Revisiting the Anticompetitive Effects of Common Ownership*

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Abstract

We use data from the U.S. airline industry to study the effect of intra-industry and inter-industry common ownership on prices. We find that, consistent with the hypothesis from the general equilibrium model of Azar and Vives (2021), 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.

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

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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. Although measures of common ownership are positively correlated, an elastic net 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.

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 (the weights that the manager of a firm puts on the profits of other firms) is a better measure of that carrier's common ownership. To address the endogeneity of market shares, we use the within-components of Melitz-Polanec decompositions of both the intra and inter-industry lambdas as instruments (Melitz and Polanec, 2015). 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). 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 their respective within components.

[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.

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.

To address concerns that ownership is endogenous, and not just market shares, we constructed instruments based on mergers of financial institutions, using the list of mergers from Lewellen and Lowry (2021). These mergers generated variation in both 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. Schmalz (2021) provides a comprehensive survey of the potential mechanisms at work including engagement (voice and exit), executive compensation, common directors, and disclosure. The conclusion is that common owners do influence firms' decisions.[3] We are agnostic on the specific mechanism. 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

[3] Shekita (2022) displays thirty instances where common owners that document how they affect firm behavior. Among them work by Condon (2020) is cited that shows how common owners lobbied successfully oil companies to adopt carbon abatement targets. See, also Hemphill and Kahan (2019), Elhauge (2021), and Tzanaki (2022).

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.

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, the upward pricing pressure from common ownership by diversified shareholders like the Big Three is mitigated (partially or fully, depending on the route).[4]

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 elastic net 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

[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.

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.

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

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

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

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

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:

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

[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).

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 calculate the within component of the Melitz-Polanec decomposition of intra- and inter-industry lambdas, that are not weighted by market shares, which we use as instruments for the weighted measures. This treats 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] We also instrument using variation from asset manager mergers, which relaxes this exclusion restriction.

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 *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

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

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, 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,

[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.

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.

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%*

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 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. We added five more years to the dataset, and therefore our sample is for the period 2001Q1-2019Q4. 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]

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

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 2001Q1-2019Q4 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} (Route-Level)	0.41	0.28	0	1.93	1605524
λ^{intra} (Firm-Level)	0.43	0.25	0	1.52	1578613
λ^{inter}	0.34	0.21	0	1.17	1578613
$\lambda^{intra}_{BigThree}$	0.18	0.16	0	0.9	1578613
λ^{intra}_{Other}	0.25	0.14	0	0.93	1578613
$\lambda^{inter}_{BigThree}$	0.21	0.18	0	0.97	1578613
λ^{inter}_{Other}	0.13	0.06	0	0.31	1578613
Average Fare	227.84	95.2	25	2498.62	1626344
Log Average Fare	5.36	0.37	3.22	7.82	1626344
HHI	4701.92	2075.99	971.16	10000	1626344
MHHI	6928.3	1928.89	1194.47	14337.68	1578613
delta	2217.98	1612.93	0	12722.24	1578613
Number of Nonstop Carriers	0.81	1.27	0	11	1626344
Southwest Indicator	0.11	0.31	0	1	1626344
Other LCC Indicator	0.1	0.31	0	1	1626344
Share of Passengers Traveling Connect, Market-Level	0.66	0.39	0	1	1626344
Share of Passengers Traveling Connect	0.86	0.33	0	1	1626344
Log(Population)	0.64	0.69	-3.9	2.79	1573089
Log(Income Per Capita)	-3.15	0.13	-3.87	-2.18	1573089
distance	2639.6	1523.67	27	12714	1626344
Average Passengers	4073.86	11674.09	10	251171.3	1626344

sample.
[11]This measure of common ownership has been used also by, for example, Antón, Ederer, Giné, and Schmalz (2023).

Table 2 shows summary statistics for our dataset. The average of the intra-industry lambdas is 0.43, with a standard deviation of 0.25. The average of the inter-industry lambdas is somewhat lower, at 0.34, with a standard deviation of 0.16. The correlation coefficient between the intra- and inter-industry lambdas is 0.904.

We can do a decomposition of both the intra-industry and inter-industry lambdas, by taking only the terms of the numerator that correspond to the Big Three shareholders (BlackRock, Vanguard, and State Street), and the terms that correspond to other (i.e., non-Big Three) shareholders. We can see that, on average, the Big Three account for 0.18 (out of 0.43 in total) of the intra-industry lambda, while the other shareholders account for 0.25. For the inter-industry lambda, however, the Big Three account for 0.21 (out of 0.34 in total), and the other account for only 0.13. This indicates that, although the Big Three are important in accounting both intra-industry and inter-industry common ownership, they are relatively more important in driving inter-industry common ownership, compared to intra-industry common ownership.

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]

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

[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).

[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 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

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

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

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.

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 2001Q1-2019Q4. We exclude routes with less than 20 passengers per day on average. We weigh observations by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier 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} (Route-Level)	0.0927***	0.0810***	0.0664***	0.211***	0.191***	0.158***
	(0.0164)	(0.0131)	(0.0141)	(0.0340)	(0.0310)	(0.0312)
λ^{inter}	-0.0595**	-0.0478**	-0.0361*	-0.197***	-0.176***	-0.144***
	(0.0229)	(0.0204)	(0.0211)	(0.0406)	(0.0374)	(0.0368)
Number of Nonstop Carriers			-0.0117***			-0.0120***
			(0.00275)			(0.00272)
Southwest Indicator			-0.130***			-0.128***
			(0.00847)			(0.00840)
Other LCC Indicator			-0.0869***			-0.0858***
			(0.00650)			(0.00642)
Share of Passengers Traveling Connect, Market-Level			0.0478***			0.0487***
			(0.0134)			(0.0135)
Share of Passengers Traveling Connect			0.110***			0.107***
			(0.0106)			(0.0107)
Log(Population)			0.0136			0.0196
			(0.0829)			(0.0809)
Log(Income Per Capita)			-0.227***			-0.220***
			(0.0796)			(0.0764)
Log(Distance) × Year-Quarter FE		✓	✓		✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	1,554,120	1,554,120	1,507,347	1,554,120	1,554,120	1,507,347
R-squared	0.006	0.005	0.079	-0.003	-0.003	0.073
Number of market-carrier pairs	48001	48001	46275	48001	48001	46275
Kleibergen-Paap F-Stat				433.4	431.3	421.5

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

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 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 the within component of a Melitz-Polanec decomposition (Melitz and Polanec, 2015). 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

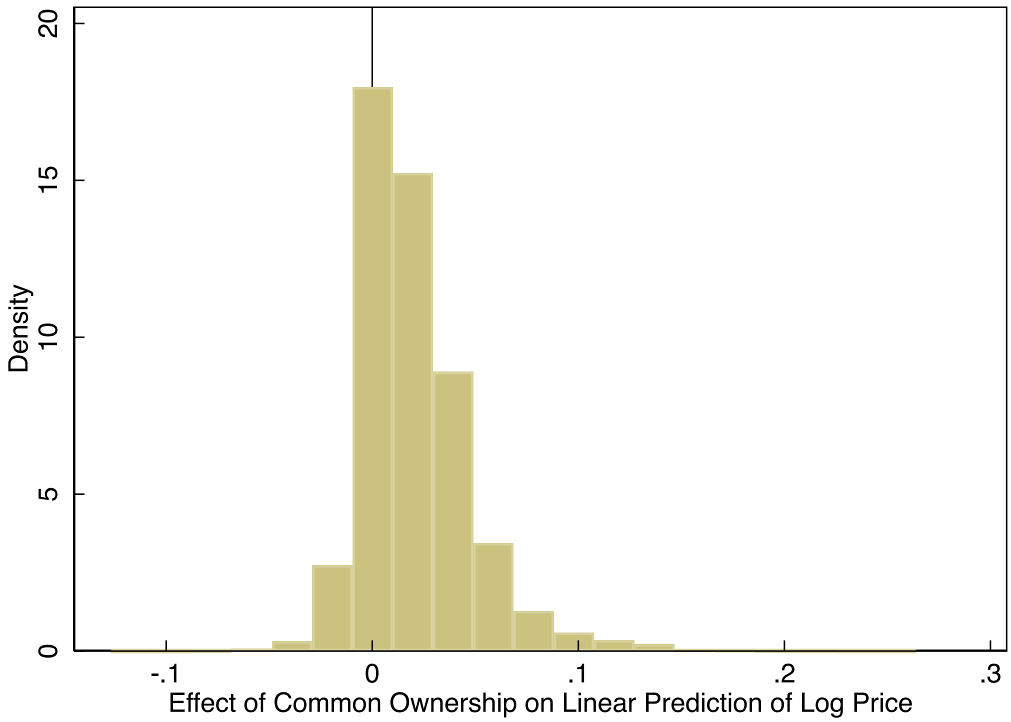


Figure 1. Distribution of the Total Effect of Common Ownership on the Linear Prediction of Log Price. Results are based on predictions using specification (6) from Table 4.

common ownership measures set equal to zero. 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, with the effect being negative in a non-trivial fraction of the observations.

6 Variable Selection Using Elastic Nets

The raw correlation between the route-level lambda-intra and lambda-inter is close to 0.8. The correlation between the residuals of lambda-intra and the residuals of lambda-inter from regressions with market-carrier and time fixed effects goes down to around 0.7. This correlation between lambda-intra and lambda-inter could potentially raise concerns about multicollinearity. Given that lambda-intra and lambda-inter are positively correlated, would it be better to include only intra-industry lambda (or only inter-industry lambda) in the regressions? To answer this question, we used the Lasso and its generalization (elastic nets) for variable selection to see if technique would select only one of the two lambdas for inclusion in the regression model.

Elastic nets are 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). Ridge regression is similar to the Lasso, but it uses the L_2 distance to measure the size of the coefficients instead of L_1. Elastic nets are a generalization that nests the two, and cover a continuum of intermediate distances.

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

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 elsatic net 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. If $\alpha = 0$, then the elastic net is equivalent to the Ridge, while if $\alpha = 1$ it is equivalent to the Lasso.

In all cases with $\alpha > 0$, the penalty function is not smooth (i.e., it has "kinks"), and some of the coefficients with the elsatic net estimator can be exactly zero. It is this property that makes the elastic nets, except for the Ridge regression, useful as a variable selection technique.[14] We still run the Ridge regression, because it is the classical treatment for multicollinearity when there is the suspicion that the $X'X$ matrix may be close to singular.

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 2 shows the value of the cross-validation objective function and the evolu-

[14]Before we apply the elastic net, we partial out the market-carrier and time fixed effects, so that we estimate the model using the residualized versions of the log price, and of lambda-intra and lambda-inter. We also standardize the variables so that both have a mean of zero and a variance of one. Thus, we use the elastic net models to select the lambda variables to be included in the already double-within-transformed model. This way, we do not use the elastic net models to select a subset of the dummy variables in the fixed effects model.

tion of the coefficients as a function of the penalty parameter k, for three cases: $\alpha = 0$ (Ridge), $\alpha = 0.5$ (an intermediate elastic net), and $\alpha = 1$ (Lasso). In all three cases, the technique selects a penalty parameter very close to zero, indicating that a model that is virtually identical to OLS is the one that fits the data best out-of-sample.

As can be seen in Figure 2, for a relatively high value of the penalty parameter, both the intermediate elastic net and the Lasso set the coefficients for both lambda-intra and lambda-inter equal to zero, effectively excluding both variables from the model and leaving only the constant. However, these models has the worst out-of-sample fit out of the possible models. As we decrease the penalty parameter, both models choose 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 a certain threshold, both models set non-zero coefficients for both lambda-intra *and* lambda-inter, and the out-of-sample model fit improves 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, and including both variables, lambda intra and lambda inter. The magnitude of the coefficients in the best-fitting model is not comparable to that in our OLS estimates from Table 4, because the variables have been standardized.

In addition to the elastic net models for variable selection, we calculated the variance inflation factors (VIF) of the (residualized) lambda-intra and lambda-inter in the regression model, in order to assess how close to singular the $X'X$ matrix of the coefficients is. The VIF captures the fact that, if the predictors are correlated with each other, the standard errors of the coefficients will be larger than if they were uncorrelated. The VIF for both variables is 1.85, confirming the conclusion from the elastic net analysis, which indicates that multicollinearity is not a serious concern in our case.[15] The reason for the low VIF despite the high correlation between the two variables is that we have a very high number of observations (more than a million). Our large sample enables us to separately identify the effect of both variables despite the fact that they are correlated.

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

[15] It is generally thought that VIF above 10 indicate that multicollinearity is a serious problem (Shalizi, 2015).

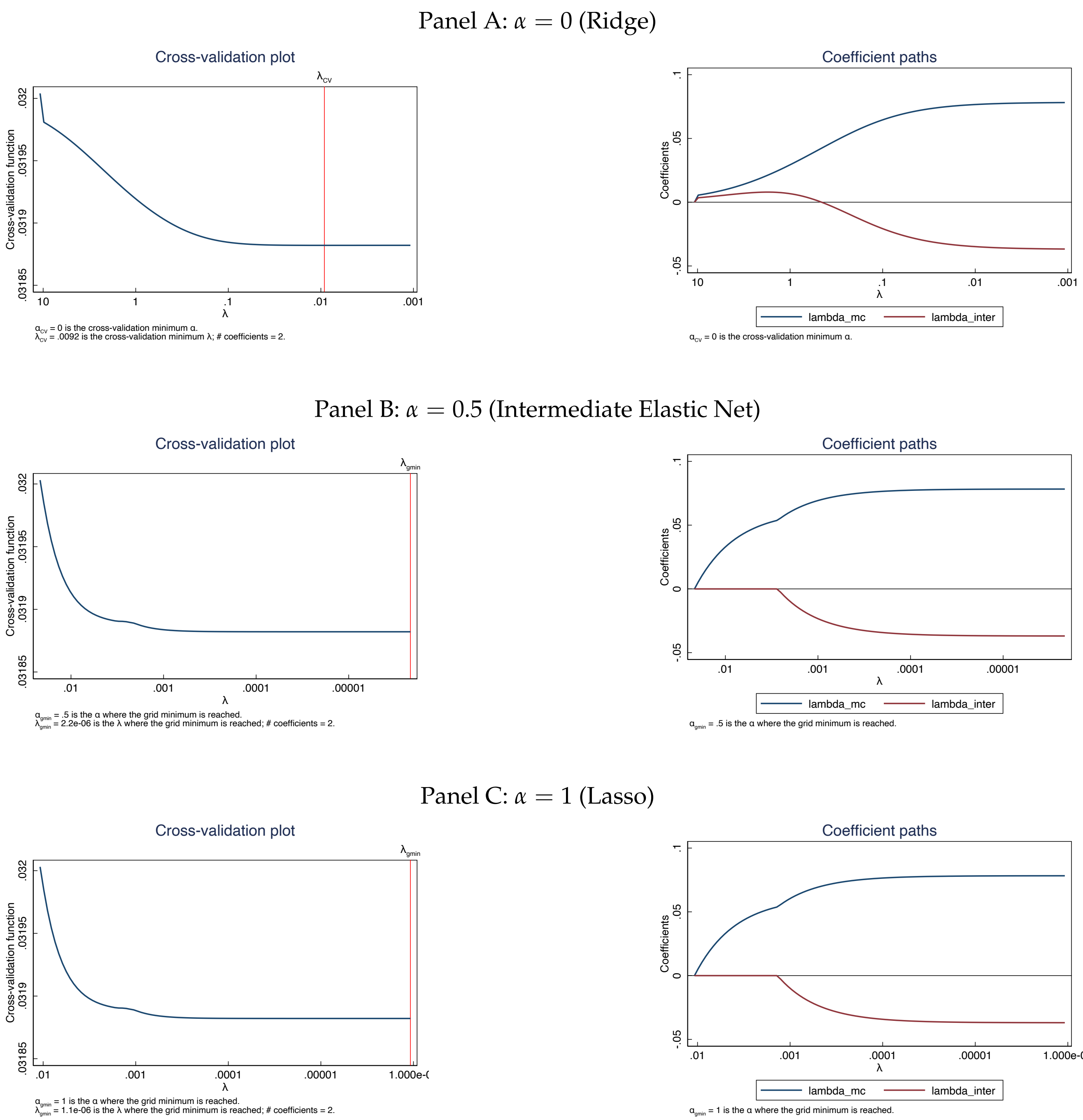


Figure 2. Elastic Net Cross-Validation and Coefficient Paths Plots. Panel A shows the out-of-sample MSE of the predictions of the model as a function of the penalty parameter k in the $\alpha = 0$ case (Ridge). Lower values of the cross-validation objective function (the mean squared error of the out-of-sample 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. On the right, it shows the evolution of the coefficients as the penalty parameter k decreases. Panels B and C show analogous results for the $\alpha = 0.5$ (intermediate elastic net) and $\alpha = 1$ (Lasso).

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 two-thirds the size as the original sample (900,835 observations vs 1,524,950 observations in the baseline specification). 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 route level, as suggested by the theoretical framework. However, we can also calculate a 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.

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 2001Q1-2019Q4. 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. We weigh observations by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. Variable definitions are provided in the Appendix.

	Dependent Variable: Log(Average Fare)					
	Excluding Bankruptcies (1)	Only Intra (2)	Firm-Level Intra (3)	Proportional Control (4)	Including HHI (5)	Dynamic (6)
λ^{intra} (Route-Level)	0.176***	0.0720***		0.170***	0.155***	-0.00126
	(0.0422)	(0.0157)		(0.0340)	(0.0311)	(0.0469)
λ^{intra} (Firm-Level)			0.308***			
			(0.0403)			
λ^{inter}	-0.109**		-0.310***	-0.156***	-0.141***	0.0104
	(0.0470)		(0.0487)	(0.0396)	(0.0364)	(0.0567)
λ^{intra}_{t+1} (Route-Level),						0.0514
						(0.0322)
λ^{intra}_{t-1} (Route-Level),						0.124***
						(0.0399)
λ^{inter}_{t+1},						-0.0486
						(0.0419)
λ^{inter}_{t-1},						-0.131***
						(0.0469)
HHI					0.294***	
					(0.0716)	
Additional Controls	✓	✓	✓	✓	✓	✓
Log(Distance) × Year-Quarter FE	✓	✓	✓	✓	✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	900,835	1,507,347	1,524,950	1,507,347	1,507,347	1,240,051
R-squared	0.074	0.078	0.083	0.073	0.070	0.073
Kleibergen-Paap F-Stat	252.1	2057	157.4		90.19	131.1
Number of market-carrier pairs	41711	46275	46814	46275	46275	36146

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

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, 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.

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 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):[16]

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

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

[16]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.

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 both intra-industry common ownership by the Big Three and other shareholders has a positive effect on airline prices. The effect is statistically significant (at the 5% level for the Big Three, and at the 10% level for the other shareholders).

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 for both, but only statistically significant for the Big Three.

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

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

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.

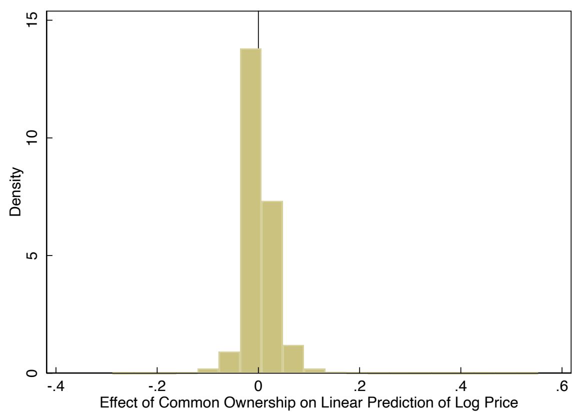
Table 6. Effect on Airline Prices of Intra- and Inter-Industry Common Ownership by the Big Three and by Other Shareholders.

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 2001Q1-2019Q4. We exclude routes with less than 20 passengers per day on average. We weigh observations by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. Variable definitions are provided in the Appendix.

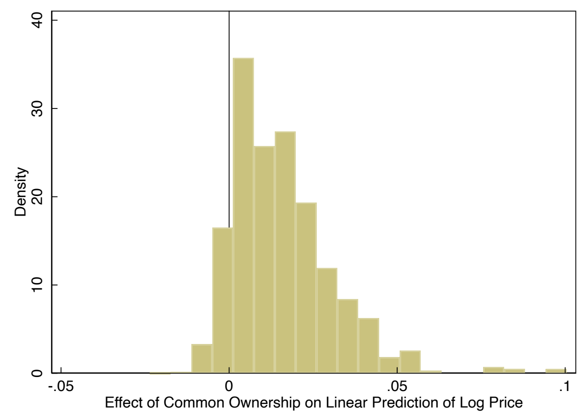
	Dependent Variable: Log(Average Fare)			
	(1)	(2)	(3)	(4)
λ^{intra}_{Big3}	0.101**	0.549***		
	(0.0402)	(0.0963)		
λ^{intra}_{Other}	0.0581*	0.102***		
	(0.0316)	(0.0338)		
λ^{inter}_{Big3}		-0.422***		
		(0.0744)		
λ^{inter}_{Other}		-0.0776		
		(0.0552)		
$\lambda^{intra}_{MoreDiversified}$			0.0905***	0.531***
			(0.0339)	(0.0953)
$\lambda^{intra}_{LessDiversified}$			0.0616*	0.0981***
			(0.0337)	(0.0352)
$\lambda^{inter}_{MoreDiversified}$				-0.409***
				(0.0730)
$\lambda^{inter}_{LessDiversified}$				-0.0735
				(0.0552)
Additional Controls	✓	✓	✓	✓
Log(Distance) × Year-Quarter FE	✓	✓	✓	✓
Year-quarter FE	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓
Observations	1,507,347	1,507,347	1,507,347	1,507,347
R-squared	0.077	0.061	0.077	0.060
Kleibergen-Paap F-Stat	477.7	48.94	437.2	50.43
Number of market-carrier pairs	46275	46275	46275	46275

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

Figure 3 (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. A large fraction of the observations is to



(a) Big Three



(b) Other Shareholders

Figure 3. 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.

the left of zero, indicating that, for a large number of market-carriers, the effect of common ownership by the Big Three was to reduce prices.

Figure 3 (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.[17] 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, both common ownership by the more and less diversified groups has a significant positive effect on prices (at the 1% level for the more diversified gruop, and at the 10% level for the less diversified). When

[17] 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.

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 effect on prices, with the effect being stastitically significant for the more diversified group of shareholders.

9 Identification from Financial Institution Mergers

The econometric analysis thus far treats market shares as endogenous, but ownership as exogenous. In this section, we implement a strategy used in the literature to relax this identification assumption. In particular, we identify the effect of intra-industry and inter-industry common ownership using only variation from mergers and acquisitions of financial institutions.[18]

To implement this identification strategy, we calculate the ex-ante predicted change in λ^{intra} and λ^{inter} from each financial institution M&A event, by calculating the counterfactual lambdas as if the acquisition had taken place the quarter before the acquisition, and taking the difference between these counterfactual lambdas and the actual lambdas. We then construct series for each lambda starting at zero and summing the predicted changes in the lambdas with each acquisition. We use these cumulative shock series as our instruments for the realized intra-industry and inter-industry lambdas.

The results are shown in Table 7. The first three specifications are the same as the baseline but using financial institution mergers as instruments. The next three specifications present the same specifications, but excluding events from 2008 and 2009 in the calculation of the instruments, given the concern raised by Lewellen and Lowry (2021) about potential contamination from the financial crisis. In all cases, we find a large and significant positive effect of intra-industry common ownership on prices, and a large and significant negative effect of inter-industry common ownership on prices.

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-

[18]This strategy was first implemented in Azar, Schmalz, and Tecu (2018), based on the acquisition of Barclays Global Investors by BlackRock. It was extended by He and Huang (2017) and Lewellen and Lowry (2021) to use all the financial institution in the period. In this section, we use the list of financial institution M&A from Lewellen and Lowry (2021).

Table 7. Effect of Intra- and Inter-Industry Common Ownership on Airline Ticket Prices: Panel Regressions with Financial Institution Mergers as Instruments.

Intra-industry common ownership is measured as λ_{intra}. Inter-industry common ownership is measured as λ_{inter}. Data are for the period 2001Q1-2019Q4. We exclude routes with less than 20 passengers per day on average. We weigh observations by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier and year-quarter level. Variable definitions are provided in the Appendix.

	Dependent Variable: Log(Average Fare)					
	All Events			Excluding 2008-2009 Events		
	(1)	(2)	(3)	(4)	(5)	(6)
λ^{intra} (Route-Level)	0.723***	0.619**	0.581**	0.731***	0.630***	0.602***
	(0.242)	(0.247)	(0.239)	(0.210)	(0.209)	(0.195)
λ^{inter}	-1.132***	-1.014***	-0.900***	-1.059***	-0.944***	-0.786**
	(0.189)	(0.186)	(0.176)	(0.356)	(0.339)	(0.305)
Additional Controls	✓	✓	✓	✓	✓	✓
Log(Distance) × Year-Quarter FE		✓	✓		✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	1,554,120	1,554,120	1,507,347	1,554,120	1,554,120	1,507,347
R-squared	-0.314	-0.247	-0.131	-0.294	-0.228	-0.114
Kleibergen-Paap F-Stat	14.03	12.96	16.64	7.481	6.865	7.127
Number of market-carrier pairs	48001	48001	46275	48001	48001	46275

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

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.[19]

[19]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%.

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.

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. SCHMALZ (2023): "Common ownership, competition, and top management incentives," *Journal of Political Economy*, 131(5), 1294–1355.

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): "Ownership Diversification and Product Market Pricing Incentives," *Working Paper*.

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.

CONDON, M. (2020): "Externalities and the common owner," *Wash. L. Rev.*, 95, 1.

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.

MELITZ, M. J., AND S. POLANEC (2015): "Dynamic Olley-Pakes productivity decomposition with entry and exit," *The Rand journal of economics*, 46(2), 362–375.

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.

SCHMALZ, M. C. (2021): "Recent studies on common ownership, firm behavior, and market outcomes," *The Antitrust Bulletin*, 66(1), 12–38.

SHALIZI, C. (2015): "Lecture 17: Multicollinearity," *Carnegie Mellon University, Statistics Department Lecture Notes*.

SHEKITA, N. (2022): "Interventions by common owners," *Journal of Competition Law & Economics*, 18(1), 99–134.

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} (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.

- 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.

- $\lambda^{intra}_{BigThree}$ 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

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

.

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

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

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 2001Q1-2019Q4. We exclude routes with less than 20 passengers per day on average. We weigh observations by average passengers for the market carrier over time and cluster standard errors two-ways at the market-carrier 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} (Within Component)	0.574***	0.00188	0.564***	0.00151	0.560***	0.000523
	(0.0194)	(0.00410)	(0.0194)	(0.00407)	(0.0194)	(0.00392)
λ^{inter} (Within Component)	0.501***	0.967***	0.509***	0.968***	0.513***	0.970***
	(0.0246)	(0.0121)	(0.0244)	(0.0120)	(0.0243)	(0.0119)
Log(Distance) × Year-Quarter FE			✓	✓	✓	✓
Additional Controls					✓	✓
Year-quarter FE	✓	✓	✓	✓	✓	✓
Market-Carrier FE	✓	✓	✓	✓	✓	✓
Observations	1,554,120	1,554,120	1,554,120	1,554,120	1,507,347	1,507,347