Revisiting the Anticompetitive Effects of Common Ownership*

José Azar
University of Navarra, IESE & CEPR

Xavier Vives
IESE Business School & CEPR

May 25, 2022

Abstract

We use data from the U.S. airline industry to test the hypothesis, consistent with the general equilibrium oligopoly model of Azar and Vives (2021), that inter-industry common ownership should be associated with lower prices in product markets. We find that, as the model predicts, increases over time in intra-industry common ownership are associated with higher prices, while increases in inter-industry common ownership are associated with lower prices. We also find that common ownership by the "Big Three" (BlackRock, Vanguard and State Street) is associated with lower airline prices, while common ownership by shareholders other than the Big Three is associated with higher prices. The results highlight the limitations of partial equilibrium oligopoly theory in the context of common ownership, and the need to consider a general equilibrium perspective.

Keywords: Common Ownership, Antitrust, Competition Policy, General Equilibrium

*Azar: jazar@iese.edu; Av Pearson, 21, 08034 Barcelona, Spain; Vives: xvives@iese.edu; Av Pearson, 21, 08034 Barcelona, Spain. For helpful comments we thank seminar participants at the FTC, HKUST, the National University of Singapore, the Toulouse School of Economics, Universitat Pompeu Fabra, University of Amsterdam, and Universidad Autónoma de Madrid. We gratefully acknowledge financial support for Azar by Secretaria d'Universitats I Recerca, Generalitat de Catalunya (Ref. 2016 BP00358), and for Vives by the European Research Council (Advanced Grant no. 789013).

1 Introduction

As is by now well known, common ownership of publicly traded companies has increased rapidly in recent years. A debate has emerged over whether this can affect competition, with especial focus on product prices. The theory is allegedly simple enough: if companies in the same industry have the same owners, and they act in the interest of their shareholders, they will compete less aggressively in product markets (Rotemberg, 1984; O'Brien and Salop, 2000).

However, this theory misses an important point, which is that the recent rise of common ownership is not an industry-wide phenomenon, but an economy-wide one, driven to a large extent by index funds who are close to "universal owners" and hold every publicly traded firm in the economy. In fact, recent theoretical work by Azar and Vives (2021) shows that, in a general equilibrium oligopoly model, common ownership covering the whole economy implies lower markups for consumers, not higher. The reason is that, in general equilibrium, when an industry expands, it creates positive externalities for firms in other industries, and therefore inter-industry common ownership increases the incentive for firms to expand, reducing prices in their industry relative to the price level. It turns out that this effect, in a standard model, is stronger than the intra-industry effect that common ownership of firms in the same industry generates. Thus, the total effect is to reduce product-market markups.

The empirical literature, however, has so far mainly focused on measuring intra-industry common ownership and its effects.[1] Therefore, inter-industry common ownership is a crucial missing variable in the analysis. In this paper, we address this problem by measuring both intra-industry and inter-industry common ownership, and reassess the evidence on its competitive effects in the airline industry. Although the theory is not specific to the airline industry, we use it as an empirical example because it allows us to directly compare the results with those of Azar, Schmalz, and Tecu (2018), and thus see which of the results in that paper change when taking into account general equilibrium effects.

Our main finding is that, while it is still the case that intra-industry common ownership is positively associated with airline prices, inter-industry common ownership is *negatively* associated with airline prices. The overall predicted effect of common ownership on prices is positive in some routes and

[1] For example, Azar, Schmalz, and Tecu (2018); Newham, Seldeslachts, and Banal-Estanol (2018); Gutiérrez and Philippon (2017); Boller and Scott Morton (2020). An exception is Freeman (2019), which studies the effect of common ownership on the longevity of customer-supplier relations between firms and finds a positive effect of common ownership on the longevity of relations.

negative in others. The average effect is positive, but only because some shareholders are concentrated in airlines, and therefore this failure of complete diversification implies that intra-industry common ownership is still somewhat higher than inter-industry in practice. Although measures of common ownership are positively correlated, a Lasso variable selection model, with the penalty parameter chosen using 10-fold cross validation to minimize out-of-sample prediction errors, suggests that both variables should be included in the model.

Furthermore, we conducted a panel vector autoregression analysis, and found that both intra-industry and inter-industry common ownership Granger-cause prices, in the sense that past values of the lambdas have significant predictive power for future prices, while past values of prices do not significantly predict future changes in common ownership.

In addition, we separate intra-industry common ownership into two measures, one measuring intra-industry common ownership by the "Big Three" asset managers (BlackRock, Vanguard and State Street), and one measuring intra-industry common ownership by other shareholders that are not the Big Three. We find that, while intra-industry common ownership by shareholders other than the Big Three is positively associated on airline prices, common ownership by the Big Three is negatively associated with airline prices (although the negative effect on prices is not statistically significant in all specifications). When controlling for inter-industry common ownership, the effect of intra-industry common ownership by the Big Three becomes positive. However, we show that the overall effect of the Big Three on prices is negative.

One of the main methodological criticisms of Azar, Schmalz, and Tecu (2018) is that its measure of the impact of common ownership, the MHHI delta, depends on the market shares of the firms in the market, which are endogenously determined.[2] However, our economic model suggests that a share-weighted average of a firm's lambdas is a better measure of that carrier's common ownership. To address the endogeneity of market shares, we use unweighted averages of the objective function weights. Using pairwise objective function weights to measure of common ownership was proposed by (Azar, 2012, ch. 7).

In particular, we measure intra-industry common ownership as a weighted average of the weight that an airline carrier puts on other carriers, which we denote λ^{intra} following Azar and Vives (2021).

[2]The MHHI is an augmented version of the HHI taking into account overlapping ownership between the firms in an industry (O'Brien and Salop, 2000). The MHHI delta is the difference between the MHHI and the HHI.

We measure inter-industry common ownership as the average of the weights that the carrier places on firms outside the airline industry, which we denote λ^{inter}, also following Azar and Vives (2021). For inter-industry common ownership, we give weight to firms in proportion to their revenues, since these sales are exogenous to the airline routes that we are considering. To avoid concerns related to the endogeneity of market shares, we instrument these weighted averages of lambdas with the analogous unweighted averages.

Calculating the weight that the manager of a firm puts on its rivals in her objective function requires a theory of corporate control, that is, how the manager weighs the heterogeneous interests of its shareholders. Most of the empirical literature has assumed that control is proportional to voting shares. However, this assumption has some unappealing properties. For example, a shareholder with 51% of the shares does not have full control of the firm. For this reason, we instead assume that a shareholder's weight in the objective function of a firm is proportional to her Banzhaf voting power index, which measures the number of coalitions in which the shareholder would be pivotal in a corporate election. The Banzhaf index has better properties than proportional control, including the fact that a shareholder with 51% of the shares has complete control of the firm. As shown by Azar (2017) and Brito, Osório, Ribeiro, and Vasconcelos (2018), the Banzhaf control assumption can be microfounded as the outcome of a shareholder voting model in which managerial candidates maximize the probability of winning the election. We show, however, that our main empirical results hold whether we assume Banzhaf or proportional control.

In addition to the panel regression analysis, we conducted an event study based on mergers of financial institutions, following He and Huang (2017) and Lewellen and Lowry (2021). These mergers generated variation in intra-industry and inter-industry common ownership across airlines. Estimating the effect of lambdas on prices based on variation from these acquisitions only, we confirmed our main result that increases in intra-industry common ownership lead to increases in prices, while increases in inter-industry common ownership lead to lower prices. Bindal and Nordlund (2022) use a similar methodology and find that the positive effect of intra-industry common ownership on margins is more pronounced for firms with more similar products.

There is a debate over which is a plausible mechanism that connects overlapping ownership with firms' decisions.[3] We are agnostic on this question. However, it is worth pointing out that inter-industry common ownership is in the radar of large asset managers when they are considering their corporate governance strategy. For example, recently Barbara Novick wrote an article for the Harvard Law School Forum on Corporate Governance (Novick, 2019) addressing the issue (emphasis in original):

> The 'common ownership' theory relies on the assumption that all 'common owners' benefit from lessened competition, as it is derived from theories of oligopolies and 'cross ownership' (e.g., where a company buys a stake in its competitor). While lessened competition might benefit certain concentrated investors, broadly diversified investors, like index funds, own the whole market and do not benefit from lessened competition. This is because broadly diversified investors are subject to *inter*–industry effects—meaning that what happens in one sector affects the performance of the fund's holdings in other sectors.

We should also emphasize that our measures of common ownership in this paper are at the firm-level, as opposed to the firm-route level (except in robustness checks), because we believe that any mechanism is more likely to act at broadly, by changing firm level strategy, rather than at the route level. This does not mean that there cannot be route-level mechanisms, but rather that a firm-level analysis seems more plausible as a starting point.

Our results are potentially important for the recent debate on the antitrust implications of common ownership. The literature starts with the observation that common ownership is ubiquitous, and, based on partial equilibrium reasoning, it concludes that this should lead to anticompetitive effects in product markets, and therefore it might require antitrust action (Elhauge, 2016; Posner, Scott Morton, and Weyl, 2017). On the other hand, Rock and Rubinfeld (2017), among others, have argued against using antitrust laws to prevent common ownership by diversified institutional investors. Our general equilibrium analysis shows that anticompetitive effects in product markets are driven by intra-industry common ownership while inter-industry common ownership is procompetitive. The result is that, because of inter-industry effects that were ignored in earlier empirical work, common ownership by diversified shareholders like the Big Three is actually predictive of *lower* product market prices.[4]

[3]See, for example, Hemphill and Kahan (2019), Elhauge (2021), and Tzanaki (2022).

[4]While we focus on the airline industry, a contemporaneous paper (using more aggregated price data) has found similar effects for a large sample of industries (Banal-Estañol, Seldeslachts, and Vives, 2022), which suggests that our findings have external validity.

The rest of the paper is organized as follows. Section 2 describes the economic model motivating our measures of intra and inter-industry common ownership. Section 3 provides a microfoundation for the objective of the firm used in Section 2. Section 4 describes the data used for the empirical analysis. Section 5 presents the results of the main empirical analysis. Section 6 presents the results from using the Lasso variables selection technique to determine whether both intra-industry and inter-industry common ownership should be included in the analysis. Section 7 describes various robustness checks. Section 8 shows results separating the effect of the Big Three from other shareholders. Section 9 presents an event study based on mergers of financial institutions. Section 10 concludes. Several appendices provide definitions, proofs and supplementary material.

2 Theoretical Framework

Consider an economy consisting of N industries, each producing a different product, and with J_n firms in industry n.[5] There is a continuum of worker-consumers of mass N (we denote the set of worker-consumers I_W). The utility of worker i depends on her consumption of an aggregate consumption good C_i and on her labor supply L_i as following:

$$U(C_i, L_i) = C_i - \chi L_i, \tag{2.1}$$

where $\chi > 0$ and

$$C_i = \left[\left(\frac{1}{N} \right)^{1/\theta} \sum_{n=1}^{N} c_{ni}^{(\theta-1)/\theta} \right]^{\theta/(\theta-1)},$$

with c_{ni} being worker i's consumption of the good produced by the firms in sector n, and $\theta > 1$ indicates preference for variety.

Firm j in sector n produces the good c_n using labor as a factor of production according to the production function $F_{nj}(\cdot)$, which is increasing and has non-increasing returns to scale. The profit function of firm j in sector n is $\pi_{nj}(L_{nj}) = p_n F_{nj}(L_{nj}) - wL_{nj}$, where p_n is the price of the good produced by sector n, and w is the wage.

The firm is owned by a set of owner consumers I_O, who receive the profits and use them to consume the products of the firms obtaining utility C_i.

[5] The model is a simplified but asymmetric version of the multisector model in Azar and Vives (2021).

We assume that the objective function of firm j in sector n is to maximize the real value of its profits, plus the real value of the profits of other firms, multiplied by λ weights that capture the fact that the firm may have common ownership with the other firms in the same sector n and in other sectors $m \neq n$:

$$\frac{\pi_{nj}}{P} + \sum_{k \neq j} \lambda_{nj,nk} \frac{\pi_{nk}}{P} + \sum_{m \neq n} \sum_{k=1}^{J_m} \lambda_{nj,mk} \frac{\pi_{mk}}{P}, \tag{2.2}$$

where $\lambda_{nj,mk}$ is the weight that firm j in sector n puts on the profits of firm k in sector m due to common ownership, and $P \equiv \left(\frac{1}{N} \sum_{n=1}^{N} p_n^{1-\theta}\right)^{1/(1-\theta)}$ is the price index corresponding to C_i. In Section 3 we provide a microfoundation for this objective function.

To focus on product market effects, we have assumed that the labor market is competitive with infinite elasticity of labor supply at $\omega = \chi$.

We use the Cournot-Walras equilibrium with shareholder representation introduced in Azar and Vives (2021). It consists of two steps. The first step is the competitive equilibrium conditional on the production plans of the firms. In this case, the production plan of firm nj is summarized by its level of employment L_{nj}. This step yields the relative prices in the competitive equilibrium given the vector of employment plans $\mathbf{L}$ of the firms, denoted $\rho_n(\mathbf{L})$:

$$\rho_n(\mathbf{L}) \equiv \frac{p_n}{P} = \left(\frac{1}{N}\right)^{1/\theta} \left\{ \frac{\sum_{j=1}^{J} F_{nj}(L_{nj})}{\left[\sum_{m=1}^{N} \left(\frac{1}{N}\right)^{1/\theta} \left(\sum_{j=1}^{J} F_{mj}(L_{mj})\right)^{(\theta-1)/\theta}\right]^{\theta/(\theta-1)}} \right\}^{-1/\theta}. \tag{2.3}$$

An increase in the labor demand by firm j in sector n has two effects on relative prices: (i) it decreases the relative price of sector n's consumption good, ρ_n, and (ii) it increases the relative price of the consumption goods produced by sectors other than sector n.

The second step of the Cournot-Walras equilibrium with shareholder representation defines the Nash equilibrium of the game that the firms play, by choosing their employment levels given the competitive relative price function, and the employment levels of the other firms.

Definition 1 (Cournot–Walras equilibrium with shareholder representation)**.** *A Cournot–Walras equilibrium with shareholder representation is an allocation (the consumption and labor of the worker-consumers, and the consumption of the owners), and a set of production plans* $\mathbf{L}^*$ *such that:*

(i) *The relative prices* $\{\rho_n(\mathbf{L}^*)\}_{n=1}^N$ *and the allocation are a competitive equilibrium relative to* $\mathbf{L}^*$*; (i.e., the allocation solves the optimization problem of the worker-consumers and the owner-consumers given the relative prices, labor supply equals labor demand by the firms, and total consumption equals total production in each sector), and*

(ii) *the production plan vector* $\mathbf{L}^*$ *is a pure-strategy Nash equilibrium of a game in which players are the firms, and firm nj's objective function is*

$$\frac{\pi_{nj}}{P} + \sum_{k \neq j} \lambda_{nj,nk} \frac{\pi_{nk}}{P} + \sum_{m \neq n} \sum_{k=1}^{J_m} \lambda_{nj,mk} \frac{\pi_{mk}}{P}.$$

As we already mentioned, the problem of the firm only depends on relative prices.[6] The first-order condition for firm j in sector n is

$$\underbrace{\rho_n(\mathbf{L}) F'_{nj}(L_{nj})}_{\text{VMPL}} - \underbrace{\omega}_{\text{real wage}} = \underbrace{- \underset{(-)}{\frac{\partial \rho_n}{\partial L_{nj}}} \left[F_{nj}(L_{nj}) + \sum_{k \neq j} \lambda_{nj,nk} F_{nk}(L_{nk}) \right]}_{\text{(i) own-industry relative price effect}} - \underbrace{\sum_{m \neq n} \underset{(+)}{\frac{\partial \rho_m}{\partial L_{nj}}} \left[\sum_{k=1}^{J_m} \lambda_{nj,mk} F_{mk}(L_{mk}) \right]}_{\text{(ii) other industries' relative price effect}}.$$

An increase in the lambdas with a firm in the same sector increase the extent to which a firm internalizes the effect of its employment decisions on its own industry's relative price. This effect creates incentives to reduce employment, since the cost in terms of reducing its relative price is made higher.

An increase in the lambdas with respect to firms in other sectors increases the extent to which a firm internalizes the effect of its employment decisions on other industries' relative prices. This effect creates an incentive to increase employment and output by the firm, since it increases the benefits for shareholders of increasing the relative prices of their firms in other sectors.

The first effect is the one that leads to anticompetitive effects of common ownership, and the second effect is the one that leads to procompetitive effects of common ownership.

We can obtain the following expression for the price-cost markup:

[6] This is in contrast to the original Cournot-Walras equilibrium definition of Gabszewicz and Vial (1972), in which firms maximized nominal profits instead of a weighted average of shareholder utilities. In the earlier general equilibrium oligopoly models, this created a major conceptual problem because the equilibrium depended on the choice of price normalization. This is not the case when using the Cournot-Walras with shareholder representation of Azar and Vives (2021).

Proposition 1. *In equilibrium, the markup for firm j in sector n is characterized by*

$$\mu_{nj} \equiv \frac{\rho_n - \omega/F'_{nj}}{\rho_n} = \frac{1}{\theta}(1-s_n)\left(s_{nj} + (1-s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter}\right), \tag{2.4}$$

where $s_{nj} = F_{nj}/c_n$ is the market share of firm nj in its product market, and $s_n = \frac{p_n c_n}{PC}$ is the sector n's revenue share in the economy as a whole, where $\overline{\lambda}_{nj}^{intra}$ is the weighted average of the lambdas of firm nj with respect to other firms in its industry, weighted by their product market shares, and $\overline{\lambda}_{nj}^{inter}$ is the weighted average of the lambdas of firm nj with respect to firms in other industries, where the weights are given by their revenue shares.

Remark: The objective function of firm nj is concave in own action given the strategies of other firms provided that $\overline{\lambda}_{nj}^{intra} \leq 1$. Note that the weighted averages of the lambdas depend only on the rival employment levels, and not on L_{nj}.

Our statistics of interest are the derivatives of the log relative price of sector n (in our application, airlines), with respect to the inter-industry objective function λ weights. As pointed out by O'Brien and Waehrer (2017) these derivatives are well defined, because the lambdas are exogenous parameters of the model. This is in contrast to the the derivatives of log price with respect to the HHI or the MHHI delta, which are not well defined because the latter depend on market shares, and therefore are conceptually problematic.

Remark: Note that in the symmetric case, since the equilibrium market shares are constant, the equilibrium markup of any given firm increases with λ_{intra} and decreases with λ_{inter}. An equal increase in both λ_{intra} and λ_{inter} reduces the equilibrium markup.

For the asymmetric case, we do not have closed form solutions for the derivative of the equilibrium markup or price with respect to the lambdas. However, we have explored the signs of the derivatives numerically and find that, under reasonable parameter values, the price of sector n is increasing in the intra-industry pairwise lambdas, and decreasing in the inter-industry pairwise lambdas.

Numerical Result. *In the asymmetric case, we have explored the signs of the derivatives with respect to lambdas numerically. In particular, we conducted 100 numerical simulations of the model in Julia using $N = 100$, $J = 5$, and values for the other parameters following the calibration in Azar and Vives (2019) $\alpha = 2/3$, $\theta = 3$, $A_{nj} = .4976$ for all firms, $\chi = .3827$, and lambdas drawn independently for each firm pair from a uniform distribution between zero and one.*

For each simulated economy, we calculated the equilibrium derivative of the price in sector 1 with respect to the lambda of firm 1 in sector 1 with respect to (i) firm 2 in sector 1, and (ii) firm 1 in sector 2. In all of our simulations the derivatives with respect to intra-industry lambdas are positive, and the derivatives with respect to inter-industry lambdas are negative.

The expression in Proposition 1 suggests measuring intra-industry common ownership as the weighted average of the lambdas that firm nj puts on the profits of other firms in the same industry, where the weights are the market shares of the other firms. Similarly, it suggests measuring inter-industry common ownership as the weighted average of the lambdas that firm nj puts on the profits of firms outside its industry, where the weights are proportional to the other firms' revenue shares. In the empirical implementation, we first calculate the lambdas that a firm puts on other firms in the same industry (in our case airlines), and on firms outside the industry, and then take weighted averages with weights proportional passenger shares for the intra-industry measure, and shares of sales as weights for the inter-industry measures.

However, weighted averages depend on market shares, and therefore would be endogenous in a regression with prices on the right-hand side. To address this concern, we also calculate *simple* averages of the pairwise intra- and inter-industry lambdas that are not weighted by market shares, which we use as instruments for the weighted measures. Throughout our empirical analysis, we treat ownership as exogenous, which is an assumption commonly used in structural estimation (see, for example, Backus, Conlon, and Sinkinson, 2021a; Ruiz-Pérez, 2019). Thus, our exclusion restriction is no more stringent than that used in the structural literature.[7]

3 Microfoundation for the Objective of the Firm

Assume that the owner-consumers own shares in mutual funds offered by asset managers, who hold shares in the firms on behalf of their clients. There are G asset managers, and asset manager g holds β_{gnj} in firm j in sector n. Asset managers charge a small fee (infinitesimal relative to the size of the firms), which is a percentage of their assets under management. The owner-consumers derive utility from the *real* value of the profits that they receive from the firms, and the asset managers derive utility from the

[7] Since we do not assume that all product characteristics are exogenous, it is arguably less stringent.

real value of their fees. The utility of asset manager g is therefore proportional to

$$U_g = \sum_{n=1}^{N} \sum_{j=1}^{J_n} \beta_{gnj} \frac{\pi_{nj}}{P}, \tag{3.1}$$

where P is the price index.

We assume that asset managers control the firms in proportion to their Banzhaf voting power index γ_{gnj}, and therefore we assume that firm j in industry n chooses its level of employment L_{nj} to maximize a weighted average of the utilities of its asset manager shareholders, where the weights are proportional to their Banzhaf control shares. The Banzhaf index for shareholder g at firm nj is defined as the fraction of coalitions for which shareholder g is pivotal. As we explain below, the Banzhaf index has attractive properties compared to the assumption of proportional control. For example, while proportional control implies that a shareholder with 51% of the votes has 51% of control, the Banzhaf index implies that it has full control of the firm, consistent with the intuition that the shareholder determines the outcome of every election.

The Banzhaf control assumption can be microfounded as the outcome of a probabilistic voting model in which two potential managers compete for shareholder votes in order to gain corporate office, and maximize the probability of winning the election (Azar, 2017). The intuition for the Banzhaf voting power index as a control share is the following. Suppose there are two potential managerial candidates competing for shareholders' votes by proposing a strategy plan for the firm. The objective of each of the managerial candidates is to win the election and run the firm. Consider the decision problem of a managerial candidate proposed strategy for the firm. She has to take into account that a change in her proposed strategy for the firm may be better for some shareholders and worse for others. Thus, for some shareholders, the probability that they vote in her favor will increase, and for other shareholders the probability that they vote in her favor will decrease. What will be the overall effect of a change in her strategy on her probability winning the election? The managerial candidate has to weigh the changes in the probabilities that the different shareholders vote in favor. In particular, she will give more weight to shareholders whose vote matters more, i.e., who are more likely to be pivotal. The Banzhaf index measures how likely a shareholder is to be pivotal relative to other shareholders, and therefore it is the weight that the managerial candidate uses to assess which shareholders' interests to prioritize.

With Banzhaf control shares, the objective function of firm j in industry n is thus

$$\sum_{g=1}^{G} \gamma_{gnj} \left(\sum_{m=1}^{N} \sum_{k=1}^{J_m} \beta_{gmk} \frac{\pi_{mk}}{P} \right), \tag{3.2}$$

which is equivalent to maximizing

$$\frac{\pi_{nj}}{P} + \sum_{k \neq j} \lambda_{nj,nk} \frac{\pi_{nk}}{P} + \sum_{m \neq n} \sum_{k=1}^{J_m} \lambda_{nj,mk} \frac{\pi_{mk}}{P}, \tag{3.3}$$

where

$$\lambda_{nj,mk} = \frac{\sum_{g=1}^{G} \gamma_{gnj} \beta_{gmk}}{\sum_{g=1}^{G} \gamma_{gnj} \beta_{gnj}}. \tag{3.4}$$

The empirical literature on common ownership has used mostly the assumption of control proportional to shares, which was suggested by O'Brien and Salop (2000). Proportional control can be microfounded by a probabilistic voting model under the assumption that the managerial candidates maximize their expected vote share Azar (2012, ch. 2).[8] Proportional control has been assumed, for example, by the empirical work of Azar, Schmalz, and Tecu (2018) and Banal-Estañol, Seldeslachts, and Vives (2020).[9] In a robustness check, we show that all of our regression results are robust to assuming proportional control instead of Banzhaf control.

Although it is widely used, the proportional control assumption has the unappealing implication that a shareholder with 51% of the shares would not have full control of a firm. On the other hand, the Banzhaf index tends to assign more than proportional weight to large shareholders, since they are more likely to be pivotal than smaller shareholders. As a shareholders shares approach 50%, the probability of being pivotal approaches 100%, and thus the shareholder gets close to complete control of the firm. This is an important benefit of the Banzhaf index instead of proportional control.

Another attractive property of the Banzhaf control shares relative to proportional control is that a shareholder's control share in a firm depends not only on its own share of the votes, but on the vote shares of all the other shareholders. Consider, for example, a shareholder with 5% of the voting shares of a given firm. How much control of the firm does this shareholder have? Under proportional control,

[8] Equilibrium control shares can also differ from proportional control if the distribution of the random utility components is heterogeneous across a firm's shareholders.

[9] Azar, Schmalz, and Tecu (2018) used the Banzhaf index, but only as a robustness check, while using proportional control as the baseline assumption.

the shareholder always has 5% of control. However, with Banzhaf control, the shareholder would have more than 5% of control if the other shareholders are very dispersed, but would have zero control if there is another shareholder with 51% of the votes. Thus, the voting model gives us a theory of corporate control that captures not only the intuition that a 51% stake should be associated with 100% of control, but also the intuition that control is relative, and the amount of control that a given stake provides necessarily depends on the stakes of the other shareholders.

To illustrate this, Table 1 shows the Banzhaf index (and, for comparison, the percentage of voting shares held) for the top 10 shareholders of the largest six airlines in 2014Q4. For example, the largest voting shareholder of Delta Air Lines was BlackRock, with 4.13% of the votes according to our ownership data. However, because other shareholders were relatively dispersed, the control share of Delta implied by BlackRock's ownership stake was 7.72%. The top 10 shareholders of Delta held only 22.22% of its voting shares, but, due to the dispersion of the smaller shareholders, they were pivotal in 40.85% of the cases, and therefore according to the Banzhaf index their control share was 40.85%.

It is instructive to consider also an example with a somewhat more concentrated shareholder. The largest shareholder of JetBlue was Lufthansa, with 15.74% of the votes. This large stake (relative to the other shareholders) implied that Lufthansa share of pivotal votes (i.e., its Banzhaf index) was 26.57%. Thus, a 15.74% voting share implied that Lufthansa's control share was substantially larger than 15.74%. The second largest shareholder was Dimensional Fund Advisors, with 8.32% of the votes. This implied a Banzhaf index of 10.03%, which although still greater than its voting share, but the difference was not as dramatic as for the largest shareholder. For all 10 of the largest shareholders, the control share was larger than their share of the votes. The total share of the votes of the largest 10 shareholders was 52.23%, while their total share of control as measured by the Banzhaf index was much larger, at 70.66%. Thus, the Banzhaf index analysis suggests that top 10 shareholders of JetBlue had almost complete control of the company, even if their share of votes was well below 100%.

4 Data

We test the general equilibrium implications of common ownership using data from the airline industry as an example. While the implications of the model are not particular to the airline industry, this allows us to contrast our findings with those in Azar, Schmalz, and Tecu (2018), and see what of that

Table 1. Percent of Voting Shares and Banzhaf Voting Power Index of Top 10 Shareholders of the Largest 6 Airlines.

Data on ownership and voting shares is from 2014Q4 and come from 13f filings and proxy statements. The Banzhaf voting power index is proportional to the number of times a shareholder is pivotal in an election where other shareholders vote in favor with probability 1/2.

Delta Air Lines	*[%]*	*Banzhaf*	*Southwest*	*[%]*	*Banzhaf*
BlackRock	4.13%	7.72%	BlackRock	4.48%	12.14%
State Street Global Advisors	3.85%	7.09%	State Street Global Advisors	3.88%	10.25%
Capital Group	3.70%	7.00%	Egerton Capital (UK) LLP	2.18%	5.46%
Lansdowne Partners Limited	2.68%	4.92%	PRIMECAP	1.77%	4.45%
AXA Financial Inc	2.04%	3.77%	Dimensional Fund Advisors	1.21%	2.99%
PAR Capital Mgt.	1.37%	2.33%	Acadian Asset Management, LLC	1.08%	2.75%
Winslow Capital Mgt.	1.17%	2.12%	College Retire Equities	0.93%	2.30%
Robeco Investment Mgt.	1.13%	1.94%	T. Rowe Price	0.82%	2.09%
Neuberger Berman, LLC	1.09%	1.98%	PAR Capital Mgt.	0.79%	2.06%
Viking Global Investors	1.05%	1.99%	Geode Capital Mgt., LLC	0.79%	1.91%
Total	*22.22%*	*40.85%*	*Total*	*17.94%*	*46.41%*

American Airlines	*[%]*	*Banzhaf*	*United Continental Holdings*	*[%]*	*Banzhaf*
Capital Group	5.35%	15.43%	Capital Group	11.28%	33.24%
T. Rowe Price	4.13%	9.93%	BlackRock	4.99%	5.28%
BlackRock	2.80%	7.13%	T. Rowe Price	2.16%	3.28%
JGD Management Corp.	1.70%	4.03%	Evercore Trust Company	1.75%	2.74%
State Street Global Advisors	1.18%	2.74%	PRIMECAP	1.69%	2.70%
Highland Capital Mgt.	1.03%	2.44%	Jennison Associates	1.61%	2.58%
Neuberger Berman, LLC	0.74%	1.63%	Appaloosa Mgt.	1.33%	1.99%
PRIMECAP	0.73%	1.64%	Neuberger Berman, LLC	1.31%	1.97%
Knighthead Capital Mgt.	0.72%	1.74%	Altimeter Capital Mgt.	1.30%	2.05%
Pioneer Investment Mgt.	0.69%	1.68%	State Street Global Advisors	1.29%	1.89%
Total	*19.07%*	*48.40%*	*Total*	*28.71%*	*57.70%*

Alaska Air	*[%]*	*Banzhaf*	*JetBlue Airways*	*[%]*	*Banzhaf*
BlackRock	6.74%	11.74%	Deutsche Lufthansa	15.74%	26.57%
Renaissance Techn.	5.94%	9.85%	Dimensional Fund Advisors	8.32%	10.03%
PAR Capital Mgt.	3.58%	5.97%	BlackRock	8.08%	9.90%
Acadian Asset Management, LLC	3.46%	5.58%	Acadian Asset Management, LLC	3.79%	4.54%
State Street Global Advisors	2.72%	4.43%	PRIMECAP	3.50%	4.40%
Franklin Resources	2.45%	3.91%	Donald Smith & Co.	3.29%	3.99%
AJO, LP	1.61%	2.59%	State Street Global Advisors	3.26%	3.99%
Dimensional Fund Advisors	1.38%	2.19%	Eagle Asset Management	3.04%	3.64%
James Investment Research	1.36%	2.21%	Fidelity	1.64%	1.86%
American Century	1.31%	2.10%	Wellington	1.56%	1.75%
Total	*30.55%*	*50.57%*	*Total*	*52.23%*	*70.66%*

paper's results change when one takes general equilibrium effects into account.

As in Azar, Schmalz, and Tecu (2018), we use data on airline prices and passenger shares from the Bureau of Transportation Statistics DB1B database for the period 2001Q1-2014Q4. We use data on airline ownership and ownership of the S&P 500 companies from the Thomson 13F dataset, plus data collected by Azar, Schmalz, and Tecu (2018) from proxy statements on non-institutional ownership for the airlines.[10]

We define a market as an airport pair in a given year-quarter. For each carrier and year-quarter, we calculate its level of intra-industry common ownership (λ^{intra}) as the average weight that a given carrier puts on the profits of each other airline in its objective function, using national level passenger shares as weights.[11] For each carrier and year-quarter, we calculate its level of inter-industry common ownership (λ^{inter}) as the average weight that a given carrier puts on the profits of each non-airline firm in the S&P 500 in its objective function, using the S&P 500 firms' sales as weights. We also calculate unweighted versions of these averages, to use as instruments.

Table 2. Summary Statistics.

Data for the period 2001Q1-2014Q4 come from the Department of Transportation for airfares and market characteristics. Data on ownership come from 13f filings and proxy statements. We exclude routes with less than 20 passengers per day on average. Variable definitions are provided in the Appendix.

	Mean	Std. Dev.	Min.	Max.	N
λ^{intra}	0.34	0.2	0	1.13	1221684
λ^{inter}	0.27	0.16	0	1.17	1221684
λ^{intra} (Route-Level)	0.34	0.24	0	1.94	1231167
$\lambda^{intra}_{BigThree}$	0.11	0.1	0	0.91	
λ^{intra}_{Other}	0.23	0.13	0	0.61	
$\lambda^{inter}_{BigThree}$	0.14	0.12	0	0.98	
λ^{inter}_{Other}	0.13	0.07	0	0.3	
Average Fare	228.6	98.03	25	2498.62	1243621
Log Average Fare	5.36	0.36	3.22	7.82	1243621
Number of Nonstop Carriers	0.85	1.32	0	11	1243621
Southwest Indicator	0.1	0.3	0	1	1243621
Other LCC Indicator	0.09	0.28	0	1	1243621
Share of Passengers Traveling Connect	0.87	0.32	0	1	1243621
Log(Population)	0.64	0.69	-3.9	2.79	1215267
Log(Income Per Capita)	3.73	0.11	3.07	4.53	1215267
Distance	2696.06	1556.28	27	12714	1243621
Average Passengers	3894.58	11536.96	10	234146	1243621

[10]The main change that we implemented is that we do not exclude shareholders with stakes of less than 0.5% from the sample.

[11]This measure of common ownership has been used also by, for example, Antón, Ederer, Giné, and Schmalz (2020).

Table 2 shows summary statistics for our dataset. The average of the intra-industry lambdas is 0.34, with a standard deviation of 0.2. The average of the inter-industry lambdas is somewhat lower, at 0.27, with a standard deviation of 0.16. The correlation coefficient between the intra- and inter-industry lambdas is 0.898.

Table 3, Panel A shows the objective function weights that each airline put on its rivals profits relative to its own profits in 2014Q4. For example, according to this analysis United Airlines valued a dollar of profits by American Airlines as much as 53 cents of own profits. On the other hand, it valued a dollar of profits by Frontier only as much as 10 cents of own profits.[12]

Table 3. Weight of other airlines' and non-airline firms' profits in airline's objective function in 2014Q4

Intra-industry common ownership is measured as λ_{intra}. Inter-industry common ownership is measured as λ_{inter}. Data are for the period 2014Q4. We exclude routes with less than 20 passengers per day on average.

Panel A: Weight of column airline's profits in row airline's objective function

	American	Alaska	JetBlue	Delta	Frontier	Allegiant	Hawaiian	SkyWest	United	Southwest
American	1.00	0.39	0.41	0.50	0.21	0.77	0.28	0.37	1.15	0.35
Alaska	0.32	1.00	0.71	0.43	0.50	0.88	0.52	0.70	0.44	0.51
JetBlue	0.09	0.20	1.00	0.13	0.23	0.13	0.19	0.27	0.16	0.21
Delta	0.62	0.73	0.80	1.00	0.58	0.58	0.57	0.75	1.09	0.65
Frontier	0.06	0.20	0.38	0.14	1.00	0.19	0.25	0.37	0.11	0.15
Allegiant	0.05	0.10	0.06	0.04	0.05	1.00	0.05	0.09	0.05	0.04
Hawaiian	0.15	0.36	0.52	0.24	0.43	0.25	1.00	0.56	0.28	0.25
SkyWest	0.15	0.44	0.67	0.28	0.57	0.46	0.51	1.00	0.25	0.30
United	0.53	0.18	0.23	0.38	0.10	0.20	0.19	0.14	1.00	0.17
Southwest	0.49	0.94	1.11	0.67	0.68	0.75	0.60	0.89	0.67	1.00

Panel B: Average weight on other airlines' profits and non-airline S&P 500 firms' profits in row airline's objective function

	Other airlines	Non-airline S&P 500 firms
American	0.54	0.47
Alaska	0.46	0.44
JetBlue	0.15	0.14
Delta	0.73	0.76
Frontier	0.14	0.14
Allegiant	0.05	0.05
Hawaiian	0.26	0.24
SkyWest	0.30	0.33
United	0.31	0.31
Southwest	0.67	0.70

Panel B shows the average weight across other carriers that a given airline put on its rivals, as well

[12] Three of the 90 pairwise lambdas are greater than one, which could create the possibility of tunneling, as shown by Backus, Conlon, and Sinkinson (2021b).

as the average weight that it put on firms in the S&P outside the airline industry. For example, United Airlines valued a dollar profits by other airlines on average as much as 31 cents of own profits (that is, it would have been wiling to sacrifice 31 cents of its own profits in order for the other airlines as a group to make an additional dollar of profit, because this would have left their shareholders even). At the same time, United valued a dollar of profits by non-airline S&P 500 firms as much as 31 cents of its own profits. This means that, to some extent, United would have had an incentive to *reduce* prices if it meant that the income consumers saved would be spent on goods and services sold by S&P 500 firms, or if it increased the profits of those firms because they also purchased airline tickets.[13]

5 Regressions of airline prices on λ_{intra} and λ_{inter}

In this section, we test the hypothesis that common ownership between firms in the same industry increases prices, while common ownership between firms in different industries decreases prices.

We estimate the following regression model

$$\log(p_{jrt}) = \alpha\lambda_{jt}^{intra} + \beta\lambda_{jt}^{inter} + \theta X_{jrt} + \gamma_{jr} + \delta_t + \varepsilon_{jrt}, \tag{5.1}$$

where p_{jrt} is the average price by carrier j in route r at year-quarter t, λ_{jrt}^{intra} is our measure of intra-industry common ownership by carrier j in route r at time t, λ_{jt}^{inter} is our measure of inter-industry common ownership for carrier j at time t, X_{jrt} is a vector of control variables, and γ_{jr} and δ_t are market-carrier and year-quarter fixed effects.

The results are presented in Table 4. Columns 1 to 3 present the same specifications as in Table 3 of Azar, Schmalz, and Tecu (2018), but using λ^{intra} instead of MHHI delta as the measure of intra-industry common ownership, and including λ^{inter} as a measure of inter-industry common ownership.

In all three specifications, the coefficient on lambda-intra is positive and significant, indicating a positive association between changes over time within a route in intra-industry common ownership and changes over time within a route in airline prices. The coefficient on lambda-inter is negative and significant, indicating a negative association between changes over time within a route in intra-industry

[13]Note that, for all carriers, the average intra-industry lambda is less than one, which was a sufficient condition for concavity stated in the remark after Proposition 1. In the whole dataset, the average lambda intra is less than one in 99.8% of the observations. Note that this condition is sufficient but not necessary for the concavity of the firms' objective functions.

Table 4. Effect of Intra- and Inter-Industry Common Ownership on Airline Ticket Prices: Panel Regressions.

Intra-industry common ownership is measured as λ_{intra}. Inter-industry common ownership is measured as λ_{inter}. Data are for the period 2001Q1-2014Q4. We exclude routes with less than 20 passengers per day on average. For the market-carrier-level regressions, we weight by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. For the market-level regressions, we weight by average passengers in the market over time and cluster standard errors two-ways at the market and year-quarter level. Variable definitions are provided in the Appendix.

	Dependent Variable: Log(Average Fare)					
	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
λ^{intra}	0.349***	0.319***	0.296***	0.324***	0.295***	0.267***
	(0.0466)	(0.0401)	(0.0395)	(0.0546)	(0.0510)	(0.0493)
λ^{inter}	-0.388***	-0.354***	-0.336***	-0.352***	-0.319***	-0.296***
	(0.0578)	(0.0523)	(0.0529)	(0.0685)	(0.0659)	(0.0643)
Number of Nonstop Carriers			-0.0141***			-0.0141***
			(0.00269)			(0.00274)
Southwest Indicator			-0.127***			-0.127***
			(0.00966)			(0.00961)
Other LCC Indicator			-0.0745***			-0.0746***
			(0.00773)			(0.00768)
Share of Passengers Traveling Connect, Market-Level			0.0780***			0.0776***
			(0.0147)			(0.0148)
Share of Passengers Traveling Connect			0.103***			0.103***
			(0.0153)			(0.0152)
Log(Population)			0.209*			0.213*
			(0.106)			(0.107)
Log(Income Per Capita)			0.279***			0.277***
			(0.0959)			(0.0964)
Log(Distance) × Year-Quarter FE		✓	✓		✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	1,217,886	1,217,886	1,191,098	1,217,886	1,217,886	1,191,098
R-squared	0.816	0.820	0.832	0.018	0.039	0.104
Kleibergen-Paap F-Stat				98.24	101.2	101.9
Number of market-carrier pairs	45331	45331	44117	45331	45331	44117

*** p<0.01, ** p<0.05, * p<0.1

common ownership and changes over time within a route in airline prices.

Specifications 4 to 6 shows the same specifications as in columns 1 to 3, but estimated using two-stage least squares (2SLS), instrumenting for the weighted average lambdas with simple averages of the lambdas that the carrier puts on the profits of other carriers. These instruments do not use market shares, and therefore are not subject to the concern that market shares are endogenous (see, for example, O'Brien and Waehrer, 2017; Dennis, Gerardi, and Schenone, 2019). The estimated coefficients based on the 2SLS methodology (i.e., without using market shares) are similar in sign and magnitude to the OLS coefficients. The first-stage of the 2SLS specifications is shown in Appendix Table C1. In all cases, the excluded instruments are strong predictors of the instrumented variables, with Kleibergen-Paap F-stats of around 100.

In all specifications the magnitudes of the two coefficients are similar, which implies that an increase in common ownership for the economy as a whole would predict a very small increase or decrease on prices, depending on the specification. In practice, lambda-intra is somewhat higher on average than lambda-inter, because shareholders are not perfectly diversified and some shareholders' portfolios put more weight in the airline industry than the market portfolio. The combined effect of intra and inter-industry common ownership evaluated at the average values for lambda-intra and lambda-inter is positive and statistically sigificant, although small.

For each route, we calculate the overall effect of common ownership on the conditional expectation of log price, taking into account both intra-industry and inter-industry common ownership. In particular, for each route, carrier and year-quarter, we calculate the difference in predicted values for log price between the case with the observed levels of common ownership and the case when the common ownership measures are set to zero:

$$\Delta\widehat{\log(p_{jrt})} = \widehat{\alpha}\lambda_{jt}^{intra} + \widehat{\beta}\lambda_{jt}^{inter}, \tag{5.2}$$

where $\widehat{\alpha}$ is the estimated coefficient on lambda-intra, and $\widehat{\beta}$ is the estimated coefficient on lambda-inter. We use the estimated coefficients from specification (6) in Table 4.

Figure 1 shows a histogram of the distribution of the differences between the predicted log price from the model estimated in specification (6) from Table 4, and the same predictions but with the two common ownership measures set equal to zero. The overall effect of common ownership on prices is negative in 372,468 out of 1,221,684 observations. There is substantial heterogeneity across routes in the carrier-level intra-industry and inter-industry common ownership measures, which implies substantial heterogeneity in the predicted effect on prices.

Figure 2 shows the effect of common ownership on the linear prediction of log price over time. The dotted line shows the effect of intra-industry common ownership, which is positive and economically large, implying that prices have been between 5% and 16% higher due to intra-industry common own-

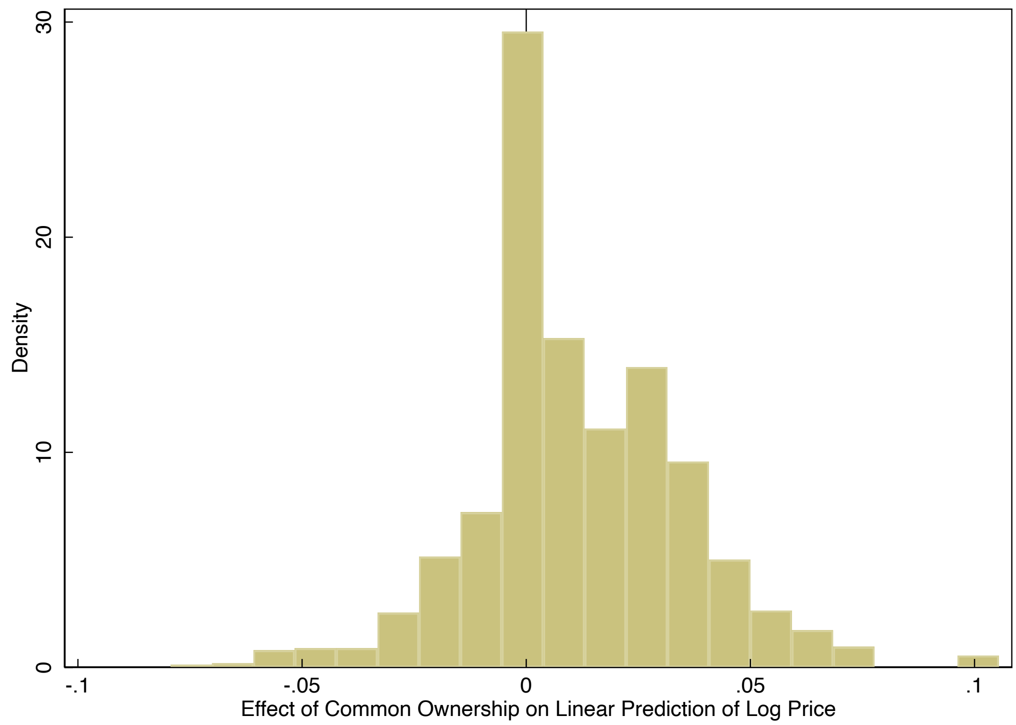


Figure 1. Distribution of the Total Effect of Common Ownership on the Linear Prediction of Log Price. Results are based on predictions using specification (6) from Table 4.

ership relative to a counterfactual without common ownership. The effect has increased over time, reflecting the increase in intra-industry common ownership. The dashed line shows the negative effect on predicted prices of inter-industry common ownership, which is almost as high in absolute value as the intra-industry effect. The solid line shows the total effect, which is close to zero in most years. This illustrates how the pro-competitive inter-industry effect and the anti-competitive intra-industry effect can mostly cancel each other out.

6 Lasso for Variable Selection

The high correlation between lambda-intra and lambda-inter (around 0.9) could raise concerns about multi-collinearity. Given that lambda-intra and lambda-inter are positively correlated, would it be better to include only intra-industry lambda in the regressions? To answer this question, we used the Lasso technique for variable selection to see if the Lasso estimator would select only one of the two lambdas for inclusion in the regression model.

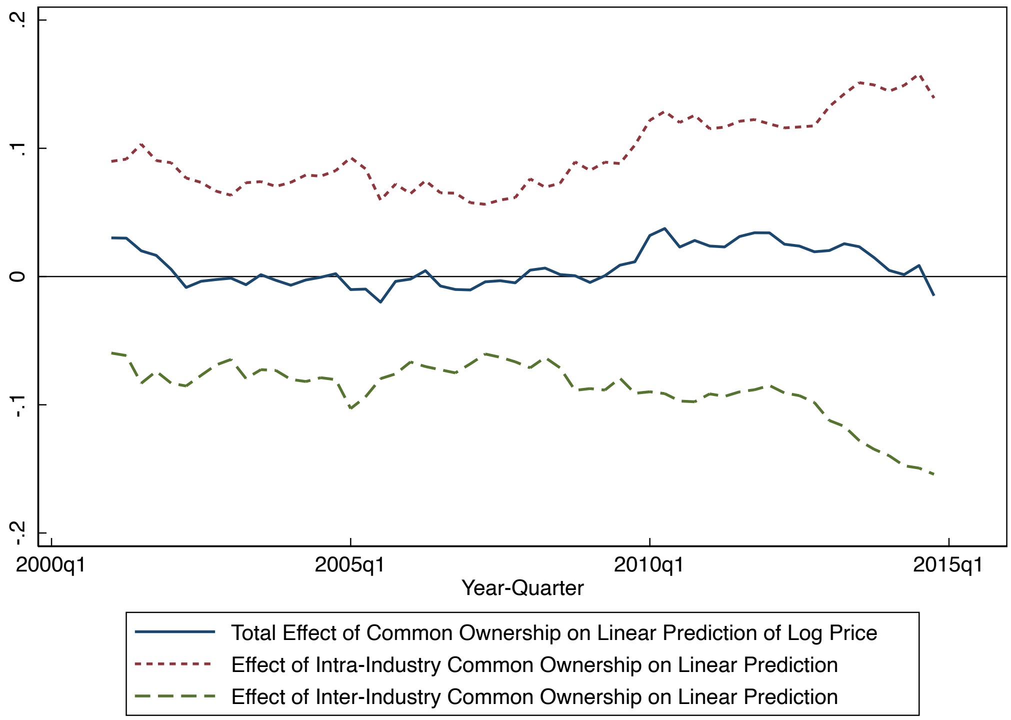


Figure 2. Effect of Common Ownership on the Linear Prediction of Log Price Over Time. Results are based on predictions using specification (6) from Table 4.

The Lasso is a variable selection technique based on minimization of the following objective function, which includes a term for ordinary least squares (OLS), and a penalization for the size of the estimated coefficients (Tibshirani, 1996; Zhao and Yu, 2006):

$$\hat{\beta} = \min_{\beta} \left\{ \frac{1}{2n} \sum_{i=1}^{n} (y_i - \boldsymbol{x_i}\boldsymbol{\beta})^2 + k \sum_{j=1}^{p} |\beta_j| \right\},$$

where y_i is the dependent variable in the regression, $\boldsymbol{x_i}$ is the vector of regressors, $\boldsymbol{\beta}$ are the regression coefficients, n is the sample size, p is the number of regressors, and k is a penalty parameter. Note that if k is equal to zero, then the Lasso estimator is the same as the OLS estimator. The higher k is, the higher the penalty for the magnitude of the coefficients, and therefore the higher the shrinkage of the coefficients relative to OLS. Because the penalty function is not smooth (i.e., it has "kinks"), some of the coefficients with the Lasso estimator can be exactly zero. It is this property that makes the Lasso useful as a variable selection technique.[14]

[14]Before we apply the Lasso, we partial out the market-carrier and time fixed effects, so that we estimate the model using

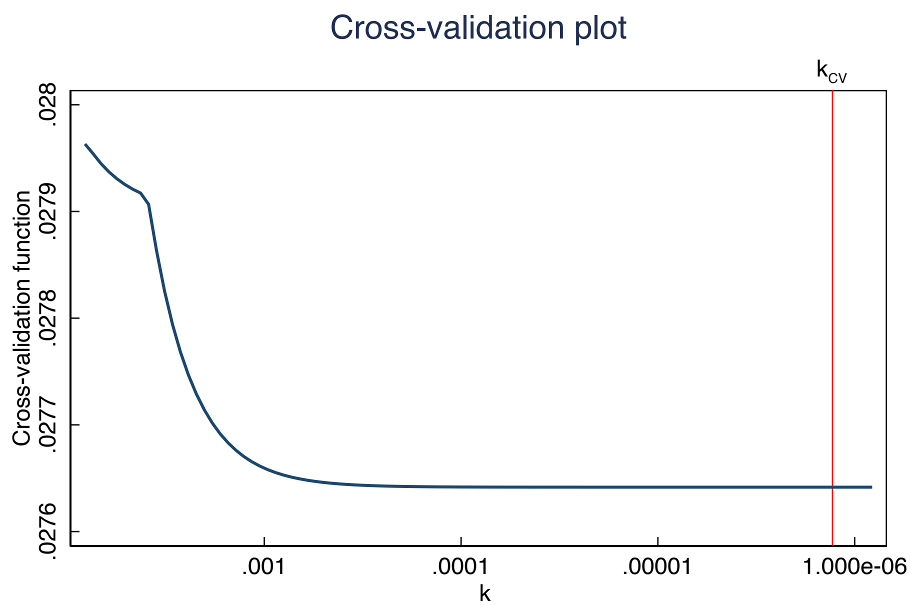
We use 10-fold cross-validation to select the value of the penalization parameter k. Cross-validation finds the k that minimizes the out-of-sample mean-squared error (MSE) of the predictions of the model. The sample is divided randomly into 10 subsamples, or "folds". The model is estimated 10 times, each time excluding one of the folds and using the other nine folds for "training". The model estimated excluding a fold is then used for out-of-sample prediction in that fold. The objective function of the cross-validation algorithm is the average of the squared out-of-sample prediction errors across the observatons in all folds. Figure 3 (a) shows the value of the cross-validation objective function as a function of the penalty parameter k. The technique selects an extremely low penalty parameter ($k_{CV} = 1.3e - 06$), indicating that a model that is virtually identical to OLS is the one that fits the data best out-of-sample.

Figure 3 (b) shows the evolution of the coefficients as the penalty parameter decreases. For a relatively high value of the penalty parameter ($k = 0.00814$), the Lasso sets the coefficients for both lambda-intra and lambda-inter equal to zero, effectively excluding both variables from the model. However, this model has the worst out-of-sample fit out of the possible models. As we decrease the penalty parameter up to $k = 0.004248$, the model chooses to include lambda-intra, but not lambda inter, and the model fit increases somewhat relative to the model without any variables. For values of the penalty parameter below $k = 0.004248$, the Lasso sets non-zero coefficients for both lambda-intra *and* lambda-inter, and the model fit increases as the penalty parameter decreases. As we have noted, the best out-of-sample fitting model is obtained at a very low value of the penalty parameter ($k_{CV} = 1.3e - 06$), and including both variables, lambda intra and lambda inter. Moreover, the graph shows that the magnitude of the coefficients in the best-fitting model is similar to that in our OLS estimates from Table 4.

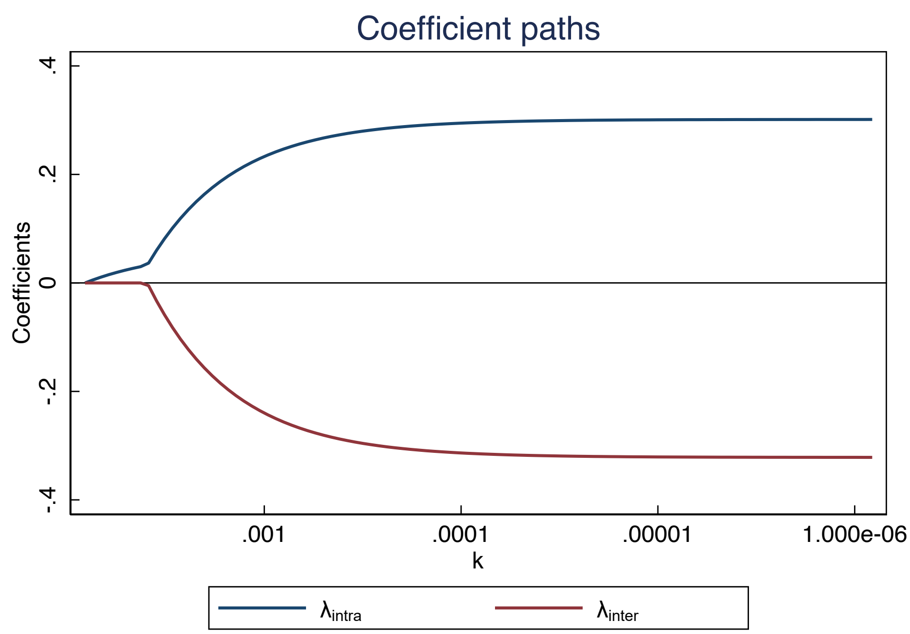
7 Robustness Checks

We conducted a number of additional specifications to assess the robustness of our main results. The results are shown in Table 5. Column (1) shows the same specification as in Table 4 column (6), but estimated excluding periods through which major airlines experienced bankruptcies. Due to the large number of bankruptcies during our sample period, this results in a sample that is about half the size as the original sample (574,678 observations vs 1,191,098 observations in the baseline specification).

the residualized versions of the log price, and of lambda-intra and lambda-inter. Thus, we use the Lasso to select the lambda variables to be included in the already double-within-transformed model. This way, we do not use the Lasso to select a subset of the dummy variables in the fixed effects model.



(a) Cross-Validation Plot



(b) Coefficient Paths

Figure 3. Lasso Cross-Validation and Coefficient Paths Plots. Subfigure (a) shows the out-of-sample MSE of the predictions of the model as a function of the penalty parameter k. Lower values of the cross-validation objective function (the mean squared error of the out-of-sample predictions of the model) indicate that the model fits the data better out-of-sample. The value k_{CV} indicates the optimal value for the penalty parameter k. Subfigure (b) shows the evolution of the coefficients as the penalty parameter k decreases.

The benefit is that we do not need to make assumptions about the objective function of the firms during bankruptcies, over which our theory of the firm has less to say. The results excluding bankrupcty periods are almost identical to the baseline results, indicating that our results are not driven by bankruptcies.

Column (2) of Table 5 shows the results of the same specification as in Table 4 column (6), but excluding lambda-inter from the list of right-hand-side variables. The coefficient on lambda-intra is still positive and statistically significant, but its magnitude is substantially lower than in the specifications in 4, that include lambda-inter as a regressor. This indicates that not accounting for inter-industry common ownership leads to omitted variable bias in the estimated coefficient on intra-industry common ownership. Since inter-industry common ownership is positively correlated with intra-industry common ownership, and is negatively associated with prices, excluding lambda-inter from the regression introduces downward bias in the estimate of the coefficient on lambda-intra.

The regression results so far are based on an intra-industry lambda average which is calculated at the carrier level, as suggested by the theoretical framework. However, we can also calculate a route$\times$carrier version of the intra-industry lambda, which takes an average of the intra-industry lambdas of a given carrier on other carriers using their route-level market shares as weights. We use the same instruments as in the carrier-level specification. Column (3) of Table 5 shows the results of airline price regressions using the carrier-route level lambda-intra instead of the carrier level. The effect is positive and significant in all specifications, although the magnitude is smaller. Thus, common ownership at the carrier-level has a bigger effect on prices than route-level common ownership, suggesting that common ownership affects competitive behavior mostly at the firm level, rather than route-by-route.

To examine whether our regression results are driven by our assumption that corporate control is proportional to the Banzhaf voting power index, we calculated all the lambda variables under the proportional control assumption. Column (4) of Table 5 shows results from the same specification as in Table 4 column (6), but using proportional control instead of Banzhaf control shares. The results are qualitatively and quantitatively similar, indicating that our baseline results are not dependent on the Banzhaf vs proportional control assumption.

Column (5) of Table 5 shows results from the same specification as in Table 4 column (6), but also controlling for the route's HHI. To deal with the issue of endogeneity of market shares, we instrument the HHI using $1/N$, where N is the number of firms operating in the route. The HHI has a large, positive,

Table 5. Effect of Intra- and Inter-Industry Common Ownership on Airline Ticket Prices: Robustness Checks.

Intra-industry common ownership is measured as λ_{intra}. Inter-industry common ownership is measured as λ_{inter}. Data are for the period 2001Q1-2014Q4. We exclude routes with less than 20 passengers per day on average. All regressions are estimated by 2SLS, instrumenting with unweighted analogues of the lambdas. For the market-carrier-level regressions, we weight by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. For the market-level regressions, we weight by average passengers in the market over time and cluster standard errors two-ways at the market and year-quarter level. Variable definitions are provided in the Appendix.

	Dependent Variable: Log(Average Fare)					
	Excluding Bankruptcies (1)	Only Intra (2)	Route-Level Intra (3)	Proportional Control (4)	Including HHI (5)	Dynamic (6)
λ_t^{intra}	0.335***	0.0461***	0.208***	0.347***	0.259***	0.0230
	(0.0751)	(0.0168)	(0.0417)	(0.0575)	(0.0485)	(0.134)
λ_t^{inter}	-0.305***		-0.221***	-0.374***	-0.293***	-0.0337
	(0.0844)		(0.0538)	(0.0718)	(0.0626)	(0.155)
λ_{t+1}^{intra},						0.0829
						(0.0984)
λ_{t-1}^{intra},						0.180**
						(0.0882)
λ_{t+1}^{inter},						-0.102
						(0.117)
λ_{t-1}^{inter},						-0.201*
						(0.102)
HHI					0.329***	
					(0.0640)	
Number of Nonstop Carriers	-0.0183***	-0.0146***	-0.0152***	-0.0141***	-0.00253	-0.0140***
	(0.00402)	(0.00285)	(0.00277)	(0.00275)	(0.00340)	(0.00271)
Southwest Indicator	-0.124***	-0.129***	-0.125***	-0.127***	-0.105***	-0.125***
	(0.0126)	(0.00969)	(0.00959)	(0.00957)	(0.00979)	(0.00989)
Other LCC Indicator	-0.0718***	-0.0758***	-0.0628***	-0.0745***	-0.0500***	-0.0730***
	(0.00790)	(0.00789)	(0.00785)	(0.00767)	(0.00802)	(0.00770)
Share of Passengers Traveling Connect, Market-Level	0.0461**	0.0747***	0.0745***	0.0778***	0.225***	0.0947***
	(0.0183)	(0.0150)	(0.0151)	(0.0148)	(0.0313)	(0.0146)
Share of Passengers Traveling Connect	0.0955***	0.102***	0.0995***	0.103***	0.0844***	0.0741***
	(0.0194)	(0.0147)	(0.0157)	(0.0153)	(0.0149)	(0.0153)
Log(Population)	0.377***	0.241**	0.241**	0.212*	0.245**	0.192*
	(0.115)	(0.110)	(0.106)	(0.107)	(0.108)	(0.106)
Log(Income Per Capita)	0.365***	0.264**	0.233**	0.272***	0.252**	0.262***
	(0.120)	(0.102)	(0.102)	(0.0950)	(0.0971)	(0.0915)
Log(Distance) × Year-Quarter FE	✓	✓	✓	✓	✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	574,678	1,191,098	1,180,967	1,191,098	1,191,098	968,781
R-squared	0.109	0.093	0.077	0.093	0.096	0.108
Kleibergen-Paap F-Stat	47.31	861.8	117.2		45.72	3.039
Number of market-carrier pairs	38825	44117	43753	44117	44117	34257

*** p<0.01, ** p<0.05, * p<0.1

and significant effect on prices, while the coefficients on the lambdas are essentially unchanged. It is interesting to note that, in an OLS specification, without instrumenting the HHI, the coefficients on the lambdas are also very similar to the baseline, while the coefficient on the HHI is much lower, suggesting that the endogeneity of market shares introduces substantial downward bias in the estimated effect of HHI concentration on prices, while it introduces almost no bias in the estimated effect of common ownership on prices. Perhaps an explanation is that, for the HHI, market share is the main driver of variation (after all, the HHI *is* the expected market share, if picking a ticket sold at random, of the firm that sold it), while for the average lambdas the main driver of variation are changes in common ownership, while the market shares are simply weights.

Finally, column (6) of Table 5 shows result from a dynamic specification which includes, in addition to the contemporaneous intra an inter-industry lambdas, also their lags and leads. We can see that only the lagged variables are statistically significant, while all of the leads and contemporaneous effects are statistically insignificant. This indicates that changes in common ownership precede the changes in prices in the temporal dimension.

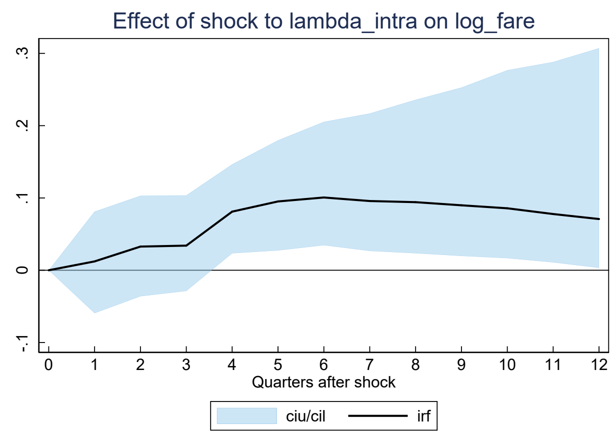
We also examined the joint dynamics of prices and lambdas using a reduced-form panel vector autoregression (VAR) model. In particular, we estimated a 3-variable panel VAR for log fare, λ^{intra}, and λ^{inter}, with 4 lags, including market-carrier and time fixed effects. We found that the two lambdas Granger-cause fares, in the sense that the lags of λ^{intra} are jointly significant in the fare equation, as are the lags of λ^{inter}, while the lags of log fare are not jointly significant in either the λ^{intra} or the λ^{inter} equation.

Figure 4 shows impulse response-functions to visualize the results. They confirm that shocks to fares do not have a significant effect on future lambdas. Shocks to λ^{intra} have a positive and significant effect on future prices, and shocks to λ^{inter} have a negative and significant effect on future prices. It can be seen that the effect of a shock to either of the lambdas on prices takes about a year and a half (6 quarters) to fully express itself.

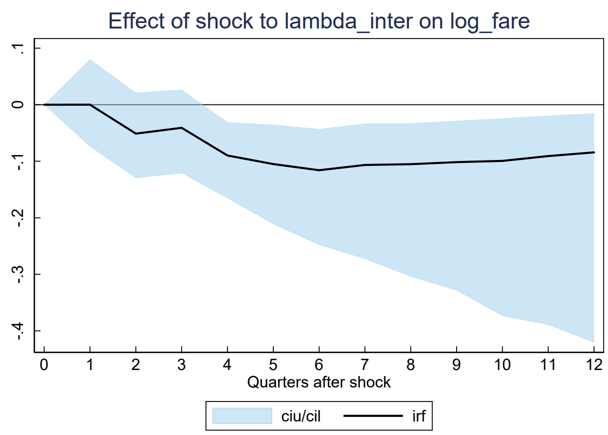
8 Separating the Effect of the Big Three

The Big Three (BlackRock, Vanguard, and State Street), are the largest asset managers in the world, and due to their salience as index providers, also thought to be examples of "universal owners", with their portfolios being highly diversified and similar to some extent to the market portfolio (Fichtner, Heemskerk, and Garcia-Bernardo, 2017). Since the Big Three create substantial common ownership both intra-industry and inter-industry, the theory of Azar and Vives (2021) would predict that their effect on prices should be negative.

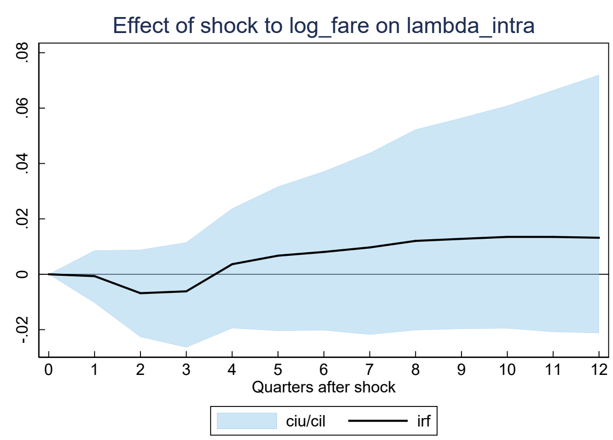
In this section, we test that prediction by breaking down our intra-industry measure of common ownership into two: common ownership generated by the Big Three, and common ownership generated by other shareholders. In particular, if we denote the Big Three as a subset of investors $I_3 \subset I$, we can



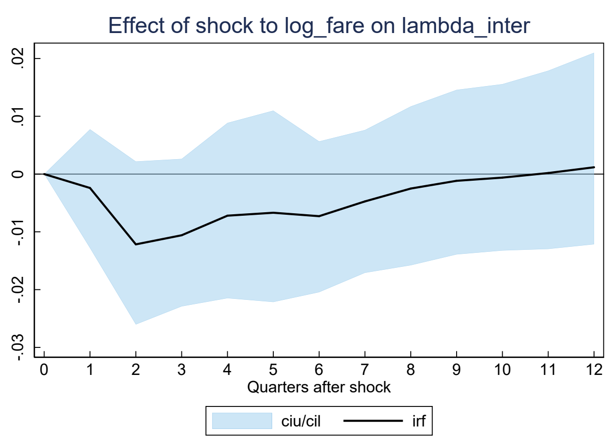
(a) Effect of λ^{intra} on log(p)



(b) Effect of λ^{inter} on log(p)



(c) Effect of log(p) on λ^{intra}



(d) Effect of log(p) on λ^{inter}

Figure 4. Impulse response functions from panel VAR of log(p), λ^{intra}, and λ^{inter}. Results are based on a 3-variable panel VAR for log fare, λ^{intra}, and λ^{inter}, with 4 lags, including market-carrier and time fixed effects. The shaded area plots the 90% confidence bands, which are calculated by taking 1,000 draws from the joint estimated distribution of the panel VAR parameters and calculating the impulse-response functions for each draw. Standard errors are clustered two-ways by market-carrier and year-quarter.

separate the carrier j's lambda over carrier k in the following way (here we drop the industry subscript, because all the firms are airlines):[15]

$$\lambda_{jk} = \frac{\sum_{i \in I} \gamma_{ij}\beta_{ik}}{\sum_{i \in I} \gamma_{ij}\beta_{ij}} = \underbrace{\frac{\sum_{i \in I_3} \gamma_{ij}\beta_{ik}}{\sum_{i \in I} \gamma_{ij}\beta_{ij}}}_{\text{Common ownership from Big Three}} + \underbrace{\frac{\sum_{i \in I \setminus I_3} \gamma_{ij}\beta_{ik}}{\sum_{i \in I} \gamma_{ij}\beta_{ij}}}_{\text{Common ownership from other shareholders}}. \tag{8.1}$$

We call the first term on the right-hand side $\lambda_{jk}^{BigThree}$, and the second term λ_{jk}^{Other}. As with the overall lambda-intra, we can take an average across carrier j's rival carriers in a market to obtain a measure of Big Three lambda-intra, and of the part of lambda-intra that's driven by shareholders other than the Big Three. We do a similar calculation for lambda-inter, separating it into two terms, one driven by the Big Three, and another driven by shareholders other than the Big Three.

Table 6 column (1) shows the results of running the same regressions as in Table 4, but instead of separating common ownership into intra-industry and inter-industry, we separate it as lambda-intra generated by the Big Three versus lambda-intra generated by other shareholders.

We see that common ownership by the Big Three has a negative effect on airline prices, which is statistically significant. On the other hand, common ownership by shareholders other than the Big Three have a positive and statistically significant effect on airline prices in all specifications.

Table 6 column (2) shows the results of running the same regressions, but also including inter-industry lambdas separated into Big Three and Other. In this case, the lambda-intra of both the Big Three and of other shareholders is positive and significant in all cases. The lambda-inter coefficient for both the Big Three and for the other shareholders is negative and significant, and larger than the lambda-intra coefficient.

Based on these results, we calculate the overall effect on prices of common ownership by the Big Three and by other shareholders separately. In particular, we estimate effect of the Big Three on the log price of carrier j in route r in year-quarter t as

$$\Delta \widehat{\log(p_{jrt})} = \widehat{\alpha_{BigThree}} \lambda_{BigThree,jt}^{intra} + \widehat{\beta_{BigThree}} \lambda_{BigThree,jt}^{inter}, \tag{8.2}$$

[15] Note that the measure $\frac{\sum_{i \in I_3} \gamma_{ij}\beta_{ik}}{\sum_{i \in I} \gamma_{ij}\beta_{ij}}$ can be thought of as the product of two factors: $\frac{\sum_{i \in I_3} \gamma_{ij}\beta_{ik}}{\sum_{i \in I_3} \gamma_{ij}\beta_{ij}}$ and $\frac{\sum_{i \in I_3} \gamma_{ij}\beta_{ij}}{\sum_{i \in I} \gamma_{ij}\beta_{ij}}$. The first factor is the weight that firm j would put on firm k in its objective function if it were controlled completely by the Big Three. The second factor is the ratio of the weighted average share that the Big Three have in firm j and the weighted average share that all of firm j's shareholders have in firm j, and can be thought of as a measure of the weight of the Big Three in the ownership of firm j.

Table 6. Effect on Airline Prices of Intra- and Inter-Industry Common Ownership by the Big Three and by Other Shareholders.

Intra-industry common ownership by the Big Three (BlackRock/Barclays, Vanguard and State Street) is measured as $\lambda^{intra}_{BigThree}$. Intra-industry common ownership by shareholders other than the Big Three is measured as λ^{intra}_{Other}. Inter-industry common ownership by the Big Three (BlackRock/Barclays, Vanguard and State Street) is measured as $\lambda^{inter}_{BigThree}$. Inter-industry common ownership by shareholders other than the Big Three is measured as λ^{inter}_{Other}. Data are for the period 2001Q1-2014Q4. We exclude routes with less than 20 passengers per day on average. For the market-carrier-level regressions, we weight by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. For the market-level regressions, we weight by average passengers in the market over time and cluster standard errors two-ways at the market and year-quarter level. Variable definitions are provided in the Appendix.

	Dependent Variable: Log(Average Fare)			
	(1)	(2)	(3)	(4)
λ^{intra}_{Big3}	-0.142**	0.712***		
	(0.0547)	(0.251)		
λ^{intra}_{Other}	0.208***	0.239***		
	(0.0418)	(0.0497)		
λ^{inter}_{Big3}		-0.666***		
		(0.190)		
λ^{inter}_{Other}		-0.209***		
		(0.0692)		
$\lambda^{intra}_{MoreDiversified}$			-0.120**	0.735***
			(0.0489)	(0.249)
$\lambda^{intra}_{LessDiversified}$			0.218***	0.234***
			(0.0436)	(0.0506)
$\lambda^{inter}_{MoreDiversified}$				-0.677***
				(0.189)
$\lambda^{inter}_{LessDiversified}$				-0.193***
				(0.0698)
Additional Controls	✓	✓	✓	✓
Log(Distance) × Year-Quarter FE	✓	✓	✓	✓
Year-quarter FE	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓
Observations	1,191,098	1,191,098	1,191,098	1,191,098
R-squared	0.097	0.107	0.097	0.107
Kleibergen-Paap F-Stat	229.1	15.75	206.3	14.72
Number of market-carrier pairs	44117	44117	44117	44117

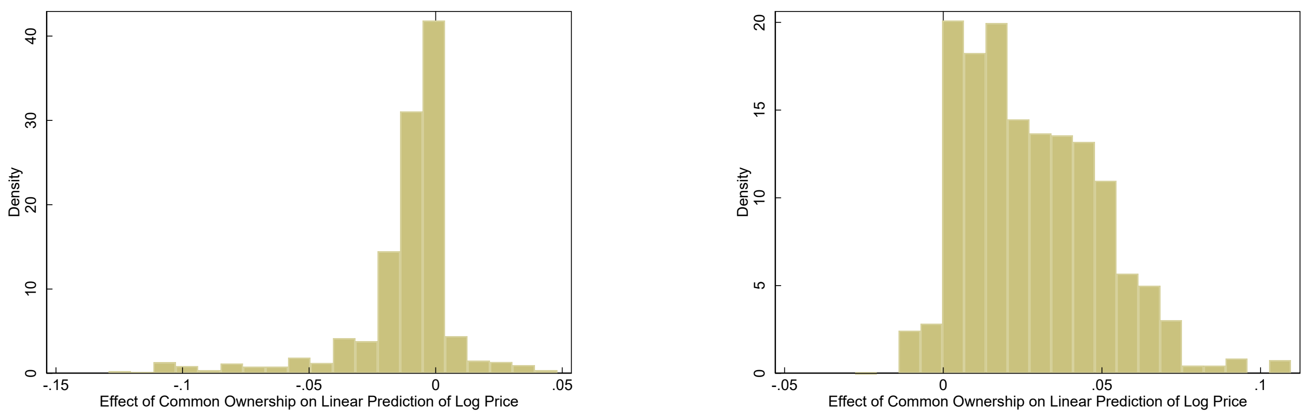
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

where $\widehat{\alpha_{BigThree}}$ is the estimated coefficient on lambda-intra by the Big Three, and $\widehat{\beta_{BigThree}}$ is the estimated coefficient on lambda-inter by the Big Three. We use the estimated coefficients from specification (2) in Table 6.

Similarly, we estimate effect of shareholders other than the Big Three on the log price of carrier j in route r in year-quarter t as

$$\Delta \widehat{\log(p_{jrt})} = \widehat{\alpha_{Other}} \lambda^{intra}_{Other,jt} + \widehat{\beta_{Other}} \lambda^{inter}_{Other,jt}, \tag{8.3}$$

where $\widehat{\alpha_{Other}}$ is the estimated coefficient on lambda-intra by the Big Three, and $\widehat{\beta_{Other}}$ is the estimated coefficient on lambda-inter by the Big Three.



(a) Big Three

(b) Other Shareholders

Figure 5. Distribution of the Total Effect of Common Ownership on the Linear Prediction of Log Price, Separated by Big Three and by Other Shareholders. Results are based on specification (2) from Table 6.

Figure 5 (a) shows a histogram of the distribution of the effect of the Big Three on prices, taking into account both the intra-industry and the inter-industry effects. Most of the distribution is to the left of zero, indicating that in most markets the effect of common ownership by the Big Three was to reduce prices.

Figure 5 (b) shows a histogram the distribution of the effect of other shareholders on prices, also taking into account both the intra-industry and inter-industry effects. In the case of other shareholders, most of the distribution is to the right of zero, indicating that in most markets the effect of common ownership by shareholders that are not the Big Three was to increase prices.

We also conducted regression analysis dividing shareholders into groups by their level of diversification. We measure an asset manager's level of diversification using the distance between its portfolio and a market portfolio based on the S&P 500.[16] The "highly diversified group" consists of the bottom 1% of asset managers in terms of their distance to the S&P 500 market portfolio. This results in a set of 54 asset mangers, which includes the Big Three. The rest of the asset managers are grouped into the "less diversified" category.

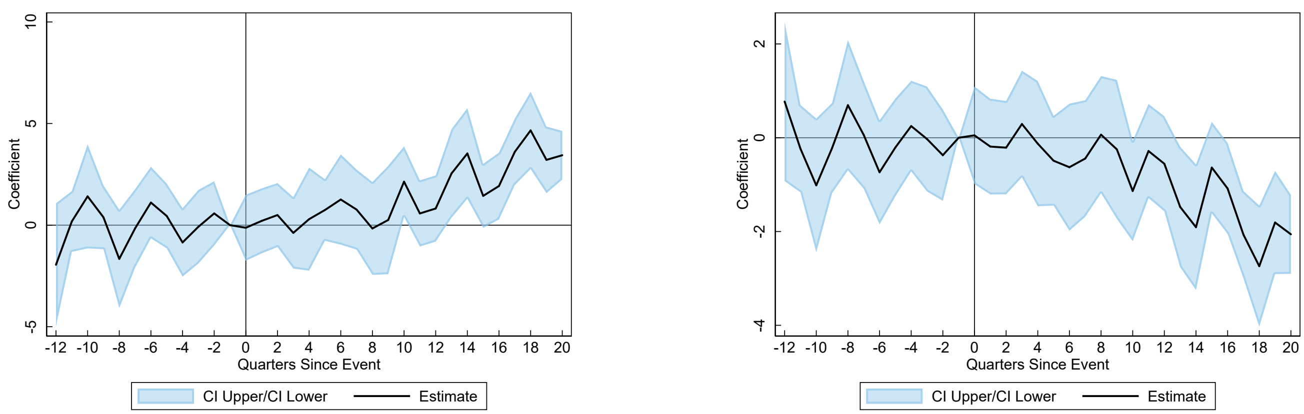
Table 6 columns (3) and (4) show the regression results. As with the Big Three regressions, when including only intra-industry lambdas, common ownership by the less diversified group has a significant positive effect on prices, while common ownership by the highly diversified group has either a negative and significant or no statistically significant effect on prices. When including both intra and inter-industry lambdas for both the more and less diversified groups, we find that for both groups the intra-industry lambdas have a positive and significant effect on prices, and the inter-industry lambdas have a negative and significant effect on prices.

9 Event Study of Financial Institution Mergers

In this section, we describe the methodology and results from an event study of the effect on prices of mergers of financial institutions, following He and Huang (2017) and Lewellen and Lowry (2021). Financial institution mergers generate variation in both intra-industry and inter-industry common ownership across airlines, because the combination of the portfolios of two financial institutions changes the ownership structure of the latter. The variation is arguably exogenous, because the acquisitions are unlikely to be driven by developments related to the airline industry. An important issue to take into account is that, for firms in different industries, Lewellen and Lowry (2021) find significant differences in pre-period trends when examining the events in the years 2008-2009. They argue that the reason is that different industries were differentially affected by the financial crisis of 2008. We find no such pre-trends, which is perhaps not surprising given that we are comparing firms within one industry (i.e., airlines).

[16] In particular, we first normalize the asset manager's ownership stakes dividing them by the average ownership stake, so that the average ownership stake is equal to one for all asset managers. We then take standard deviation of the normalized ownership stakes. Finally, we average the distance measures across year-quarter, weighting by the asset manager's total assets in the year-quarter.

For our analysis, we use the set of 11 financial institution merger events between 2004 and 2011, to allow for a 3-year pre-period and a 5-year post-period. We construct two continuous treatment variables, based on the changes in lambda-intra and lambda-inter implied by the merger, respectively. For every airline and each merger event, we calculated lambda-intra and lambda-inter using the same ownership and market shares as in the last quarter before the merger announcement, except that we counterfactually treated the acquirer and the target as if they were already combined. The difference between these counterfactual lambdas and the actual lambdas measure how much one would have expected, *ex ante*, the merger to affect intra-industry and inter-industry common ownership for each airline. We denote $\Delta\lambda_i^{intra}$ the implied change in lambda-intra for airline i, and the implied change in lambda-inter $\Delta\lambda_i^{inter}$.



(a) Interaction of $\Delta\lambda^{intra}$ with time dummies

(b) Interaction of $\Delta\lambda^{inter}$ with time dummies

Figure 6. Interaction coefficients of continuous treatment variables $\Delta\lambda^{intra}$ and $\Delta\lambda^{inter}$ with a set of dummies for number of quarters since event. This Figure shows estimated values of β_s^{intra} and β_s^{inter} from Equation (9.1). The data is for the period 2001Q1-2015Q4, which implies that we use events with announcement dates from 2004 to 2011. Standard errors are clustered two-ways, by market-carrier and year-quarter.

We then estimate the following continuous-treatment event study specification, at the market-carrier-event level:

$$\log(p_{jret}) = \sum_{s=-12}^{20} \beta_s^{intra} \mathbb{1}(t=s) \times \Delta\lambda_{je}^{intra} + \sum_{s=-8}^{20} \beta_s^{inter} \mathbb{1}(t=s) \times \Delta\lambda_{je}^{inter} + \gamma_{jre} + \alpha_t + \varepsilon_{jret}, \quad (9.1)$$

where β_s^{intra} and β_s^{inter} are the parameters of interest, $\mathbb{1}(t=s)$ are a set of time-since-event dummies at the quarterly frequency, γ_{jre} are market-carrier-event fixed effects, and α_t are time-since-event fixed effects. In addition, we include as controls year-quarter fixed effects. We use the last quarter before the announcement as the base period, normalizing its coefficients to zero.

These results are shown in Figure 6. Consistent with our regression results, we find that changes in intra-industry common ownership (in this case generated by financial institution mergers) lead to higher airline prices, while changes in inter-industry common ownership (again, generated by financial instituiton mergers) lead to lower airline prices. We find no significant effect for the pre-period interaction terms, indicating that the pre-event trends are similar across different levels of both continuous treatment variables.

10 Conclusion

In this paper, we tested empirically one of the key predictions of general equilibrium oligopoly theory: that inter-industry common ownership should lead to lower prices in product markets, while intra-industry common ownership should increase prices. Using data for the airline industry, we constructed measures of inter-industry and intra-industry common ownership, and found that the facts provide substantial support for this theoretical prediction.

Although the result is consistent with the predictions of Azar and Vives (2021), there are other potential general equilibrium effects that the negative inter-industry coefficient could be capturing. For example, as pointed out by Azar (2012) and López and Vives (2019), common ownership between vertically related firms (through a reduction in double marginalization) or between horizontally related firms (through technological spillovers) could also imply potentially lower prices for consumers. Empirically, it is difficult to disentangle the inter-sectoral pecuniary externality from Azar and Vives (2021) from the other externalities, since both involve inter-industry lambdas, but with different weights.[17]

Our results need not be inconsistent with those of Boller and Scott Morton (2020), who find that entry into the S&P 500 of competitors increases common ownership in the industry, and firm profitability. Although they interpret their results as driven by lower product market competition, their finding of higher profits could also be driven by other mechanisms, for example lower competition in input and labor markets. Further empirical work would be required to test these competing mechanisms versus product market competition.

[17] We constructed a measure of inter-industry lambda at the carrier level with weights proportional to how much air transportation they use according to BEA Input-Output tables. We found that the correlation of this measure with our general measure of inter-industry common ownership was more than 98%.

The result that inter-industry common ownership has a negative effect on prices has important implications for the antitrust common ownership debate, especially as it relates to large and diversified asset managers, of which the Big Three are the most salient example. These asset managers hold companies across the economy, which has raised concerns that their common ownership could lead to higher prices in product markets. In this paper we have shown that, at least in the airline industry, this is not the case. In fact, the prediction from Azar and Vives (2021)'s general equilibrium oligopoly model is that that common ownership by "universal owners" should lead to lower product-market prices.

References

ANTÓN, M., F. EDERER, M. GINÉ, AND M. C. SCHMALZ (2020): "Common ownership, competition, and top management incentives," *Ross School of Business Paper*, (1328).

AZAR, J. (2012): "A new look at oligopoly: Implicit collusion through portfolio diversification," *Ph.D. Thesis, Princeton University*.

——— (2017): "Portfolio diversification, market power, and the theory of the firm," *SSRN Working Paper*.

AZAR, J., M. C. SCHMALZ, AND I. TECU (2018): "Anti-competitive effects of common ownership," *The Journal of Finance*, 73(4), 1513–1565.

AZAR, J., AND X. VIVES (2019): "Common ownership and the secular stagnation hypothesis," *AEA Papers and Proceedings*, 109, 322–326.

——— (2021): "General Equilibrium Oligopoly and Ownership Structure," *Econometrica*, 89(3), 999–1048.

BACKUS, M., C. CONLON, AND M. SINKINSON (2021a): "Common ownership and competition in the ready-to-eat cereal industry," Discussion paper, National Bureau of Economic Research.

——— (2021b): "Common ownership in America: 1980-2017," *American Economic Journal: Microeconomics*, 13(3), 273–308.

BANAL-ESTAÑOL, A., J. SELDESLACHTS, AND X. VIVES (2020): "Diversification, Common Ownership, and Strategic Incentives," in *AEA Papers and Proceedings*, vol. 110, pp. 561–64.

BANAL-ESTAÑOL, A., J. SELDESLACHTS, AND X. VIVES (2022): "Financial Markets, Common Ownership, and Product Market Outcomes," .

BINDAL, S., AND J. NORDLUND (2022): "When Does Common Ownership Matter?," *Available at SSRN*.

BOLLER, L., AND F. SCOTT MORTON (2020): "Testing the theory of common stock ownership," Discussion paper, National Bureau of Economic Research.

BRITO, D., A. OSÓRIO, R. RIBEIRO, AND H. VASCONCELOS (2018): "Unilateral effects screens for partial horizontal acquisitions: The generalized HHI and GUPPI," *International Journal of Industrial Organization*, 59, 127–289.

DENNIS, P. J., K. GERARDI, AND C. SCHENONE (2019): "Common ownership does not have anti-competitive effects in the airline industry," *FRB Atlanta Working Paper*.

ELHAUGE, E. (2021): "The causal mechanisms of horizontal shareholding," *Ohio St. LJ*, 82, 1.

ELHAUGE, E. R. (2016): "Horizontal shareholding," *Harvard Law Review*, 109(5).

FICHTNER, J., E. M. HEEMSKERK, AND J. GARCIA-BERNARDO (2017): "Hidden power of the Big Three? Passive index funds, re-concentration of corporate ownership, and new financial risk," *Business and Politics*, 19(2), 298–326.

FREEMAN, K. (2019): "The effects of common ownership on customer-supplier relationships," *Kelley School of Business Research Paper*, (16-84).

GABSZEWICZ, J. J., AND J.-P. VIAL (1972): "Oligopoly "a la Cournot" in a general equilibrium analysis," *Journal of Economic Theory*, 4(3), 381–400.

GUTIÉRREZ, G., AND T. PHILIPPON (2017): "Investment-less growth: an empirical investigation," *Brookings Papers on Economic Activity*, pp. 89–190.

HE, J., AND J. HUANG (2017): "Product market competition in a world of cross ownership: evidence from institutional blockholdings," *Review of Financial Studies*, 30, 2674–2718.

HEMPHILL, C. S., AND M. KAHAN (2019): "The strategies of anticompetitive common ownership," *Yale LJ*, 129, 1392.

LEWELLEN, K., AND M. LOWRY (2021): "Does common ownership really increase firm coordination?," *Journal of Financial Economics*, 141(1), 322–344.

LÓPEZ, Á. L., AND X. VIVES (2019): "Overlapping ownership, R&D spillovers, and antitrust policy," *Journal of Political Economy*, 127(5), 2394–2437.

NEWHAM, M., J. SELDESLACHTS, AND A. BANAL-ESTANOL (2018): "Common Ownership and Market Entry: Evidence from Pharmaceutical Industry," *DIW Berlin Discussion Paper No. 1738*.

NOVICK, B. (2019): "Diversified portfolios do not reduce competition," *Harvard Law School Forum on Corporate Governance*.

O'BRIEN, D. P., AND S. C. SALOP (2000): "Competitive effects of partial ownership: financial interest and corporate control," *Antitrust Law Journal*, 67(2), 559–614.

O'BRIEN, D. P., AND K. WAEHRER (2017): "The competitive effects of common ownership: we know less than we think," *Antitrust Law Journal*, 81(3), 729–776.

POSNER, E. A., F. M. SCOTT MORTON, AND E. G. WEYL (2017): "A proposal to limit the anti-competitive power of institutional investors," *Antitrust Law Journal*, 81(3), 669–728.

ROCK, E. B., AND D. L. RUBINFELD (2017): "Defusing the antitrust threat to institutional investor involvement in corporate governance," *NYU Law and Economics Research Paper*.

ROTEMBERG, J. (1984): "Financial transaction costs and industrial performance," *MIT Sloan Working Paper*.

RUIZ-PÉREZ, A. (2019): "Market Structure and Common Ownership: Evidence from the US Airline Industry," Discussion paper, CEMFI Working Paper.

TIBSHIRANI, R. (1996): "Regression shrinkage and selection via the lasso," *Journal of the Royal Statistical Society: Series B (Methodological)*, 58(1), 267–288.

TZANAKI, A. (2022): "Varieties and Mechanisms of Common Ownership: A Calibration Exercise for Competition Policy," *Journal of Competition Law & Economics*, 18(1), 168–254.

ZHAO, P., AND B. YU (2006): "On model selection consistency of Lasso," *The Journal of Machine Learning Research*, 7, 2541–2563.

Appendix

A Variable Definitions

- λ^{intra}: We calculate the intra-industry lambda for carrier j at year-quarter t as the weighted average of the weight that the carrier puts on other carriers' profits in its objective function, relative to its own profits. The weights in the weighted average are the national-level market shares of the other carriers.

- λ^{inter}: We calculate the inter-industry lambda for carrier j at year-quarter t as the weighted average of the weight that the carrier puts on the profits of non-airline S&P 500 firms in its objective function, relative to its own profits. The weights in the weighted average proportional to the S&P 500 firms' revenues.

- λ^{intra} (Route-Level): We calculate the intra-industry lambda for carrier j at year-quarter t in route r as the weighted average of the weight that the carrier puts on other carriers' profits in its objective function, relative to its own profits. The weights in the weighted average are the route-level market shares of the other carriers.

- $\lambda^{intra}_{BigThree}$ and λ^{intra}_{Other}: These are the components of lambda-intra corresponding to the Big Three and to non-Big Three shareholders, calculated using the formula in equation 8.1.

- $\lambda^{inter}_{BigThree}$ and λ^{inter}_{Other}: These are the components of lambda-inter corresponding to the Big Three and to non-Big Three shareholders, calculated using the formula in equation 8.1.

- Average fare: We calculate the average fare for a carrier in a given market and quarter as the sum of the revenue in that market and quarter divided by the total passengers in the market and quarter.

- Number of non-stop carriers: We define a carrier to be operating nonstop in a market in a quarter if it performs at least 60 nonstop flights each way in the quarter, according to the T100 database. We then count the number of carriers on the route and quarter as the number of marketing carriers that are associated with a nonstop operating carrier on the route. We do not count carriers that are excluded in the HHI calculation.

- Southwest indicator: This is a dummy variable that is equal to one if Southwest operates at least 24 nonstop flights in each direction in a market and quarter, and zero otherwise.
- Other LCC indicator: This is a dummy variable that is equal to one if an LCC other than Southwest operates at least 24 nonstop flights in each direction in a market and quarter, and zero otherwise. We consider the following LCC carriers: Southwest, Frontier, JetBlue, Virgin, AirTran, Spirit, Allegiant, Sun Country, Independence, ATA Airlines, Skybus, and North American Airlines.
- Population: We measure the population in a market and quarter as the geometric mean of endpoint populations in millions. Data on MSA populations come from the Bureau of Economic Analysis.
- Income per capita: We measure income per capita in a market and quarter as the geometric mean of endpoint incomes per capita (in thousands, 2008 dollars). Data on MSA income per capita come from the Bureau of Economic Analysis.
- Share of passengers traveling connect, market level: This variable is the fraction of passengers in a market and quarter that use connecting flights.
- Share of passengers traveling connect: This variable is the fraction of passengers of a given carrier in a market and quarter that use connecting flights.

B Proofs

Proof of Proposition 1. The objective of firm nj's manager is to maximize

$$\rho_n F_{nj}(L_{nj}) - \omega L_{nj} + \sum_{k \neq j} \lambda_{nj,nk}(\rho_n F_{nk}(L_{nk}) - \omega L_{nk}) + \sum_{m \neq n} \sum_{k=1}^{J_m} \lambda_{nj,mk}(\rho_m F_{mk}(L_{mk}) - \omega L_{mk}).$$

The first-order condition with respect to L_{nj} is

$$\rho_n F'_{nj} - \omega = -\frac{\partial \rho_n}{\partial L_{nj}} \left[F_{nj}(L_{nj}) + \sum_{k \neq j} \lambda_{nj,nk} F_{nk}(L_{nk}) \right] - \sum_{m \neq n} \frac{\partial \rho_m}{\partial L_{nj}} \left[\sum_{k=1}^{J_m} \lambda_{nj,mk} F_{mk}(L_{mk}) \right] = 0$$

Using the fact that $\frac{\partial \rho_n}{\partial L_{nj}} = -\frac{1}{\theta} \rho_n \left[1 - \left(\frac{p_n c_n}{PC} \right) \right] \frac{F'(L_{nj})}{c_n}$, and that $\frac{\partial \rho_m}{\partial L_{nj}} = \frac{1}{\theta} \left(\frac{p_m c_m}{PC} \right) \rho_n \frac{F'(L_{nj})}{c_m}$, we can rewrite the first-order condition as

$$\rho_n F'_{nj} - \omega = \frac{1}{\theta}\rho_n F'_{nj}\left[(1-s_n)(s_{nj} + \sum_{k\neq j}\lambda_{nj,nk}s_{nk}) - \sum_{m\neq n} s_m\left(\sum_{k=1}^{J_m}\lambda_{nj,mk}s_{mk}\right)\right] = 0,$$

where s^L_{nj} is firm nj's labor market share, s_{nj} is firm nj's product market share within industry n, and s_n is industry n's revenue share in the economy.

Note that we can write

$$\sum_{k\neq j}\lambda_{nj,nk}s_{nk} = (1-s_{nj})\sum_{k\neq j}\lambda_{nj,nk}\frac{s_{nk}}{1-s_{nj}} = (1-s_{nj})\overline{\lambda}^{intra}_{nj},$$

where $\overline{\lambda}^{intra}_{nj}$ is the weighted average of firm nj's intra-industry lambdas, weighted by the other firms' product market shares.

Similarly, we can write

$$\sum_{m\neq n} s_m\left(\sum_{k=1}^{J_m}\lambda_{nj,mk}s_{mk}\right) = (1-s_n)\sum_{m\neq n}\sum_{k=1}^{J_m}\lambda_{nj,mk}\frac{s_m s_{mk}}{1-s_n} = (1-s_n)\overline{\lambda}^{inter}_{nj},$$

where $\overline{\lambda}^{intra}_{nj}$ is the weighted average of firm nj's inter-industry lambdas, weighted by the other firms' shares of revenues (note that, because we are averaging across industries, the weights involve revenues and not just quantities).

Substituting these expressions into the first-order condition:

$$\rho_n F'_{nj} = 1 + \frac{\rho_n F'_{nj}}{\omega}\frac{1}{\theta}\left[(1-s_n)(s_{nj} + (1-s_{nj})\overline{\lambda}^{intra}_{nj} - \overline{\lambda}^{inter}_{nj})\right].$$

Dividing by ω, we obtain

$$\frac{\rho_n F'_{nj}}{\omega} = 1 + \frac{\rho_n F'_{nj}}{\omega}\frac{1}{\theta}\left[(1-s_n)(s_{nj} + (1-s_{nj})\overline{\lambda}^{intra}_{nj} - \overline{\lambda}^{inter}_{nj})\right].$$

Solving for $\frac{\rho_n F'_{nj}}{\omega}$, we obtain:

$$\frac{\rho_n F'_{nj}}{\omega} = \frac{1}{1 - \frac{1}{\theta}(1-s_n)\left(s_{nj} + (1-s_{nj})\overline{\lambda}^{intra}_{nj} - \overline{\lambda}^{inter}_{nj}\right)}.$$

Note that the marginal cost for firm nj is the real wage divided by the marginal product of labor: ω/F'_{nj}. Thus, the marginal cost over the price is

$$\frac{\omega/F'_{nj}}{\rho_n} = 1 - \frac{1}{\theta}(1-s_n)\left(s_{nj} + (1-s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter}\right).$$

Therefore, the markup $\frac{\rho_n - \omega/F'_{nj}}{\rho_n}$ is

$$\frac{\rho_n - \omega/F'_{nj}}{\rho_n} = \frac{1}{\theta}(1-s_n)\left(s_{nj} + (1-s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter}\right).$$

The second-order condition of firm nj is

$$\begin{aligned}
&\frac{\partial \rho_n}{\partial L_{nj}} F'_{nj}\left\{1 - \frac{1}{\theta}\left[(1-s_n)(s_{nj} + (1-s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter})\right]\right\} \\
&+ \rho_n F''_{nj}\left\{1 - \frac{1}{\theta}\left[(1-s_n)(s_{nj} + (1-s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter})\right]\right\} \\
&- \frac{1}{\theta}\rho_n F'_{nj}\frac{\partial(1-s_n)}{\partial L_{nj}}(s_{nj} + (1-s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter}) \\
&- \frac{1}{\theta}\rho_n F'_{nj}(1-s_n)(1-\overline{\lambda}_{nj}^{intra})\frac{\partial s_{nj}}{\partial L_{nj}}.
\end{aligned}$$

The key condition for the second-order condition to be negative will be that $\Psi_{nj} \equiv (s_{nj} + (1 - s_{nj})\overline{\lambda}_{nj}^{intra} - \overline{\lambda}_{nj}^{inter})$ is less than or equal to one. A sufficient condition for this is that $\overline{\lambda}_{nj}^{intra} \leq 1$.

If the condition that $\Psi_{nj} \leq 1$ holds, then it is straightforward to show that (under non-increasing returns to scale) the first, second, and fourth terms are negative.

However, the third term is positive, since the derivative of $1 - s_n$ with respect to L_{nj} is negative. Still, we can show that the combination of the first and third terms are negative, and therefore overall the second-order condition is negative. The first and third terms can be written as:

$$\frac{\partial \rho_n}{\partial L_{nj}} F'_{nj}\left[1 - \frac{1}{\theta}(1-s_n)\Psi_{nj}\right] - \frac{1}{\theta}\rho_n F'_{nj}\frac{\partial(1-s_n)}{\partial L_{nj}}\Psi_{nj}. \tag{B.1}$$

As an intermediate step, we calculate the derivatives $\frac{\partial \rho_n}{\partial L_{nj}}$ and $\frac{\partial(1-s_n)}{\partial L_{nj}}$:

$$\frac{\partial \rho_n}{\partial L_{nj}} = -\frac{1}{\theta}\rho_n \frac{F'_{nj}}{c_n}(1-s_n),$$

$$\frac{\partial(1-s_n)}{\partial L_{nj}} = -\left(1-\frac{1}{\theta}\right)\frac{F'_{nj}}{c_n}(1-s_n)s_n.$$

Replacing these derivatives in Equation (B.1) yields

$$-\frac{1}{\theta}\rho_n\frac{(F'_{nj})^2}{c_n}(1-s_n)\left[1-\frac{1}{\theta}(1-s_n)\Psi_{nj}\right]+\frac{1}{\theta}\rho_n\frac{(F'_{nj})^2}{c_n}(1-s_n)\left(1-\frac{1}{\theta}\right)s_n\Psi_{nj}$$
$$=-\frac{1}{\theta}\rho_n\frac{(F'_{nj})^2}{c_n}(1-s_n)\left[1-\Psi_{nj}\left(\frac{1}{\theta}(1-s_n)+\left(1-\frac{1}{\theta}\right)s_n\right)\right].$$

.

This expression is negative if $\Psi_{nj}\leq 1$, since $\left(\frac{1}{\theta}(1-s_n)+\left(1-\frac{1}{\theta}\right)s_n\right)$ is less than one, and therefore the factor $\left[1-\Psi_{nj}\left(\frac{1}{\theta}(1-s_n)+\left(1-\frac{1}{\theta}\right)s_n\right)\right]$ is positive.

The second-order condition for firm nj is thus

$$\frac{\partial^2\zeta}{\partial L_{nj}^2} = -\frac{1}{\theta}\rho_n\frac{{F'_{nj}}^2}{c_n}(1-s_n)\Bigg\{1-\left[\frac{1}{\theta}(1-s_n)+\left(1-\frac{1}{\theta}\right)s_n\right]\Psi_{nj}$$
$$+(1-\overline{\lambda}_{nj}^{intra})(1-s_{nj})-\frac{F''_{nj}}{F'_{nj}(1-s_n)}\left[1-\frac{(1-s_n)\Psi_{nj}}{\theta}\right]\Bigg\}.$$

Thus, the second-order condition is negative if $\overline{\lambda}_{nj}^{inter}\leq\overline{\lambda}_{nj}^{intra}\leq 1$. □

C First-Stage Regression Tables

Table C1. Effect of Intra- and Inter-Industry Common Ownership on Airline Ticket Prices: First Stage of Panel 2SLS Regressions.

Intra-industry common ownership is measured as λ_{intra}. Inter-industry common ownership is measured as λ_{inter}. Data are for the period 2001Q1-2014Q4. We exclude routes with less than 20 passengers per day on average. For the market-carrier-level regressions, we weight by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. For the market-level regressions, we weight by average passengers in the market over time and cluster standard errors two-ways at the market and year-quarter level. Variable definitions are provided in the Appendix.

	Dependent Variable:					
	λ^{intra}	λ^{inter}	λ^{intra}	λ^{inter}	λ^{intra}	λ^{inter}
	(1)	(2)	(3)	(4)	(5)	(6)
λ^{intra} (simple average)	0.600***	-0.0567***	0.598***	-0.0540***	0.599***	-0.0541***
	(0.0425)	(0.0107)	(0.0419)	(0.0106)	(0.0418)	(0.0106)
λ^{inter} (simple average)	0.429***	1.043***	0.428***	1.042***	0.427***	1.042***
	(0.0374)	(0.0170)	(0.0373)	(0.0170)	(0.0374)	(0.0170)
Log(Distance) × Year-Quarter FE			✓	✓	✓	✓
Additional Controls					✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	1,217,886	1,217,886	1,217,886	1,217,886	1,191,098	1,191,098