. This assumption is unlikely to be hold, but it is valuable for illustration, and the qualitative conclusions in this part hold if this assumption is relaxed.

$$\text{Estimate of } \alpha_3 \text{ (MHHI Effect)} = \frac{Cov(M,P)}{Var(M)} = \frac{Cov(M,u)}{Var(M)}, \quad (11)$$

where *Cov* represents the estimated covariance between the indicated variables and *Var* is the estimated variance. Because the variance of the MHHI is positive, the estimate of the effect of the MHHI on price will not be zero unless the covariance between the MHHI and the error term u is zero. However, standard theories of oligopoly behavior suggest that this covariance will be zero only in very special cases. This is because the MHHI is a function of both the common-ownership incentive terms and market shares, and even if the common-ownership incentive terms are not correlated with price, the market-share parts of MHHI delta almost certainly are. This means that estimating regression equation (9b) using least squares is likely to yield a relationship between price and the MHHI even if common ownership does not affect price.

Regression (9a) differs from (9b) by allowing separate effects of the HHI and MHHI delta. In the Appendix, we show that the least-squares estimates under the assumption that common ownership involves no control and thus has no effect on price are as follows:

$$\text{Estimate of } \alpha_1 \text{ (HHI Effect):} \quad K[Var(M_D)Cov(H,u) - Cov(H,M_D)Cov(M_D,u)] \quad (12)$$

$$\text{Estimate of } \alpha_2 \text{ (MHHI delta Effect): } K[-Cov(H,M_D)Cov(H,u) + Var(H)Cov(M_D,u)], \quad (13)$$

where $K = 1/[Var(M_D)Var(H) - Cov(M_D,H)^2]$ is positive. The variance terms are always positive. Thus, estimates of the effects of the HHI and MHHI delta on price will not be zero unless the covariance terms in (12) and (13) are zero or the terms in square brackets in each equation cancel out. However, none of the covariance terms are expected to be zero, nor are the terms generally expected to cancel out. Again, this is because the HHI and MHHI delta are both functions of market shares, and even when the common-ownership incentive terms are not correlated with price, the share parts of the HHI and MHHI delta almost certainly are.

To gain intuition, turn again to a tractable example motivated by pricing in the airline industry. Consider three firms engaged in competition in a particular city-pair market over time. In the airline business, prices fluctuate significantly over time and across markets due to market-specific changes in demand.[56] For example, airline tickets to Lake Tahoe and Aspen may be higher during ski season—periods of high demand—than they are during

[56] The standard deviation of airline ticket prices in the airline paper is $98.94, which is large relative to the mean of $227.03. Azar, Schmalz & Tecu 2016, *supra* note 1, at 49 tbl. 2. The standard deviation of the fees in the banking paper ranges from just under half the mean fee to

other periods. In our example, we assume that one of the firms ("airline 1") is capable of responding flexibly to changes in market conditions, while the other two are not. The price fluctuations we envision are not associated with variables that are included in the regression relations (9a–b), but arise from the variation in price that is not explained by the regressions. The airlines are independently owned except for two common owners, one of which has a financial position F in airlines 1 and 2, and the other of which has a financial position F in airlines 1 and 3.[57]

In this example, the flexible airline adjusts price and quantity in response to fluctuations in demand. An increase in demand generally leads to an increase in the equilibrium price and the flexible airline's equilibrium quantity and share, as it responds to a positive demand shock by increasing both its quantity and price. This is true whether or not the common owners have any control over the flexible airline's management. The effects of a positive shock on the HHI and MHHI delta both depend on the flexible airline's share and, for the MHHI, on the assumption about control. In the three-firm example, if the common owners are assumed to have some control (e.g., proportional control) and the flexible airline's share is between 33 percent and 50 percent, then a positive demand shock increases both the HHI and the MHHI delta, and therefore the MHHI.[58] Over this range, the covariances between the HHI and the error, between the MHHI delta and the error, and between the MHHI and the error are all positive.

In this environment, consider the output from regression of price on the MHHI, i.e., an estimate of regression relation (9b), which restricts the HHI and MHHI delta to have the same effects. (The airline paper allows these effects to differ, but examining the implications of requiring them to be the same is illustrative.) If demand fluctuations generate shares for the flexible airline between 33 percent and 50 percent in this example, then the covariance between the MHHI and error term are positive, which means that the estimate of α_3 will be positive. This is true even if common ownership has no effect on the equilibrium price.

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nearly the same as the mean, depending on the particular fee. Azar, Raina & Schmalz, *supra* note 1, at 47.

[57] This example yields precisely equation (10) when price is measured in levels rather than logs, demand is linear, and firms have constant marginal cost. In particular, suppose that the inverse demand for airline travel is $P = a + \varepsilon - bQ$ where Q is the aggregate quantity of airline travel in the market, ε is a random component of demand with mean zero, and a and b are constants. In the Appendix, we show that this inverse demand generates the equation (10), and that estimating the equations (9a) and (9b) using least squares yields the coefficient estimates given in (11), (12), and (13).

[58] *See infra* Appendix for derivation of this result.

An estimate of (9a) is also generally expected to yield nonzero estimates for the separate effects of the HHI and the MHHI delta, although determining the sign of the expected effects is more complicated. In the appendix, we show that if demand fluctuations are such that the flexible airline's share is close to 33 percent, then the covariances between H and u and between H and M_D are small, while the covariance between M_D and u remains strictly positive. In this case, the estimate of the MHHI-delta effect α_2 will be positive. More generally, a Monte Carlo examination of this example with normally distributed demand shocks yielded in all 2000 random samples positive and statistically significant regression coefficients for both α_1 and α_2 even though none of the variation in H or M_D was the result of changes in common ownership.[59]

This example is illustrative and does not purport to establish that the panel regressions in the airline and banking papers would always yield positive relationships between the MHHI or its components and price in cases where common ownership has no effect. The actual regressions in these papers include variables omitted from our example; they also include common-ownership incentive terms (components of the MHHI delta) that vary over time and across markets. The estimate of the effect of the MHHI or its components generally depends on multiple correlations among all the included variables (including the concentration measures) and between each included variable and the error term. The general point of the example is that when common owners are assumed to have some degree of control (here proportional control), the expected value of the regression coefficients is generally not zero even if common ownership has no competitive effect, and in plausible circumstances, the expected coefficients are positive. The reason for this result is that the variables in the regression, the HHI and MHHI delta, depend on market shares as well as the common-ownership incentive term C, and market shares are endogenous variables. Because market shares are correlated with factors that affect price through the error term in the regression in the example, the positive relationship found between price and the MHHI components is an artifact of the positive relationship between price and market shares rather than evidence of a positive relationship between price and common ownership C.

In airline markets, market-specific demand fluctuates seasonally and for other reasons. Nowhere near all of the factors that affect demand are included as explanatory variables in the airline paper's panel regressions. In particular, none of these regressions reports an R-squared greater than 28 percent, and the panel regression that includes only the HHI and MHHI delta as explanatory variables has an R-squared of 9.5 percent. This means that the

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[59] *See infra* Appendix for further discussion.

variables included in the regression other than the HHI and MHHI delta explain less than 20 percent of the variation in price. The rest of the variation in price is captured in the error. The panel regressions in the banking paper explain a higher percentage of the variation in price, but between about 20 and 48 percent of the variation remains unexplained. Because the HHI and MHHI delta are undoubtedly correlated with some of these factors, it would not be surprising to find a relationship between the MHHI or MHHI delta and price even if common ownership does not affect price.

2. *Spurious Correlation 2: Endogenous Instruments*

The airline paper recognizes that the panel regressions suffer from "reverse causality and other endogeneity concerns."[60] The panel-IV regressions attempt to deal with this issue.

Specifically, the airline paper uses the BlackRock-Barclays merger as a "plausibly exogenous" variable to serve as an instrument for the MHHI delta. The use of instrumental variables is a widely accepted technique for dealing with endogenous explanatory variables. However, because the regression equations contain two endogenous variables—the HHI and the MHHI delta—and instrumental variables are used to correct only for the endogeneity of the MHHI delta but not the endogeneity of the HHI, the panel-IV regression estimates remain problematic.[61]

The issue that remains can be identified from expressions for the estimated coefficients in (11) and (12). Focus on (12), which we rewrite here replacing M_D with the predicted value $\widehat{M}_D$ from a first-stage regression in a two-stage least squares procedure:

$$\text{Estimate of } \alpha_2 \text{ (MHHI delta Effect): } K[\underbrace{-Cov(H,\widehat{M}_D)Cov(H,u)}_{\text{Part 1}} + \underbrace{Var(H)Cov(\widehat{M}_D,u)}_{\text{Part 2}}] \quad (14)$$

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[60] Azar, Schmalz, & Tecu 2016, *supra* note 1, at 21.

[61] The most recent version of the airline paper presents a difference-in-difference analysis of the effects of BlackRock's acquisition of Barclays Global Investments in 2009Q1 on airline prices. *See* Azar, Schmalz & Tecu 2016, *supra* note 1. In particular, the authors group markets into terciles according to the size of the one-time implied change in MHHI delta caused by the BlackRock/Barclays transaction based on shareholdings in 2009Q1. They then use regression analysis to relate the change in price between the two periods to the tercile of the implied change in the MHHI delta and to other covariates. (They use the upper tercile as the "treatment" and the lower tercile as the "control.") The revision also presents "continuous-treatment" and "discrete-treatment" instrumental variables analyses. The continuous-treatment IV uses the implied change in the MHHI delta as an instrument for the actual MHHI delta. The discrete-treatment IV uses a dummy for the tercile of the change in the MHHI delta caused by the acquisition (upper versus lower) as an instrument for the actual MHHI delta. In both IV approaches, the HHI in 2009Q1 is an instrument. Like the regression equations in the 2016 paper, their regression equations are not grounded in the theory of partial ownership and they include endogenous explanatory variables. Thus, they do not resolve the interpretation and endogeneity issues raised in this article.

The panel IV procedure is supposed to eliminate the correlation between $\widehat{M}_D$ and u, which would eliminate the bias in Part 2. However, because H is treated as exogenous, $\widehat{M}_D$ explicitly depends on H from the first-stage regression. Thus, $\widehat{M}_D$ is correlated with H, and because H is actually endogenous (correlated with u), $\widehat{M}_D$ is also correlated with u. Thus, the bias in Part 2 remains. In addition, the bias in Part 1 remains because H and $\widehat{M}_D$ are correlated and H and u are correlated. Therefore, both terms in (14) are likely nonzero, so the estimate of the MHHI delta effect is likely to differ from zero even if the true effect of common ownership is zero. The sign of the bias in this example depends on the covariances between H and $\widehat{M}_D$ and between H and u. More generally, the sign of the bias depends on multiple correlations among all the included variables and each included variable and the error.[62]

The banking paper also uses a panel-IV approach to correct for endogeneity. In particular, that paper uses a measure of index-fund activity in the banks in each county and time period as an instrument for the MHHI. The argument is that index-fund activity is not driven by factors that affect prices across counties and over time.

However, the measure of index-fund activity used is not an exogenous variable and thus not a valid instrument. In particular, index-fund activity is defined as the market share-weighted average (across bank branches in a given county and time period) of the percentage of the bank owned by index funds. This instrument depends *explicitly* on market shares, which are highly endogenous. The use of this variable as an instrument creates all the problems created by endogenous explanatory variables generally. In the context at hand—estimating the relationship between banking prices and the MHHI—the panel-IV regressions could generate a relationship between price and the MHHI as an artifact of the correlation between market shares and prices even if common ownership has no competitive effect in the banking markets studied.

3. *Spurious Correlation 3: Investor Selection Bias*

An additional endogeneity issue arises if the common owners' investments depend on factors that drive prices. We will refer to this as "selection bias." In the common-ownership context, the idea is that investors may opt ("select") to own shares of firms in markets with particular characteristics that also affect prices. For example, investors may tend to purchase shares of more successful companies, and such companies may tend to have higher prices or operate in markets that tend to have higher prices. The airline paper refers to this poten-

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[62] For a discussion of the endogeneity problem and how to treat it with instrumental variables, see WOOLDRIDGE, *supra* note 52, ch. 5, at 83–113.

tial problem as "reverse causality" because the problem is that high prices may cause higher common ownership rather than the other way around.[63]

Reverse causality of this sort is simply another source of endogenity in which the MHHI and its constituent parts are correlated with factors omitted from the regression that affect prices. For example, if the financial interest F is positively correlated with the random component of price u, and if the MHHI delta is positively related to the financial interest—as it is under the proportional-control assumption—then the MHHI delta will be positively correlated with the random component of price (i.e., $Cov(M_D,u) > 0$). In this case, we would expect to find a correlation between price and the MHHI delta even if common ownership has no causal effect on price. The expected effect is positive if the correlations between the HHI and MHHI delta and between the HHI and error have opposite signs.

The airline and banking papers contend that the panel-IV results address reverse causality. However, the panel-IV analysis in the airline paper uses an endogenous variable (the HHI) as an instrument in the first-stage regression. Because the HHI is endogenous, this is not a valid IV approach. Similarly, the instrument in the banking paper depends on endogenous shares and is not a valid instrument. The airline paper argues as well that quantity regressions showing that the MHHI delta has a negative effect on quantity addresses reverse causality. However, the quantity regressions have the same misspecification problem as the price regressions. For these reasons, we do not agree that the panel-IV approaches in these papers address the endogeneity issues.

IV. TESTING FOR THE EFFECTS OF COMMON OWNERSHIP

The airline and banking papers present their empirical analyses as formal hypothesis tests. The airline paper tests the null hypothesis that "[c]ommon ownership by diversified institutions, as measured by the MHHI delta, has no effect on market-carrier-level and market-level ticket prices" against the alternative that common ownership has positive effect on these prices.[64] The banking paper tests the null hypothesis that the HHI and MHHI are equally effective at predicting prices against the alternative that the MHHI is a better predictor of prices.[65]

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[63] It is important to recognize that the theoretical problems and other endogeneity issues we have identified invalidate any causal interpretations of the relationship between common ownership and price based on regressions of price on concentration. For a detailed discussion of causality in econometrics, see James J. Heckman & Edward J. Vytlacil, *Econometric Evaluation of Social Programs, Part I: Causal Models, Structural Models and Econometric Policy Evaluation*, *in* 6B HANDBOOK OF ECONOMETRICS 4779 (James J. Heckman & Edward E. Leamer eds., 2007); James J. Heckman, *The Scientific Model of Causality*, 35 SOC. METHODOLOGY 1 (2005).

[64] Azar, Schmalz & Tecu 2016, *supra* note 1, at 12.

[65] Azar, Raina & Schmalz, *supra* note 1, at 19.

The analysis in the preceding two sections criticizes these tests on two levels. First, it shows that equilibrium prices depend on the common-ownership incentive terms, not the MHHI. This leads to an equilibrium relationship between P and C (and other factors) rather than between P and H and M_D (and other factors).[66] The relevant question for assessing the effects of common ownership on price is whether C affects managers' optimizing conditions, and therefore their decisions, in a way that leads to higher equilibrium prices. Second, the analysis shows that even if the true coefficient in Equation (10) above is zero ($\alpha = 0$), the estimation of (9a–b) is likely to yield a relationship between price and the concentration measures because these measures are endogenous. The analysis also shows that the steps taken to address endogeneity in these papers are inadequate. For these reasons, we do not believe that the analyses in the airline and banking papers constitute valid tests of whether common ownership affects prices in those industries.

It is beyond the scope of this article to present a complete framework for conducting such a test, but we briefly describe how such a test might be performed. First, if financial shares are exogenous, an estimate of a relationship like (8) under some control assumption would address the question of whether common ownership under the specific control assumption affects the equilibrium price. If financial shares are endogenous, the common-ownership incentive terms also become endogenous, and a systems-estimation technique would be required. If the goal is simply to test whether common ownership matters, this estimation approach may help answer the question. However, if the desire is to predict the size of the effect, it would be important to use the right control scenario. The reason is that the wrong control assumption introduces error into the common-ownership incentive terms, biasing the estimates.

A better approach would allow the data to determine the relationship between ownership and control. For example, we might posit some function $W(F,\theta)$ as the mapping that translates the ownership matrix F into a control-weight matrix W where θ is a vector of parameters to be estimated. It is not obvious what form this function should take, but desirable properties would include that an owner with no shares in a firm has zero control, an owner that holds all shares has complete control, and the control weights across all owners of a given firm sum to 1. Observe that proportional control is a special case where $W_{ij} = F_{ij}$ for all owners i and firms j.

This assumption satisfies these desirable properties, but it imposes conditions on the parameter vector θ such that each owner's control weight varies

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[66] Of course, the linearity (or log linearity) of both relations is an assumption that is not a prediction of the theory.

linearly with its ownership share. This restriction may not be valid—it seems more likely that the degree of control would take some nonlinear form. For example, an individual owner's control likely rises rapidly (or may even jump) at or near a 50 percent ownership stake. In place of the proportional-control assumption, one could allow control to vary with ownership in a different way subject to the properties described. One could then substitute $W(F,\theta)$ into a first-order condition in a structural model or into an equation like (6) (or a more flexible version of (6)) in a reduced-form model and attempt to estimate θ to determine how financial interests map into control and how common ownership affects price under the estimated control scenario.

A. Is Proportional Control Reasonable?

The airline, banking, and compensation papers all assume proportional control, which O'Brien and Salop[67] posited as an intermediate case between no control and full control. However, O'Brien and Salop did not justify this assumption based on theory or evidence, nor do the papers that employ this assumption in empirical analysis do so. To the best of our knowledge, there is no accepted relationship between ownership and control in oligopoly environments in which owners have divergent interests. This remains an open question in economics and finance.

The proportional-control assumption has some questionable implications. In the example with a single common owner taking a financial position F with a positive control weight W in each firm, and I non-common owners holding the remaining shares of each firm, the common-ownership incentive term between any two firms is

$$C = \frac{FW}{FW + \frac{(1-F)(1-W)}{I}}. \tag{15}$$

Observe that as the number of non-common owners I becomes large, the second term in the denominator goes to zero, and the common-ownership incentive term goes to 1. (C becomes $FW / FW = 1$.) This means that as the number of non-common shareholders grows large, the common shareholder gains complete control of the firm. This follows from the observation that when I is large, the firm's manager places the same weight on profits of the rival firms held by the common shareholder as it places on the profits of the firm it manages. The implication is that given *any* positive control weight on the common owner, the monopoly outcome arises (or is closely approximated) as the remaining ownership of each firm becomes diffuse.

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[67] O'Brien & Salop, *supra* note 9.

Carl Shapiro points out that this is a counterintuitive implication of the proportional control assumption.[68] It implies, for example, that if a single common owner holds only 1 percent of each firm in the industry and 10,000 non-common owners hold equal proportions of the remaining shares of each firm, then each firm's objective will be nearly equal to industry profit, and the industry will operate as a near monopoly. On the other hand, if the 10,000 non-common owners are able to act as a block, contrary to the proportional control assumption, then managers will put only small weight on their rivals' profits.[69] Voting models frequently yield outcomes between these extremes. For example, the Banzhaf Power Index gives an owner complete control as its ownership share approaches 50 percent.[70]

The large differences in the control weights under these different assumptions is unsettling. When no shareholder has majority control, or when control is not subject to explicit constraints (e.g., nonvoting shares, or board rights, etc.), then appropriate choice of control weights is far from obvious, but the choice is critical both for measuring concentration with the MHHI and for any empirical analysis intended to quantify the effects of common ownership. Our view is that more research is needed before conclusions can be drawn about the effects of common ownership from an analysis that imposes a control assumption (proportional control) that is not firmly grounded in theory and does not as yet have empirical support.

V. WHAT IS THE MECHANISM?

A. EXECUTIVE COMPENSATION

Managerial behavior presumably depends to a significant degree on how managers are rewarded for the decisions they make.[71] An obvious reality check on any analysis of common ownership is to ask whether managers actually have incentives to take the actions they are predicted to take under the particular control scenario employed. Under the proportional-control assumption, owners with financial interests in rivals prefer that managers compete

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[68] Carl Shapiro, Discussion of *Anti-Competitive Effects of Common Ownership*, Eighth Annual Fed. Trade Comm'n Microeconomics Conference (Nov. 12, 2015) (discussing an earlier version of Azar, Schmalz & Tecu 2016, *supra* note 1) (on file with authors).

[69] In our three-firm example, if the 10,000 non-common shareholders have proportional control, the common-ownership incentive term for each pair of firms is 0.992. Each manager's objective function is then $\Pi_1 + (0.992 \times \Pi_2) + (0.992 \times \Pi_3)$, which is very close to industry profits. If the 10,000 non-common shareholders act as a block, then the common-ownership incentive term is 0.0001, which means that each manager's objective is very close to the profits of the firm it manages.

[70] *See* Azar, *supra* note 21.

[71] At one level, this is tautological, assuming managers are rational. However, discerning managers' incentives is not straightforward, as they can be hired or fired for reasons that are not obviously reflected in their compensation.

less aggressively than owners that do not hold rival shares would prefer. In this case, managers are assumed to take actions that increase industry profits at the expense of own-firm profits. Do managers actually have an incentive to behave this way?

1. *Compensation Based on Stock Options*

As evidence in support of this kind of behavior, Elhauge cites Lucian Bebchuk and Jesse Fried[72] for the observation that "corporations generally compensate executives using measures (like stock options) that are 70 percent driven by general market [conditions] and only 30 percent driven by individual corporate performance."[73] However, this evidence does not mean that managers compensated with stock options have an incentive to sacrifice their own firm's profits to raise a measure of industry profits. That argument conflates the natural correlation between a firm's profits and general market profits with the incentives created by the manager's contract. This correlation arises because many exogenous factors that affect general market profits also tend to move own-firm profits in the same direction. However, an action by a manager that increases own-firm profits beyond any changes driven by exogenous factors will increase the firm's stock price and the manager's compensation if compensation is conditioned on the stock price. It is a mistake to claim that managers will make choices that reduce own-firm profits to increase the profits of rival firms simply because a firm's profits are correlated with industry profits.

2. *Correlation Between the MHHI and Industry-Based Compensation*

The compensation paper finds evidence that compensation skews away from rewarding managers based on own-firm profit toward rewarding them based on industry profit as the degree of common ownership increases. Like the airline and banking papers, the compensation paper measures concentration due to common ownership using the MHHI delta. The specific empirical finding in the paper is the following: as the MHHI delta increases, the sensitivity of managers' compensation to industry profits grows relative to its sensitivity to own-firm profits.

Heung Jin Kwon reaches the opposite conclusion using a methodology very similar to the one that the compensation paper employs.[74] That is, he finds that common ownership increases the sensitivity of compensation to own profit

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[72] LUCIAN BEBCHUK & JESSE FRIED, PAY WITHOUT PERFORMANCE: THE UNFULFILLED PROMISE OF EXECUTIVE COMPENSATION (2004).

[73] Elhauge, *supra* note 2, at 1278.

[74] Heung Jin Kwon, Executive Compensation under Common Ownership (Nov. 29, 2016) (unpublished manuscript) (on file with author).

relative to industry profits and thereby makes markets more competitive. The biggest difference between the approaches is the functional form posited for the relationship between compensation and performance. The compensation paper relates the dollar change in pay to the dollar change in firm value, whereas Kwon relates the percentage change in pay to the percentage change in value. Kwon also conducts a second analysis that relates the likelihood that managers receive explicit performance awards for increasing their performance relative to other firms in the industry to common ownership as measured by the MHHI delta. This analysis also shows that common ownership increases the extent to which managers are rewarded for actions that increase own profits relative to industry profits.

That two recent working papers reach opposite conclusions using slightly different empirical specifications (different functional forms) indicates that the relationship between compensation and common ownership is at best unsettled. In addition, both of these papers have flaws similar to the problems in the airline and banking papers. Specifically,

- The theory of compensation that both the compensation paper and Kwon employ does not predict that compensation depends on share-based measures of concentration except in unrealistic cases; and

- Given the endogeneity of concentration, the finding that compensation is correlated with a concentration variable is not unexpected even if common ownership has no effect on compensation.

The empirical analysis in both papers builds off an earlier analysis of compensation by Rajesh Aggarwal and Andrew Samwick,[75] which finds evidence that owners that control management may structure compensation to soften or enhance competition with their rivals. However, neither the Aggarwal and Samwick paper nor the compensation paper's extension to the case of common ownership predicts that compensation depends on share-based measures of concentration except in cases where competing firms are symmetric.[76]

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[75] Rajesh K. Aggarwal & Andrew A. Samwick, *Executive Compensation, Strategic Competition, and Relative Performance Evaluation: Theory and Evidence*, 54 J. FIN. 1999 (1999).

[76] Aggarwal and Samwick build on the strategic-delegation literature that shows that if owners that control their managers can commit to compensation contracts that their rivals can observe, then the owners may write contracts that enhance or soften competition relative to situations where rivals cannot observe these contracts. *See* Chaim Fershtman & Kenneth L. Judd, *Equilibrium Incentives in Oligopoly*, 77 AM. ECON. REV. 927 (1987); Steven D. Sklivas, *The Strategic Choice of Managerial Incentives*, 18 RAND J. ECON. 452 (1987); Giacomo Bonanno & John Vickers, *Vertical Separation*, 36 J. INDUS. ECON. 257 (1988). In this theory, compensation may depend on the intensity of competition, but it does not depend on share-based measures of concentration. The compensation paper extends this theory to cases of common ownership and shows that common ownership that carries control may lead to changes in compensation that

Thus, there is a disconnect between the empirical analysis and the underlying economic theory that makes it hard to interpret the results that the compensation paper and Kwon report.

In addition, the HHI and MHHI depend on market shares, which are endogenous, and owners' financial interests, which may be endogenous. The issues are the same as with airline and banking papers. It is difficult in the abstract to predict the correlations between explanatory variables that depend on concentration and factors that affect compensation that are omitted from the regression equations. For example, the components of the MHHI delta for a firm with a high share tend to be higher than the components of the MHHI delta for a firm with a lower share, other factors being equal. If a firm's share is correlated with factors that affect the sensitivity of its managers' compensation to own-firm and industry performance (e.g., if higher-quality firms are more likely to condition compensation based on own-firm profit), then the MHHI delta will also be correlated with these factors. There is little reason to believe that these correlations are zero. Given this observation, it would not be surprising to find a relationship between common ownership and the relative sensitivities of compensation to own-firm and industry profits even if common ownership has no effect on compensation.

B. INCENTIVES OF INSTITUTIONAL INVESTORS

The theory of partial ownership that generates the MHHI assumes that managers weigh each owner's investment returns in proportion to the owner's control weight. However, a reasonable question is whether an institutional investor would actually benefit from encouraging managers to behave this way.

An institutional investor's profit increases with the number of retail investors it attracts, and this number likely increases with an institution's success in picking winners relative to the success of other institutional investors. If institutional investor *A* successfully convinces firm 1 to raise its price, this may benefit investor *A* through its ownership of firm 2, but it also benefits other institutional investors that hold shares of firm 2. It is far from obvious that instructing the manager of firm 1 to raise price will benefit the institution *A* by more than it benefits rival institutional investors. If a rival owns a greater share of firm 2 than institutional *A* holds, then the rival presumably benefits

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soften competition. However, the theory in the compensation paper does not predict a specific relationship between compensation and share-based measures of concentration except in the special case where firms are symmetric (i.e., have the same shares). Importantly, the empirical specification in the compensation paper, which uses the MHHI as an explanatory variable, does not arise from the underlying theory and raises the same types of issues as the use of the MHHI in the airline and banking papers.

more than institution *A* does, and that greater benefit could shift business from institution *A* to its rival.

The airline and the banking papers do not examine the strategic interaction between institutional investors and the implications of that interaction for the types of influence these investors would like to have over the managers of the firms they own. Instead, this research makes the mechanical assumption that ownership confers proportional control, which basically assumes that managers of firms owned by institutions with shares in rival firms have incentives to behave less competitively. Recent empirical evidence[77] suggests that institutional ownership may actually have the opposite effect, i.e., it may cause managers to place greater weight on own-firm performance. Bell and Van Reenen[78] find that as the institutional ownership of a firm increases ("stronger governance"), executive pay tends to be more responsive to the firm's performance, and rewards tend to be lower if a firm performs poorly relative to its industry in periods where the industry as a whole performs well. This evidence is consistent with institutional investors encouraging managers to operate more efficiently, and it tends to undermine the notion that greater institutional ownership leads managers to behave less competitively.

C. FIDUCIARY OBLIGATION

Our understanding is that laws on fiduciary obligation require a corporation's directors and officers to serve as trustees for the stockholders with respect to the interests of the stockholders in the corporation.[79] However, anticompetitive effects from common ownership arise only if the members of corporate management routinely pursue the interest of common owners—e.g., in setting fares on certain airline routes—in violation of their fiduciary obligations to the corporation. The lawyers we have spoken with concede that legal costs may interfere with enforcing fiduciary obligation in this context, but they express skepticism about a theory of anticompetitive effects that requires an explicit assumption that management behaves this way.

The theory of how ownership translates into control is just beginning to develop. In our view, it is an empirical question whether common ownership

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[77] Brian Bell & John Van Reenen, *CEO Pay and the Rise of Relative Performance Contracts: A Question of Governance?* (Nat'l Bureau of Econ. Research, Working Paper No. 22407, 2016); Kwon, *supra* note 74.

[78] Bell & Van Reenen, *supra* note 77.

[79] Lafferty, Schmidt, & Wolfe, *supra* note 14. The fiduciary duty of corporate directors and corporate officers are identical. Gantler v. Stephens, 965 A.2d 695, 708–09, 709 n.36 (Del. 2009). Gilbert v. El Paso Co., Civ. A. Nos. 7075, 7078, 7079, 1988 Del. Ch. LEXIS 150, at *27–28 (Del. Ch. Nov. 21, 1988) ("[T]he directors' fiduciary duty runs to the corporation and to the entire body of shareholders generally, as opposed to specific shareholders or shareholder subgroups."). Thus, both directors and officers are obligated to make decisions in the best interests of the corporation *qua* corporation.

leads to managerial behavior that violates fiduciary obligation and harms competition, and this question requires careful answers before developing policy toward common ownership.

VI. THE ROLE OF THE MHHI

We have raised several concerns about the use of the MHHI to predict the price effects of common ownership. In doing so, we are not suggesting that MHHI cannot be a useful index. This index is a measure of concentration that provides a rough gauge of the potential for anticompetitive effects in a market that involves common ownership. We think the index may be appropriate for safe harbors in such environments, but only when the competition authority has a high degree of confidence in the relevant control scenario(s) for the specific case under study.

One context in which the MHHI may be helpful is in the analysis of transactions involving joint ventures. For example, when a joint venture allocates control to a single entity, the appropriate control assumption for the venture is clear, and an MHHI analysis of the transaction may provide useful information. Even when joint venture participants each have minority positions in the venture, the MHHI may provide a range of concentration measures that are useful for evaluating a transaction involving the venture. For example, the feasible control scenarios for the venture include complete control by any one of the participants and intermediate cases with control weights distributed differently. If each participant competes in the same market as the joint venture and holds a significant share of the venture, and if the market is highly concentrated, then an MHHI analysis may place the transaction outside a safe harbor for all reasonable control scenarios. This would be useful information for the antitrust authority examining the transaction.

Outside the joint venture context, there are also cases where the control assumptions are clear enough for the MHHI to provide useful information. For example, a financial position that involves nonvoting shares and no board rights should probably be considered passive (zero control weight) absent evidence to the contrary. O'Brien and Salop referred to such investments as "silent financial interests,"[80] and the MHHI may provide a useful measure of concentration in such cases.[81]

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[80] O'Brien & Salop, *supra* note 9.

[81] Jon Dubrow questions whether a company that takes a passive financial interest in a competitor would take into account this interest in choosing its own strategy. Even though the company controls its own actions, he argues that incomplete information, the personal financial incentives of managers, and the inability of the acquiring firm to capture the benefits of its investment may prevent such an investment from altering incentives. *See* Jon B. Dubrow, *Challenging the Economic Incentives Analysis of Competitive Effects in Acquisitions of Passive Minority Equity Interests*, 69 ANTITRUST L.J. 113 (2001). For a response to these arguments, see

At the other extreme, governance provisions sometimes give control to a single owner. For example, Mark Zuckerberg appears to control Facebook as a result of his majority share of the company's voting stock, even though his overall share of the company is less than 50 percent. If this is true, his control weight is presumably 1 (i.e., 100 percent) in any competitive analysis of an industry involving Facebook.[82] If Zuckerberg were also a common owner who held shares in a Facebook rival, he might be in a position to develop policies that encourage Facebook's managers to account for the effects of their decisions on the value of his financial holdings in the rival.[83] On the other hand, an institutional investor that owns, say, 5 percent of Facebook would likely have no ability to influence Facebook's managers in this way, as the investor does not control Facebook. The institutional investor's control weight is therefore likely to be zero. If this investor is also a common owner that holds shares in a Facebook rival, there is probably no reason for Facebook management to take this into account. In cases where a single entity has control, the MHHI may also provide a useful measure of concentration.

In intermediate cases, where some owners hold a significant fraction of the voting shares, but no single owner (institutional or otherwise) has a controlling interest in any of the competitors, the appropriate control assumptions are not clear a priori. In many of these cases, the range of "reasonable" control assumptions does not narrow the range of concentration predictions of an MHHI analysis enough to provide helpful guidance. This is the situation for the minority shareholdings at issue in the airline and banking industries and many other industries in which questions about the competitive effects of common ownership are being raised. In this situation, there does not appear to be an accepted theoretical basis to pick among the range of possible control weights.[84] How ownership translates into control in these cases is an open question, and the answer could vary from case to case.

VII. CONCLUSION

In this article, we reach three conclusions about recent empirical research on the competitive effects of common ownership:

Daniel P. O'Brien & Steven C. Salop, *The Competitive Effects of Passive Minority Equity Interests: Reply*, 69 ANTITRUST L.J. 611 (2001).

[82] Facebook's annual report states: "Mr. Zuckerberg has the ability to control the management and major strategic investments of our company as a result of his position as our CEO and his ability to control the election or replacement of our directors." Facebook, Inc., *Annual Report* (Form 10-K), at 17 (Jan. 28, 2016).

[83] Whether fiduciary obligations to other shareholders could constrain such behavior despite Zuckerberg's majority position in Facebook's voting stock is a legal question beyond our expertise.

[84] Economic theory on the topic is just beginning to develop. *See* Azar, *supra* note 21, and references therein.

- The predictions rely on misspecified models and therefore do not imply that common ownership via minority shareholdings raises prices in the airline, banking, or other industries, or that it increases the sensitivity of compensation to industry profits relative to its sensitivity to own-firm profits. Instead, the research identifies correlations that are not unexpected given the model misspecification.
- Therefore, researchers and policy makers are getting ahead of themselves in proposing and implementing policy changes based on this research.
- More research is warranted that (1) employs empirical specifications consistent with the underlying economics of common ownership; and (2) identifies whether or how common ownership translates into control over managers in ways that affect competition.

One of the policy proposals based on this research is to ramp up antitrust enforcement against the shareholdings of institutional investors: "no institutional investor invested in more than a single (effective) firm in an oligopoly may own more than 1 percent of the industry or communicate with its managers."[85] This proposal is not warranted as it is based on research that is not fully vetted, has numerous shortcomings, and has not been confirmed with further study. Research on common ownership has not progressed to the point where it can provide a basis for such a policy.

Even if future research finds a relationship between price and common ownership in some industry, that finding would not support broad constraints on institutional investing. The antitrust laws wisely limit per se rules to cases where economic arguments provide a strong basis for such rules. An example is the per se rule against horizontal price fixing. However, institutional investing benefits millions of retail investors by allowing them to diversify their portfolios at low transaction costs. We have not seen research documenting that these benefits are outweighed by potential harms from common ownership. Indeed, this has not even been possible given the early stages of the research on common ownership.

The debate surrounding common ownership raises significant issues not only for antitrust and regulation, but also for the economic theory of the firm, which provides important bedrocks for much of applied economics. Theories of oligopoly used in antitrust and other areas of economics tend to assume that firms pursue profit-maximizing behavior, consistent with the Fisher separation theorem. This convenient assumption makes sense when markets are competitive or when owners with some control in imperfectly competitive

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[85] Posner et al., *A Proposal to Limit*, *supra* note 2, at 724.

markets all have the same interests, but it has less resonance when owners have divergent interests. How firms behave when this assumption is relaxed is an ongoing area of research that has only recently come to the fore in antitrust. It is too early to say where this research will lead. Firm behavior when owners have divergent interests presumably may depend on corporate law (e.g., fiduciary obligations), corporate governance (e.g., voting and board rights), the competitive dynamic among institutional investors seeking to attract retail investors, the extent to which owners are also consumers of the products the firms produce, and other factors that might affect shareholder influence and its transmission to management. These are complex issues, and we do not believe they are sufficiently resolved at this point to provide sufficient guidance to warrant large changes in antitrust or regulatory policy toward common ownership involving minority shareholdings.

APPENDIX

I. DERIVATION OF MANAGERS' PROFIT OBJECTIVES IN PART II

The profits of an original owner of firm 1, the common owner, and the manager of firm 1 are given in equations (1), (2), and (3), respectively, in the main text. Substituting (1) and (2) into (3) yields

$$\begin{aligned}&\text{Manager of Firm 1's Objective}\\&= W_1 \times [\text{Profit of Common Owner}] + \left(\frac{1-W_1}{I_1}\right) \times [\text{Profit of an Original Owner}] \times I_1\\&= W_1[F_1\Pi_1 + F_2\Pi_2 + F_3\Pi_3] + \left(\frac{1-W_1}{I_1}\right)\left(\frac{1-F_1}{I_1}\right)\Pi_1 I_1\\&= \left[W_1F_1 + \frac{(1-W_1)(1-F_1)}{I_1}\right]\Pi_1 + W_1F_2\Pi_2 + W_1F_3\Pi_3.\end{aligned}$$

Dividing the this expression through by the term in square brackets yields

$$\text{Manager of Firm 1's Objective} \propto \Pi_1 + C_{12}\Pi_2 + C_{13}\Pi_3,$$

where

$$C_{12} = \frac{W_1F_2}{W_1F_1 + \frac{(1-W_1)(1-F_1)}{I_1}}$$

and the expression for C_{13} is similar with subscript '3' replacing subscript '2'. This objective is equation (4a) in the text, and equations (4b) and (4c) are derived in analogous ways. The notation '$\propto$' means "proportional to," which is appropriate because we have divided the manager of firm 1's objective by a constant factor of proportionality equal to the term in square brackets.

II. DOMINANT FIRM EXAMPLE IN PART II

Consider a market with inverse demand $P = a - bQ$, where Q is total quantity and a and b are positive constants. A dominant firm (firm 1) can produce any amount of output q_1 at marginal cost v; a competitive fringe produces a fixed supply Q_f at marginal cost v. The dominant firm's profit is thus

$$\pi_1 = [P - v]q_1 = [a - b(q_1 + Q_f) - v]q_1. \tag{A1}$$

If there are N–1 equally sized fringe firms, fringe firm k's profit is

$$\pi_k = \frac{[P - v]Q_f}{N-1} = \frac{a - b(q_1 + Q_f) - v}{N-1}Q_f. \tag{A2}$$

The controlling owner of firm 1 takes a financial position F in each of the fringe firms that carries no control (a "silent financial interest"). For a silent financial interest, the common-ownership incentive term for the interaction between the dominant firm and each fringe firm's is equal to the financial interest, i.e., $C = F$. The profit objective of the dominant firm's manager is

$$\pi_1 + C(N-1)\pi_k. \tag{A3}$$

In this example, we assume that the fringe firm's output is fixed and that the dominant firm's output is flexible. The first order condition for the dominant firm's manager's optimal quantity is

$$-bq_1 + [a - b(q_1 + Q_f) - v] + C(-b)\, Q_f = 0. \tag{A4}$$

Solving for q_1 yields the dominant firm's optimal quantity

$$q_1^* = \frac{a - bQ_f - v}{2b} - \frac{CQ_f}{2}. \tag{A5}$$

Substituting q_1^* into the expression for price yields the optimal price

$$P^* = \frac{a - b(1-C)Q_f + v}{2}. \tag{A6}$$

Observe that the dominant firm's quantity falls and price rises as the common-ownership incentive term increases.

Let s_1 be the dominant firm's share (which depends on all the parameters in the model). The HHI is

$$HHI = s_1^2 + (N-1)\left(\frac{\frac{Q_f}{N-1}}{q_1^* + Q_f}\right)^2$$

$$= s_1^2 + \frac{\left(\frac{Q_f}{q_1^* + Q_f}\right)^2}{N-1}. \tag{A7}$$

Observe that as the number of fringe firms grows, the HHI approaches s_1^2. Let s_k be the share of fringe firm k. The MHHI delta is

$$\begin{aligned}\text{MHHI delta} &= \sum_{k=2}^{N} Cs_1 s_k \\ &= Cs_1(N-1)\left(\frac{\frac{Q_f}{N-1}}{q_1^* + Q_f}\right) \\ &= Cs_1\left(\frac{Q_f}{q_1^* + Q_f}\right) \\ &= Cs_1(1-s_1). \end{aligned} \tag{A8}$$

When the number of fringe firms is large, the MHHI is approximately

$$\text{MHHI} \approx s_1^2 + Cs_1(1-s_1). \tag{A9}$$

After some algebra, the equilibrium expressions for the HHI, the MHHI delta, and the MHHI when the number of fringe firms is large work out to be

$$\text{HHI} \approx \frac{\left(a - b(C+1)Q_f - v\right)^2}{\left(a - b(C-1)Q_f - v\right)^2} \tag{A10}$$

$$\text{MHHI delta} \approx \frac{2bCQ_f(a - b(C+1)Q_f - v)}{(a - b(\text{C}-1)Q_f - v)^2} \tag{A11}$$

$$\text{MHHI} \approx \frac{\left(a + b(C-1)Q_f - v\right)\left(a - b(C+1)Q_f - v\right)}{\left(a - b(C-1)Q_f - v\right)^2}. \tag{A12}$$

Figure 1 in the text is plotted from these expressions assuming that $a = 100$, $b = 1$, $Q_f = 50$, and $v = 0$.

III. REGRESSION ESTIMATES IN PART III.C.1

Recall from the text:

Airline Price-Concentration Relation (Simplified): $P = \alpha_1 H + \alpha_2 M_D + u$

TPO Relation (Simplified): $P = \alpha C + u$.

Suppose common ownership carries no control. Then $\alpha = 0$ in the TPO relation. That is, the true relationship (abstracting from other factors that affect price) is $P = u$.

Now suppose we estimate the price-concentration relation under the assumption that common ownership carries control when the true relationship is $P = u$. Let $Z = (H, M_D)$ and $\beta = (\alpha_1, \alpha_2)'$. The price concentration relation is then

$$P = Z\beta + u.$$

The ordinary least squares estimate of β is

$$\hat{\beta} = (Z'Z)^{-1}Z'P = (Z'Z)^{-1}Z'u \ \ (\text{using } P = u)$$

Breaking out the individual coefficients yields

$$\begin{aligned}\begin{pmatrix}\hat{\alpha}_1\\ \hat{\alpha}_2\end{pmatrix} &= \begin{pmatrix}H'H & H'M_D\\ M_D'H & M_D'M_D\end{pmatrix}^{-1}\begin{pmatrix}H'u\\ M_D'u\end{pmatrix}\\ &= K\begin{pmatrix}M_D'M_D & -M_D'H\\ -H'M_D & H'H\end{pmatrix}\begin{pmatrix}H'u\\ M_D'u\end{pmatrix}\\ &= \begin{bmatrix}K[Var(M_D)Cov(H,u) - Cov(M_D,H)Cov(M_D,u)]\\ K[-Cov(H,M_D)Cov(H,u) + Var(H)Cov(M_D,u)]\end{bmatrix},\end{aligned}$$

where $K = 1/[Var(H)\ Var(M_D) - Cov(H,M_D)^2] \geq 0$. This is the expression for the estimates of α_1 and α_2 given in the text.

IV. EXAMPLE IN PART III.C.1

The example considers a market for a homogenous product with linear demand, constant marginal cost, and three firms, one of which has flexible quantity (airline 1) and two of which are inflexible (fixed quantities). The inflexible firms are the same size. There are two common owners, one that takes a position F in airlines 1 and 2, and the other of which takes the same position F in airlines 1 and 3. The first claim was that under the assumption of proportional control, the HHI, MHHI delta, and MHHI are each positively correlated with the error term in the price-concentration regression when the flexible firm's share is between 33 percent and 50 percent. In this case, estimating the price-concentration regression (9b) yields a positive estimate for the MHHI effect even though common ownership has no effect on incentives.

To establish this, we show that price, the HHI, and MHHI delta, and MHHI all increase with demand shocks over this range. This example is a special case of the dominant-firm model described earlier in the Appendix. Suppose the inverse-demand intercept a has a random component that competitors observe but that the researcher does not include in the regression relationship. Equations (A5) and (A6) show that increases in the demand intercept raise the flexible firm's equilibrium quantity and the equilibrium price. Because the

other firms' quantities are fixed, the flexible firm's share also increases with the demand intercept.

The HHI in the N firm case is

$$\begin{aligned}\text{HHI} &= s_1^2 + (N-1)\left(\frac{1-s_1}{N-1}\right)^2 \\ &= s_1^2 + \frac{(1-s_1)^2}{N-1}.\end{aligned}$$

The derivative of the HHI with respect to s_1 is

$$\frac{\partial \text{HHI}}{\partial s_1} = \frac{2}{N-1}[Ns_1 - 1].$$

Observe that the HHI increases with s_1 if $s_1 > 1/N$, which in the three-firm case means $s_1 > 0.33$.

The MHHI delta in the N-firm case where $N-1$ common owners each hold the same financial positions in firm 1 and in a firm $k \neq 1$ is

$$\begin{aligned}\text{MHHI delta} &= 2Cs_1\frac{(N-1)(1-s_1)}{N-1} \\ &= 2Cs_1(1-s_1).\end{aligned}$$

The derivative of the MHHI delta with respect to s_1 is

$$\frac{\partial \text{MHHI delta}}{\partial s_1} = 2C(1-2s_1).$$

Observe that the MHHI delta increases with s_1 when $s_1 < 0.5$. We have confirmed that price, the HHI, the MHHI delta, and the MHHI all increase with demand shocks and are thus positively correlated in our three-firm example when the flexible firm's share is between 0.33 and 0.5.

The next claim was that if firm 1's share is close to 0.33, then the covariances between H and M_D and between H and u are small, in which case the estimate of α_2 will be positive. To see this, write the estimate of α_2 as

$$\hat{\alpha}_2 = \frac{-Cov(H, M_D)Cov(H, u) + Var(H)Cov(M_D, u)}{Var(H)Var(M_D) - Cov(H, M_D)^2}. \qquad (A13)$$

Observe that $\frac{\partial H}{\partial s_1} = 0$ at $s_1 = 0.33$, which means that a change in firm 1's share has a small effect on H in a neighborhood of $s_1 = 0.33$. By contrast,

$\frac{\partial M_D}{\partial s_1} > 0$ at $s_1 = 0.33$. It follows that for changes in demand in which s_1 stays sufficiently close to 0.33, the covariances involving H will be small. As these covariances become small, the estimate of α_2 approaches

$$\hat{\alpha}_2 \approx \frac{Var(H)Cov(M_D, u)}{Var(H)Var(M_D)} \approx \frac{Cov(M_D, u)}{Var(M_D)} > 0.$$

The third claim was that a Monte Carlo analysis of this example yields positive and statistically significant coefficients in the regression equation (9a) even when there is no effect from common ownership. Using the dominant firm model described above, we assumed that the demand intercept a is normally distributed such that 95 percent of firm 1's equilibrium market shares lie between 0.33 and 0.5. We took 1,000 draws from this distribution and derived the equilibrium values of firm 1's quantity, price, market share, the HHI, the MHHI delta, and the MHHI under the assumption that the common-ownership incentive term for the MHHI calculation is 0.1. None of the variation in the HHI or the MHHI delta is due to variation in common ownership; it is all the result of changes in market shares. We used ordinary least squares to obtain regression estimates for α_1 and α_2. We repeated this experiment 1,000 times. In all 1,000 regressions, the coefficients on the HHI and MHHI delta were positive and significant.

We then increased the variance of the distribution so that firm 1's equilibrium share varied more widely. Across samples, firm 1's mean share was 0.42 and the standard deviation of its share was 0.12. Again, in all 1,000 samples, the regression coefficients were positive and significant.

V. REGRESSION ESTIMATES IN PART IV.C.2

The airline paper's panel-IV estimates use the Blackrock/Barclays merger as an instrument for the MHHI delta. However, the HHI is still treated as exogenous and part of the instrument set. To describe the issues that this treatment raises, we explain the implications of two-stage least squares applied to equation (9) but using an instrument W (e.g., a dummy for the Blackrock/Barclays merger) for the MHHI delta. The first stage regresses M_D on W and H to get

$$\widehat{M}_D = \hat{\delta}_1 W + \hat{\delta}_2 H,$$

where $\hat{\delta}_1$ and $\hat{\delta}_2$ are the regression estimates. The second stage uses $\widehat{M}_D$ in place of M_D in the price-concentration regression. Substituting $\widehat{M}_D$ for M_D in the expression for the estimates of α_1 and α_2 gives

$$\begin{pmatrix}\hat{\alpha}_1\\ \hat{\alpha}_2\end{pmatrix} = \begin{bmatrix}K[Var(\widehat{M}_D)Cov(H,u) - Cov(\widehat{M}_D,H)Cov(\widehat{M}_D,u)]\\ K[-Cov(H,\widehat{M}_D)Cov(H,u) + Var(H)Cov(\widehat{M}_D,u)]\end{bmatrix}.$$

Because H is likely endogenous and correlated with u, and $\widehat{M}_D$ explicitly depends on H and is therefore likely correlated with both H and u, the estimates $\hat{\alpha}_1$ and $\hat{\alpha}_2$ are likely to differ from zero even if common ownership carries no control.