Privatization and Service Quality: Empirical Evidence for the Proper Scope of Government

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Abstract

China has taken a unique approach to privatizing state-owned enterprises (SOEs): share issue privatization (SIP). The structure features mixed ownership of the enterprise by the government (central or local) and the public. This research studies how the extent of privatization influences firms' service quality, using flight-level data in China and an instrumental variable strategy that leverages aircraft redeployability as an instrument for financial distress. We find that the increased government ownership is generally associated with worsened on-time performance, with the most pronounced delays occurring when the government holds a majority stake (50%–70%). The negative effect of public control is exacerbated in markets with higher concentration, underscoring the importance of competitive pressure.

Keywords: mixed ownership, privatization, scope of government, airlines' on-time performance, state-owned enterprises, competition

JEL classification codes: H11, L15, L32, L93, P31

1. Introduction

This paper examines how the scope of government ownership impacts firms' service quality. The effect of privatization on service quality is theoretically ambiguous because cost-saving and quality-enhancing efforts interact through incomplete contracts (Hart et al., 1997; Schmitz, 2000; Bennett and Iossa, 2006; Hoppe and Schmitz, 2010). For a benevolent government prioritizing social welfare over profit maximization, the service quality of state-owned enterprises (SOEs) can be excessively high (Hart et al., 1997). On the other hand, if cost reduction efforts unnecessarily reduce quality, or the deteriorated quality increases

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operational costs, the service quality provided by private firms is not necessarily inferior. The effect of government share on a firm's service quality remains an empirical exploration.

The existing empirical research on quality is limited to the comparison between private and public provision, as opposed to mixed ownership. The settings range from school voucher programs (Angrist et al., 2002, 2006; Hsieh and Urquiola, 2006; MacLeod and Urquiola, 2013) prison services (Hart et al., 1997; Bédard and Frech, 2009), to nursing homes (Chou, 2002; Anderson et al., 2003; Amirkhanyan et al., 2008; Grabowski and Stevenson, 2008) and elderly care (Bergman et al., 2016). The typical finding is that quality in public provision is superior to private provision, while evidence from some research suggests there is no difference. There is an enormous literature studying the effects of mixed ownership on firms' (financial) performance (Xu and Wang, 1999; Sun et al., 2002; Sun and Tong, 2003; Gupta, 2005; Bai et al., 2009, Xia and Walker, 2015), productivity (Brandt et al., 2012, 2017, 2019; Chen et al., 2021) and efficiency (Friese et al., 2020). However, little is known about how mixed ownership affects the quality of services or products. This paper addresses that gap by analyzing how varying degrees of privatization affect service quality, using airline on-time performance in China from 2019 to 2023 as an empirical setting. The Chinese aviation sector during this period offers an ideal context for studying ownership effects. Firstly, China's economic reform features a unique approach to privatizing state-owned enterprises (SOEs): share issue privatization (SIP). As a result, state ownership share (SOS) precisely measures the scope of government ownership. Secondly, airlines in China were largely disrupted in the COVID-19 pandemic and experienced unforeseen interruptions due to lockdowns for the Zero-COVID policy. The turmoil has resulted in some airlines' privatization and others' being more strongly gripped by the government. Focusing on the years before and after the pandemic, an event study is conducted to examine the effect of a change in government ownership on service quality. Lastly, pro-market entry and/or exit and pricing allow the coexistence of airlines with a diverse scope of government ownership (see details in Section 2). The paper further examines how market concentration influences the effects of government ownership on a firm's quality.

China offers unusually fine-grained variation in SOS because the share-issue privatization (SIP) program allowed everything from minority private stakes to complete divestiture. Yet selection into SIP was not random: the policy of 'grasp the large, let go of the small' led the state

to retain the largest, most strategic SOEs and privatize troubled regional carriers (Cao et al., 1999; Sun and Tong, 2003; Xu, 2011; Chen et al. 2021). This context does make endogeneity a potential problem that we carefully address in our empirical work. In China, the world's second-largest economy, the partial privatization of SOEs has played an essential role in its phenomenal economic reform since the economic liberalization in 1978. By selling stakes to the private sector, the "share ownership scheme" privatized or partially privatized many SOEs, which became a hybrid of corporate organizations and government ministries.[3] Yet, in the last decade, the country has shown signs of reversing economic liberalization by increasing state control of SOEs (Chen et al., 2021).[4] This research provides a timely understanding of the effects of mixed ownership.

In the airline industry context, while quality improvement is associated with higher costs, deteriorated quality unnecessarily results in cost savings. On the one hand, the cost-saving efforts, such as higher work intensity, aggressive routes/schedules, and shorter aircraft turnaround time, will likely lead to delays. However, the ripple effect of delays on the flight network may lead to significant revisions of logistics, which is costly. Airlines have an incentive to keep the service quality at a reasonable level. The empirical evidence from this research provides implications for other network industries, such as distribution logistics, trucking, and fleet management. It also brings insights into sectors that require close coordination among many production participants, such as aircraft production. Notably, the research sheds light on restructuring ownership of the air transportation industry. In Europe, while the governments are the principal shareholders of some major airlines (for example, Air France-KLM, TAP Portugal, ITA Airways, etc.), like China, many airports have been fully or partially privatized. However, in the US, all airlines are fully privatized after deregulation, while the government controls almost all airports.[5] The infrastructures and facilities at fully government-owned airports cannot keep up with the increased traffic brought by fully privatized airlines, resulting in airport congestion and flight delays (Borenstein and Rose, 2014). The complex operation of air

[3] https://www.chathamhouse.org/2021/11/who-decides-chinas-foreign-policy/chinese-soes-and-foreign-policy-decision-making (accessed May 24th, 2024).
[4] https://www.wsj.com/articles/ownership-is-key-to-fixing-chinas-soes-1466441214 (accessed May 24th, 2024).
[5] https://businessreview.studentorg.berkeley.edu/the-economics-of-airports-and-privatization/ (accessed October 9th, 2024).

transportation demands the exploration of a viable ownership structure, such as mixed public-private ownership (International Civil Aviation Organization, ICAO, 2013).

The policy context in China can be summarized as follows: to reduce fiscal burdens, the Chinese government has tended to privatize or liquidate smaller, underperforming state-owned enterprises (SOEs), while retaining larger or more profitable ones. This selection process introduces potential endogeneity, as financial heterogeneity may be correlated with both ownership structure and service quality. To address this, our empirical model incorporates firm fixed effects, consistent with the approach used in prior studies (e.g., Frydman et al., 1999; Sun & Tong, 2003; Gupta, 2005). In addition, we use aircraft redeployability as an instrumental variable (IV) for bankruptcy risk to control for each carrier's financial health. This paper also takes advantage of the plausibly exogenous privatization of Hainan Airlines Group (the fourth largest airline in China) and the strengthened state ownership of China Southern Airlines Group (the largest carrier in China's domestic flight market), using a difference-in-differences method to study the effects of privatization and reversal of privatization on flight quality.

The rest of the paper is organized as follows. The next section discusses the relevant background of China's airline industry. Section 3 describes the data, the variables, and their predicted effects. Section 4 presents econometric models and discusses the results. Section 5 conducts difference-in-difference and event study for privatization and reversal cases, and Section 6 concludes the paper.

2. Institutional Background

China's airline industry has evolved significantly since the country's economic liberalization in 1978. Privatization began in the mid-1990s, following reforms that reduced the Civil Aviation Administration of China's (CAAC) direct control (Oum and Yu, 1998). By 2006, most domestic routes could be launched or withdrawn with simple notification rather than central approval (Fu and Zhang, 2010). Fare regulations were also relaxed, with only upper limits now set for economy class prices (Zhang and Round, 2009b).

The 2002 market-oriented consolidation created the "Big Three" airline groups—Air China, China Eastern, and China Southern—all under central government control via SASAC.

Hainan Airlines, in contrast, grew under local government support. These firms now form a competitive yet politically nuanced aviation sector alongside regional state-affiliated carriers and a dozen private airlines. Since the mid-2000s, China's flight market has largely mirrored Western markets regarding pricing, route access, and infrastructure expansion. Government ownership remains a defining feature. As shown in Table 1, the Big Three and Hainan Airlines accounted for 75% of domestic flights in 2019. Private airlines and regional SOEs share the remaining market. On-time performance, however, remains a persistent challenge. Rapid growth in passenger volume, limited infrastructure, and tightly controlled airspace—70% of which is reserved for military use—frequently disrupt operations. In 2023, nearly 24% of flight disruptions were attributed to military activities. To address congestion, CAAC adopted a performance-based slot allocation system in 2017, penalizing airports with on-time rates below 85%. While effective in reducing delays, this policy has drawn criticism for punishing airlines for uncontrollable factors. Additional causes of delay include short turnaround times, overbooking, and staffing shortages, particularly in privatized firms with leaner operations (Fu et al., 2012).

Private carriers, facing tighter margins and fewer resources, tend to operate with higher work intensity and more aggressive schedules. In contrast, government-owned airlines often pad their schedules and allow longer turnaround times, improving punctuality at the cost of efficiency. On average, state-controlled carriers build in longer buffers between flights and report lower crew fatigue indices. However, bureaucratic inertia and limited managerial autonomy may offset these advantages. Leadership in state-owned firms often lacks specialized business training and may be subject to political appointments, while private airline executives tend to be younger, more agile, and industry-focused. Finally, the preferential treatment afforded to SOEs—such as subsidized landing fees and fast-tracked approvals—can dull competitive pressures, ultimately compromising service quality despite resource advantages (Zhang and Round 2009a).

COVID-19 and the Hainan Airlines Privatization Event

The COVID-19 pandemic disrupted global aviation, but China’s airline industry faced especially severe volatility due to its strict zero-COVID policy. Unlike the steady recovery in the

U.S., Chinese flight volumes remained unstable from 2020 to 2023, with abrupt government-imposed shutdowns tied to localized outbreaks.[6]

The *Big Three* are majority-owned by the central government and are less likely to go bankrupt (Czerny et al., 2021). Hainan Airlines—part of the debt-laden HNA Group—was particularly vulnerable. As early as December 2019, Hainan Airlines defaulted on ¥300 million in bond payments, triggering broader cross-default clauses on billions in short-term obligations. The Civil Aviation Administration of China (CAAC) placed the airline under enhanced supervision, and the incident marked the start of a court-led restructuring that culminated in its acquisition by Liaoning Fangda Group in 2021. This takeover replaced Hainan's provincial government with a private owner and offers a plausibly exogenous shift in ownership structure (more details about the timeline of these events are provided in the Appendix). The pre-COVID default in late 2019 serves as a natural benchmark for analyzing the causal impact of privatization on airline service quality—particularly on-time performance—making it an ideal case for our empirical study.

3. Data and Variables

The Official Airline Guide (OAG) Daily Flight Reports provide detailed schedules and performance information for every flight worldwide. The sample is limited to the mainland flight market of China, flight type J, which is a scheduled passenger standard service. The sample spans two years, specifically 2019 and 2023, totaling 730 days. The reasons for skipping 2020-2022 are twofold. Firstly, the flight market and airlines' on-time performance in China during the COVID-19 pandemic were unpredictable and volatile due to lockdowns during the "zero-COVID" policy era. Secondly, government ownership changes take time to materialize fully. For example, the Hainan government first took over the HNA group in 2020, following the shareholders' holding reduction in late 2019,[7] and then underwent a court-led reorganization. Fangda took control of Hainan Airlines in late 2021. Furthermore, the effects of privatization on punctuality would be intertwined with the impact of financial distress experienced during the

[6] https://www.cnn.com/2022/04/28/china/china-covid-lockdown-explainer-intl-hnk/index.html; https://mappv5.caixin.com/m_topic_detail/1696.html (accessed April 15th, 2024).
[7] https://hnair.com/guanyuhaihang/tzzgx/dshgg/201910/P020191015329465114192.pdf. Reference date: 3/24/2025.

pandemic until the situation "settles." The route is defined as a directional pair of airports. The sample excludes carriers with less than 1% flight shares, as the ultra-small airlines are either entirely government-controlled or exclusively serve dedicated routes with little to no interaction with other airlines or lack key variable values, such as government share or minutes late upon arrival. The summary statistics for the 750,656 observations in the sample, along with variable definitions, are presented in Table 2.

Three variables in the main analysis are constructed from OAG. The outcome variable *Minutes Late in Arrival (MinsLateArrival)* is calculated as the minute difference between actual arrival and scheduled arrival time. It is measured per flight and averaged at the carrier's daily route level. Arriving minutes late is a crucial indicator of flight quality, as consumers plan their schedules at their destinations solely according to the scheduled arrival time. Table 2 shows that, on average, flights arrive 14 minutes late.

Firm Size is calculated as the total number of departing flights by the carrier nationwide during the day. A large *Firm Size* indicates a greater market share and market power. Carriers may leverage such power to improve on-time performance on their flight network. It is also likely that large-sized firms render more bureaucracy and redundancy, which are detrimental to performance (Sun and Tong, 2003). Larger *Firm Size* also means the carrier has more balls to juggle and more complicated logistics to arrange. Each carrier fulfills about 1,355 flights nationwide on average per day. After controlling for *Route Frequency*: the number of flights fulfilled by the carrier on the route during the day, which captures the carrier's presence and market power of the route, one suspects that *Firm Size* results in poorer flight quality. *Route Frequency*, an indicator of the carrier's market dominance and market power, is likely to positively correlate with on-time performance, as they can leverage their bargaining power in using airport facilities. The average number of flights a carrier operates on a route per day is two.

Network Integration measures the chance the route influences a mainline carrier's flight network (Forbes and Lederman, 2009). *Network Integration* is calculated as the summation of departing flights at the endpoints of the route for the carrier. The summary statistics of *Network Integration* indicate that the service departing from the endpoints of a route by a carrier consists

of 97 flights. After controlling for *Firm Size*, high *Network Integration* means the route is more integrated into the carrier's flight web, and therefore, more likely to influence and be influenced by the rest of the flights in the network. It also indicates the carrier's high demand and market presence. It is intuitive to expect carriers to prioritize the reliability of flights on such routes and devote efforts to ensure punctuality within their capabilities.

The Herfindahl-Hirschman Index (*HHI*) is calculated to measure market concentration, using the share of flights fulfilled by each airline on a given route on a particular day. *HHI* is excluded from the main regressions due to perfect multicollinearity with route-day fixed effects. However, the interactive terms of state-owned shares and *HHI*, reveal how government ownership's influence on punctuality is affected by market concentration.

State-ownership share (SOS) refers to the shares held by central governments, local governments, or solely government-owned enterprises. In this paper, state-ownership share is also referred to as government share (*GovShare*). State-ownership shares are collected from the airline's annual reports and equity penetration charts. The more detailed SOS from representative periods is summarized in Table 1. One can see a rich variation in SOS over time and across airlines. Compared to January 2019, Air China's SOS in January 2023 increased by 1.35%, while its subsidiaries, Shenzhen and Kunming Airlines, experienced a significant decrease in SOS. China Eastern and its subsidiaries reported a slight decrease in SOS in 2023, still hovering around 50%. Following the reorganization, the entities under Hainan Airlines were largely privatized, with evidence of significantly lower SOS. For the other local government-controlled airlines, Shandong Airlines' SOS decreased by more than 12% after being taken over by Air China. The SOS of Sichuan Airlines and Joy Air increased, while the SOS of other local government-controlled airlines remained relatively unchanged.

There have also been reversals in cases of privatization by Chinese airlines. China Southern Airlines and its subsidiaries experienced a significant increase in SOS after Guangdong's local government increased its stock holdings in China Southern Airlines in response to the promotion of equity diversification reform for state-owned enterprises (SOEs).[8]

[8] http://finance.china.com.cn/industry/20190721/5034493.shtml (accessed April 15th, 2024).

China Southern Airlines Group is used as another counterfactual to examine how punctuality is influenced by strengthened state control.

Due to financial difficulties during the pandemic, the local government took over some previously privately owned airlines, including Ruili Airlines, Okay Airways, and Qingdao Airlines. About 29% of the initially purely privately owned airline travel is now controlled by the local government. It would be interesting to examine how flight quality is influenced by the reversal of privatization among the initially private airlines. However, parallel analysis is not feasible due to private airlines' large-scale missing values for delay information.

Government ownership may increase service quality for the following reasons: While private owners aim for profit maximization and efficiency, the SASAC representing the government is committed to achieving social welfare objectives, such as the size of employment, wages and benefits per employee, prices of main products, and government taxes (Bai et al., 2000; Bai et al., 2009). Excessive employment and generous benefits for government-controlled airline employees likely lead to higher quality (Hart et al., 1997). In addition, SOEs can extract subsidies, preferential access to loans, and other favorable policies from the government (Zhang, 1998; Tian, 1999; Sun and Tong, 2003). Support from the government may help state-owned airlines improve their punctuality; however, bureaucracy and political interventions can interfere with the airlines' everyday operations. More importantly, government support may give SOEs an advantage in market competition, which can harm flight quality.[9] An important but often overlooked channel is what industry practitioners refer to as "competition bypass"—when central or provincial SASACs subsidize landing fees, guarantee bank loans, or fast-track slot approvals for favored carriers. These privileges distort the competitive landscape, allowing state-backed airlines to raise rivals' costs while dulling their own incentives to uphold service quality. Mixed-duopoly theory suggests such protections reduce market discipline and degrade punctuality (Ishibashi & Kaneko, 2008). Therefore, the net effect of the state-owned share on service quality remains an empirical question.

To test the potential non-linear effects of state-ownership share, the SOS is further categorized into the following groups: smaller than 50%, 50-70%, and 70-100%. An alternative

[9] https://www.wsj.com/articles/SB10001424127887323368704578591241796640654 (accessed May 30th, 2024).

category method is based on the government shares' quartiles: SOS's 25th, 50th, and 75th percentiles. Tian (1999) theorizes that government ownership exceeding a certain threshold can exert sufficient control to reduce agency costs and improve firm performance through cooperative governance. Sun and Tong (2003) further argue that state influence becomes more pronounced as ownership approaches or exceeds a controlling stake. Building on these insights, our analysis adopts categorical thresholds at 50% and 70% to reflect key inflection points in government control. The 50% threshold marks the transition to majority ownership, where the state can unilaterally direct firm policy, while the 70% level captures near-total control, often accompanied by competition-bypass privileges. By omitting a category for state ownership below 50%, we focus on the policy-relevant range in which government influence is theoretically and empirically consequential, allowing us to isolate the quality implications of state dominance in mixed-ownership structures. The remaining 22% of observations are from carriers either heavily or entirely controlled by the government (*GovShare_70)*. The effects of mixed ownership between the government and the private sector on flight quality are difficult to predict. On the one hand, financial support and information shared by the private sector benefit state-owned enterprises (SOEs). Additionally, private ownership may limit government bureaucratic intervention. On the other hand, contradictions between social welfare goals and profit maximization may lead to tensions among management that represent different interest groups (Estrin and Perotin, 1991). Chen et al. (2021) also point out that the multiplicity of stakeholders and reporting lines (i.e., bureaucracy) tends to add noise and cause delays in decision-making at SOEs. One suspects that the scope of government ownership plays a role in determining the net effect of punctuality, which warrants empirical exploration.

Bankruptcy Indicator and Instrumental Variable

The emerging market *Altman-z-score* (*Z-Score*) for predicting bankruptcy, which takes the firm's profitability, leverage, liquidity, solvency, and activity ratios into account, is constructed (Altman, 2013) from the airlines' annual financial report.[10] Although not reported,

[10] *Z″ = 6.56 (X1) + 3.26 (X2) + 6.72 (X3) + 1.05 (X4) + 3.25*, where *X1* = working capital/total assets, *X2* = retained earnings/total assets, *X3* = earnings before interest and taxes/total assets, *X4* = market value equity/book value of total liabilities, *X5* = sales/total assets. It is interpreted that firm is financially distressed if its *z-score* is lower than 1.81. And if it is between 1.81 and 2.99, the firm has a medium chance of going bankrupt or a medium distress company. A firm with a *z-score* higher than 3 has little financial distress.

in 2019, the *Big Three* and Hainan Airlines were ranked as medium distressed, and the financial situation of the *Big Three* was better than that of Hainan Airlines. Then, COVID-19 thrust everyone into a difficult situation, and although Air China and China Eastern Airlines were more financially distressed than Hainan Airlines, neither went bankrupt due to heavy government intervention. China Southern Airlines' financial situation stayed stable due to the financial support of the Guangdong Provincial government. The *Altman z-score* of other regional airlines endorsed by local governments plummeted after COVID-19 due to the fragile flight structure and more limited business scope. Private airlines, including Juneyao Airlines and Spring Airlines, were in a strong financial position in 2019 and 2023. The average *Z-score* in the sample is 2, indicating a medium distressed financial situation for airlines. Phillips and Sertsios (2013) point out that airlines' quality decisions are differentially affected by financial distress and bankruptcy. Product quality is suspected to decrease when airlines are financially distressed, but it increases relative to financial distress when there is a high likelihood of bankruptcy. As the *Altman z-score* is a bankruptcy indicator, it is suspected to be positively related to delays.

Fleet Redeployability is a weighted average of the popularity of an airline's fleet composition. Following Phillips and Sertsios (2013), it is calculated as follows:

$$Fleet\ Redeployability_{c,t} = \sum_{i=1}^{n} \frac{\#\ of\ aircraft_{i,c,t}}{\#\ of\ aircraft_{c,t}} * (\#\ of\ aircraft_{i,t} - \#\ of\ aircraft_{i,c,t}),$$

$$i = aircraft\ type$$

The parenthesis is the difference between the total number of airplanes for the type i at time t on duty all over the world, and the number of airplanes of the corresponding type owned by the carrier c. It measures the "market thickness" or the popularity of the aircraft. Then, it is further weighed using the fraction of each aircraft type. For example, if airline *C* has 100 aircraft, including 80 Boeing 737-800s and 20 Airbus A380s. Suppose there are 4000 B737 and 200 A380 in service worldwide. The *Fleet Redeployability* for carrier *C* is: $\frac{80}{100}(4000 - 80) + \frac{20}{100}(200 - 20) = 3,172$. The average *Fleet Redeployability* is 4,142, ranging from 754 to 11,100.

4. Evidence from Multi–Way Fixed Effect Model

Considering the government treats firms of different sizes differently, airlines are grouped into individual carriers based on their flight frequency shares in the sample, which are either equal to or higher than 5%[11], or equal to or higher than 1% but lower than 5%.[12] The equations below are regressed separately for each group.

4.1 Baseline Model

Equation (1) examines the impact of government control on carriers' on-time performance.

(1) $MinsLateArrival_{c,r,t} = \alpha + \beta GovShare_{c,t} + \delta Network\ Integration_{c,r,t} + \theta Frequency_{c,r,t} + \eta Fir$

,

where c, r, t denotes carrier, route, and time period, respectively. A continuous variable of the government ownership shares for the carrier: $GovShare_{c,t}$ is the key variable of interest. $Network\ Integration_{c,r,t}$ measures how integrated the routes are into the airlines' network, $Frequency_{c,r,t}$ captures the market dominance and appearance. $Firm\ Size_{c,t}$ measures the operating flights daily by the carrier's flight web. *Network Integration*, *Frequency,* and the Outcome Variable $MinsLateArrival_{c,r,t}$ vary at carrier-route-day level. A carrier's quarterly financial situation is captured by $Z_{score_{c,t}}$ or *Altman-z-score*. Empirical regression also includes carrier C_c, route R_r and day T_t fixed effects. Calendar day T_t, fixed effects capture any time trend, such as fuel prices, macro-level policies, or seasonal variations in flight quality. Further, RT_{rt}, the two-way route-day fixed effects control for any carrier-invariant route effects that vary with time, which may influence flights' punctuality, such as weather, military activity-related interruptions, route-season regulations aimed at alleviating congestion, endpoint economic and demographic indicators, as well as market competition and structure. Therefore, the identification is from carrier level changes in government ownership over time.

[11] Air China, China Eastern, China Southern, Hainan Airlines, Sichuan Airlines, Shenzhen Airlines.
[12] Lucky Air, Spring Airlines, Shanghai Airlines, Tianjin Airlines, Beibu Gulf Airlines, Juneyao Airlines, Beijing Capital Airlines, China United Airlines, Kunming Airlines, Xiamen Air, Hebei Airlines, West Air, Shandong Airlines

4.2 Nonlinear Effects of Government Ownership

Three equations are employed to explore the nonlinear effects of government ownership on flight punctuality. Equation (2) features a share the government owns and its squared terms.

(2) $MinsLateArrival_{c,r,t} = \alpha + \beta GovShare_{c,t} + \gamma GovShare_{c,t}^{2} + \delta Network\ Integration_{c,r,t} + \theta Freq$

,

Equation (3) features categorical variables, specifically whether the government owns the carrier's share, categorized as less than 50%, 50-70%, and greater than 70%, with the classification of less than 50% omitted. The model and empirical findings by Tian (1999) suggest that the government should provide cooperative governance and control agency costs if it holds a sufficiently large stake. Therefore, the categorical variable indicating a state-ownership share of 50% or less can help determine whether government support improves on-time performance. Equation (4) is similar to (3), but the government ownership is categorized based on the quartile for the corresponding airline group, omitting the lowest 25th percentile category.

(3) $MinsLateArrival_{c,r,t} = \alpha + \beta_1 GovShare\_30_{c,t} + \beta_2 GovShare\_50_{c,t} + \beta_3 GovShare\_70_{c,t} + \rho + \delta N$

,

(4) $MinsLateArrival_{c,r,t} = \alpha + \beta_1 GovShare\_25th_{c,t} + \beta_2 GovShare\_50th_{c,t} + \beta_3 GovShare\_75th_{c,t} + \rho + \delta Net$

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4.3 Essential Market Competition

The competition bypass phenomenon is observable in the data: when a high-SOS carrier also faces a high local HHI, its protected position magnifies any latent complacency. To quantify this crowd-out effect, we interact SOS with the route-day Herfindahl index. Equation (5) includes an interaction term between state-owned shares and *HHI*, which examines how market concentration influences the effect of government ownership on the airline's punctuality. *HHI* is not included by itself due to perfect multicollinearity with the RT_{rt} route-day fixed effects.

(5) $MinsLateArrival_{c,r,t} = \alpha + \beta GovShare_{c,t} + \varphi GovShare_{c,t} * HHI_{r,t} + \delta Network\ Integration_{c,r,t}$

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4.4 Endogenous Financial Condition and Identification

The financial stress a firm faces is likely to influence its service quality; meanwhile, inferior service quality and discouraging prices may push the firm into an unfavorable financial condition. Therefore, the primary issue in determining the attributing effects of a bankruptcy indicator (*Altman-z-score*) is that it may be endogenous. The problem is alleviated by including the carrier's fixed effects and time fixed effects; however, this does not fully resolve it.

An instrumental variable is employed to address the endogeneity issue. This instrumental variable must be related to the probability of default but not the flights' punctuality. The airline's fleet redeployability measures the popularity of the airline's fleet, which is constructed as described in Section 3 and used as the instrumental variable. Aircraft are assessed based on their production and cost measurement, such as RPKs (Revenue Passenger Kilometers) and CASK (Cost per Available Seat Kilometers).[13] An aircraft type becomes popular among carriers if it features some or a combination of fuel efficiency, versatility, reliability, passenger capacity, ease of maintenance, and standardized pilot training. Some aircraft, such as the Airbus A380, are highly reliable, comfortable, and quiet to fly with; however, they are not popular among carriers due to high costs, inefficient engines, excess capacity, and infeasible size in many airports. Suppose a carrier holds a fleet featuring popular aircraft types, facing unfavorable financial conditions. In that case, it can easily sell or rent some of its planes to other carriers and is more resilient to financial difficulties. The fleet's redeployability is influenced by the popularity of aircraft types, which refers to the perceived value of these types by carriers worldwide and is not within the control of any one carrier. Changing the composition of aircraft types in its fleet is not feasible in the short run, as it requires coordination in maintenance, training, and airport infrastructure. On-time performance, conversely, after controlling for the route-day fixed effects, is attributed to the carrier's time-varying characteristics. The fleet's redeployability is negatively related to the carrier's default probability but stays exogenous to the airline's on-time performance. The multi–way fixed effect results reported in Tables 3.1 and 3.2, along with the interpretations below, focus on those with *Altman-z-score* instrumented by *Fleet Redeployability*.

4.4 Results for Airlines with Flight Shares of 5% or Higher

[13] Source: https://www.oag.com/blog/worlds-most-heavily-used-aircraft-types-ask; https://www.entireflight.com/blogs/aviation-is-a-lifestyle/most-common-airplane-types. Reference date: 3/26/2025.

The results for airlines with flight shares of 5% or higher are presented in Table 3.1. These refer to the big-four airlines and Shenzhen Airlines, as well as Sichuan Airlines. The bottom part of Table 3.1 shows that the Kleibergen-Paap $\chi 2$ test rejects the hypothesis that the IV regression is under-identified, and the Kleibergen-Paap F test rejects the hypothesis that the IV regression is weakly identified. These results lend support to our specification and IV choices. The results for equation (1) are presented in column 1. It shows that, for example, a carrier's government-owned shares increase from 45% to 55%, and the carrier arrives 1.4 minutes later than it would have otherwise, indicating that enhanced government ownership is negatively related to flight punctuality.

The results for equation (2) with a squared term of government-owned shares, presented in column 2, are consistent with the fact that delayed time at arrival increases with respect to government-owned shares, but at a decreasing rate. Arrival delays are estimated to plateau when the government share is approximately 52.8%. Results from the state-owned shares categorical variables in column 3 further indicate that the relationship between *Minutes Late on Arrival* and *GovShare* is non-linear. The flight quality of carriers with the government as the minority shareholder (*GovShare* < 50%) is not statistically different from that of carriers with the most government ownership (*GovShare* > 70%). This is consistent with expectations because there is no direct trade-off between quality improvement and cost savings in the context of airlines' on-time performance. Airlines can save costs by increasing the workload intensity of employees, reducing aircraft turnaround times, and implementing aggressive schedules during peak periods. However, those cost-saving efforts have a negative impact on punctuality. When a flight is significantly delayed, the aircraft and crew members may be unable to be on the next scheduled flight on time. The delay will negatively impact subsequent flights, and airlines must adjust their logistics accordingly. Passengers may be unable to make it to their connecting flights, resulting in compensation costs. The reputation of abnormal flights may negatively impact future revenue. Therefore, private airlines attempt to reduce costs only to the extent that no significant detrimental effect on quality is incurred.

Interestingly, when the government has a significant stake (50% < GovShare < 70%) in controlling the airline, its on-time performance is the worst. Passengers experience 37 minutes longer delays than those in the private provision, indicating that not only do bureaucratic

interventions erode its daily operation, but also that it suffers the most from tensions among management personnel representing conflicting interests between private owners and the government.

The airlines of interest are also categorized based on the government-owned share quartiles, and the results are presented in column 4. Compared to the airlines with state-owned shares in the 25th percentile (*GovShare* < 47.633%), the delayed time of airlines with state-owned shares in the second quartile (47.633% < *GovShare* < 49.8%) is slightly longer but not statistically different; however, the delayed minutes by airlines with government as the majority holder in the third quartile (49.8% < *GovShare* < 53.052 %) is 13.5 minutes longer, and the flights fulfilled by airlines overwhelmingly controlled by the government (*Govshare* > 53.052%) experience 6.74 minutes longer arrival delays. The results from equations (1) to (4) suggest that government ownership does not improve the punctuality of flights operated by large airlines. If the government must hold shares of the firm, holding them at a minority stake is deemed desirable.

The results in equation (5) (Table 3, column 5) show that intensified market concentration exacerbates the negative impact on service quality resulting from enhanced government ownership. And when the government's grip is stronger, the negative impact of a more concentrated market on punctuality is heightened. Table 4 summarizes the effects of a 1,000 increase in *HHI* on *Minutes Late on Arrival*. When the government share is at 10%, a 1,000 increase in *HHI* increases the arrival delays by 14 seconds; when the government share is at 50%, the same amount increases in market concentration increases the delays by 1.2 minutes, and when the government has full control of the carrier, a 1,000 increase in *HHI* dials punctuality back by 2.37 minutes. The negative impact of a concentrated market on service quality becomes more pronounced with increased government control. The policy implication is that the government needs to refrain from providing a competitive bypass to SOEs controlled by SASAC. Comparable market competition is never more essential when government control is in place.

Results for other variables in equations (1)-(5) are consistent with the expectations outlined in Section 3: Passengers tend to enjoy flights with better on-time performance on routes

more integrated into the airline's flight network, although the results are not statistically significant. Larger firm sizes are associated with more delays, whereas market dominance and high flight frequency are associated with fewer delays. The results for the bankruptcy indicator, the *Altman-Z-score*, are statistically significant and positive, indicating flights by airlines with higher bankruptcy risks are more likely to be on time for arrivals. This finding is consistent with the research by Phillips and Sertsios (2013), who noted that "in bankruptcy, product quality increases relative to financial distress."

4.5 Results for Airlines with Flight Shares of 1% or Higher

The results for airlines with flight shares of 1% or higher but lower than 5%, however, are not significant. The results are presented in Table 3.2. This group includes airlines such as Lucky Air, Spring Airlines, Shanghai Airlines, Tianjin Airlines, Beibu Gulf Airlines, Juneyao Airlines, Beijing Capital Airlines, China United Airlines, Kunming Airlines, Xiamen Air, Hebei Airlines, West Air, and Shandong Airlines. Consistent with the Chinese government's policy in interacting with firms: *"zhua da fang xiao," i.e., "grasp the large, let go of the small."* Those airlines receive limited, if any, government support. Some of them, such as Shanghai Airlines, have extensive market contacts and face intense competition from private airlines. Other airlines, such as Shandong Airlines, face substantial demand diversion from the bullet train or high-speedway system. Some of them, such as Tianjin Airlines and Shandong Airlines, are located close to the military base, which makes them more susceptible to intervention in military affairs. Therefore, the government's support, if there is any, may have a limited impact on their everyday operations, one way or another.

5. Difference-in-Difference and Event Study

5.1 Privatization and the Reversal Case Study

As shown in Table 1 and discussed above, the airlines that experienced privatization are mainly from Hainan and its subsidiaries. All carriers within Hainan Airlines experienced a dramatic ten percentage point or more decrease in government ownership. More importantly, the government is no longer the majority shareholder in Hainan and its subsidiaries except Air Guilin (GT). Under Air China's wing, Shenzhen Airlines' SOS declined from 75% to 27%, and

its subsidiary, Kunming Airlines, saw a decrease in SOS from 41% to 27%. The Shandong Provincial government endorsed Shandong Airlines, which then became a subsidiary of Air China. The change in SOS to Shandong Airlines is in both quantity (-12.7%) and quality (below 50%). The privatized airlines with 1% or higher flight shares marked in bold in Table 1 are up for analysis.

As noted, the local government took over some private airlines during the COVID-19 pandemic due to financial difficulties. Unfortunately, it is not possible to examine the effect of "nationalization" on the flight quality of those airlines because there are insufficient numbers of observations that report on-time performance. Instead, this paper focuses on China Southern Airlines and its subsidiaries, most of which have experienced a more than 10% increase in government shares, including China Southern Airlines, Xiamen Air, and Hebei Airlines, etc. Southern Airlines is also a majority shareholder of Sichuan Airlines, whose SOS increased by 5.42%. While the airlines underlined in Table 1 are used to study the effect of reversed privatization on flight quality, Sichuan Airlines are excluded from the robustness checks. It's worth noting that the change in China Southern Airlines' and its subsidiaries' government shares is in "quantity" instead of "quality". The government was already the majority holder before the enhanced control (SOS > 50%). The change made the government from a majority to an overwhelming majority in control. The interpretation of the results requires caution, as the change is not from less than 50% (more privatized) to more than 50% (more government control).

The government-owned shares for Air China, China Eastern Airlines, and their subsidiaries remained largely unchanged from 2019 to 2023. The airlines listed in italics in Table 1, which are comparable in size, serve as control groups in the difference-in-difference analysis. Please note that since Hainan Airlines and China Southern Airlines were both partially owned by the government in 2019, airlines that were private in 2019, such as Spring Airlines, are excluded from the control group, despite their government ownership shares remaining unchanged.

To quantify the on-time performance changes by privatized and "nationalized" airline carriers following the significant change in government shares, the following fixed effects model is estimated separately for privatized and reversal privatized airlines:

(6) $MinsLateArrival_{c,r,t} = \alpha + \beta Privatization_c * Event_t + \delta Network\ Integration_{c,r,t} + \theta Frequen$

,

Privatization is an indicator variable referring to airlines that experience a 10% or more decrease in SOS, as discussed above. The indicator *Event* turned to one since the last quarter of 2019 for privatized airlines. I also estimate identical regressions for the reversal of privatization for the airlines, with underlines in Table 1, compared to airlines with some government control that experience minimal change in SOS. The indicator *Event* became one in 2023 for nationalized airlines. All other variables are the same as defined above. Therefore, equation (6) compares *MinsLateArrival* for privatized (/reversal) airlines versus a group of control airlines that experience little change in SOS. β is the parameter of interest, measuring the average treatment effect on the treated of privatization, and it is reported in Table 5. Privatized airlines are, on average, associated with 6.85-minute shorter delays on arrival. The results are consistent with those from the multi-way fixed effects model in Table 3.2 (Equations 1-5), which indicate that privatization increases flight quality in terms of punctuality. Meanwhile, airlines with significantly strengthened government control experience almost 50 minutes shorter delays at arrival, which is a substantial economic benefit. Please note that this does not contradict our main findings discussed above. Because the enhanced government control for China Southern Airlines and its subsidiaries shifted them from approximately 50% to 70% government shares, the most delayed category to the absolute government control category (70% or above), the group that is not statistically or economically different from the airlines that are more privatized (below 50%). The result is consistent with the findings from Equation (3) and presented in Table 3.1, column 3.

5.2 Results – Common Trend Analysis

Lastly, the dynamics of the effect across the sample period are examined to facilitate visualization of the responsiveness of privatization over time. Furthermore, it formally tests whether pre-existing trends introduce bias into the estimates reported in Table 5. The treatment effect of interest, which measures the impact of *Privatization* and *Reversal* on on-time performance, is presented graphically in Figure 2. The lead and lag coefficients for *Privatization* and *Reversal* are estimated using the event study (7) and (8), respectively:

(7) $$MinsLateArrival_{c,r,t} = \alpha + \sum_{j=Jan2019}^{August2019} \beta_j Privatization_c + \sum_{j=Oct2019}^{Dec2023} \beta_j Privatization_c + \delta Network$$

,

(8) $$MinsLateArrival_{c,r,t} = \alpha + \sum_{j=Jan2019}^{Nov2019} \beta_j Privatization_c + \sum_{j=Jan2023}^{Dec2023} \beta_j Privatization_c + \delta Network$$

,

Figure 2 visually depicts the changes in minutes late at arrival across privatized and "nationalized" airlines over a twenty-four-month period surrounding the end of 2019. Overall, since confidence intervals hover around zero during the time before the event, this suggests that *MinsLateArrival* was neither significantly higher nor lower relative to the reference month. Alternatively stated, Figure 2 shows that one can reject the presence of divergent pre-event trends between the treated and control groups for all periods in the privatization sample and most periods in the reversal of privatization data. Figure 2 also reveals that post-change delay patterns exhibit statistically significant differences. The privatization case figure in Panel A shows that the delay situation was worse immediately after the event, indicating adaptation and learning in the transition period. We can see that the delays returned to pre-pandemic levels toward the end of the sample period. One suspects that the positive impact of privatization on punctuality might be more pronounced in the long run. We can observe a more stable difference in the strengthened government control case in Panel B, where the on-time performance improved after the government enhanced its control over China Southern Airlines and its subsidiaries to a dominant level. However, this better on-time performance effect gradually fades away toward the end of the sample period.

6. Conclusion

This research is the first to empirically examine how mixed ownership influences a firm's service quality. Using the setting of airlines' on-time performance in China for 2019 and 2023, this paper fills the gap and studies how flight delays are influenced by the extent to which the carriers are privatized. The findings reveal a non-linear relationship between government ownership and flight punctuality. Airlines with 50-70% government ownership experience the worst on-time performance, with delays averaging 37 minutes longer compared to those with

minority government shares. Conversely, airlines with lower government stakes perform similarly to those with high government control, indicating that mixed ownership could be negatively related to quality, as having a multitude of bureaucrats leads to tensions among leaders representing different interest groups and, therefore, decision delays. Consumers enjoy the best flight quality when the carrier's ownership is delineated, either with dominant private ownership or super majority control by the government share. Higher market concentration amplifies the adverse effects of government ownership on service quality, highlighting the critical role of robust market competition in sustaining performance standards.

The findings offer critical insights into the implications of mixed ownership for service quality, particularly in fleet-based industries, manufacturing sectors requiring interdepartmental coordination, and semipublic enterprises. Contrary to the view that public-private balance uniformly enhances service quality, our results indicate that service performance deteriorates when the government holds a majority stake—especially between 50% and 70%—due to bureaucratic frictions and diluted managerial incentives. Notably, firms with over 70% state ownership do not significantly underperform compared to privatized entities, suggesting that other forces—such as heightened scrutiny or reduced commercial pressure—may offset further decline at extreme levels. In other words, overwhelming state control may stabilize expectations or shift objectives away from commercial efficiency. Importantly, high market concentration amplifies the negative effects of government control, reinforcing the essential role of competition in maintaining service quality. While increased government oversight can reduce managerial opportunism, reversing privatization without solid accountability measures risks lowering service quality. These results caution against the broad adoption of diversified central-local ownership structures, which may compound governance complexity and delay decision-making, ultimately impairing operational efficiency. Therefore, maintaining clear lines of authority and ensuring robust market competition are essential to realizing the potential benefits of public-private cooperation.

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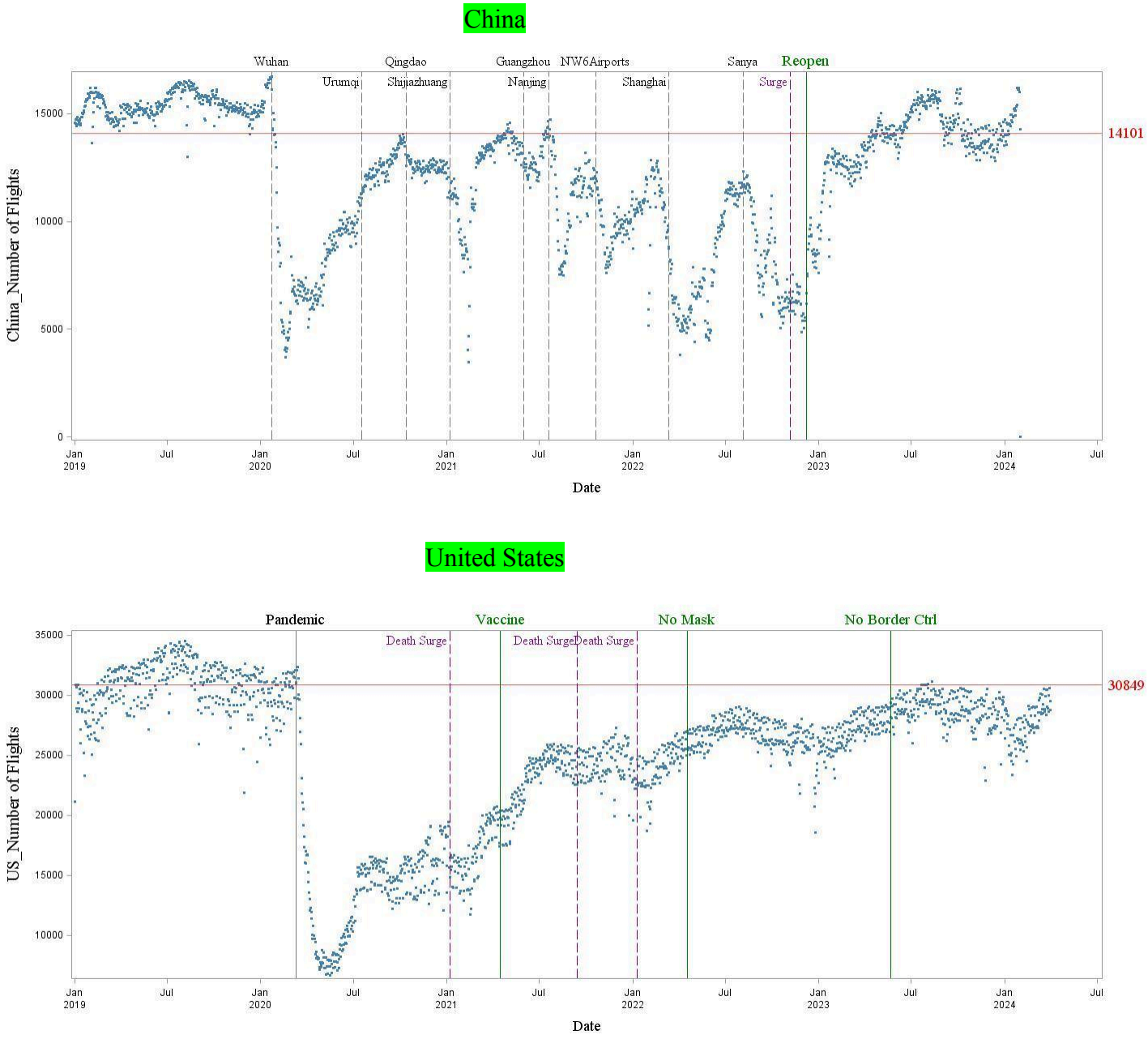
Figure 1: Passenger Flights 2019-2023

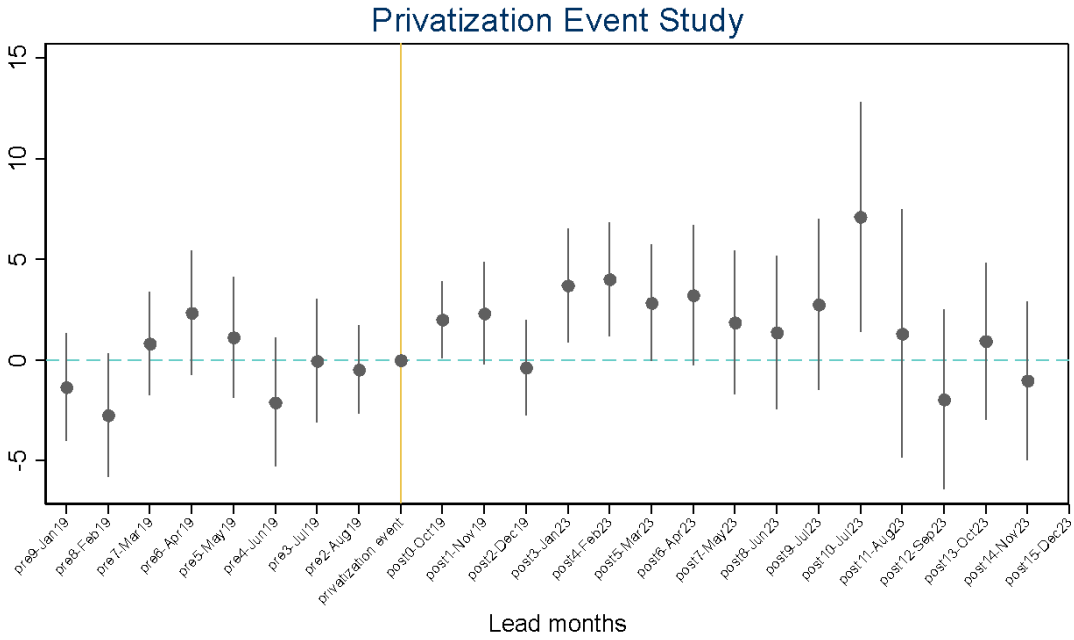


Source: flights data is from Official Airline Guide (OAG).

Note: The China's Covid lockdown timelines are from the "COVID Records" by caixin.com. Each grey dash line refers to a region lockdown. The Covid related information for the US is collected from Centers for Disease Control and Prevention (CDC) Museum COVID-19 Timeline, and Johns Hopkins University and Medicine. Policy-events information is from mass media. Red reference lines are 2019's averages.

Figure 2. Common Trend Event Study

Panel A



Panel B

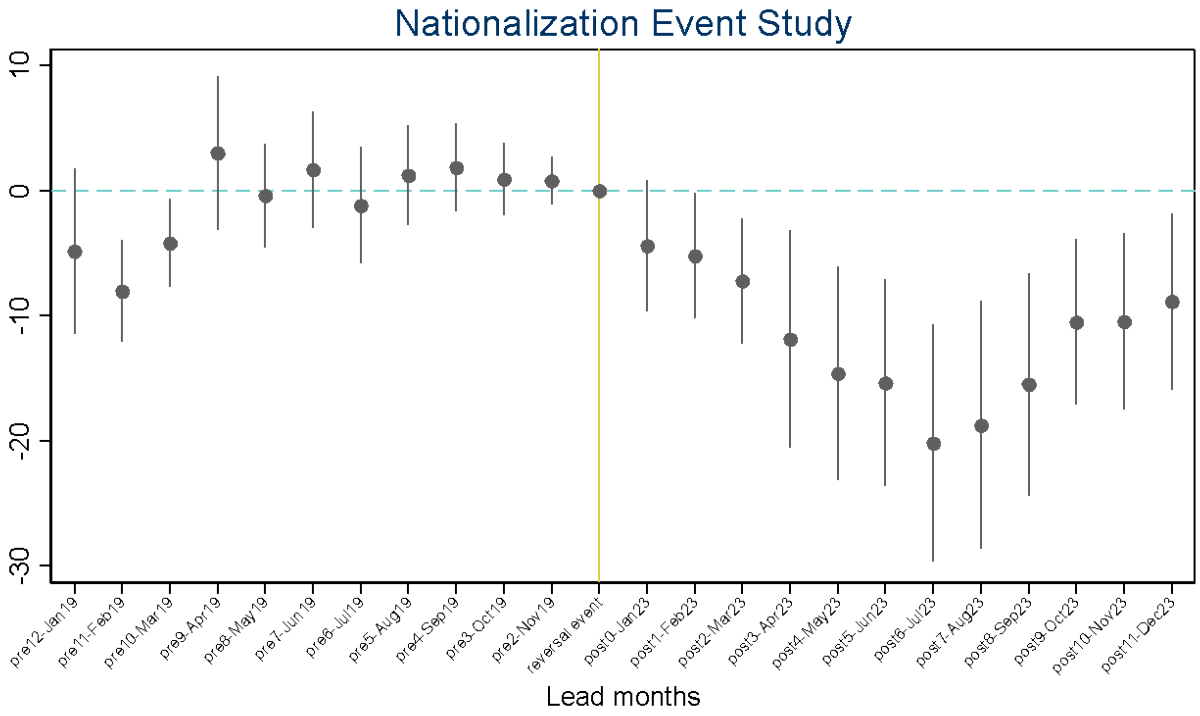


Table 1: State-Ownership Share (SOS)

Airline Corporation	Subsidiary	Sub-Subsidiary	Government Share %	
			Jan2019	Jan2023
Air China (*CA*)			51.7	53.05
	Shenzhen Airlines (**ZH**)		75	27.06
		Kunming Airlines (**KY**)	41	27.06
	Air Macau (NX)		56.09	56.09
Shandong Airlines (**SC**)[14]			53.88	41.23
Tibet Airlines (TV)			36.03	36.45
Cathay Pacific (CX)[15]			15.5	15.61
China Eastern Airlines (*MU*)			49.79	47.63
	China United Airlines (*KN*)		49.79	47.63
	Shanghai Airlines (*FM*)		49.79	47.63
China Southern Airlines (CZ)			50.54	68.04
	Xiamen Air (MF)		73	82.42
		Hebei Airlines (NS)	73	82.42
		Jiangxi Air (RY)	84	89.45
	Chongqing Airlines (OQ)		70	80.82
	Air Guizhou (G4)		70	80.82
Sichuan Airlines (3U)[16]			70	75.42
	Chengdu Airlines (EU)		100	100
Hainan Airlines (**HU**)			54	7.45
	Grand China Air (CN)		57	5.51
	Beijing Capital Airlines (**JD**)		100	19.42
	Tianjin Airlines (**GS**)		55.64	7.75
	Suparna Airlines (Y8)		52	6.75
	Lucky Air (**8L**)		67.5	19.78
	West Air (**PN**)		68.63	19.16
	Air Changan (9H)		59	18.55
	Fuzhou Airlines (FU)		52	24.47
	Urumqi Air (UQ)		67.59	35.22
	Beibu Gulf Airlines (**GX**)		69	35.22
	Air Guilin (GT)		99	89.69
Colorful Guizhou Airlines (GY)			100	100
Joy Air (JR)			89	92.06
Private Airlines				
Ruili Airlines (DR)			0	81.06
Juneyao Airlines (HO)			7.47	15.78
	9 Air (AQ)		7.47	15.78
Spring Airlines (9C)			5	5.21
Okay Airways (BK)			0	61.17
Donghai Airlines (DZ)			0	0
LOONG AIR (GJ)			0	0
Longjiang Airlines (LT)			0	0
Qingdao Airlines (QW)			0	100
Air Travel (A6)			0	28.56
China Express Airlines (G5)			0	12.36

Source: airlines' annual reports and equity penetration charts. IATA codes are in parentheses. Privatized airlines are marked in bold, and nationalized ones are underlined. Airlines in the control group are in italics.

[14] Shandong Airlines become Air China's subsidiary in 2023.
[15] Air China is a shareholder of Tibet Airlines and Cathy Pacific.
[16] China Southern is a majority shareholder of Sichuan and Chengdu Airlines.

Table 2: Summary Statistics for Airlines with Flight Shares ≥ 1%

Variable	Mean	Std. dev.	Min	Max	Source	Definition
MinsLateArrival	13.93	45.67	-146	1380	OAG	Airplane in gate – scheduled arrival
Firm Size	1354.82	725.72	61	2539	OAG	Total flights of the carrier-day
Route Frequency	2.08	1.93	0	23	OAG	Number of flights for carrier-route-day
Network Integration	97.41	83.33	2	511	OAG	Summation of departing service at endpoints of the route for the carrier-day
HHI	3706.1	1308.6	1111	10000	OAG	Summation of squared terms for each airline's market share in flights* 10000
GovShare	50.03	20.41	5	100	Carrier's Annual Report	The share of carrier owned by government
GovShare_50	0.31	0.46	0	1	Carrier's Annual Report	=1 *50<=GovShare<70*
GovShare_70	0.22	0.41	0	1	Carrier's Annual Report	=1 *70<=GovShare<=100*
Altman z-Score	1.99	0.96	-1.38	6.21	Author's Construction	See footnote 19
Fleet Redeployability	4388.33	1967.53	3.18	17730	OAG	See Section 3

Note: Number of observations: 750,656. *MinsLateArrival*, *Network Integration,* and *Route Frequency* are consolidated at carrier-route-day level. *Firm Size*, government ownership variables, *Altman z-score*, and *Fleet Redeployability* vary by carrier-time; *MinsLateArrival* is measured in minutes.

Table 3.1: Multiple-Way Fixed Effects with Instrumental Variable for Airlines with Flight Shares>=5%

VARIABLES	(1) GovShare	(2) GovShare & Squared Term	(3) Categorical	(4) Quartiles	(5) GovShare*HHI
GovShare	0.1406***	1.8173***			0.0523
	(0.0527)	(0.5525)			(0.0773)
GovShare^2		-0.0172***			
		(0.0052)			
50<=GovShare<70			37.0484***		
			(11.4193)		
GovShare>=70			2.4019		
			(1.8530)		
GovShare_25th				1.2226	
				(1.2056)	
GovShare_50th				13.5317**	
				(5.6766)	
GovShare_75th				6.7393***	
				(2.4561)	
HHI GovShare*					0.2372*
					(0.1408)
Network Integration	-0.0015	-0.0022	-0.0023	-0.0012	-0.0023
	(0.0047)	(0.0047)	(0.0047)	(0.0048)	(0.0047)
Firm Size	0.0059*	-0.0027	-0.0025	0.0041	0.0059*
	(0.0031)	(0.0034)	(0.0034)	(0.0030)	(0.0031)
Route Frequency	-0.6316***	-0.6569***	-0.6589***	-0.6312***	-0.6564***
	(0.2000)	(0.1999)	(0.2000)	(0.1999)	(0.2003)
Altman Z-score	14.4020***	38.4889***	40.5230***	12.9705***	14.5704***
	(3.4831)	(10.5738)	(11.2499)	(3.2166)	(3.4922)
Underidentification test:					
Kleibergen-Paap rk LM statistic	123.528	57.308	56.742	130.049	123.864
Chi-sq(1) P-val	0.0000	0.0000	0.0000	0.0000	0.0000
Weak identification test:					
Kleibergen-Paap rk Wald F statistic	65.622	42.717	39.010	66.352	65.908

Note: The number of observations is 497,779 after dropping singleton observations. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Carrier, day, route, route-day fixed effects are included. *GovShare* values less than 50% are omitted for column (3); *GovShare* with the lowest percentile are omitted for column (4). The instrument used for *Altman Z-score* is *Fleet Redeployability*.

Table 3.2: Multiple-Way Fixed Effects with Instrumental Variable for Airlines with Flight Shares (1%-5%)

VARIABLES	(1) GovShare	(2) GovShare & Squared Term	(3) Categorical	(4) Quartiles	(5) GovShare*HHI
GovShare	-0.2083	-3.0181			-0.1220
	(0.1778)	(2.4776)			(0.2071)
GovShare^2		0.0386			
		(0.0311)			
50<=GovShare<70			-10.1494		
			(6.8501)		
GovShare>=70			4.2653		
			(4.3977)		
GovShare_25th				6.8782	
				(22.8332)	
GovShare_50th				-63.3406	
				(69.1856)	
GovShare_75th				7.4872	
				(8.5859)	
HHI GovShare*					-0.2905
					(0.2763)
Network Integration	0.0448	-0.0570	0.0075	-0.0116	0.0462
	(0.0478)	(0.0518)	(0.0341)	(0.0420)	(0.0479)
Firm Size	0.0360	0.0187	0.0145	0.0287	0.0386
	(0.0237)	(0.0239)	(0.0175)	(0.0235)	(0.0247)
Route Frequency	-0.2092	-0.1674	-0.1002	0.1476	-0.3877
	(1.0796)	(0.9321)	(0.8438)	(0.8705)	(1.0504)
Altman Z-score	14.2458	-39.1847*	3.9938	-36.3054	15.1559
	(10.4886)	(20.2795)	(4.3090)	(34.9781)	(10.9581)
Underidentification test:					
Kleibergen-Paap rk LM statistic	3.984	5.070	6.503	0.706	3.996
Chi-sq(1) P-val	0.0459	0.0243	0.0108	0.4007	0.0456
Weak identification test:					
Kleibergen-Paap rk Wald F statistic	3.490	3.231	10.514	1.056	3.491

Note: The number of observations is 38,722 after dropping singleton observations. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Carrier, day, route, route-day fixed effects are included. *GovShare* values less than 30% are omitted for column (3); *GovShare* with the lowest percentile are omitted for column (4). The instrument used for *Altman Z-score* is *Fleet Redeployability*.

Table 4: Impact of Δ*HHI*=1,000 on Minutes Late at Arrival

GovShare	Δ*MinsLate Arrival*
10	0.2372
20	0.4744
30	0.7116
40	0.9488
50	1.186
60	1.4232
70	1.6604
80	1.8976
90	2.1348
100	2.372

Table 5: Difference-in-Difference Analysis

	(1)	(2)
VARIABLES	Privatized	Reversal
Event	-6.8452***	-49.7845***
	(2.3521)	(16.7608)
Observations	548,308	353,690

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Carrier, day, route, route-day fixed effects are included.

Appendix

Hainan Airlines started operation in 1993, with approval by the Hainan Provincial Government. It initially focused on the flight web centering on Hainan Province and neighboring areas. Hainan Airlines has spread its nationwide flight network since the early 2000s by acquiring other regional airlines. It further established an operational base across China, offering flights that cover all provinces, autonomous regions, and municipalities on the Chinese mainland, as well as 100 international and regional routes to 37 overseas cities, spanning the Asia, Europe, Africa, North America, and Oceania regions.[17] Furthermore, Hainan Airlines' parent company, HNA Group, has become a conglomerate through hyper-acquisitions by collecting stakes in overseas hotels, financial institutions, and office towers.[18] By mid-2019, the HNA conglomerate was already on the regulator's "high-risk" watch list. Matters came to a head on 11 December 2019, when Hainan Airlines failed to meet a ¥300 million coupon payment on its 2017 MTN-001 notes, triggering a technical default and cross-default clauses on roughly ¥4 billion of short-term paper. Credit-rating agency China Chengxin immediately downgraded the carrier to "BB—on watch," and the Civil Aviation Administration (CAAC) placed the airline under enhanced financial supervision. This default, coming weeks before the first reported domestic COVID-19 cases, set in motion the court-led restructuring that culminated in the Fangda takeover two years later. HNA was under a court-led bankruptcy and reorganization proceeding in January 2021, and Hainan Airlines was subsequently taken over by Liaoning Fangda Group Industrial, a privately owned conglomerate. Fangda had no airline business before the acquisition, in which it replaced the Hainan provincial government as the carrier's controlling shareholder.[19] Hainan Airlines strategically declined Juneyao Airlines' offer to avoid management friction. Hainan Airlines' financial woes were strictly attributed to mismanagement by the parent HNA group.[20]

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[17] https://www.hainanairlines.com/HUPortal/dyn/portal/DisplayPage?LANGUAGE=US&COUNTRY_SITE=US&SITE=CBHZCBHZ&PAGE=CHAP (accessed June 5th, 2024).

[18] https://www.wsj.com/articles/hna-groups-financial-maneuvers-powered-its-riseand-caused-its-downfall-11612780203?mod=saved_content (accessed April 12th, 2024).

[19] https://www.wsj.com/articles/hna-group-chairman-chen-feng-ceo-adam-tan-detained-by-police-11632486703 (accessed April 15th, 2024).

[20] https://www.caixinglobal.com/2021-09-30/in-depth-who-gets-what-in-hnas-complex-bankruptcy-restructuring-101782763.html (accessed April 15th, 2024).