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 airline directors' appointments to the board of third, non-competing firms. These connections do not arise from changes to airlines' boards, and are arguably unrelated to airlines' 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. Consistent with an anti-competitive effect, board connections are associated with an average increase of 3.7% in ticket fares. I provide evidence on director networks enabling tacit coordination among competing firms, even when direct interlocks are not allowed.

Keywords: board of directors, director networks, collusion, antitrust, airline

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1 Introduction

Antitrust scholars and authorities have since long recognized the anti-competitive effects of board connections (Dooley, 1969; Mizruchi, 1996). In the U.S., 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 interlocks). However, past papers and authorities overlooked the possibility that directors of competing firms can meet on the board of other firms. Thus, it is still unclear how information flows across the entire network of directors and affects product market competition. The goal of this project is to fill this gap.

Directors often hold multiple directorships, and, most importantly, directors of competing firms often sit together on the board of another non-competing firm. In the airline industry, an outside director of American Airline sat together with Delta's CEO on the board of Bellsouth Corporation from 2001 to 2004.[1] In the same period, he also sat with two other outside directors of Delta on the board of General Motors. In the last two decades, these connections have become more common across all industrial sectors, Nili (2019). This phenomenon raises questions on the relation between board connections and competition. Under which conditions do board connections enable communication among competing firms? What are their effects on product market competition?

In this project, I investigate the impact of board connections among U.S. legacy airlines on product market competition. The focus on this industry has several advantages. First, the public availability of high-quality route-level seats and price data, with each route representing a separate market. Second, I focus on board connections generated by the appointment of airline directors on the board of third, non-competing firms, which are unlikely to be related to airlines' current and future economic activity. Third, I ac-

[1] https://www.sec.gov/Archives/edgar/data/732713/000095014404001649/g86981e10vk.htm

count for the unobserved confounding variation across markets and airlines over time, by including airline-market and airline-time dummies.

To measure board connections, I gather directors' data from BoardEx. The data contains extensive information on all U.S. airline directors (e.g., name, role, and education). Most importantly, it reports their entire employment history 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 legacy airlines as connected if at least one director of each airline sits on the board of an intermediate firm. Next, to relate board connections to airlines' competitive behavior, I define a market as board-connected if all legacy airlines in that market share a board connection. The rationale is that all airlines in the market must be connected to tacitly coordinate and not have incentives to deviate.

I regress the log of seats offered by each airline in a market in a month on a dummy which equals one if the market is 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 seats offered declines by 2.5%. The effect monotonically increases with 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).

Connected directors of competing firms regularly meet and may easily exchange information. Recognizing this, the U.S. Department of Justice (DOJ) has recently started an investigation to tackle board connections. In his opening remarks at the 2022 Spring Enforcers Summit, Assistant Attorney General Johnatan Kanter stated the DOJ's intention to "*identify violations across the broader economy and bring Section 8 cases to break up interlocking directorates.*" In October 2022, seven directors of ten different companies resigned from their role.[2] However, there is still no clear evidence on the anti-competitive

[2] https://www.crn.com/news/managed-services/solarwinds-dynatrace-directors-resign-after-doj-crackdown

role of these indirect board connections.

I conduct a range of placebo tests to ensure that the established relationship is not driven by unobserved factors. For example, 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. Taken together, these results highlight how board connections allow a firm to monitor its competitor's actions in connected markets and ensure tacit coordination.

Next, I address the endogeneity of market structure using a control function approach. If market structure is endogenous, then board connections will be endogenous as well. 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, Aryal et al. (2021); Ciliberto and Tamer (2009), and, consequently, determines its decision to enter that market. I find that legacy carriers reduce the number of offered seats by 2.5% in board-connected markets.

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 a model of airline competition with board connections, the results highlight the potentially negative effects of board connections on consumers.

The paper is among the first to provide evidence of the anti-competitive 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 and an increase in

competition. Complementary to their result, I show that firms can still tacitly coordinate through their directors' network even when interlocks are formally banned. Thus, my results highlight the importance of going beyond direct interlocks and considering the entire network of director connections among competitors. 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 document a direct effect of board connections on product market outcomes (offered seats and ticket fares). 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.

Moreover, I contribute to the large corporate governance 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 and the resulting benefits for shareholders. For example, Cai and Sevilir (2012) find that board connections create a communication advantage and lead to higher value creation in M&A transactions. 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 anti-competitive side of directors' networks. Thus, even if board connections may be valuable to airlines' shareholders, they may hurt consumers and reduce welfare.

Finally, I also contribute to the industrial organization literature on collusion in the airline market. Aryal et al. (2021) show that U.S. airlines coordinate via quarterly earn-

ings calls with investors. Ciliberto and Williams (2014) find that multi-market 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 anti-competitive effects of common ownership among U.S. airlines. 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 law 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 tacitly coordinate. 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 represent an alternative communication channel to alleviate the above communication hurdles. Despite the Clayton Act, the DOJ has historically allowed directors and executives of competing firms to sit together on the board of a third non-competing firm. 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. For example, connected directors may regularly discuss capacity allocation policies in markets where they compete. 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. Finally, coordination among connected

airlines may also happen implicitly. By hiring connected directors, airlines may signal to each other the intention to soften competition.

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 different products. Legacy carriers are traditional airlines operating before deregulation.[3]. 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. 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

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

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

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	507
AA	4.4	1.6	2	6	55
DL	1.9	1.6	0	4	55
CO	1.5	0.7	1	2	55
UA	1	0.9	0	2	55
NW	1.2	1.7	0	4	24
AS	0.2	0.4	0	1	55
US	1.1	0.7	0	2	44
WN	1.1	0.8	0	2	55
B6	0.7	0.7	0	2	55
FL	0.8	0.4	0	1	34
NK	0.2	0.4	0	1	44
# Connecting Boards	1.2	1.4	0	3	507
Legacy Carriers	1.5	1.6	0	4	319
LCCs	0.7	0.7	0	2	188

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.

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

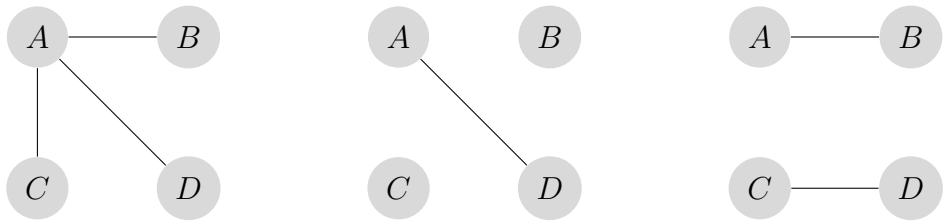
To estimate the effect of board connections on market outcomes, I identify those markets where carriers are board-connected. The idea is that, to successfully coordinate, all legacy carriers must be connected. Consistent with the literature on communication in the U.S. airline industry (e.g.,Aryal et al. (2021)), I focus 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:

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

where 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, i.e. at least one director of i and a director of j sit together on the board of an intermediate firm. $J_{m,t}^{Legacy}$ represents the set of all legacy carriers serving market m at time t.

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.

Figure 1 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 market (B,C, and D) and, hence, Board 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 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 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 Conn$_{m,t}$ is equal to one if at least one legacy carrier has a board connection with all the other participants.[4]

[4]There exists cases in which all legacy carriers are connected in a market, but none of them has a

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

As in Aryal et al. (2021), I define the dummy variable 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-monopolistic markets by introducing the dummy Monopoly Market$_{m,t}$, equal to 1 if only on legacy airline servers market m in month t. In the sample, 24% of the observations have the potential for coordination, and 52% of the observations are monopolistic 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.

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 Conn$_{m,t}$ is equal to zero. When I include these cases in the definition of Board Conn$_{m,t}$, the results remain unchanged.

4 Empirical Analysis

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

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

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 having all airlines in a market sharing board connections 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 that could influence the allocation of seats in a market in a given year. 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 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 airline directors' network and market structure.

4.1 Main results

Table 3 Column (1) reports the results from the estimation of equation (1). Markets in which all the legacy airlines share board connections are associated with an average statistically significant reduction in available seats by 2.5%.

To determine the economic significance of the main estimate, I follow Aryal et al. (2021) and compare it to the average change in capacity in non-connected comparable markets. In particular, I select all the talk-eligible markets where legacy airlines could have shared board connections but did not. The average change in the number of offered seats in these markets is 3.22%. Therefore, when legacy airlines share board connections, they reduce capacity by 63.6% of the average capacity change in comparable markets.

I then investigate how the above effect varies with market structure. As the number of legacy carriers in a market grows and competition increases, successful coordination becomes more difficult to achieve. Thus, if board connections allow successful coordination among competing airlines, their effect may increase with the number of market participants. 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 (2) 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 amounts to 4.1% when four legacy carriers are

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

	(1) Log seats	(2) Log seats	(3) Log seats	(4) Log seats
Board Connection	-0.025***			-0.030***
	(-2.821)			(-3.351)
Board Connection 2		-0.023**		
		(-2.384)		
Board Connection 3		-0.034*		
		(-1.736)		
Board Connection 4		-0.041*		
		(-1.838)		
Board Connection X Board Connection LCC			-0.054**	
			(-2.185)	
Legacy-Talk				-0.024***
				(-3.552)
Board Connection X Legacy-Talk				0.012
				(0.937)
Airline-market FE	Yes	Yes	Yes	Yes
Airline X Year-Quarter FE	Yes	Yes	Yes	Yes
Origin X Year FE	Yes	Yes	Yes	Yes
Destination X Year FE	Yes	Yes	Yes	Yes
Observations	841,804	841,804	840,632	841,804
Adjusted R-squared	0.891	0.891	0.903	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.

connected.

Next, I study how the effect of board connections varies with the presence of LCCs in the market. In particular, I create a dummy variable, Board Connection $\text{LLC}_{m,t}$, equal to one if at least one legacy carrier in market m shares a board connection with a low-cost carrier operating in market m. I then interact it with Board $\text{Connection}_{m,t}$ to capture the effect of having a board-connected low-cost carrier in a board-connected market. Column (3) reports the result. Having a board connection with an LCC in a board-connected market reduces seat capacity by 5.4%, on average.

Finally, I study the relation of Board $\text{Connection}_{m,t}$ with other measures of communications among legacy carriers previously documented in the literature. Aryal et al. (2021) provide evidence on legacy carriers communicating via quarterly earning calls. In particular, they document a reduction in capacity when all legacy carriers in the market communicate to investors their intention to reduce capacity in the future. In Column (4), I include $Legacy - talk$, a dummy equal to one when all legacy carriers discuss capacity reductions in the market. The coefficient of Board $\text{Connection}_{m,t}$ remains unchanged. Interestingly, the interaction of Board $\text{Connection}_{m,t}$ and $Legacy - talk$ is not statistically different from zero. Hence, board connections appear to represent a substitute for other forms of communication among legacy airlines.

4.2 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. Thus, board connections may only reflect similar

policies of firms operating in the same markets. I address the potential endogeneity of board connections in several ways.

First, the airline-year-quarter fixed effects absorb airline-specific characteristics within the same quarter (e.g., board characteristics and bankruptcy period). Hence, the coefficient of Board Connection$_{m,t}$ is identified by the variation in airlines' behavior across markets within the same year-quarter. Second, I exploit the timing of the connection

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

	(1) 3rd-Party	(2) Partial	(3) Partial	(4) Mkt Struct.	(5) CO	(6) MMC
Board Connection	-0.030**			-0.015**		
	(-2.109)			(-2.001)		
Only-One-Pair		0.002				
		(0.195)				
Board Connection (N-1)			0.001			
			(0.078)			
Log(MMC)					0.020**	
					(2.485)	
CO						-0.016
						(-1.283)
Airline-market FE	Yes	Yes	Yes		Yes	Yes
Airline-market-structure FE				Yes		
Airline X Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin X Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination X Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	777,007	841,804	841,804	840,632	399,851	841,804
Adjusted R-squared	0.891	0.891	0.891	0.903	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. Column (1) considers only third-party initiated board connections. In Column (2), the coefficient of interest is the one of Only-One-Pair$_{m,t}$, a dummy equal to 1 if only pair of legacy carriers has a board connection in market m and month t. In column (3), 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. Column (4) includes the airline-market structure fixed-effect. Columns (5) and (6) respectively add common ownership and multi-market contact (MMC) to the set of controls. Standard errors are clustered at the bi-directional market level. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

between connected airlines and focus on board connections that are third-party initiated. Such connections do not stem from changes in the airlines' boards, but from the appointment of airline directors on the board of the connecting firms. Hence, conditional on the fixed-effects in Equation 1, they can be regarded as more exogenous to the airlines' current and future economic performance in each market.

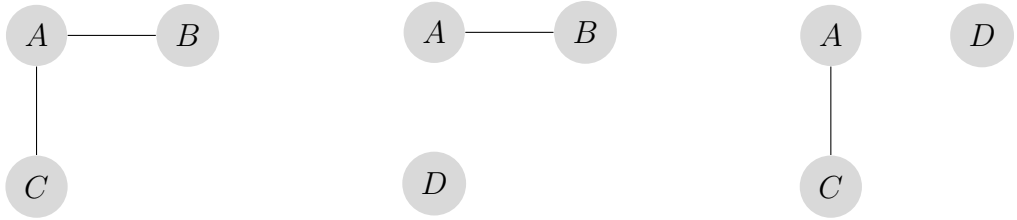
I re-define Board Connection$_{m,t}$ as equal to 1 if at least one legacy airline in market m at month t shares at least one third-party initiated board connection with all the other legacy airlines in the market. Consistently, I exclude the market-months observations affected by connections that were, instead, initiated by the airlines. Column (1) of Table 4 reports the estimate of Equation 1 using only third-party initiated board connections. The coefficient of Board Connection$_{m,t}$ remains negative and significant.

Third, I conduct an additional test to rule out the possibility that the main result in table 3 is caused by unobserved characteristics of connected directors (e.g., managerial skills). Consider markets m_1, m_2, and m_3 depicted in Figure 2. The directors that determine the connections between legacy airlines A and B and legacy airlines A and C in market m_1 are the same that connect A and B in market m_2 and A and C in market m_3. However, markets m_2 and m_3 are not board connected, as legacy airline D, which operates in both markets, does not share any connections. If the characteristics of the connecting directors spuriously determine the negative relation board connections and seat capacity, I should also observe a decline in the number of offered seats in partially connected markets, where both connected and non-connected legacy airlines compete.

Thus, I estimate the following variation of equation 1:

$$\begin{aligned} ln(seats)_{j,m,t} = \beta_0 \times \text{Only-One-Pair}_{m,t} + \beta_1 \times \text{Talk-Eligible}_{m,t} + \beta_2 \times \text{Monopoly}_{m,t} \\ + \beta_4 \times X_{j,m,t} + \mu_{j,m} + \mu_{j,t} + \gamma_{origin,yr} + \gamma_{dest,yr} + \varepsilon_{j,m,t} \end{aligned} \tag{2}$$

Figure 2: **Fully vs partially connected markets**



(a) m_1 **(b)** m_2 **(c)** m_3

The figure illustrates three possible board connections within a market. In sub-figure (a), legacy airline A has at least a board connection with both B and C. In sub-figure (b), legacy airline A is board-connected only to B and, does not share any director connections with D. In sub-figure (c), legacy airline A is board-connected only to C and, does not share any director connections with D.

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

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

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. 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.

Similarly, 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 1 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.

4.3 Additional robustness tests

In Table 4, I conduct additional robustness tests. First, Board Connection$_{m,t}$ depends on the number of legacy airlines competing in the market and, hence, it may only 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 multi-market 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,

I re-estimate equation (1), including common ownership (C.O.) and multi-market 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 multi-market contact or common ownership among U.S. legacy carriers.

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.

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

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	Yes	Yes
Airline X Year-Quarter FE	Yes	Yes
Origin X Year FE	Yes	Yes
Destination X Year FE	Yes	Yes
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.

(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:

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

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 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.

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 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

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

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.

Third, 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.

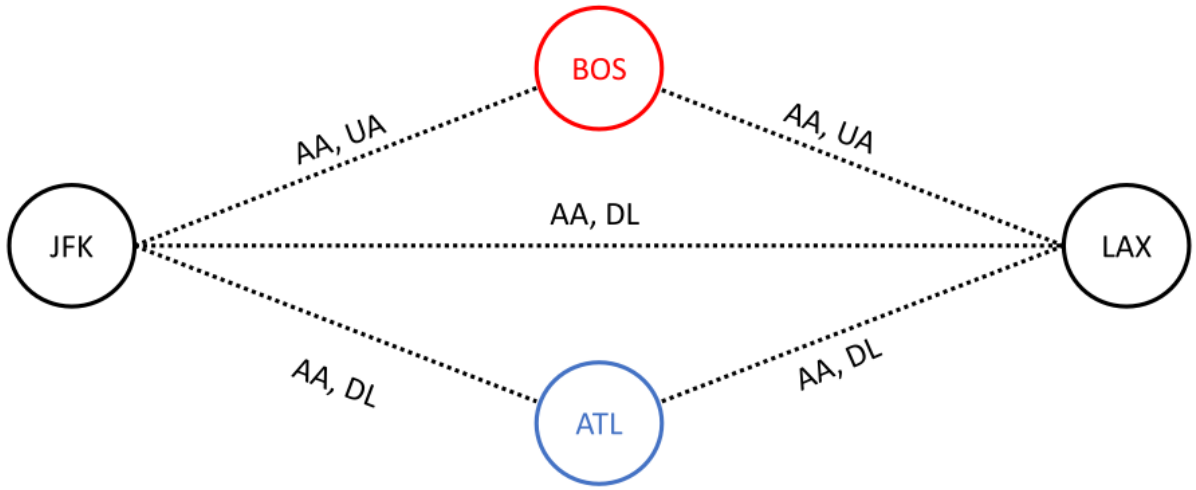
Table 6: **Board Connections, market-level capacity, number of flights, and fares**

	(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	Yes	Yes	Yes	Yes	Yes
Airline-Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Origin X Year FE	Yes	Yes	Yes	Yes	Yes
Destination X Year FE	Yes	Yes	Yes	Yes	Yes
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.

Differently from capacity, allocated at the nonstop segment level, tickets are sold for the origin and final destination airport pairs. Hence, the same airport pair may be served by airlines across different routes with different degrees of board connections. Figure 3 provides a graphical example. For the same market JFK-LAX, American Airlines (AA) offers three possible routes: a direct flight and two connecting flights over Boston and Atlanta, respectively. In these three routes, American Airlines competes with different airlines and different levels of board connections.

Figure 3: **Market definition for ticket fares**



The figure graphically illustrates the airport pairs market definition for ticket fares.

To account for the multiple routes within the same market, for each airline, I compute Perc. Board Connection$_{j,m,t}$ as the average percentage of board connections that legacy airline j has across all routes serving market m in quarter t. Then, I estimate the following equation:

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

where $X_{j,m,t}$ contains the same fixed effects and controls as in equation 1 with the addi-

tion 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 and the effect is not driven by common ownership or multi-market contact among legacy airlines.

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.

References

Aryal, G., Ciliberto, F., and Leyden, B. T. (2021). Coordinated Capacity Reductions and Public Communication in the Airline Industry. *The Review of Economic Studies*. rdab100.

Awaya, Y. and Krishna, V. (2016). On communication and collusion. *American Economic Review*, 106(2):285–315.

Azar, J. (2022). Common shareholders and interlocking directors: The relation between two corporate networks. *Journal of Competition Law & Economics*, 18(1):75–98.

Azar, J., Schmalz, M. C., and Tecu, I. (2018). Anticompetitive effects of common ownership. *The Journal of Finance*, 73(4):1513–1565.

Barone, G., Schivardi, F., and Sette, E. (2022). Interlocking directorates and competition in banking. *Working paper*.

Berry, S. T. (1992). Estimation of a model of entry in the airline industry. *Econometrica: Journal of the Econometric Society*, pages 889–917.

Bet, G. (2021). Market power in the us airline industry. *Working paper*.

Borenstein, S. (1989). Hubs and high fares: dominance and market power in the us airline industry. *The RAND Journal of Economics*, pages 344–365.

Cai, Y. and Sevilir, M. (2012). Board connections and m&a transactions. *Journal of Financial Economics*, 103(2):327–349.

Ciliberto, F. and Tamer, E. (2009). Market structure and multiple equilibria in airline markets. *Econometrica*, 77(6):1791–1828.

Ciliberto, F., Watkins, E., and Williams, J. W. (2019). Collusive pricing patterns in the us airline industry. *International Journal of Industrial Organization*, 62:136–157.

Ciliberto, F. and Williams, J. W. (2014). Does multimarket contact facilitate tacit collusion? inference on conduct parameters in the airline industry. *The RAND Journal of Economics*, 45(4):764–791.

Coles, J. L., Daniel, N. D., and Naveen, L. (2020). Director overlap: Groupthink versus teamwork. *Working paper*.

Dass, N., Kini, O., Nanda, V., Onal, B., and Wang, J. (2014). Board expertise: Do directors from related industries help bridge the information gap? *The Review of Financial Studies*, 27(5):1533–1592.

Dittmann, I., Maug, E., and Schneider, C. (2010). Bankers on the boards of german firms: What they do, what they are worth, and why they are (still) there. *Review of Finance*, 14(1):35–71.

Dooley, P. C. (1969). The interlocking directorate. *The American Economic Review*, pages 314–323.

Drobetz, W., Von Meyerinck, F., Oesch, D., and Schmid, M. (2018). Industry expert directors. *Journal of Banking & Finance*, 92:195–215.

Duchin, R., Matsusaka, J. G., and Ozbas, O. (2010). When are outside directors effective? *Journal of financial economics*, 96(2):195–214.

Evans, W. N. and Kessides, I. N. (1994). Living by the "golden rule": Multimarket contact in the us airline industry. *The Quarterly Journal of Economics*, 109(2):341–366.

Fracassi, C. (2017). Corporate finance policies and social networks. *Management Science*, 63(8):2420–2438.

Geng, H., Hau, H., Michaely, R., and Nguyen, B. (2022). Does board overlap promote coordination between firms? *Swiss Finance Institute Research Paper*, (21-79).

Gopalan, R., Li, R., and Zaldokas, A. (2022). Do board connections between product market peers impede competition? *Working paper*.

Güner, A. B., Malmendier, U., and Tate, G. (2008). Financial expertise of directors. *Journal of financial Economics*, 88(2):323–354.

Harrington Jr, J. E. et al. (2006). How do cartels operate? *Foundations and Trends® in Microeconomics*, 2(1):1–105.

Marshall, R. C. and Marx, L. M. (2014). *The economics of collusion: Cartels and bidding rings*. Mit Press.

Miller, A. R. (2010). Did the airline tariff publishing case reduce collusion? *The Journal of Law and Economics*, 53(3):569–586.

Mizruchi, M. S. (1996). What do interlocks do? an analysis, critique, and assessment of research on interlocking directorates. *Annual review of sociology*, pages 271–298.

Nili, Y. (2019). Horizontal directors. *Nw. UL Rev.*, 114:1179.

Nili, Y. (2022). Horizontal directors revisited. *Journal of Competition Law & Economics*, 18(1):5–28.

Renneboog, L. and Zhao, Y. (2014). Director networks and takeovers. *Journal of Corporate Finance*, 28:218–234.

Wooldridge, J. M. (2007). Control functions and related methods. *NBER Summer Institute*.