Board Connections and Competition in Airline Markets

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Abstract

I investigate the effects of board connections on coordination among U.S. legacy airlines. I focus on connections caused by the appointment of an airline director on the board of an intermediate firm. Such connections are unlikely to be related to the airline's current and future economic prospects. In my baseline specification, I find a reduction of 2.5% in offered seats when all legacy airlines in a market are board-connected. The effect materializes only in markets where all legacy airlines are connected. Finally, I find that board connections are associated with an average increase of 3.7% in ticket fares.

Keywords: director connections; airline market; competition

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1 Introduction

A large body of the corporate governance literature has studied the effects of director connections on firm policies (e.g., investment Fracassi (2017)). Recent evidence highlights the advisory role of connected directors and their superior ability to gather relevant information through their network (e.g., Engelberg et al. (2012); Coles et al. (2020)). However, less is known about the effects of director connections on product market competition. The goal of this project is to fill this gap.

Section 8 of the Clayton Antitrust Act of 1914 (Clayton Act) forbids anyone from simultaneously working as an officer or director for competing corporations in the U.S. (board interlock). Despite the current regulation, several factors can make it challenging to prevent competing firms' directors from communicating. First, in many sectors, it is hard to identify the actual product market competitors and, hence, to enforce Section 8[1]. Second, directors often hold multiple directorships. Therefore, two directors of competing firms may sit together on the board of a third non-competing company. In this case, they could regularly meet and exchange private information.

Legal scholars and antitrust authorities have recently renewed their interest in director connections and their potential anticompetitive effects. For example, Nili (2022) provides evidence of growing interconnectedness among U.S. competitors via their director networks and discusses the related legal challenges. In his opening remarks at the 2022 Spring Enforcers Summit, Assistant Attorney General Johnatan Kanter stated the Department of Justice's (DOJ) intention to "*identify violations across the broader economy and bring Section 8 cases to break up interlocking directorates.*" On October 19, 2022,

[1]One of the most well-known cases is the one of Google and Apple. Google's CEO served as a director on the board of Apple from 2006 to 2009. In the same period, the two firms competed in the market for internet browsers, and Google launched its mobile operating system Android https://www.cnet.com/tech/tech-industry/i-resigned-from-apple-board-for-the-right-reasons-says-googles-eric-schmidt/.

the DOJ announced that seven directors resigned from their role in response to antitrust concerns on Section 8 violations [2].

In this project, I investigate the effects of director connections on product market competition in the U.S. airline industry. The focus on this industry is motivated by the public availability of high-quality route-level quantity and price data. These characteristics allow me to study the impact of board connections on product competition within the same firm and period, reducing the amount of confounding variation.

To measure board connections among U.S. airlines, I gather directors' data from BoardEx. The data contains extensive information on directors' characteristics (e.g., name, role, and education). Most importantly, it reports the entire employment history of all U.S. airline directors and their multiple appointments. Thus, I can track the entire employment network for each airline director in my sample at each point in time. I define two airlines as connected if at least two of their directors are sitting together on the board of another firm. Next, to relate board connections to airlines' competitive behavior, I define a market as board-connected if all airlines in that market share a board connection. The rationale is that all airlines in the market must be connected to successfully collude and not have incentives to deviate. Then, I regress the log of seats offered by an airline in a market in a month on a dummy equal to 1 if all airlines are board-connected.

In my baseline specification, I find that when all legacy carriers in a market are connected through their directors' network, the average number of offered seat declines by 2.5%. This reduction is monotonically increasing in the number of legacy airlines in the market, ranging from 2.3% with two legacy carriers to 4.1% with four legacy carriers. Moreover, the effect is more pronounced in markets where legacy carriers compete against low-cost carriers (LCCs).

I address the endogeneity of board connections by focusing on third-party initiated board

[2] https://www.justice.gov/opa/pr/directors-resign-boards-five-companies-response-justice-department-concerns-about-potentially

connections, i.e., connections caused by the appointment of airline directors on the board of a third non-competing firm. Hence, these connections are not related to airlines' current and past characteristics (e.g., performance). Moreover, I rely on a large set of fixed effects to control for unobserved heterogeneity. In particular, including airline-time fixed effects allows me to control for airline-specific characteristics. Thus, the effect of board connections is identified by variations in airline behavior across markets and time.

In addition, I conduct various placebo tests to ensure that the established relationship is causal. Assume board connections reflect more skilled directors who are rewarded by the director labor market with multiple directorships. In that case, I should observe an effect also in markets where only a few legacy airlines are connected. However, I do not find such an effect. In markets where only one pair of legacy airlines are connected, board connections do not affect the number of offered seats. Similarly, when all but one legacy airline are connected, board connections do not impact seat availability.

Finally, Consistent with a reduction in competition among legacy airlines, I find that board connections are associated with a lower number of flights offered and an average increase in ticket fares by 3.7%. Even though I do not estimate welfare effects, the results highlight the potentially negative effects of board connections for consumers.

The paper is one of the first to provide evidence of the anticompetitive effects of board connections. Closely related, Barone et al. (2022) show that the prohibition of interlocks among Italian banks resulted in lower loan interest rates. I show that firms can still collude through their directors' network even when interlocks are formally banned. Gopalan et al. (2022) conduct a cross-industry study of director connections among competing firms and provide evidence of higher profitability among connected firms. Similarly, Geng et al. (2022) show that the introduction of Corporate Opportunity Waivers in nine U.S. states caused higher board overlap among firms in the same industry and higher profitability. Different from Gopalan et al. (2022) and Geng et al. (2022), I focus on something other than total firm profitability and show a direct effect of board connections on product market outcomes (offered seats and ticket fares). Moreover, I show how board connections affect firms' behavior in connected markets. Nili (2019, 2022) discusses the recent growth in director interlocks among firms in the same industry and the difficulties in enforcing Section 8 of the Clayton Act.

I contribute to the literature on director networks and firms' outcomes (e.g., Renneboog and Zhao (2014); Dass et al. (2014); Coles et al. (2020); Duchin et al. (2010); Güner et al. (2008); Dittmann et al. (2010); Drobetz et al. (2018)). Part of the literature highlights the importance of directors' network in acquiring information. For example, Cai and Sevilir (2012) find that board connections create a communication advantage and lead to higher value creation in the merger market. Fracassi (2017) shows that board-connected firms have similar investment policies and exhibit better economic performance. Coles et al. (2020) find that connected directors provide valuable advice to the management. By focusing on connections among competing airlines, I show the anticompetitive side of directors' networks. Thus, even if board connections may be valuable to airlines' shareholders, they may hurt consumers.

Finally, I contribute to the industrial organization literature on collusion among U.S. airlines. Aryal et al. (2021) show that U.S. airlines coordinate via quarterly earnings calls with investors. Ciliberto and Williams (2014) find that multimarket contact, i.e., airlines repeated interaction in multiple markets, facilitates collusion among competing firms. Bet (2021) analyzes market power in the U.S. airline industry and the determinants of its growth in the past decade. Azar et al. (2018) demonstrate the anticompetitive effects of common ownership among U.S. airlines. Building on the work of Aryal et al. (2021), I present a new important channel of communication among U.S. airlines, i.e., board connections, and its impact on product market outcomes.

The paper proceeds as follows. Section 2 discusses the main hypotheses. Section 3 contains a description of the data and construction of the sample. Section 4 reports the empirical analysis. Finally, Section 5 concludes by discussing the policy implications of the results.

2 Hypotheses Development

When coordinating, competing firms share monopolistic profits higher than those under oligopolistic competition. There exist several ways to coordinate among competitors. For example, firms may engage in price fixing by agreeing on product prices or production quotas. Alternatively, they may assign specific markets or clients to particular competitors in order to not compete with each other. In both cases, shareholders of the competing firms would enjoy a higher value, but consumer surplus and social welfare would be lower. Successful coordination among competitors, however, is hard to achieve for several reasons. First, antitrust regulation forbids collusion, and competing firms may be restricted in the exchange of information with each other. For example, Section 1 of the Sherman Act forbids any exchange of information that may restrict trade. Second, monitoring the actions of all cartel members without direct communication is imperfect and difficult. Hence, a firm may find it optimal to deviate from the collusive agreement and increase its market share at the expense of its competitors. Consistently, Harrington Jr et al. (2006) and Marshall and Marx (2014) describe communication as one of the most important elements to sustain collusion.

Communication is crucial in the U.S. airline industry. Airline markets are characterized by stochastic demand and private and noisy monitoring, making it hard to collude without communication Aryal et al. (2021). Airlines cannot immediately observe their competitors' actions and cannot react quickly. Consequently, they may engage in several forms of inter-firm communication to reduce competition. In the past decades, there have been accusations against airlines of communicating illegally. In 1992, the DOJ sued the U.S. largest airlines for fixing prices through the Airline Tariff Publishing Company's electronic fare system, Miller (2010). In 2015, consumers filed lawsuits in several U.S. courts accusing American, Delta, Southwest, and United of price fixing and reducing capacity despite the increased demand and lower fuel prices. More recently, Aryal et al. (2021) show that U.S. airlines regularly communicate via quarterly earning calls to reduce capacity and raise prices on competitive routes.

In this setting, board connections may represent another communication channel to alleviate the above communication hurdles. The current regulation allows directors and executives of competing firms to sit together on the board of a third non-competing firm, as they do not violate Section 8 of the Clayton Act. Due to their multiple appointments, connected directors meet and talk regularly. Hence, they may easily exchange information about their product market strategies and firm policies. Importantly, this does not require the direct exchange of a large amount of private information or agreeing on specific capacity levels in each market. Awaya and Krishna (2016) show that "cheap talk" in many cases is enough to achieve near-perfect collusion in environments where firms cannot observe each other actions.

Thus, I should observe outcomes more consistent with a collusive equilibrium in markets where all airlines are connected via their directors' networks. I derive the two following hypotheses:

Hypothesis 1. *Board connections have a negative effect on the number of available seats*

Hypothesis 2. *Board connections have a positive effect on ticket fares*

In both cases, the null hypothesis is that board connections do not affect the number of available seats and ticket fares.

3 Data

3.1 Airline data

I collect data from several sources to construct two datasets. In order to establish the effect of board connections on capacity, I construct a panel of offered seats by airlines in each market. I download capacity data from the Bureau of Transportation Statistics (BTS) T-100 Domestic Segment. The T-100 reports monthly information on domestic non-stop segments (i.e., routes) reported by U.S. carriers. In particular, it contains information on the operating carrier, number of available seats, origin, and destination airport. The data, however, does not consider ownership or contracting relationships between national and regional carriers. For example, Piedmont is a fully owned subsidiary of American Airlines, but it is reported as an independent carrier in the T-100 data. To account for these relations between operating and ticketing carriers, I merge the T-100 data with that of Aryal et al. (2021). Aryal et al. (2021) collect information on airlines' subsidiaries and codeshare agreements from a private data provider to allocate capacity to the appropriate ticketing carriers from 2003Q1 to 2013Q3. The final sample contains seven legacy carriers, namely American Airlines (A.A.), Delta Airlines (DL), Continental Airlines (C.O.), United Airlines (U.A.), Northwest Airlines (N.W.), Alaska Airlines (AS), and U.S. Airways (U.S.), and four major low-cost carriers (LCCs), namely Southwest (W.N.), JetBlue (B6), AirTran Airways (F.L.), and Spirit Airlines (N.K.). Even though they directly compete, legacy carriers and LCCs offer very different products. Legacy carriers are those traditional airlines operating before deregulation[3]. On the contrary, LCCs are airlines that entered the market in the post-regulation era. They display lower operational costs and offer lower-quality products compared to legacy carriers. Moreover, they maximize aircraft utilization rates by flying point-to-point. On

[3]In 1978, the Airline Deregulation Act removed federal controls over fares, routes, and market entry.

the contrary, legacy carriers utilize a hub-and-spoke network to operate among airport pairs, Bet (2021). I define a market m as a route between airport pairs. Thus, The unit of observation is denoted by jmt, namely capacity offered by airline j in market m in month t.

To estimate the effect of board connections on ticket fares, I gather price data from the BTS Airline Origin and Destination Survey (DB1B). The DB1B is a 10% sample of all domestic tickets sold each quarter and contains information on the complete itinerary (origin, destination, and connecting airports) and fare paid by all passengers in the sample. Moreover, the data contains information on each itinerary segment's operating and ticketing carriers, the number of traveling passengers, and the distance flown. Following prior studies in the literature, I exclude fares greater than $2,500 or less than $25, as they most likely represent keypunch errors or frequent-fliers tickets, Ciliberto et al. (2019). Moreover, I drop carriers transporting fewer than ten passengers in the DB1B's sample of itineraries in a given year-quarter, Berry (1992). I follow Borenstein (1989), and Evans and Kessides (1994) and treat roundtrip tickets as two one-way tickets, dividing the fare by two. All fares are deflated using the 2008Q3 CPI index. Finally, I define a market as a unidirectional trip between airport pairs regardless of the number of connections between origin and destination. Noteworthy, markets in the capacity and the price panels do not always coincide. This is because airlines set capacity for each direct route, but ticket fares are determined based on the whole itinerary of each consumer. Hence, an itinerary may involve several connecting flights, and its price reflects the capacity of each of these routes.

3.2 Director data

I obtain data on directors and officers of U.S. airlines from BoardEx for the years 2003 to 2016. BoardEx mainly collects board and individual director characteristics from SEC filings and supplements them with additional publicly available information. It reports biographical information for each individual on current and past employment, education, and other activities. Hence, I can track all the appointments that an airline officer or director has on other boards during the sample period.

In my analysis, I focus on current employment connections, as directors serving on the same board regularly meet during the year. Hence, existing employment connections may better capture the information flow between connected airline directors. I consider two airline officers or directors to be connected if they sit together on the board of another firm. To avoid my connection measure capturing the transition between two jobs rather than the simultaneous employment for two firms, I exclude cases where an airline officer or director simultaneously serves on another board for less than a year.

Board connections among legacy carriers are pervasive in my sample. For example, from 2007 to 2011, one independent director of American Airlines (A.A.) and two independent directors of Delta Airlines (DL) served together on the board of Texas Instruments. American Airlines also shared board connections with United Airlines (U.A.) and U.S. Airways (U.S.) in the same period. Hence, directors of the four largest U.S. legacy airlines could have easily communicated through the board connections that American Airlines had in those years. From 2003 to 2016, U.S. legacy airlines had 47 board connections via 37 boards.

To better understand the board connections in my sample, Table 1 shows their main characteristics. Panel A reports the duration distribution of connections among connected airline directors by connection type. Around half of the connections in my sample are between airline independent directors ("Independent - Independent"), i.e., directors that do not hold any executive role in the airlines. In ten cases, I observe connections among airline executives ("Executive - Executive"). A priori, these connections are the most problematic in terms of antitrust concerns, as they directly involve airline executives.

On average, connections among independent directors tend to last longer, three years, compared to connections involving airline executives, which last two years. Panel B of Table 1 shows that, on average, airlines have around one director connecting them to a competitor over a third non-competing board. However, there is considerable heterogeneity in the number of connections across airlines, with American having four connections on average, followed by Delta with two. Overall, legacy carriers are more connected compared to LCCs.

3.3 Variable Definitions

To estimate the effect of board connections on market outcomes, I identify those markets where carriers are board-connected. Consistent with the literature on communication in the U.S. airline industry (e.g.,Aryal et al. (2021)), I focus only on board connections among legacy airlines. As discussed above, this choice is motivated by the fact that legacy carriers and LCCs traditionally have offered different products.

I define a market as connected if at least two legacy carriers serve it and all legacy carriers are connected through their boards. More specifically, I create the following dummy variable:

$$\begin{aligned} &\textit{Board Connection}_{m,t} = \\ &\begin{cases} \mathbb{1} \quad \{\text{if } \exists i : \textit{Board Connection}_{i,j,m,t} = 1 \; \forall j \in J_{m,t}^{Legacy}\} & , \quad |J_{m,t}^{Legacy}| \geq 2 \\ 0 & , \quad |J_{m,t}^{Legacy}| < 2 \end{cases} \end{aligned}$$

where $\textit{Board Connection}_{i,j,m,t}$ is a dummy equal to one if legacy carriers i and j have a board connection at time t and $J_{m,t}^{Legacy}$ represents the set of all legacy carriers serving market m at time t.

Figure **??** provides a graphical interpretation of Board Connection$_{m,t}$. In Panel 1a, legacy carrier A has a board connection with all the other legacy carriers serving the

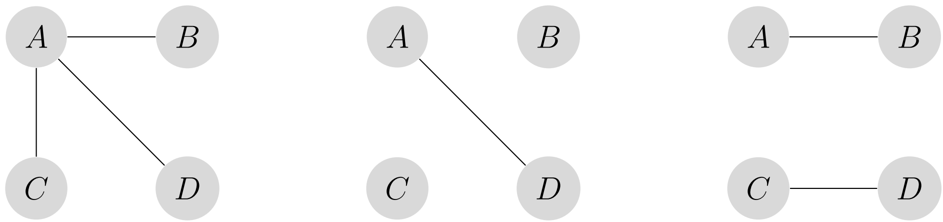
Table 1: **Board Connections Characteristics**

Panel A: Connection Duration (months)					
	Mean	SD	p10	p90	N
Connection Type					
Independent - Independent	36.0	32.0	3	77	23
Independent - Executive	24.1	19.4	4	48	14
Executive - Executive	18.9	16.2	5	44	10

Panel B: Airline-Year-Month characteristics					
	Mean	SD	p10	p90	N
# Connected Directors	1.3	1.5	0	4	1859
AA	4.4	1.6	2	6	1859
DL	1.9	1.6	0	4	1859
CO	1.5	0.7	1	2	1859
UA	1	0.9	0	2	1859
NW	1.2	1.7	0	4	1859
AS	0.2	0.4	0	1	1859
US	1.1	0.7	0	2	1859
WN	1.1	0.8	0	2	1859
B6	0.7	0.7	0	2	1859
FL	0.8	0.4	0	1	1859
NK	0.2	0.4	0	1	1859
# Connecting Boards	1.2	1.4	0	3	1859
Legacy Carriers	1.5	1.6	0	4	1859
LCCs	0.7	0.7	0	2	1859

The table reports summary statistics on board connections. Panel A reports the distribution of board connections' duration (in months) for airline director pairs by connection type. "Independent - Independent" denotes connections established by two airline independent directors. "Independent - Executive" denotes connections established by one airline independent director and one airline executive. "Executive - Executive" denotes connections established by two airline executives. Panel B reports the distribution of the number of connected directors and connecting boards for each airline in a year-month.

Figure 1: **Board Connection Examples**



(a) Board Connection = 1 **(b)** Board Connection = 0 **(c)** Board Connection = 0

The figure illustrates three possible board connections within a market. In sub-figure (a), legacy airline A has at least a board connection with B, C, and D. Hence, Board Connection = 1. In sub-figure (b), legacy airline A is board-connected to D, while C and D do not have any connection. Hence, Board Connection = 0. In sub-figure (c), legacy airline A is connected to B and C to D. However, A and B do not share any connection with C and D. Hence, Board Connection = 0.

market (B,C, and D) and, hence, Board $\text{Conn}_{m,t}$ is equal to 1. Conversely, in Panel 1b, legacy carrier A has only one board connection with D, while legacy carriers B and C do not have any board connection. In this case, Board $\text{Conn}_{m,t}$ equals 0. Finally, in Panel 1c, all legacy carriers have at least one board connection (A with B and C with D), but they are not all connected. Indeed, A and B can communicate but cannot exchange information with C and D, and vice versa. Hence, Board $\text{Conn}_{m,t}$ is equal to 0 also in this case. The idea is that, to successfully coordinate, all legacy carriers must be connected. Therefore, Board $\text{Conn}_{m,t}$ is equal to one if at least one legacy carrier has a board connection with all the other participants[4].

Table 2 reports summary statistics at the carrier-market-month level for the capacity dataset. On average, legacy carriers offer 11,757.9 seats monthly and LCCs 11,255.1. The number of offered seats is higher in mixed markets (13,349.4), i.e., markets operated by both legacy and LCCs, compared to markets with only legacy carriers (9,915). Moreover,

[4] There exists cases in which all legacy carriers are connected in a market, but none of them has a direct board connection with all the others. For example, consider a market with legacy carriers A, B, C, and D. If A is connected with B, B is connected with C, and C is connected with D, all carriers are connected, but Board $\text{Conn}_{m,t}$ is equal to zero. When I include these cases in the definition of Board $\text{Conn}_{m,t}$, the results remain unchanged.

LCCs are less likely to participate in board-connected markets.

As in Aryal et al. (2021), I define the dummy variable $\textit{Talk-Eligible}_{m,t}$ equal to 1 if there are at least two legacy carriers operating in market m in month t, and 0 otherwise. This variable controls for the fact that markets where legacy carriers could coordinate with each other, may function differently from markets where it is not possible. Similarly, I account for the differences between monopolistic and non-monopolist markets by introducing the dummy Monopoly $\text{Market}_{m,t}$. In the sample, 24% of the observations have the potential for coordination, and 52% of the observations are monopoly markets.

Table 2: **Summary Statistics**

	Seats		Board Connection		Talk Eligible		Monopoly Market		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	N
Carrier Type									
Legacy	11,757.894	12,264.478	0.104	0.305	0.311	0.463	0.546	0.498	562,469
LCC	11,255.056	10,467.260	0.034	0.180	0.106	0.307	0.471	0.499	279,522
Market Participants									
Mixed Market	13,349.373	12,749.700	0.061	0.240	0.197	0.398	0.321	0.467	410,888
Legacy Market	9,915.007	10,330.230	0.099	0.299	0.287	0.452	0.713	0.452	431,103
Total	11,590.963	11,700.888	0.081	0.272	0.243	0.429	0.521	0.500	841,991

The table reports the summary statistics for the key variables by carrier and market types. Observations are at the carrier-market-month level. Markets are defined at the airport-pair level.

4 Empirical Analysis

I investigate the relation between director connections among airlines and the number of seats offered, estimating the following fixed-effect model:

$$\begin{aligned} ln(seats)_{j,m,t} = &\beta_0 \times \textit{Board Connection}_{m,t} + \beta_1 \times \text{Talk-Eligible}_{m,t} + \beta_2 \times \text{Monopoly}_{m,t} \\ &+ \beta_4 \times X_{j,m,t} + \mu_{j,m} + \mu_{j,t} + \gamma_{origin,yr} + \gamma_{dest,yr} + \varepsilon_{j,m,t} \end{aligned} \tag{1}$$

where the dependent variable, $ln(seats)_{j,m,t}$, represents the total number of seats offered by carrier j in market m and month t.

The main explanatory variable, $Board\ Connection_{m,t}$, is the dummy variable introduced in Section 3.3. It is equal to 1 if there are at least two legacy carriers in market m at month t and they are all connected via their directors' board seats, and 0 otherwise. Hence, $Board\ Connection_{m,t}$ captures the effect of board-connected markets on capacity allocation.

I control for unobserved confounding variation in the number of offered seats using a large set of fixed effects. First, I include carrier-year-quarter fixed effects, $\mu_{j,t}$, to control for any carrier-specific unobserved factor at time t (e.g., bankruptcy). Second, I use market-carrier fixed effects, $\mu_{j,m}$, to control for time-invariant differences in carrier behavior across markets. Third, I include origin- and destination-airport time trends, $\gamma_{origin,yr}$ and $\gamma_{dest,yr}$, to control for airport-specific unobserved factors to could influence the allocation of seats in a market. Fourth, there have been several mergers between U.S. carriers in the past two decades. Consequently, a carrier may change its behavior in specific markets following a merger. For example, following its merger with U.S. Airways, American Airlines reorganized its presence across several U.S. routes. Since these changes in conduct may bias my results, I follow Aryal et al. (2021) and introduce two separate fixed effects for the merged entity before and after the merger. Finally, I double-cluster standard errors by bi-directional market.

Given the fixed effects in equation (1), the coefficient of board connections is identified by the cross-sectional variation of $Board\ Connection_{m,t}$ across markets and over time, which in turn depends on the variation of market structure and airline directors' network.

4.1 Main results

Table 3 Column (1) reports the results from the estimation of equation (1). Board-connected markets are associated with an average significant reduction in available seats by 2.5%. Next, I study the relation of *Board Connection*$_{m,t}$ with other measures of communications among legacy carriers previously documented in the literature. Aryal et al. (2021) show that legacy carriers communicate with each other via quarterly earning calls. In particular, they provide evidence of a reduction in capacity when all legacy carriers in the market communicate to investors their intention to reduce capacity. In Column (2), I include $Legacy - talk$, a dummy equal to one when all legacy carriers discuss capacity reductions in the market. The coefficient of *Board Connection*$_{m,t}$ remains unchanged. Interestingly, the interaction of *Board Connection*$_{m,t}$ and $Legacy - talk$ is not statistically different from zero. Hence, board connections seem to substitute for other forms of communication among legacy airlines.

Next, I investigate how the effect of board connections changes with the number of market participants. As the number of legacy carriers in a market grows and competition increases, successful coordination becomes more difficult to achieve, and board connections may be more valuable. I test this hypothesis by substituting *Board Connection*$_{m,t}$ with *Board Connection* $k_{m,t}$, where $k \in \{2, 3, 4\}$ represents the number of legacy carriers operating in market m in year-month t. Column (3) of Table 3 shows that the effect of board connections on capacity allocation is monotonically increasing. Board connections are associated with an average decrease of 2.3% in the number of available seats in markets with two legacy carriers. The reduction is -4.1% when four legacy carriers are connected.

Finally, in Column (4), I study how the effect of board connections varies with the presence of LCCs in the market (mixed markets). In legacy-only markets, board connections

Table 3: **Board connections and capacity allocation**

	(1) Log seats	(2) Log seats	(3) Log seats
Board Connection	-0.025***		
	(-2.821)		
Board Connection 2		-0.023**	
		(-2.384)	
Board Connection 3		-0.034*	
		(-1.736)	
Board Connection 4		-0.041*	
		(-1.838)	
Board Connection X Legacy Market			-0.024**
			(-2.141)
Board Connection X Mixed Market (Legacy)			-0.039**
			(-2.425)
Board Connection X Mixed Market (LCC)			-0.008
			(-0.434)
Airline-market FE	✓	✓	✓
Airline X Year-Quarter FE	✓	✓	✓
Year-Quarter FE	✓	✓	✓
Origin X Year FE	✓	✓	✓
Destination X Year FE	✓	✓	✓
Observations	841,804	841,804	841,804
Adjusted R-squared	0.891	0.891	0.891

The table reports the OLS regression parameter estimates and t-statistics of Equation 1. The dependent variable is the log of available seats offered by carrier j in market m and month t. The coefficient of interest is the one of Board Connection$_{m,t}$, a measure of board connections among legacy airlines as defined in equation 1. In column (2) the coefficients are interacted with the number of legacy airlines in the market. In column (3), they are interacted with market type (legacy only or mixed), and, within mixed markets, with carrier type (legacy or LCCs). Standard errors are clustered at the bi-directional market level. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

are associated with a capacity reduction of 2.4%. In mixed markets, board connections are associated with a reduction of 3.9% in seats offered by legacy carriers and no statistically significant reduction in LCCs seats.

4.2 Robustness tests

I conduct several robustness tests in Table 4. First, *Board Connection*$_{m,t}$ depends on market structure. Therefore, it may capture the effect of market structure on capacity allocation rather than coordination through connected directors. For example, if American Airlines and Delta Airlines have a board connection, *Board Connection* will be equal to one in all markets where only American and Delta operate. The same connection, however, will result in *Board Connection* equal to 0 in markets with a third non-connected legacy carrier. It follows that *Board Connection* is mechanically correlated with the number of legacy carriers in the market. Therefore, I follow Aryal et al. (2021) and substitute the market-carrier fixed effect in equation (1) with the market structure-carrier fixed effect. The effect of board connections is now identified by the cross-sectional variation of *Board Connection* across markets with the same number of legacy carriers. Column (1) in Table 4 shows that the inclusion of carrier-market-structure fixed effects does not affect the results. On average, board connections are associated with a capacity reduction of 3%.

Second, the literature has recently documented other important factors allowing market participants to coordinate. For example, Ciliberto and Williams (2014) provide evidence that multimarket contact facilitates tacit collusion among U.S. airlines. Moreover, Azar et al. (2018) show that common ownership reduces competition among U.S. airlines. In light of these previously documented effects, *Board Connection* may only represent a proxy for one of the above. For example, Azar (2022) provides evidence of a positive overlap between common owners and directors interlocks across U.S. public firms. Therefore,

Table 4: **Board connections and capacity allocation: robustness tests**

	(1)	(2)	(3)	(4)	(5)
	Log seats	Log seats	Log seats	Log seats	Log seats
Board Connection	-0.015**	-0.021**	-0.024***		
	(-2.001)	(-2.341)	(-2.778)		
Log(MMC)		0.020**			
		(2.485)			
CO			-0.016		
			(-1.283)		
Only One Pair Connected				0.003	
				(0.268)	
Board Connection (N-1)					-0.001
					(-0.048)
Board Connection Not j					
Airline-market FE		✓	✓	✓	✓
Airline X Year-Quarter FE	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓
Origin X Year FE	✓	✓	✓	✓	✓
Destination X Year FE	✓	✓	✓	✓	✓
Airline-market-structure FE	✓				
Observations	840,632	399,851	841,804	841,804	841,804
Adjusted R-squared	0.903	0.891	0.891	0.891	0.891

The table reports the OLS regression parameter estimates and t-statistics of Equation 1. The dependent variable is the log of available seats offered by carrier j in market m and month t. In column (1), the coefficient of interest is the one of Only One Pair Connected$_{m,t}$, a dummy equal to 1 if only pair of legacy carriers has a board connection in market m and month t. In column (2), the coefficient of interest is the one of Board Connection (N-1)$_{m,t}$, a dummy equal to 1 if $(N-1)$ legacy carriers have a board connection in market m and month t. In column (3), the coefficient of interest is the one of Board Connection Not j$_{m,t}$, a dummy equal to 1 if only legacy carrier j does not have a board connection in market m and month t. In column (4) and (5), the coefficient of interest is the one of Board Connection$_{m,t}$, a measure of board connections among legacy airlines as defined in equation 1. Standard errors are clustered at the bi-directional market level. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

I re-estimate equation (1), including common ownership (C.O.) and multimarket contact (MMC) as additional controls. Columns (2) and (3) report the results. The coefficient of *Board Connection* remains statistically significant, and its magnitude is almost unchanged. Thus, the effect of *Board Connection* is not driven by multimarket contact or common ownership among U.S. legacy carriers.

4.3 Endogeneity of board connections

Corporate governance literature has long studied directors' connections and firm outcomes. A very well-established fact is the endogeneity of board structure and firm policies. For example, anticipating future downturns and reductions in demand, an airline may appoint as a new director an industry expert who is also connected to other airlines. Moreover, more skilled directors may be rewarded by the labor market with more directorships and, hence, be more connected.

I address the potential endogeneity of board connections in several ways. First, I observe that 83% of board connections listed in Table 1 are initiated by the connecting firm appointing an airline director. These connections do not stem from changes in the airlines' boards. Thus, they should be exogenous to the airline's current and future outcomes. In unreported results, when I exclude the market-months affected by the remaining cases (3% of airline-initiated connections and 14% of undefined cases due to missing data), the coefficient of *Board Connection* remains negative and significant. Second, the airline-year-quarter fixed effects absorb airline-specific characteristics within the same quarter (e.g., board characteristics and bankruptcy period). Hence, *Board Connection* is identified by the variation in airlines' behavior across markets within the same year-quarter. Third, suppose a connected director's characteristics determine the results. In that case, I should also observe a decline in capacity in those markets affected by the connection, but the other legacy airlines are not connected. Hence, I estimate the following variation of equation 3.3:

$$ln(seats)_{j,m,t} = \beta_0 \times \textit{Only-1-Connected}_{m,t} + \beta_1 \times \text{Talk-Eligible}_{m,t} + \beta_2 \times \text{Monopoly}_{m,t} + \beta_4 \times X_{j,m,t} + \mu_{j,m} + \mu_{j,t} + \gamma_{origin,yr} + \gamma_{dest,yr} + \varepsilon_{j,m,t} \quad (2)$$

where the variable of interest $\textit{Only-One-Pair}_{m,t}$ is defined as

$$\textit{Only-One-Pair}_{m,t} = \begin{cases} \mathbb{1} \quad \{\text{if } \exists i, j \in J^{Legacy}_{m,t} : \textit{Board Connection}_{i,j,m,t} = 1 & , |J^{Legacy}_{m,t}| \geq 3 \\ \quad \wedge \textit{ Board Connection}_{i,-j,m,t} = 0\} & \\ 0 & , |J^{Legacy}_{m,t}| < 3 \end{cases}$$

$\textit{Only-One-Pair}_{m,t}$ is equal to one in markets where only one pair of legacy airlines i and j is connected, conditional on having at least three legacy carriers in the market. The parameter of interest β_1 captures the effect of a board connection among two legacy carriers when no other market-level competitors are connected. If board connections reflect characteristics of the connected directors and not communication (e.g., directors' ability or industry knowledge), the coefficient of β_1 should be negative and statistically significant. I report the estimation results in Column (4) in Table 4. There is no evidence of capacity reductions when only one pair of legacy airlines is connected.

Third, I consider cases where all but one legacy carriers are connected in the market. I estimate equation 1 with the treatment variable *Board Connection(N-1)* equal to one if only one legacy carrier in the market does not have a board connection with any of the other market participants. Column (5) in Table 4 reports the estimation results. The coefficient of interest, β_1, is not statistically different from zero. Overall, I find no significant effects of board connections on capacity allocations when only some legacy airlines in a market are connected.

4.4 Endogeneity of market structure

As previously discussed, *Board Connection* is the product of *Talk-Eligible* and whether all legacy carriers share director connections. *Talk-Eligible* is a function of market structure, i.e., the number of legacy airlines serving market m in month t. The airline's decision to serve market m depends on several unobserved factors (e.g., entry costs) that may not be entirely captured by the fixed effects in equation 1. Hence, both *Talk-Eligible* and *Board Connection* may be endogenous. In addition, the results in Table 3 could also be driven by reverse causality. Namely, the possibility that legacy airlines without board connections better anticipate reductions in future demand and exit, leaving only board-connected firms to compete in the market. Under this alternative hypothesis, I should also observe a negative correlation between *Board Connection* and the number of available seats.

I address the endogeneity of market structure by following the methodology outlined by Aryal et al. (2021). In particular, I instrument for market structure using the average distance between a market's origin and destination airport and the carrier's closest hub. This distance is a proxy for the fixed costs that a carrier faces to serve a market, Ciliberto and Tamer (2009), and, consequently, determines its decision to enter that market. Therefore, hub distance indirectly affects market structure [5].

I estimate the effect of board connections on capacity using the hub-distances measure computed by Aryal et al. (2021) in a control function approach, Wooldridge (2007). In the first stage, I regress the endogenous market structure variable, *Talk-Eligible*, on the hubs-distances, $D_{j,m,t}$, for each carrier-market combination:

$$\textit{Talk-Eligible}_{m,t} = \sum_{j \in J} \sigma_j D_{j,m,t} + \alpha_0 \times X_{j,m,t} + r_{m,t} \tag{3}$$

[5] See Aryal et al. (2021) Appendix A for a detailed discussion on the use of hub-distances as an instrument for market structure.

where, $X_{j,m,t}$ contains the same controls and fixed-effects as in equation 1. Next, in the second stage, I re-estimate equation 1, adding the residuals $\hat{r}_{m,t}$ as an additional control. In Table 5, I report the second stage estimates together with the baseline result from

Table 5: **Control function: board connections and capacity allocation**

	(1) Log seats	(2) Log Seats
Board Connection	-0.025*** (-2.821)	-0.025*** (-2.811)
Residual		-0.277 (-1.563)
Airline-market FE	✓	✓
Airline X Year-Quarter FE	✓	✓
Year-Quarter FE	✓	✓
Origin X Year FE	✓	✓
Destination X Year FE	✓	✓
Observations	841,804	841,166
Adjusted R-squared	0.891	0.890

Column (1) reports the baseline estimation of equation 1. Column (2) reports the control function estimates. Standard errors are bootstrapped and clustered at the bi-directional market level. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

Table 3[6]. Column (2) shows that the coefficient of *Board Connection* remains significant after controlling for the endogeneity of market structure. When all legacy carriers in a market are board-connected, they reduce their capacity by 2.5%.

4.5 Market-level changes, flights departure, and fares

After establishing the negative relationship between board connections and the number of offered seats, I now study the implications for other market outcomes and ticket fares.

[6] I do not report the first-stage here, as it is the same as in Aryal et al. (2021) Appendix A

First, I investigate if the firm-level reductions in seat availability documented in Table (2) imply a reduction in total market capacity and the number of scheduled flights. In Column (1) of Table 6, I re-estimate equation (1) at the market level. On average, board-connected markets are associated with a 2.2% decrease in market capacity. Hence, reductions in the number of available seats at the airline level in board-connected markets result in a decrease in the total offered seats.

Second, I investigate if the reduced number of offered seats observed in board-connected

Table 6: **Board Connections, market-level capacity, number of flights, and fares**

	(1) Log Market Seats	(2) Flights	(3) Price	(4) Price	(5) Price
Board Connection	-0.022**	-0.012*			
	(-2.016)	(-1.946)			
Perc. Board Connection			0.037***	0.042***	0.031***
			(4.700)	(5.291)	(3.822)
CO				0.029***	
				(5.853)	
Log(MMC)					0.058***
					(10.746)
Airline-market FE	✓	✓	✓	✓	✓
Airline-Year-Quarter FE	✓	✓	✓	✓	✓
Origin X Year FE	✓	✓	✓	✓	✓
Destination X Year FE	✓	✓	✓	✓	✓
Observations	614,256	614,256	461,860	461,860	443,283
Adjusted R-squared	0.896		0.621	0.621	0.614

The table reports additional evidence on the effect of board connections. Column (1) reports a market-level estimation of equation 1. Hence, the dependent variable, number of available seats, is aggregated at the market level. Column (2) shows the estimate coefficient from the Poisson model on the number of flights. In columns (3)-(5), the dependent variable is the log of average fares charged by carrier j in market m and quarter t. The coefficient of interest is the one of $Board_conn_perc$, measuring the percentage of connections that a legacy airline has in market m in quarter t. Standard errors are clustered at the bi-directional market level. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

markets translates into a reduced number of offered flights. Hence, I follow Aryal et al.

(2021) and assume that the number of flights in a market follows a Poisson distribution, with its mean depending on the explanatory regressors outlined in equation 3.3. I then estimate the coefficient of *Board Connection* using the conditional maximum likelihood method.

Column (2) of Table 6 reports the estimation results. Board-connected markets are associated with a 1.2% average decline in the number of offered flights. Hence, all else equal, board connections in a market are associated with fewer available seats and flights.

Finally, I estimate the relation between *Board Connection* and ticket fares. If board connections have anti-competitive effects, I should observe positive effects on ticket prices in markets where legacy carriers are board-connected.

Differently from capacity, allocated at the nonstop segment level, tickets are sold for origin and final destination airport pairs. Hence, the same airport pair may be served by airlines across different routes with different levels of board connections. Thus, to estimate the effect of board connections on ticket fares, I compute $Perc.\ Board\ Connection_{j,m,t}$ as the average percentage of board connections that legacy carriers j has across all routes serving market m in quarter t. Then, I estimate the following equation:

$$\begin{aligned} ln(fare)_{j,m,t} = \beta_0 \times Perc.\ Board\ Connection_{j,m,t} + \beta_1 \times X_{j,m,t} \\ + \mu_{j,m} + \mu_{j,t} + \gamma_{origin,yr} + \gamma_{dest,yr} + \varepsilon_{j,m,t} \end{aligned} \quad (4)$$

where $X_{j,m,t}$ contains the same fixed effects and controls as in equation 1 with the addition of other standard controls in the literature. Namely, I add the share of connecting passengers, the distance between the origin and destination airport, and the number of legacy airlines operating in the market.

Columns (3)-(5) in Table 6 report the estimation results. On average, board connections are associated with an increase of 3.7% in ticket fares. Moreover, the effect is not driven by common ownership among legacy airlines or multimarket contact.

5 Conclusion

In this article, I investigate the (anti)competitive effects of board connections among U.S. legacy airlines. Using detailed employment data for all U.S. airline directors, I find that when all legacy airlines in a market are connected via their directors' network, there is an average reduction of 2.5% in the number of offered seats.

Even though I do not estimate a structural model of competition featuring board connections among competing firms, the evidence is most consistent with board connections being harmful to consumers. Indeed, I find that board connections are, on average, associated with 3.7% higher ticket fares.

I address the endogeneity of board connections by focusing on third-party-initiated connections. Namely, I define two airlines as board connected if two airline directors sit together on the board of another firm. In my sample, most of these connections do not stem from airline board changes. Instead, airlines become connected because their current directors are appointed on the board of the connecting firms. Hence, they do not reflect changes in airline boards that may correlate with airlines' future performance. Furthermore, I conduct several placebo tests to rule out alternative hypotheses and employ a control function approach to rule out the possibility that the results are driven by endogenous market structure.

The results are especially relevant for policymakers. Even though competing firms may formally comply with antitrust regulations (e.g., section 8 of the Clayton Act), they can still communicate via their directors' network.

Finally, my findings unveil a new effect of board connections on product market outcomes. So far, the literature has primarily studied the impact of board connections on firm value and ignored potentially anticompetitive effects. I show that even if board connections may be valuable for shareholders, they may harm consumers.

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