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A novel approach to determinants of corporate cash holdings: Evidence from the airline industry

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ABSTRACT

Net cash flow is extremely important in capital-intensive industries. In industries operating on a global scale, such as the airline industry, situations such as a terrorist attack, financial crises, pandemic, or war can make cash flow uncertain and unreliable. The airline industry has faced significant cash flow problems during the COVID-19 pandemic. The interruption of net cash flow, especially during crises (e.g., Covid-19), causes some industries to experience financial stress. In this study, we aim to reveal the financial determinants of corporate cash holdings in the airline industry, based on the airline business model. In this context, we empirically analyzed airlines employing low-cost and traditional business models. Unlike previous research, we analyze the financial determinants of airlines' net cash flows from financing activities, investing activities and operating activities. This paper makes a substantial contribution to the literature by leveraging a comprehensive analysis of cash flow dynamics, shedding new light on financial performance. We devised a comprehensive approach by formulating five distinct models to scrutinize the determinants that influence corporate cash holdings. The proposed model demonstrates versatility within various segments of the aviation industry, making it applicable to both traditional and low-cost airline business models. The findings of the study indicate that there are differences between models regarding the financial determinants of corporate cash holdings. The analysis reveals interesting insights contrary to the conventional wisdom on corporate cash holdings in the airline industry. For instance, one of the most interesting findings of the study is that the financial structure of airlines is significantly determined by the source of net cash flow (from financing, investment and operational activities). Furthermore, the findings of the study provide a multidimensional understanding of the factors affecting airlines' corporate cash holdings.

1. Introduction

The air transport industry has substantially developed due to legal amendments and deregulations in the United States in 1978, and in the EU countries in the 1990s. Thanks to the deregulation, the transformation of the market structure from a monopoly structure to an oligopoly structure was achieved, and the legal barriers to the operation of private-sector airlines in the market were either completely removed or significantly flexed. This has paved the way for a significant increase in the number of airlines operating in the air transport sector over time, an expansion of the airline fleet structure, and the execution of activities using larger aircraft. The increase in the number of companies and capacity in the air transport sector has led to a significant rise in competition among airlines. This has led airlines to pursue a number of competitive strategies and develop business models to gain a competitive advantage over one another. The fierce competition among airlines also requires airlines to make optimal use of their available financial and physical resources. In particular, directing the cash flow to the right areas ensures that airlines maintain more robust financial statement. If an airline burns through cash faster than it can generate revenue, it may be forced to take drastic cost-cutting measures such as cutting staff, reducing its fleet size, or even filing for bankruptcy. Daily cash burn (DCB) is an extremely important metric for airlines, particularly during times of financial stress, such as during the COVID-19 pandemic. DCB refers to the amount of money an airline is spending each day in excess of its revenue or income. Daily cash burn (DCB) is also used to measure airlines' ability to meet their obligations with corporate cash balances. This is because DCB reflects how much corporate cash is available to cover daily expenditures. Therefore, in this study, we focus on the financial factors that affect the cash flow of airlines.

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In the literature on the airline industry, many studies categorize airlines as their size (Lin, 2012; Lordan and Klophaus, 2017; Teker et al., 2016), their regions (Klophaus and Lordan, 2018; Pavlović and Babić, 2018), their ownership structures (Chen et al., 2017; Choo et al., 2018), and their financial performances (Chuang et al., 2008; Gudiel Pineda et al., 2018; Wang, 2008). Recent studies (Daft and Albers, 2015; Karwowski, 2016; Vatankhah et al., 2019) have focused on the business models that airlines apply. The fact that airlines have different business models indicates that they have a different understanding of transacting business. Therefore, there is a close relationship between the business model and the image and philosophy of business that the airline wants to create in the eyes of customers. In the first stage of the study, we classified airlines into two groups based on the business model they employ. The first group includes airlines that employ a low-cost business model (commonly referred to as 'low-cost carriers'). The distinctive feature of low-cost carriers is their focus on minimizing costs at every stage of their operations. The second group consists of airlines that follow traditional business models (commonly referred to as 'legacy carriers'). Legacy carriers have historically served as flag carriers for their respective countries. Legacy carriers typically have an extensive network and a wide range of products. Examining studies in the literature showed that many studies were addressing low-cost carriers (Álvarez-Díaz et al., 2019; Soyk et al., 2017; Wen and Chen, 2017) and traditional airlines (Carlton et al., 2019; Cheng, 2010; Rieple and Helm, 2008). However, this study differs from other studies in the way that it evaluates both groups namely, low-cost and traditional airlines, and compares findings according to the business model. Thus, this study is expected to contribute to the literature from this perspective.

In efficient capital markets, there is no relationship between firm value and corporate cash holdings. In such markets, companies can achieve this without any cost when they need funds to make new investments. In efficient capital markets, there is no opportunity cost of cash holdings since there is no liquidity premium. Therefore, when firms borrow or invest in liquid assets, the value of the firm and therefore the income of the shareholders do not vary (Opler et al., 1999). However, given current market conditions, it is evident that capital markets are not efficient. This also indicate that firm financing decision can significantly affect the value of the firm. Therefore, the cash holdings behavior of firms can affect the value of the firm. In this context, it is important to examine the factors affecting the corporate cash holdings.

Airlines are particularly vulnerable to cash flow problems due to the high fixed costs generated by operating an aircraft. The literature suggests that there are four motivators that determine firms' corporate cash holdings. These are tax motive, agency motive, transaction motive and precautionary motive (Bates et al., 2009). The tax motive theory is based on the hypothesis that firms view cash holdings as a means to reduce their tax burden. In particular, as a result of the policy of imposing high tax rates on foreign income that firms repatriate, they prefer to hold large amounts of cash. Therefore, the tax motive is a strategy to avoid taxes by having firmsmaintain higher cash holdings (Tran, 2020). As discussed by Jensen and Meckling (1976), the agency motive of cash holding distinguishes between firm control and firm ownership rights. Managers with firm control tend to hold more cash than necessary to build up cash reserves to spend or invest in way that favors them. Foreign investors, on the other hand, are good at monitoring firm financing behavior, forcing financial managers to hold more cash to avoid costly access to external financing and to mitigate riskier cash flows (Jensen and Meckling, 1976; Tran, 2020; Nyborg and Wang, 2021). Transaction motivation refers to the ability of firms to make payments arising from their day-to-day operations in full and to make expected payments on time. Firms that benefit significantly from economies of scale tend to hold less cash. Avoiding the transaction costs associated with converting a non-cash financial assets into cash and the need to hold cash for payments arising from daily operations lead to optimal cash demand (Bates et al., 2009; Kim et al., 2011). Moreover, the transaction motive theory argues that firms with financial constraints and more costly access to finance have fewer opportunities to enter the capital market. Therefore, firms may need to hold more cash to avoid financial constraints when they are more likely to fall into liquidity traps and financial difficulties (Cui et al., 2022). Another important reason for firms to hold cash is the precautionary motive. Currently, firms do not operate in a perfect capital market where there are no financing frictions and holding cash would be irrelevant. Rather, they operate in an environment of asymmetric information and frequent economic fluctuations. The cost of external financing is therefore often uncertain and can be high. The precautionary motive for holding cash provides them with protection against financial distress and adverse shocks (Xu et al., 2019; Sun et al., 2023). In addition, there is a close relationship between cash holdings in enterprises, prudential behavior, and agency cost. In this context, studies in the literature (Opler et al., 1999; Ozkan and Ozkan, 2004) assumes that cash holdings are influenced by three sources of motivation. These are operating costs, interim injunction, and agency costs. In addition, the literature also emphasizes the close relationship between cash holdings and capital structure theories (Al-Najjar, 2013). According to the Trade-off Theory, firms can maximize their market value by taking into account the marginal benefit of sitting in cash and the marginal cost of sitting in cash. In this context, enterprises need to balance the gain of sitting in cash and the cost of sitting in cash (Al-Najjar, 2013). According to the Pecking Order Theory, enterprises follow a hierarchy when considering sources of financing. Accordingly, the company's retained earnings are preferred over debt. In addition, enterprises only prefer low-risk liabilities when the company's retained earnings are insufficient. This pecking order significantly affects the cash holdings of firms and their cash-handling policies.

There have been many studies in the literature examining the factors affecting cash holdings. Among these studies, Hu et al. (2019) empirically examined the relationship between the liquidity level of stocks and cash holdings in the United States. The study's findings revealed that firms with liquid stocks have lower cash holdings. Orlova and Sun (2018) examined the impact of corporate determinants of companies (such as company management and the protection of investors' rights) on cash holdings behavior. The results of the study, conducted with a large sample, showed that corporate determinants influence cash holdings. Al-Najjar (2013) empirically examined the financial determinants of cash holdings in emerging markets. The findings of the study revealed that capital structure and dividend policies influence companies ' cash holdings policies. In a similar study, Graef et al. (2019) examined the relationship between cash holdings and yield performance for investment funds located in the EU. In the literature, there are some studies examining the relationship between cash holdings and earnings quality (Farinha et al., 2018) and the relationship between cash holdings and financial development (Lei et al., 2018).

In the literature, there are also industry-oriented studies examining the impact of corporate cash holdings on companies. For example, Ahrends et al. (2018) empirically examined the impact of corporate cash holdings on the shipping industry. The findings of the study revealed that companies in this industry are more conservative than those operating in other sectors in terms of cash holdings. In a similar study, Drobetz et al. (2016) empirically examined the cash flow behaviors of shipping companies in normal times and times of crisis. The results of the study demonstrate that these companies did not prefer cash flow-related restrictions even during periods of a financial crisis. Demir et al. (2019), empirically examined the impact of geopolitical risks on cash holdings for companies operating in the hospitality industry in developing countries. The findings from the study showed that companies operating in the hospitality industry are highly sensitive to geopolitical risks when it comes to cash holdings.

Examining studies in literature, many studies have addressed the factors affecting cash holdings for different industries or country groups. However, studies examining this relationship in the context of airline transportation are limited. In this study, airlines will be grouped based on the business model they apply, and the factors determining cash

holdings will be analyzed by considering the business model, and the results will be compared. Therefore, this study is expected to fill this gap in the literature and make a significant contribution.

2. Theoretical background

The Cost of Capital, Corporate Finance, and the Theory of Investment, published by Franco Modigliani and Merton Miller (M&M) in 1958 and 1961, is one of the most impactful finance articles ever written (Brigham and Houston, 2014) and is based on David Durand's Entity Theory (Bernstein, 1997). The M&M theory demonstrated with mathematical evidence that the market value of a firm is independent of its capital structure under certain assumptions (Miller and Modigliani, 1961; Modigliani and Miller, 1958). Therefore, according to the M&M theory, a firm's market capitalization is irrelevant to the cost of capital and capital structure. The market value of a firm is equal to the future cash flows discounted at a discount rate determined by taking into account the risk category of the firm.

In the M&M theory, there is no explicit distinction between business risk and financial risk (Megginson and Smart, 2008). The M&M theory assumes that capital structure has no effect on the average cost of capital and the market capitalization of the firm in a perfectly competitive market without taxes, transaction costs, and market failures (Usta, 2005). If there is asymmetrical information between managers and investors, the choice of capital structure may be influenced by signaling effects and the market's perception of the firm's risk. Although the assumptions in the M&M theory have been subjected to considerable criticism for being unrealistic (Durand, 1959), corrective studies have been carried out to adapt them to real market conditions. In this context, M&M developed several propositions that take into account tax and cost of equity in the capital structure. Based on M&M theory, trade-off theory and the pecking order theory were developed to determine the optimal capital structure of the firm. The balancing theory argues that the capital structure is optimal when the tax advantage of debt is balanced with the costs of financial distress and bankruptcy. The financing hierarchy theory assumes that firms follow a certain hierarchy in financing investments.

2.1. Trade-off theory

The Trade-off theory emphasizes that to maximize firm value, a balance must be maintained between the marginal benefit of holding cash and the marginal costs of cash reserves. Accordingly, companies' opportunity cost is determined by considering the difference between the earnings from the cash holdings and the interest payment on the amount borrowed when needed (Al-Najjar, 2013). Therefore, companies should consider the balance between the opportunity cost of cash holdings and the acquisition costs if cash is needed when determining cash holdings. This also indicates that firms take into account a certain balance in terms of cash holdings. The Trade-off theory also focuses on the close relationship between the level of deviation from the optimal amount of cash cash balance and corporate cash holdings. Accordingly, if firms deviate from the optimal amount of cash, they return to the optimal amount of cash as soon as possible (Orlova and Sun, 2018).

Airlines are particularly vulnerable to cash flow problems due to the high fixed costs associated with operating an airline. The literature states two primary motivators that determine the corporate cash holdings of firms. These are transaction costs and interim injunction. Companies that experience cash flow problems have several financial tools that they can use to overcome this problem. These financial instruments such as selling assets, issuing new debt securities, or borrowing from financial institutions, issuing shares, and not distributing dividends (Ozkan and Ozkan, 2004). However, regardless of which financial instrument is used, transaction costs will be incurred. Therefore, companies can adjust cash holdings to avoid this transaction cost. In these situations, cash can be critical for keeping an airline operational during the bankruptcy proceedings. Airlines with low cash reserves may struggle to keep the business running during bankruptcy process, which can reduce their chances of emerging successfully. In addition, cash flow volatility leads firms to increase their cash balances due to interim injunction motive (Opler et al., 1999). As cash flow risk increases, firms tend to hold more cash or use their cash holdings more precautionarily. Therefore, airlines should follow interim injunction policies and maintain a balance in cash holdings not only to hedge against risk but also to cope with external challenges.

2.2. Pecking order theory

The Covid-19 pandemic has disrupted the typical financing mix for airlines, with many airlines relying more on debt financing than they would in normal times. The Pecking Order theory suggests that a company should first use retained earnings to finance its investments, followed by debt, and finally by equity. If a company cannot fully finance its investments through retained earnings and debt, it may consider issuing equity. However, the theory may not be appropriate for all airlines, as the optimal financing structure may vary depending on the airline's specific financial and operational conditions. Moreover, airlines must also consider the unique factors and risks associated with the industry, such as high operating costs, high capital requirements, and economic volatility.

Pecking Order Theory considers the information asymmetry between firm owners and investors. According to this approach, firms tend to implement their financial choices in a certain hierarchical order. The pecking order theory states that a company should prefer to finance itself first internally through retained earnings. As a result, firms prefer internal resources to external resources when financing their investments. In addition, when endogenous resources are insufficient, firms first turn to low-risk borrowing options. Issuing new shares is preferred by firms as the last financing method when debt financing is too costly (Bontempi, 2002). The Hierarchy of Financing Theory, which suggests that firms do not target a specific capital structure, assumes that firm insiders have more information than firm outsiders (Chakraborty, 2010). Therefore, the main reason why firms follow a certain order in the financing of new investments is due to the differences in the level of knowledge about the resources in question (Antonczyk and Salzmann, 2014).

Asymmetric information between firm owners and investors significantly affects corporate cash holdings. According to Myers and Majluf (1984), asymmetric information among stakeholders (firm owners and investors) can cause firms to follow a certain hierarchy in their financing policies. In this context, companies may prefer to use internal sources of funds rather than external sources of funds sensitive to information asymmetry. This may causes firms to hold excessive cash (Ozkan and Ozkan, 2004). Additionally, the difference in point of view and conflict of interest between the manager and the stockholders, in other words, the proxy and the owner, also affect the availability of corporate cash holdings. According to agency theory, managers tend to hold more cash to strengthen their positions within the company, reduce the risk of financial distress, and exercise greater discretionary power (Opler et al., 1999). In addition, the use of surplus cash for the interests of managers leads to a conflict of interest among stakeholders (Ahrends et al., 2018).

3. Data, variables, and panel data modeling

We obtain the data used to construct our model from the Thomson Reuters Refinitiv data source. The sample period spans from 2003 to 2021 and covers airline financial data for airlines. In the study, 627 observations of 33 airlines following a differentiation competitive strategy (legacy carriers) and 190 observations of 10 airlines following a cost leadership competitive strategy (low-cost carriers) were analyzed. The airlines analyzed are those with the most operations and the highest passenger numbers globally. We considered the works of (Ahrends et al.,

2018; Dittmar and Mahrt-Smith, 2007; Graef et al., 2019; Hu et al., 2019; Orlova and Sun, 2018) for the inclusion and formulation of variables.

Data that has been polled or generated by merging time series and horizontal section data is referred to as longitudinal data. Such data may have different horizontal cross-section and time dimensions. Panel data is a type of longitudinal data where the cross-sectional units are held constant (Güriş, 2015, p. 2). Using panel data in economic research provides numerous advantages over using a horizontal section or time series. Compared to cross-section and time series analyses, panel data analysis provides a greater number of observations. Therefore, more freedom is granted while less collinearity exists between the independent variables. The efficiency of econometric prediction in research is enhanced by using panel data (Hsiao, 2014, p. 3). Panel data is produced by including *N* units and *T* observations of each unit in the same data set (Tatoğlu, 2013, p. 37). In panel data analysis, *i* subscripts are employed to demonstrate the units and t subscripts to disclose the time period. The linear panel data model created with the panel data, where the dependent variable *Y* is demonstrated by independent variable *X*, is as follows. Panel data equation, *i* cross-section units (i = 1, …,N), *t* change over time (t = 1, …,N) and the dependent variable *Y*, by displaying the independent variables with *X*. This can be defined as

$$Y_{it} = \alpha_{it} + \beta_{it}X_{it} + \varepsilon_{it}.$$

Here ε_{it} exhibits the error terms.

This research employs the methodology of Seemingly Unrelated Regression Analysis (SUR) to investigate and analyze the relationships among the variables under consideration. This technique has been used extensively when multiple regression equations are being estimated, and the error terms across equations are correlated. SUR was developed by Arnold Zellner in the 1960s as an extension of Ordinary Least Squares (OLS) regression (Zellner, 1962). SUR is particularly useful when dealing with datasets that have multiple dependent variables, where the independent variables may differ across equations, but the error terms of the equations are related to each other. Theil (1964) also developed a similar method for analyzing systems of equations with correlated disturbances. This method is known as Generalized Least Squares (GLS). The tabulated information below delineates the array of dependent and independent variables employed in this paper, providing a comprehensive overview of the factors under scrutiny in the study.

Model 1- $WCR_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 ROA_{it} + \beta_3 ROS_{it} + \beta_4 TANG_{it} + \beta_5 LIQ_{it} + \beta_6 LEV1_{it} + \beta_7 LEV2_{it} + \beta_8 LEV3_{it} + \beta_9 RISK_{it} + \beta_{10} GROW1_{it} + \beta_{11} GROW2_{it} + \beta_{12} GFC_{it} + \varepsilon_{it}$.

Model 2- $CASH_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 ROA_{it} + \beta_3 ROS_{it} + \beta_4 TANG_{it} + \beta_5 LIQ_{it} + \beta_6 LEV1_{it} + \beta_7 LEV2_{it} + \beta_8 LEV3_{it} + \beta_9 RISK_{it} + \beta_{10} GROW1_{it} + \beta_{11} GROW2_{it} + \beta_{12} GFC_{it} + \varepsilon_{it}$.

Model 3-$CASH - F_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 ROA_{it} + \beta_3 ROS_{it} + \beta_4 TANG_{it} + \beta_5 LIQ_{it} + \beta_6 LEV1_{it} + \beta_7 LEV2_{it} + \beta_8 LEV3_{it} + \beta_9 RISK_{it} + \beta_{10} GROW1_{it} + \beta_{11} GROW2_{it} + \beta_{12} GFC_{it} + \varepsilon_{it}$.

Model 4- $CASH - I_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 ROA_{it} + \beta_3 ROS_{it} + \beta_4 TANG_{it} + \beta_5 LIQ_{it} + \beta_6 LEV1_{it} + \beta_7 LEV2_{it} + \beta_8 LEV3_{it} + \beta_9 RISK_{it} + \beta_{10} GROW1_{it} + \beta_{11} GROW2_{it} + \beta_{12} GFC_{it} + \varepsilon_{it}$.

Model 5- $CASH - O_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 ROA_{it} + \beta_3 ROS_{it} + \beta_4 TANG_{it} + \beta_5 LIQ_{it} + \beta_6 LEV1_{it} + \beta_7 LEV2_{it} + \beta_8 LEV3_{it} + \beta_9 RISK_{it} + \beta_{10} GROW1_{it} + \beta_{11} GROW2_{it} + \beta_{12} GFC_{it} + \varepsilon_{it}$.

In the models above, the corporate cash holdings of airlines and their derivatives were used as dependent variables. In this context, net working capital to total assets (WCR), the corporate-cash holdings to total assets (CASH), the cash-flow-to-total-assets ratio (CASH-F), investment-related-cash-flow-to-total-assets ratio (CASH-I) and the operating-cash-flow-to-total-assets ratio (CASH-O) were used as the dependent variables. The independent variables used in the study and the hypotheses developed for them are given below, taking consideration into studies in the literature (Al-Najjar, 2013; Ferreira and Vilela, 2004; Guney et al., 2007; Hall et al., 2014; Ozkan and Ozkan, 2004).

3.1. Firm size

Firm size affects firms' access to external resources and their financing costs. Ceteris paribus, larger firms can obtain financing more easily than smaller firms and have lower debt costs. One of the main reasons for this is that larger firms have a longer and broader business history. In addition, larger firms have a more established reputation than smaller firms. Therefore, larger firms can borrow at lower costs because they have more bargaining power. Studies in the literature show that there is a significant relationship between firm size and cash holdings. There are empirical studies in the literature that the relationship between firm size and cash holdings is negative (Farinha et al., 2018; Al-Najjar, 2013; Ferreira and Vilela, 2004; Opler et al., 1999). on the other hand, due to economies of scale and the existence of information asymmetries, it is argued that large-scale firms have higher cash holdings for business operations and daily transactions (Magerakis et al., 2020). Therefore, there are also studies in the literature arguing that the relationship between firm size and cash holdings is positive (Ullah and Kamal, 2017; Harford et al., 2014; Ozkan and Ozkan 2004). In this study, in line with the common hypothesis in the literature, we argue that larger airlines tend to hold lower cash holdings because they have easier access to finance and can borrow at lower costs. In addition, since large airlines have more diversified operations and lower bankruptcy risk, they are more likely to use external financing rather than high cash balances. This study seeks to discern whether larger firms exhibit a tendency to maintain lower levels of cash reserves, contributing to a nuanced understanding of the relationship between corporate size and liquidity management.

For legacy airlines, our analysis reveals a negative relationship between company size and cash holdings, indicating that larger legacy carriers tend to maintain lower levels of cash reserves. Conversely, for low-cost carriers (LCCs), no such negative relationship is observed, suggesting a distinct pattern in the liquidity management practices of these two airline categories (see Fig. 1 and 2).

3.2. Profitability ratio

Despite significant value created for passengers, the airline industry has found it difficult to make an adequate level of profits. While some airlines have achieved an acceptable level of profitability, others have been forced to go bankrupt and leaving the market. The purpose of this article is to provide a quantitative analysis of between airlines profitability and cash holdings.

According to the Trade-Off Theory, firms with higher profitability have higher borrowing capacity and are more likely to benefit from tax shields (Chang, Chen, & Liao, 2014; Chakraborty, 2010). In addition, firms with high profitability have the opportunity to obtain foreign resources at lower interest rates and have lower financial distress and bankruptcy costs. Therefore, it becomes possible for companies with a high-profit margin to pay dividends, fulfill their obligations or have high

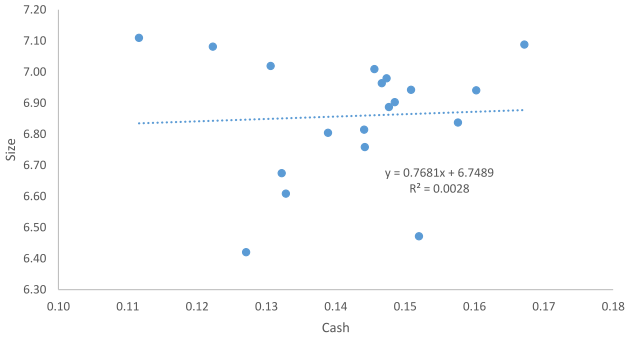

Fig. 1.1. Firm size to cash holdings correlation for legacy carriers.

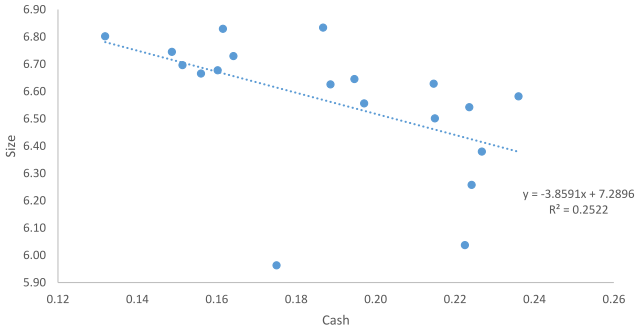

Fig. 1.2. Firm size to cash correlation for low-cost carriers.

cash holdings. Companies with low-profit margins have fewer cash holdings and rely on borrowing to function (Al-Najjar, 2013). In addition, the literature emphasizes that firms with high-profit margins can more easily access liabilities and borrow at a lower cost (Hall et al., 2014). Therefore, it is expected that there will be a positive relationship between the profitability ratio of firms and the cash holdings. In the study, the ratio of operating revenue to total assets was used as a measurement indicator of the profitability ratio variable of firms. Our subsequent hypothesis investigates whether variations in firm profitability are associated with discernible patterns in cash reserve management, providing insights into the interplay between financial performance and liquidity strategies (see Fig. 3 and 4).

3.3. Fixed asset ratio

Airlines typically use a variety of financing methods, including issuing bonds, asset-backed securities (ABS), mortgage-backed securities (MBS), and leasing aircraft to borrow money. An ABS is a type of financial investment that is collateralized by an underlying pool of assets, usually ones that generate a cash flow from debt, such as loans, leases, credit card balances, or receivables. Airlines regularly pledge their fixed assets (aircraft, brands and loyalty programs) as collateral to raise more funds in debt markets when their financial situation requires it. For example, Philippine Airlines pledged 15 aircraft, spare engines and frequent flyer miles as collateral to secure loans needed as part of its ongoing restructuring requirements in 2021.

Firms with high fixed asset ratios operate with lower cash holdings (Lei et al., 2018). One of the main reasons for this is that firms with high fixed asset ratios can show their fixed assets as collateral against the possibility of financial difficulties or bankruptcy. Firms with high fixed asset ratios are able to obtain debt at lower costs and more easily. Therefore, firms with high fixed assets are expected to have lower cash holdings (Opler et al., 1999). In addition, firms with more collateral face fewer problems in issuing debt (Titman and Wessels, 1988) and

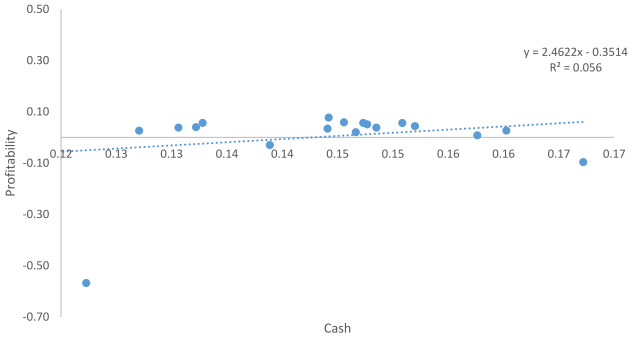

Fig. 2.1. Firm profitability and cash holdings correlation for legacy carriers.

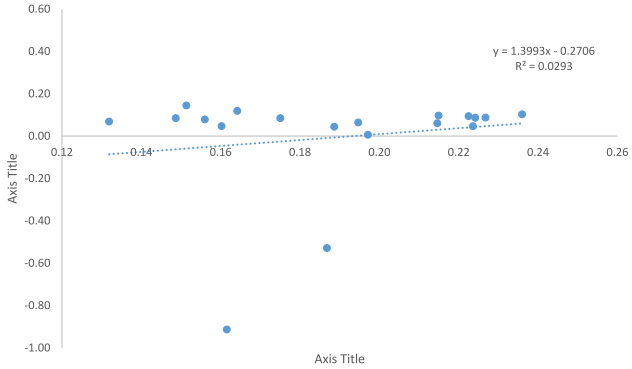

Fig. 2.2. Firm profitability and cash holdings correlation for low-cost carriers.

therefore have less need to build high cash reserves. Studies in the literature show that there is a negative relationship between firms' fixed asset ratio and cash holdings (Drobetz and Grüninger, 2007; Uyar and Kuzey, 2014; Elyasiani and Movaghari, 2022; Tran Minh et al., 2022). The airline transportation sector is one of the sectors with the highest ratio of fixed assets (aircraft). Therefore, companies with more fixed assets are expected to carry out their operations with lower cash balances. In this study, the ratio of fixed assets to total assets is used as the measurement indicator of the fixed asset ratio variable. In this following, our objective is to examine whether there exists a negative correlation between fixed assets and cash holding (see Fig. 5 and 6).

3.4. Liquidity level

As is the case in any industry, liquidity and financial health are some of the prototypical metrics in financial analysis. Hence, airlines need more liquidity to handle any potential challenges ahead. There is a close relationship between the level of liquidity and cash holdings. The main reason for this is that the level of liquidity and cash holdings are sometimes used as substitutes for each other. In addition, it is easier for liquid assets to liquidate when necessary than fixed assets. This indicates that firms with more liquid assets regulate their cash holdings accordingly, as they can easily liquidate these assets (Al-Najjar, 2013; Ozkan and Ozkan, 2004). In addition, studies in the literature (Hall et al., 2014) indicate a negative directional relationship between liquidity level and cash holdings. Therefore, it is expected that there will be an inverse relationship between the level of liquidity and cash holdings. Cash is widely considered the most liquid asset because it can be readily used for transactions and the other components of liquidity include short-term investments, accounts receivable, and inventory. While these assets may not be as immediately accessible as cash, they still contribute to an

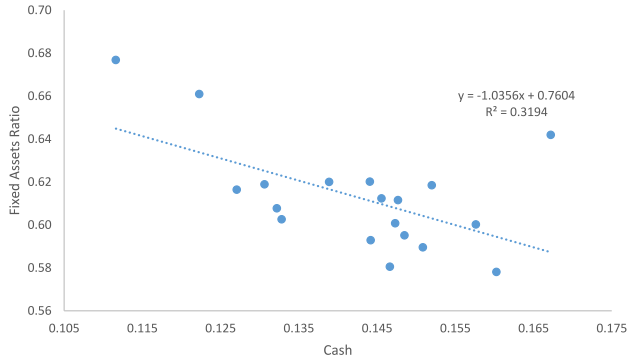

Fig. 3.1. Firm Fixed Assets Ratio and cash Holdings Correlation for Legacy Carriers.

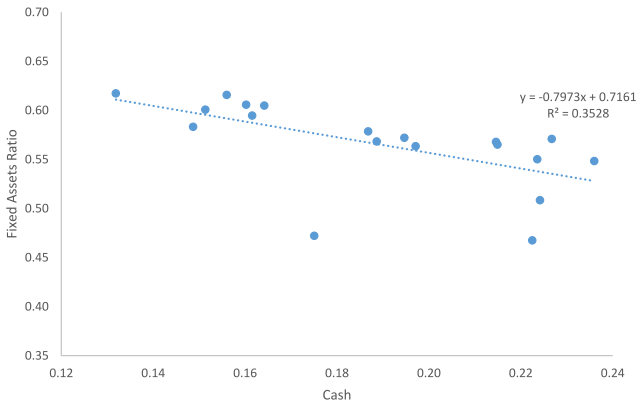

Fig. 3.2. Firm fixed assets ratio and cash holdings correlation for low-cost carriers.

entity's liquidity. In the study, the ratio of current assets to short-term liabilities was used as a measurement indicator of the liquidity level variable (see Fig. 7 and 8).

3.5. Short-term debt level

Short-term debt finances airlines with enough liquidity to manage their day-to-day operations, nonetheless it may also increase their financial risk and exposure to interest rate fluctuations. In studies examining the relationship between firms' leverage levels and cash assets, a non-linear relationship was found between the variables (Guney et al., 2007; Hall et al., 2014). Accordingly, companies tend to reduce cash holdings until debt rates reach a certain level. But when debt levels rise above the critical level, it increases the cash holdings to avoid the costs of bankruptcy (Bartholdy et al., 2012; Hall et al., 2014). In the study, the leverage level of airlines was examined and its term (short and long) was taken into account. The main reason for this is that while short-term liabilities are effective in the daily operations of airlines, long-term liabilities are important in long-term investment decisions (such as purchasing aircraft). Therefore, the effect of the short-term debt level and the long-term debt level on cash holdings were examined separately. In the study, the ratio of short-term debt to total assets was used to measure the level of short-term debt (see Fig. 9 and 10).

3.6. Long-term debt level

This section aims to delve into the financial intricacies of the entity under consideration, aiming to discern any discernible patterns that may

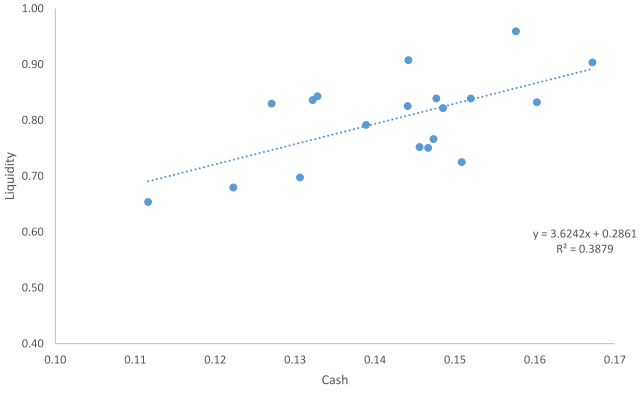

Fig. 4.1. Firm liquidity level and cash holdings correlation for legacy carriers.

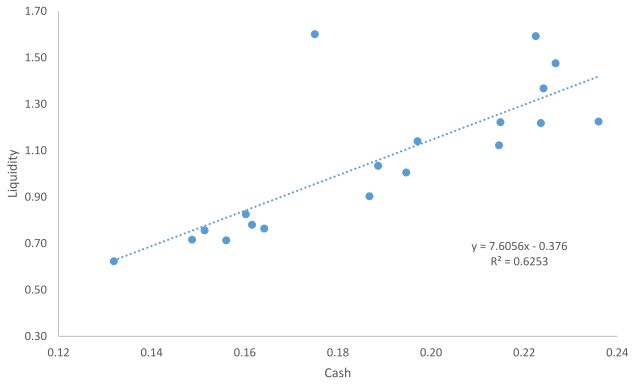

Fig. 4.2. Firm liquidity level and cash holdings correlation for low-cost carriers.

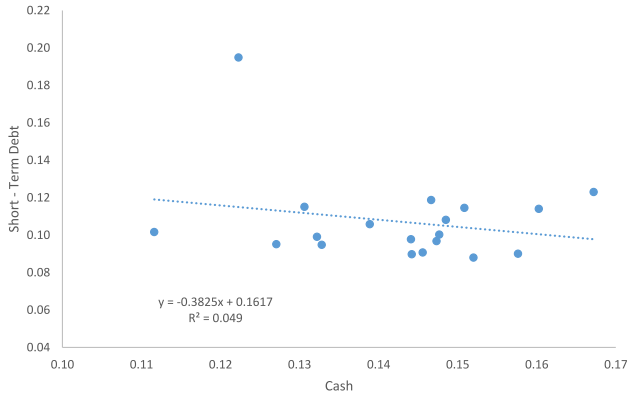

Fig. 5.1. Firm short – term debt and cash holdings correlation for legacy carriers.

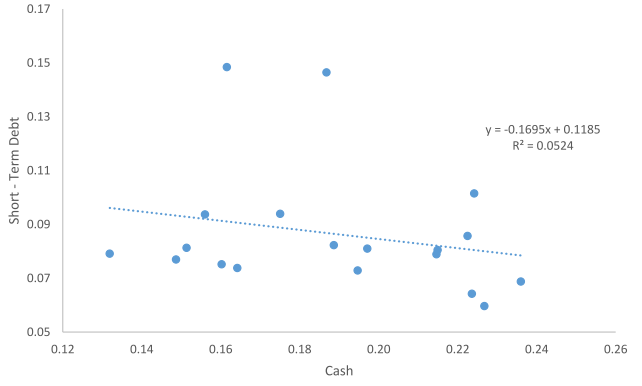

Fig. 5.2. Firm short – term debt and cash holdings correlation for low-cost carriers.

suggest an inverse relationship between long-term debt and available cash. Excessive airline debt has played a significant role in leading to bankruptcy in the airline industry. Airlines often incur significant debt in order to finance the purchase or lease of aircraft, fund capital expenditures, and maintain their operations. To meet the needs for massive capital spending, airlines must carefully manage their debt levels and maintain strong financial planning and risk management strategies. Trans World Airlines (TWA) filed for bankruptcy in 1992,

which was caused in part by a significant amount of debt. TWA had amassed a large amount of debt from the purchase of new aircraft and investing in new technology.

Firms with high levels of leverage are more likely to experience financial difficulties. To avoid financial distress, requires firms with high leverage to have more cash holdings to avoid financial distress (Al-Najjar, 2013). From the point of view of airlines, it seems that long-term liabilities are used in high-cost investments in fixed assets, such as aircraft purchases. Therefore, airlines with a high level of leverage and more long-term liabilities are more likely to experience financial difficulties. In this case, it is expected that airlines with high long-term debt ratios have more cash holdings. Studies in the literature (Ferreira and Vilela, 2004; Hall et al., 2014) shows a negative correlation between long-term debt level and cash holdings. In the study, the ratio of long-term debt to total assets was used to measure the level of long-term debt (see Fig. 11 and 12).

3.7. Firm risk

An increase in the likelihood of bankruptcy of firms affects their cash holdings. Accordingly, as firms are more likely to experience financial difficulties or bankruptcy, their cash holdings will also increase (Farinha et al., 2018; Hall et al., 2014). In this case, firms that are likely to experience financial difficulties or bankruptcy are expected to have more cash holdings. Therefore, it is expected that there will be a positive relationship between the probability that firms will experience financial difficulties or bankruptcy and cash holdings. One of the most widely used methods in literature for measuring the probability of firms experiencing financial difficulties or bankruptcy is the Z-score method developed by Altman in 1968. The Z-score, developed by Altman (1968), refers to a positively directional linear function consisting of the ratio of financial variables to each other and the multiplication of these resulting ratios by certain coefficients. The Altman Z-score is frequently used in predicting financial distress and bankruptcy across industries. In this study, we used the Altman Z Score as a measure of the risk of financial insolvency (see Fig. 13 and 14).

3.8. Growth opportunities

A conflict of interest occurs between shareholders and investors in firms with high growth opportunities. This significantly increases the cost of liabilities for the company. Therefore, it is seen that firms with high growth opportunities operate with higher cash holdings, rather than endure the increasing cost of external financing (Farinha et al., 2018). Studies in the literature show that small firms and firms with high growth opportunities have more cash holdings (Ozkan and Ozkan, 2004). Therefore, it is expected that there will be a positive relationship between company growth opportunities and cash holdings. In this study, the percentage change in sales was used as a measurement indicator of company growth opportunities (see Fig. 15 and 16).

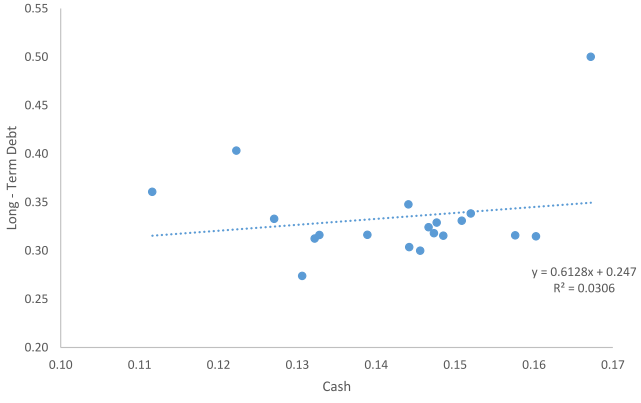

Fig. 6.1. Firm long – term debt and cash holdings correlation for legacy carriers.

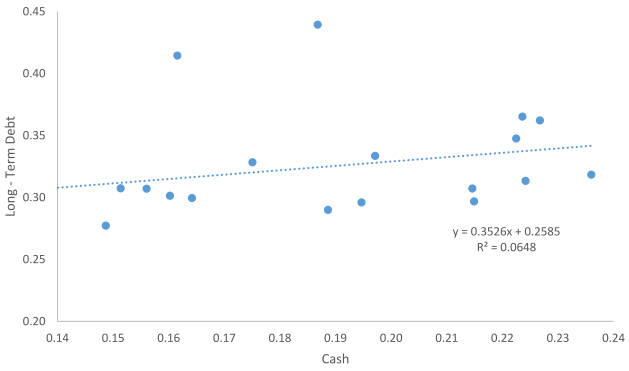

Fig. 6.2. Firm long – term debt and cash holdings correlation for low-cost carriers.

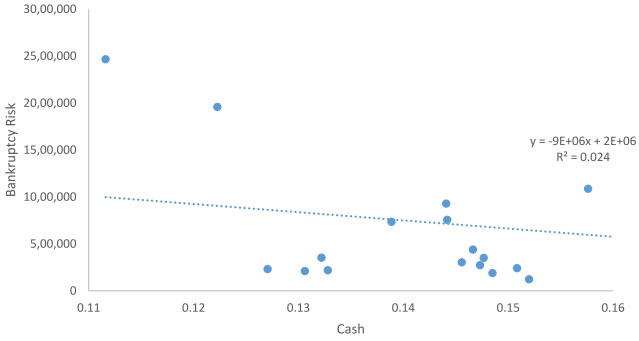

Fig. 7.1. Firm risk and cash holdings correlation for legacy carriers.

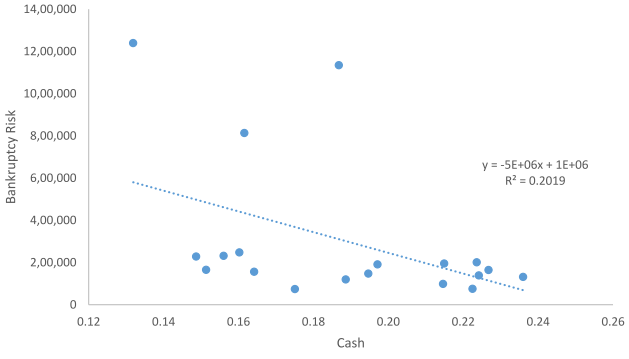

Fig. 7.2. Firm risk and cash holdings correlation for low-cost carriers.

3.9. Global financial crisis (GFC)

The 2008 financial crisis and the associated recession caused serious challenges for firms. It also provided a unique opportunity to understand the impact of crisis-induced fiscal restraints on firm policies (Campello et al., 2010). The Global Financial Crisis (GFC) that emerged in 2008 led to a significant contraction in the GDP of countries. Per capita income and household expenditures also declined considerably. There is a close relationship between air transportation and GDP. The economic

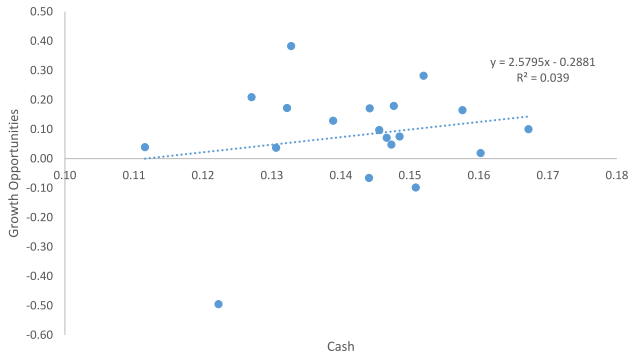

Fig. 8.1. Firm growth opportunities and cash holdings correlation for legacy carriers.

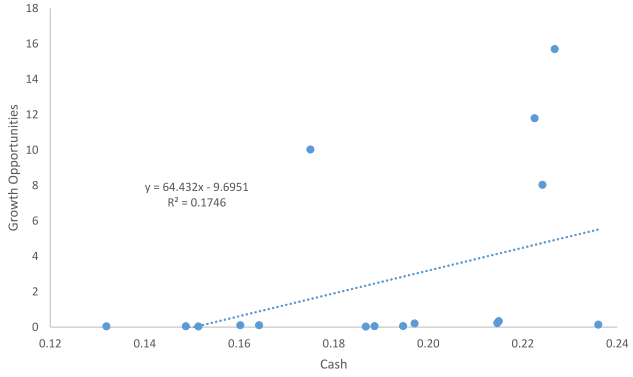

Fig. 8.2. Firm growth opportunities and cash holdings correlation for low-cost carriers.

contraction in national economies has led individuals to reduce their travel and tourism expenditures. According to Batuman et al. (2022), economies lose credibility due to inadequate liquidity. Therefore, during times of crisis, there is a contraction in national economies and cash flow problems for companies.

The GFC emphasized the importance of liquidity, financial stability, and risk management, influencing companies to adopt more conservative financial strategies with a focus on maintaining higher levels of cash reserves. According to Campello et al. (2009), during the 2008 credit crisis, planned investments in attractive projects were not only curtailed, but firms canceled or postponed investment plans altogether. While the typical firm had cash and liquid securities equal to about 15% of total assets in 2007, firms were able to maintain these cash balances until late fall 2008. During the crisis, firms burn through about one-fifth of their liquid assets, ending the year with liquid assets equal to about 12% of asset value. The same pattern of cash burning for firms is financially consistent with the view that firms build cash reserves to insulate themselves from credit supply shocks. The 2008 global financial crisis led to a global economic recession and increased unemployment. The economic contraction and increase in the unemployment rate resulted in lower disposable income and reduced demand for the airline transportation industry. The passenger revenue of airlines decreases due to the crisis, and the cash flow of airlines is interrupted. Therefore, the GFC is expected to have a negative impact on airline cash flow.

4. Results and discussion

In this part of the study, results, discussion and conclusion parts are given respectively. The variables and correlation matrix used in the study are as follows.

We have included descriptive statistics in Table 2. ROA, which is the ratio of net income to total assets, and ROS, which is the ratio of EBIT to total sales; are −0.0271 and −0.0006, respectively. TANG, the ratio of property, plant & equip to total assets, averages 0.602. The standard deviation of profitability, asset structure and liquidity variables are quite low. Among the leverage ratios, LEV1, the ratio of long-term to total assets, and LEV2, the ratio of short-term debt to total assets, averaged 0.3293 and 0.1021, respectively. The standard deviation of LEV1 and LEV2 is low. However, the standard deviation of the LEV3 variable (the ratio of operating expenses to total assets) is relatively high.

Having the correlation coefficient of the independent variables less than 0.80 reduces the risk of multicollinearity in the modeling problem. In Table 3, it is seen that the correlation coefficient between the variables is low in general, so the risk of multicollinearity is low.

4.1. Results

In this study, we examined the financial factors that determine corporate cash in the airline industry according to the airline business model. We utilized five different dependent variables in the study. Our main goal is to reveal the relationship between different variations of cash holdings and financial variables. Net cash flow can vary across firms. For instance, cash flows can originate from financing activities, investing and operating activities. Therefore, the net cash flows of the companies may differ depending on how they are realized. In this study, we used various forms of net cash flows as dependent variables. The details of the dependent and independent variables are in Table 1.

In this study, we categorized the airlines into two groups based on their business model, low-cost carriers and legacy carriers. The business model defines how airlines create value. The differences in business models among airlines also impact the composition of corporate cash holdings. Therefore, we analyzed the airlines by taking into account the business model they implement.

The SUR model results for low-cost carriers are presented in Table 4.

Table 1
List of dependent and independent variables.

	Acronym	Variables	Formula
Dependent variables	WCR	Working capital requirement	Net working capital/ total assets
	CASH	Cash ratio	Cash/total assets
	CASH-F	Net cash flow-financing	NCF-financing/total assets
	CASH-I	Net cash flow-investing	NCF-investing/total assets
	CASH-O	Net cash flow - operating activities	NCF-operating activities/total assets
Independent variables	SIZE	Firm size	Log (total assets)
	ROA	Return on assets	Net income/total assets
	ROS	Return on sales	EBIT/total sales
	TANG	Tangibility	Property, plant & equip/total assets
	LIQ	Liquidity	Current assets/current liabilities
	LEV1	Leverage ratio-1	Long-term debt/total assets
	LEV2	Leverage ratio-2	Short-term debt/total assets
	LEV3	Leverage ratio-3	Operating expenses/ total assets
	RISK	Firm risk	EBIT std deviation
	GROW1	Growth opportunities	Percentage change in sales
	GROW2	Growth opportunities	Percentage change in total assets
	GFC	The 2007–2008 Global Financial Crisis	Years of crisis 1, other years 0

Table 2
Descriptive analysis of included variables.

	SIZE	ROA	ROS	TANG	LIQ	LEV1	LEV2	LEV3	RISK	GROW1	GROW2	GFC
Mean	6.7546	−0.0271	−0.0006	0.6020	0.8689	0.3293	0.1021	1.0264	563100	0.7923	0.4173	0.1052
Median	6.8495	0.0170	0.0530	0.6260	0.7807	0.3381	0.0641	0.7065	136711	0.0786	0.0645	0.0000
Maximum	7.8523	0.5860	0.6229	0.9205	4.4115	1.0886	1.1533	199.72	23569633	199.88	233.36	1.0000
Minimum	2.9355	−19.719	−7.7952	0.0174	0.0655	0.0000	0.0005	0.0764	28.99138	−0.9858	−0.9967	0.0000
Std. Dev.	0.6365	0.7031	0.3731	0.1617	0.5175	0.1479	0.1061	6.9531	1605070	10.353	8.1470	0.3070
Skewness	−1.1215	−26.891	−13.1922	−0.8698	1.8258	0.4629	3.0537	28.474	7.44884	15.557	28.523	3.0514
Kurtosis	5.6241	751.67	246.26	3.8586	9.1466	4.5559	19.627	814.16	78.68872	255.97	816.04	10.311
Jarque-Bera	407.65	192731	2048246	128.74	1748.6	112.1	10733	226195	203564	22223	227244	2494.2
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	821	821	821	821	821	821	821	821	821	821	821	821

Table 3
Correlation matrix.

	SIZE	ROA	ROS	TANG	LIQ	LEV1	LEV2	LEV3	RISK	GROW1	GROW2	GFC
SIZE	1											
ROA	0.23[b]	1										
ROS	0.03	0.09[b]	1									
TANG	0.25[b]	0.11[b]	0.11[b]	1								
LIQ	−0.09[b]	0.07[a]	0.13[b]	−0.35[b]	1							
LEV1	−0.03	0.009	−0.03	0.37[b]	−0.22[b]	1						
LEV2	−0.09[b]	−0.02	−0.36[b]	0.17[b]	−0.49[b]	0.24[b]	1					
LEV3	−0.23[b]	−0.97[b]	−0.005	−0.12[b]	−0.05	−0.05	−0.03	1				
RISK	0.31[b]	−0.04	−0.18[b]	−0.058	0.03	−0.03	−0.01	−0.016	1			
GROW1	−0.24[b]	−0.002	−0.006	−0.116	0.03	0.11[b]	−0.03	−0.008	−0.026	1		
GROW2	−0.06[a]	0.005	0.011	−0.118	0.01	−0.04	−0.02	−0.006	−0.014	0.008	1	
GFC	−0.015	−0.001	−0.010	0.011	0.005	−0.004	−0.003	−0.007	−0.001	−0.015	−0.008	1

*p < 0.1.
[a] p < 0.05.
[b] p < 0.01.

Table 4
SUR model results for low-cost carriers.

Dep. variables	WCR	CASH	CASH-F	CASH-I	CASH-O
Exp. variables	Coef.	Coef.	Coef.	Coef.	Coef.
Intercept	0.076	0.414[c]	−0.116	−0.136	−7.5E-05
SIZE	−0.011	−0.054[c]	0.009	0.025	0.011
ROA	0.228[c]	−0.053	−0.222[b]	0.334[c]	0.464[c]
ROS	0.125[c]	0.026	0.067[b]	−0.017	0.016
TANG	−0.405[c]	−0.035	−0.052	0.158[a]	−0.139[b]
LIQ	−0.011	0.188[c]	0.024	−0.001	−0.004
LEV1	0.349[c]	0.033	−0.057	−0.134	0.012
LEV2	−0.252[b]	−0.338[c]	0.396[c]	0.691[c]	0.186
LEV3	−0.196[c]	−0.029	−0.087[b]	0.031	0.041
RISK	7.22E-09	4.16E-09	5.64E-09	−8.91E-09	−7.4E-09
GROW1	0.001	−0.001[c]	0.002[c]	0.001[b]	0.000
GROW2	0.009	−0.022	0.173[c]	0.107[c]	0.035
GFC	0.035	−0.006	0.039	−0.032	−0.037[b]

[a] p < 0.1.
[b] p < 0.05.
[c] p < 0.01.

There is generally a positive relationship between airline profitability and corporate cash holdings. Within the airline asset structure, there is a negative relationship between cash flows, but there is a positive relationship between tangible assets and cash flows arising from airline investments. The relationship between liquidity and airline cash flows is positive. Debt structure and maturity are closely related in the relationship between leverage level and cash flows. The relationship between long-term debt and cash flows is positive. Additionally, there is a positive relationship between short-term debt and cash flows associated with financial activities and investments. The relationship between operating expenses and cash flows is negative. The relationship between the growth possibilities of airlines and operating expenses is positive. Furthermore, the relationship between the global financial crisis in 2007–2008 and cash flows is negative. Therefore, airlines' cash flows were negatively affected during the global financial crisis (GFC).

Analysis results for legacy carriers are given in Table 5. There is a negative relationship between airline size and cash flows. There is a positive relationship between cash flows arising from investment and operational activities and profitability. However, the relationship between cash flow from financial activities and profitability is negative. Airline asset structure and cash flows arising from investment and operational activities are positive. Benefiting from the economies of scale of the airlines, better financing options and the increase in efficiency are among the possible reasons. Debt maturity and amount are important factors that affect cash flows. The findings indicate that the airline cash flow varies according to the maturity structure of the debts. There is a positive relationship between firm risk and cash flow from

Table 5
SUR model results for legacy carriers.

Dep. variables	WCR	CASH	CASH-F	CASH-I	CASH-O
Exp. variables	Coef.	Coef.	Coef.	Coef.	Coef.
Intercept	−0.052	0.250[c]	0.007	0.236[c]	0.242[c]
SIZE	0.009	−0.026[c]	−0.005	−0.024[c]	−0.021[c]
ROA	−0.087[b]	0.041	−0.103[c]	0.138[c]	0.256[c]
ROS	0.103[c]	−0.002	−0.022[c]	−0.007	0.015[c]
TANG	−0.630[c]	−0.093[b]	−0.189[c]	0.098[b]	0.077[b]
LIQ	0.016[b]	0.098[c]	0.022[c]	0.017[b]	0.004
LEV1	0.518[c]	−0.039	0.386[c]	0.076[b]	−0.242[c]
LEV2	−0.341	−0.180[c]	0.118[c]	−0.047	−0.164[c]
LEV3	−0.015	−0.003[c]	−0.016[c]	−0.002[c]	0.011[c]
RISK	−6.95e-10	1.01e-09	−1.69e-09	2.19e-09	2.81e-09[b]
GROW1	0.027[b]	−0.016[a]	0.011	0.019[b]	0.012[a]
GROW2	0.000	0.000	0.000	−0.001[c]	0.000
GFC	−0.010	−0.007	0.007	−0.011	−0.021[c]

[a] p < 0.1.
[b] p < 0.05.
[c] p < 0.01.

operational activities. Additionally, the Global Financial Crisis (GFC) negatively affects airlines' cash flow from operational activities. The main reasons for this negative relationship include decreased demand for air transportation, increased operational costs, and the credit and liquidity crunch.

4.2. Discussion

In this study, we examined the financial variables affecting cash holdings in the airline industry. Using five different models, we revealed the relationship between dependent and independent variables through the panel data analysis method. Our main goal is to analyze the variables that determine cash holdings, taking into account the details of cash holdings. For this reason, we created a separate model for each variation of cash holdings arising from financing, investing, and operating activities. In the first model, where the ratio of net working capital to total assets is the dependent variable (WRC), there is a positive relationship between size and corporate cash holdings. This is consistent with studies that analyze the cash holding level for retail firms (Chireka and Fakoya, 2017). On the other hand, in other models where various variations of corporate cash holdings are dependent variables, a significant negative relationship was found between corporate cash holdings and firm size. This study has similar results to studies examining the relationship between corporate cash holdings and firm size for trucking firms (Yang and Susanto, 2021), for companies operating in the Economic and Monetary Union (EMU) region (Ferreira and Vilela, 2004) and accommodation firms (Kwan and Lau, 2020).

Another variable associated with corporate cash holdings is profitability. Le et al. (2022) revealed that there is a positive relationship between ROA and corporate cash holdings in the services industry. Similar results were obtained in another study for the travel and leisure industry (Chen et al., 2020). In this study, the ROA and ORS variables are used to measure profitability. The findings show that there is a positive relationship between profitability and corporate cash holdings for all models except the dependent variable CASH-F. Therefore, the level of corporate cash holdings is higher in airlines with high profitability.

Our results are consistent with studies on the service industry in the literature. Asset structure refers to the fleet, which comprises the airline's core fixed assets. In principle, the presence of tangible assets allows airlines to be less likely to experience financial difficulties and to exercise greater leverage (Kiraci and Aydin, 2018). Thus, tangible assets decrease the need for corporate cash holdings. Moreover, it is emphasized that all tangible assets are equally liquid and contribute equally to a firm's overall asset liquidity (Usman, 2022). A negative relationship was found in studies examining corporate cash holdings and tangible assets in a country sample (Lei et al., 2018). Similarly, a study on US industrial firms found a significant negative relationship between cash holdings and tangible assets (Elyasiani and Movaghari, 2022). In this study, we employed the ratio of property, plant and equipment to total assets for the asset structure of the airlines. The findings of the study indicate that the results were consistent with the studies in the existing literature. There is a close relationship between liquidity and corporate cash holdings of companies. Liquidity refers to assets that can be converted into cash in the short term an additional cash holding requirement of firms increases their financial flexibility (Eskandari and Zamanian, 2022). A positive relationship was found in studies on the restaurant industry, where the effect of corporate cash holdings on liquidity was examined (Chathoth and Olsen, 2007). In this study, we used the ratio of current assets to current liabilities to measure liquidity, similar to previous studies in the literature. The findings of the study indicate that liquidity has a significant and positive relationship with corporate cash holdings, in line with our expectation.

The debt level, or financial leverage, is an important determinant of corporate cash holdings. Therefore, firms' cash holdings and debt policies are closely interrelated. This is because debt is used as a cash substitute (Elyasiani and Movaghari, 2022). In this study, we included different variations of the leverage ratio for airlines. Airlines usually have a long-term debt structure. However, we consider it important to examine the impact of short-term debt levels on corporate cash holdings as well. Additionally, we found it worthwhile to examine the impact of operating expenses on corporate cash holdings, as airlines' operating expenses are high and extremely critical. In this study, we used the ratio of long-term debt to total assets to analyze the impact of long-term debt on corporate cash holdings. The results showed that the LEV1 variable had a positive effect on corporate cash holdings. However, the results for the LEV2 variable vary across models. In the first and fifth models, the short-term debt ratio has a negative effect on corporate cash holdings. In contrast, in the second and third models, the short-term debt ratio has a positive effect on corporate cash holdings. Therefore, the findings suggest that airlines' short-term debt ratio has a negative effect on net cash flow resulting from operating activities. The findings showed that airlines may have used funds from short-term debts in operating activities. For the LEV3 variable, we used the ratio of operating expenses to total assets. The operating expenses of airlines have a negative impact on corporate cash holdings. Therefore, an increase in airlines' expenses due to operating expenses has a negative effect on corporate cash holdings. However, it has a positive effect on the net cash flow resulting from operating activities. There is a close relationship between the behavior of companies holding cash holdings and the firm. Existing literature emphasizes that firms with greater total risk tend to hold more cash (He et al., 2022).

Cash reserves are an important financial instrument that have the potential to reduce the negative impact of firms' refinancing risks (Yuan and Gao, 2022). In this study, we used the standard deviation in EBIT to determine the impact of firm risk on corporate cash holdings. The findings of the study show that risk has a negative effect on the net cash flow resulting from operating activities. Therefore, the increase in firm risk has a significant effect on the net cash flow resulting from operating activities. However, we found a positive relationship in the model where the ratio of net working capital to total assets was the dependent variable.

In this study, we examined the relationship between airlines' growth opportunities and corporate cash holdings. We used the percentage change in sales and the percentage change in total assets to measure growth opportunities. Firms with corporate cash holdings are more likely to have growth opportunities. Firm growth opportunities can enable investors to earn more, but growth opportunities also increase firm risk (Al-Hadi et al., 2020). Firms may hold less cash than is necessary to increase their growth potential. On the other hand, companies with higher growth, that is, their sales and total assets increasing rapidly, may have more corporate cash holdings. The findings in this study showed that there is a positive relationship between the growth opportunities of airlines and corporate cash holdings.

5. Conclusion, limitations, and future research

Corporate cash assets are of critical importance for capital-intensive industries. The airline industry is one of the most capital-intensive industries. Therefore, in this study, we focused on the financial factors that determine corporate cash holdings in the airline industry. This research aids in our comprehension of the discussion surrounding the necessity for airlines to maintain corporate cash reserves. In addition, as a contribution to the existing literature, we analyze different variations of net cash flow. Therefore, we have developed a multidimensional and in-depth approach to the relationship between corporate cash holding and financial indicators. In this study, we created a model for each of the net cash flows originating from financing activities, investing and operating activities.

The empirical results of the study have useful policy implications for airline transportation industry decision makers. First of all, corporate cash holdings in airlines are important especially in times of crisis so that

airlines do not experience financial distress or bankruptcy risk. In the Covid-19 pandemic, airlines' revenues decreased significantly, cash flows from operations almost completely stopped. However, the liabilities of the airlines arising from fixed costs continued. During the Covid-19 era, airlines' probability of experiencing financial stress was dependent on their corporate cash holdings. A metric has been devised to gauge the survivability of airlines during the Covid-19 pandemic based on their existing cash reserves. Known as the Daily Cash Burn (DCB), this metric was utilized by industry experts to assess the correlation between an airline's daily expenditure during crises like a pandemic and their available cash holdings. Through calculations, projections were made regarding the duration for which airlines could sustain their operations with their total corporate cash reserves. The DCB metric precisely calculates the daily cash outflow of airlines juxtaposed against their overall cash reserves. By leveraging the total corporate cash holdings of airlines, an analysis was conducted to determine the number of days they could endure without generating revenue, solely based on their existing expenditure patterns. Therefore, the importance of corporate cash holding for airlines has once again emerged, as corporate cash holding is one of the main indicators that determine the likelihood of airlines facing financial difficulties or going bankrupt during crisis periods.

In this study, we have uncovered the financial indicators that are critical for airlines to avoid bankruptcy risk due to their corporate cash assets during crisis periods such as the oil crisis, the September 11 terrorist attack, the global financial crisis and Covid-19, when demand for the airline transportation industry shrinks and/or costs increase. In this study, the financial variables that determine corporate cash holdings were analyzed by considering the airline business model. Therefore, the period 2003–2021 for low-cost and legacy carriers was analyzed by SUR method. In the study, this long-term analysis with a large data set allows us to make general inferences about the corporate cash holdings attitude of airlines. In this study, we revealed the financial factors that determine net cash flow of different net cash flow variations (cash flow-general, net cash flow-financing, net cash flow-investing, net cash flow - operating activities) in the airline industry. Therefore, this study also provides useful information on which financial indicators airlines should focus on in order to maintain their operations and have a more robust financial structure in times of crisis.

This study of the financial determinants of corporate cash flow in the airline industry has some limitations. First, the study analyzed the financial data of a certain number of airlines. The study analyzed financial data of 33 legacy carriers and 10 low-cost carriers. In the current airline market, the number of legacy carriers and low-cost carriers is higher than the number of airlines analyzed in our sample. However, the sample of this study consists of airlines whose financial data we can access incompletely from databases. Therefore, the results of the study are limited to the airline sample we analyzed. Secondly, this study analyzed airlines following a differentiation competitive strategy (legacy carriers) and airlines following a cost leadership competitive strategy (low-cost carriers). In the literature, there are airlines that follow competition strategies other than these two competition strategies. However, the number of airlines that follow competition strategies other than these two competition strategies is small and their data is not sufficient for econometric analysis. Therefore, in this study, airlines other than legacy carriers and low-cost carriers are not included in the analysis. Thirdly, the study analyzes the airlines' financial data for the period 2003 to 2021. The period 2003 to 2021 is the observation interval that optimizes not only the number of airlines but also the number of observations. Therefore, the financial data for the period 2003 to 2021 are analyzed. It should be noted that different results can be obtained by applying different combinations of the analysis period.

We recommend researchers who will work on this topic in the future to examine airlines that apply other airline competitive strategies apart from differentiation strategy and cost leadership strategy (which could include a focus strategy). In addition, further studies could be conducted for regionally focused airlines with similar network structure and operating markets. Finally, similar studies could be conducted for other service-producing sectors where different corporate cash holding patterns are critical.

CRediT authorship contribution statement

Kasım Kiracı: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Bijan Vasigh:** Writing – review & editing, Supervision, Investigation, Conceptualization.

Appendix

Table 1
Cross-sectional dependence test results

Cross-section dependence							
Variable	Test	Statistic	d.f.	Variable	Test	Statistic	d.f.
LWRC	Breusch-Pagan LM	3049.765***	946	TANG	Breusch-Pagan LM	2866.075***	946
	Pesaran scaled LM	47.35405***			Pesaran scaled LM	43.13102***	
	Bias-corrected scaled LM	46.13182***			Bias-corrected scaled LM	41.9088***	
	Pesaran CD	11.92861***			Pesaran CD	5.875128***	
CASH	Breusch-Pagan LM	2437.958***	946	LIQ	Breusch-Pagan LM	2820.464***	946
	Pesaran scaled LM	33.28858***			Pesaran scaled LM	42.08242***	
	Bias-corrected scaled LM	32.06636***			Bias-corrected scaled LM	40.8602***	
	Pesaran CD	4.564347***			Pesaran CD	16.55634***	
CASH-F	Breusch-Pagan LM	1535.155***	946	LEV1	Breusch-Pagan LM	2945.748***	946
	Pesaran scaled LM	12.53312***			Pesaran scaled LM	44.9627***	
	Bias-corrected scaled LM	11.3109***			Bias-corrected scaled LM	43.74047***	
	Pesaran CD	15.97064***			Pesaran CD	19.1992***	
CASH-I	Breusch-Pagan LM	1563.574***	946	LEV2	Breusch-Pagan LM	1995.506***	946
	Pesaran scaled LM	13.18648***			Pesaran scaled LM	23.1166***	
	Bias-corrected scaled LM	11.96426***			Bias-corrected scaled LM	21.89438***	
	Pesaran CD	12.05276***			Pesaran CD	9.404605***	
CASH-O	Breusch-Pagan LM	3108.607***	946	LEV3	Breusch-Pagan LM	4616.202***	946
	Pesaran scaled LM	48.70683***			Pesaran scaled LM	83.36648***	
	Bias-corrected scaled LM	47.48461***			Bias-corrected scaled LM	82.14426***	

(*continued on next page*)

Table 1 (*continued*)

Cross-section dependence							
Variable	Test	Statistic	d.f.	Variable	Test	Statistic	d.f.
	Pesaran CD	37.54156***			Pesaran CD	47.60472***	
SIZE	Breusch-Pagan LM	9775.687***	946	RISK	Breusch-Pagan LM	6002.753***	946
	Pesaran scaled LM	201.9832***			Pesaran scaled LM	115.2433***	
	Bias-corrected scaled LM	200.7609***			Bias-corrected scaled LM	114.0211***	
	Pesaran CD	85.98427***			Pesaran CD	61.4469***	
ROA	Breusch-Pagan LM	3368.606***	946	GROW1	Breusch-Pagan LM	5404.872***	946
	Pesaran scaled LM	54.68421***			Pesaran scaled LM	101.498***	
	Bias-corrected scaled LM	53.46198***			Bias-corrected scaled LM	100.2758***	
	Pesaran CD	40.6204***			Pesaran CD	59.32628***	
ROS	Breusch-Pagan LM	5783.276***	946	GROW2	Breusch-Pagan LM	1704.063***	946
	Pesaran scaled LM	110.1975***			Pesaran scaled LM	16.41634***	
	Bias-corrected scaled LM	108.9753***			Bias-corrected scaled LM	15.19411***	
	Pesaran CD	59.44686***			Pesaran CD	25.00448***	

*p < 0.1; **p < 0.05; ***p < 0.01.

Table 2
Pesaran (2007) panel unit root test

Variable	Model	Stat	Variable	Model	Stat
WCR	Constant	−1.965	ΔTANG	Constant	−2.766***
	Constant & trend	−2.012		Constant & trend	−3.255***
ΔWCR	Constant	−2.694***	LIQ	Constant	−2.289***
	Constant & trend	−2.755***		Constant & trend	−2.509
CASH	Constant	−2.327***	LEV1	Constant	−1.739
	Constant & trend	−2.582*		Constant & trend	−2.16
CASH-F	Constant	−2.843***	ΔLEV1	Constant	−2.794***
	Constant & trend	−2.996***		Constant & trend	−2.882***
CASH-I	Constant	−2.705***	LEV2	Constant	−2.218**
	Constant & trend	−3.084***		Constant & trend	−2.414
CASH-O	Constant	−2.469***	LEV3	Constant	−1.698
	Constant & trend	−2.921***		Constant & trend	−2.125
SIZE	Constant	−2.057*	ΔLEV3	Constant	−2.461***
	Constant & trend	−2.278		Constant & trend	−2.487
ROA	Constant	−2.351***	RISK	Constant	−2.192**
	Constant & trend	−2.772***		Constant & trend	−2.731**
ROS	Constant	−1.904	GROW1	Constant	−2.376***
	Constant & trend	−2.362		Constant & trend	−3.08***
ΔROS	Constant	−3.292***	GROW2	Constant	−3.03***
	Constant & trend	−3.335***		Constant & trend	−3.316***
TANG	Constant	−1.933			
	Constant & trend	−2.266			

*p < 0.1; **p < 0.05; ***p < 0.01.

Table 3
Diagnostic tests for model decision

Cross-Section/Period			
	F Test	LM Test	Hausman Test
	Stat.	Stat.	Stat.
Model 1	3.331783***	22.1826***	129.5464***
Model 2	19.88259***	1671.81***	7.974566
Model 3	2.835692***	25.6877***	49.15882***
Model 4	2.971708***	44.7769***	38.11989***
Model 5	4.528799***	45.1460***	80.9947***

*p < 0.1; **p < 0.05; ***p < 0.01.

Table 4
Diagnostic tests for heteroskedasticity and serial correlation

		Stat.	Test	Stat.
Model 1	Modified Wald	2836.15***	Durbin Watson (DW)	1.75361
			Baltagi–Wu (LBI)	1.92608
Model 2	Levene and Brown-Forsythe test	W0 = 8.05***	Durbin Watson (DW)	0.63684
		W50 = 5.05***	Baltagi–Wu (LBI)	0.90580
		W10 = 7.08***		
Model 3	Modified Wald	1036.23***	Durbin Watson (DW)	1.49798
			Baltagi–Wu (LBI)	1.70583

(*continued on next page*)

Table 4 (*continued*)

		Stat.	Test	Stat.
Model 4	Modified Wald	6832.7***	Durbin Watson (DW)	1.58592
			Baltagi–Wu (LBI)	1.73523
Model 5	Modified Wald	947.78***	Durbin Watson (DW)	1.61385
			Baltagi–Wu (LBI)	1.84173

*p < 0.1; **p < 0.05; ***p < 0.01.

Table 5
SUR model results for low-cost carriers (Dependent variable: WCR)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	−0.011	0.0132	−0.810	0.4150	−0.03662	0.01514
ROA	0.228	0.0757	3.010	0.0030	0.07930	0.37648
ROS	0.125	0.0250	5.010	0.0000	0.07606	0.17403
TANG	−0.405	0.0770	−5.250	0.0000	−0.55587	−0.25350
LIQ	−0.011	0.0135	−0.780	0.4340	−0.03718	0.01597
LEV1	0.349	0.0689	5.070	0.0000	0.21407	0.48460
LEV2	−0.252	0.1268	−1.980	0.0480	−0.50040	−0.00264
LEV3	−0.196	0.0288	−6.790	0.0000	−0.25240	−0.13922
RISK	7.22E-09	1.05E-08	0.680	0.4940	−1.35E-08	2.79E-08
GROW1	0.001	0.0004	1.270	0.2050	−0.00028	0.00131
GROW2	0.009	0.0230	0.390	0.6940	−0.03603	0.05413
GFC	0.035	0.0212	1.670	0.0950	−0.00612	0.07696
_cons	0.076	0.0925	0.820	0.4130	−0.10569	0.25725

Table 6
SUR model results for low-cost carriers (Dependent variable: CASH)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	−0.054	0.0112	−4.870	0.0000	−0.07616	−0.03239
ROA	−0.053	0.0640	−0.830	0.4050	−0.17907	0.07228
ROS	0.026	0.0211	1.210	0.2250	−0.01580	0.06706
TANG	−0.035	0.0651	−0.530	0.5960	−0.16240	0.09334
LIQ	0.188	0.0115	16.43	0.0000	0.16572	0.21068
LEV1	0.033	0.0583	0.560	0.5730	−0.08152	0.14728
LEV2	−0.338	0.1072	−3.160	0.0020	−0.54897	−0.12798
LEV3	−0.029	0.0244	−1.200	0.2300	−0.07716	0.01856
RISK	4.16E-09	8.91E-09	0.470	0.6410	−1.33E-08	2.16E-08
GROW1	−0.001	0.0003	−2.930	0.0040	−0.00168	−0.00033
GROW2	−0.022	0.0194	−1.150	0.2520	−0.06041	0.01584
GFC	−0.006	0.0179	−0.340	0.7370	−0.04115	0.02911
_cons	0.414	0.0782	5.300	0.0000	0.26093	0.56789

Table 7
SUR model results for low-cost carriers (Dependent variable: CASH-F)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	0.009	0.0155	0.560	0.5750	−0.02179	0.03924
ROA	−0.222	0.0893	−2.480	0.0130	−0.39692	−0.04648
ROS	0.067	0.0294	2.260	0.0240	0.00883	0.12435
TANG	−0.052	0.0908	−0.580	0.5650	−0.23059	0.12595
LIQ	0.024	0.0160	1.530	0.1270	−0.00694	0.05573
LEV1	−0.057	0.0813	−0.700	0.4840	−0.21633	0.10267
LEV2	0.396	0.1495	2.650	0.0080	0.10234	0.68928
LEV3	−0.087	0.0340	−2.560	0.0110	−0.15384	−0.02038
RISK	5.64E-09	1.24E-08	0.450	0.6500	−1.87E-08	3E-08
GROW1	0.002	0.0005	3.350	0.0010	0.00066	0.00254
GROW2	0.173	0.0271	6.400	0.0000	0.12016	0.22646
GFC	0.039	0.0250	1.570	0.1170	−0.00981	0.08816
_cons	−0.116	0.1090	−1.060	0.2900	−0.32953	0.09844

Table 8
SUR model results for low-cost carriers (Dependent variable: CASH-I)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	0.025	0.0161	1.560	0.1190	−0.00648	0.05684
ROA	0.334	0.0926	3.600	0.0000	0.15194	0.51552
ROS	−0.017	0.0305	−0.540	0.5880	−0.07646	0.04340
TANG	0.158	0.0942	1.680	0.0930	−0.02655	0.34337
LIQ	−0.001	0.0166	−0.090	0.9280	−0.03400	0.03102
LEV1	−0.134	0.0843	−1.590	0.1120	−0.29949	0.03149
LEV2	0.691	0.1551	4.450	0.0000	0.38649	0.99546
LEV3	0.031	0.0353	0.880	0.3790	−0.03818	0.10028
RISK	−8.91E-09	1.29E-08	−0.690	0.4890	−3.42E-08	1.64E-08
GROW1	0.001	0.0005	2.440	0.0150	0.00024	0.00219
GROW2	0.107	0.0281	3.820	0.0000	0.05218	0.16248
GFC	−0.032	0.0259	−1.230	0.2180	−0.08275	0.01889
_cons	−0.136	0.1131	−1.210	0.2280	−0.35851	0.08552

Table 9
SUR **model** results for low-cost carriers (Dependent variable: CASH-F)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	0.011	0.0125	0.890	0.3730	−0.01345	0.03581
ROA	0.464	0.0720	6.440	0.0000	0.32229	0.60513
ROS	0.016	0.0238	0.670	0.5000	−0.03061	0.06263
TANG	−0.139	0.0733	−1.900	0.0580	−0.28280	0.00497
LIQ	−0.004	0.0129	−0.310	0.7540	−0.02933	0.02126
LEV1	0.012	0.0656	0.180	0.8600	−0.11715	0.14032
LEV2	0.186	0.1207	1.540	0.1240	−0.05106	0.42267
LEV3	0.041	0.0274	1.500	0.1330	−0.01263	0.09509
RISK	-7E-09	1E-08	−0.740	0.4610	−2.71E-08	1.23E-08
GROW1	-5E-04	0.0004	−1.210	0.2280	−0.00122	0.00029
GROW2	0.035	0.0219	1.590	0.1130	−0.00825	0.07755
GFC	−0.037	0.0201	−1.860	0.0640	−0.07692	0.00215
_cons	-8E-05	0.0880	0.000	0.9990	−0.17279	0.17263

Table 10
SUR model results for legacy carriers (Dependent variable: WCR)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	0.009	0.0071	1.320	0.1860	−0.00455	0.02337
ROA	−0.087	0.0426	−2.030	0.0420	−0.17019	−0.00300
ROS	0.103	0.0089	11.50	0.0000	0.08524	0.12028
TANG	−0.630	0.0580	−10.87	0.0000	−0.74365	−0.51631
LIQ	0.016	0.0091	1.750	0.0800	−0.00191	0.03376
LEV1	0.518	0.0419	12.35	0.0000	0.43548	0.59987
LEV2	−0.341	0.0449	−7.580	0.0000	−0.42873	−0.25255
LEV3	−0.015	0.0007	−21.65	0.0000	−0.01666	−0.01390
RISK	−6.95E-10	2.38E-09	−0.290	0.7700	−5.37E-09	3.98E-09
GROW1	0.027	0.0121	2.190	0.0290	0.00279	0.05028
GROW2	4E-04	0.0004	1.150	0.2500	−0.00029	0.00112
GFC	−0.010	0.0109	−0.890	0.3720	−0.03119	0.01167
_cons	−0.052	0.0524	−1.000	0.3190	−0.15496	0.05054

Table 11
SUR model results for legacy carriers (Dependent variable: CASH)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	−0.026	0.0052	−4.950	0.0000	−0.0360063	−0.0155653
ROA	0.041	0.0312	1.300	0.1930	−0.0205988	0.1018342
ROS	−0.002	0.0065	−0.240	0.8110	−0.0143903	0.011269
TANG	−0.093	0.0425	−2.190	0.0290	−0.1761776	−0.0096998
LIQ	0.098	0.0067	14.70	0.0000	0.0848825	0.111005
LEV1	−0.039	0.0307	−1.290	0.1990	−0.0996516	0.0207307
LEV2	−0.180	0.0329	−5.460	0.0000	−0.2440797	−0.1150656
LEV3	−0.003	0.0005	−6.350	0.0000	−0.0042963	−0.0022695
RISK	1.01E-09	1.74E-09	0.580	0.5620	−2.41E-09	4.43E-09
GROW1	−0.016	0.0089	−1.780	0.0760	−0.0331414	0.0016391

(*continued on next page*)

Table 11 (*continued*)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
GROW2	4E-04	0.0003	1.640	0.1010	−0.0000839	0.0009491
GFC	−0.007	0.0080	−0.900	0.3660	−0.022929	0.0084607
_cons	0.250	0.0384	6.520	0.0000	0.1751275	0.3256117

Table 12
SUR model results for legacy carriers (Dependent variable: CASH-F)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	−0.005	0.0061	−0.810	0.4210	−0.01684	0.00703
ROA	−0.103	0.0365	−2.820	0.0050	−0.17436	−0.03138
ROS	−0.022	0.0076	−2.920	0.0040	−0.03729	−0.00733
TANG	−0.189	0.0496	−3.810	0.0000	−0.28600	−0.09158
LIQ	0.022	0.0078	2.850	0.0040	0.00693	0.03744
LEV1	0.386	0.0358	10.77	0.0000	0.31590	0.45649
LEV2	0.118	0.0384	3.070	0.0020	0.04278	0.19345
LEV3	−0.016	0.0006	−26.33	0.0000	−0.01708	−0.01471
RISK	−1.69E-09	2.04E-09	−0.83	0.406	−5.69E-09	2.3E-09
GROW1	0.011	0.0104	1.090	0.2750	−0.00900	0.03162
GROW2	-2E-04	0.0003	−0.510	0.6070	−0.00076	0.00044
GFC	0.007	0.0093	0.770	0.4400	−0.01111	0.02555
_cons	0.007	0.0448	0.160	0.8770	−0.08092	0.09482

Table 13
SUR model results for legacy carriers (Dependent variable: CASH-I)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	−0.024	0.0057	−4.210	0.0000	−0.03531	−0.01288
ROA	0.138	0.0343	4.010	0.0000	0.07038	0.20474
ROS	−0.007	0.0072	−0.980	0.3250	−0.02114	0.00701
TANG	0.098	0.0466	2.110	0.0350	0.00699	0.18968
LIQ	0.017	0.0073	2.350	0.0190	0.00283	0.03150
LEV1	0.076	0.0337	2.260	0.0240	0.00998	0.14209
LEV2	−0.047	0.0361	−1.300	0.1940	−0.11769	0.02389
LEV3	−0.002	0.0006	−4.380	0.0000	−0.00359	−0.00137
RISK	2.19E-09	1.91E-09	1.140	0.253	−1.56E-09	5.94E-09
GROW1	0.019	0.0097	1.980	0.0480	0.00014	0.03831
GROW2	−0.001	0.0003	−3.740	0.0000	−0.00165	−0.00052
GFC	−0.011	0.0088	−1.250	0.2130	−0.02817	0.00627
_cons	0.236	0.0421	5.590	0.0000	0.15293	0.31808

Table 14
SUR model results for legacy carriers (Dependent variable: CASH-O)

Variable	Coef.	Std. err.	t	P>|t|	[95% conf. interval]	
SIZE	−0.021	0.0042	−5.130	0.0000	−0.02971	−0.01329
ROA	0.256	0.0251	10.22	0.0000	0.20722	0.30557
ROS	0.015	0.0053	2.900	0.0040	0.00493	0.02554
TANG	0.077	0.0341	2.250	0.0240	0.00996	0.14369
LIQ	0.004	0.0054	0.790	0.4310	−0.00627	0.01471
LEV1	−0.242	0.0247	−9.810	0.0000	−0.29032	−0.19362
LEV2	−0.164	0.0264	−6.200	0.0000	−0.21577	−0.11214
LEV3	0.011	0.0004	26.44	0.0000	0.01016	0.01179
RISK	2.81E-09	1.4E-09	2.010	0.0450	6.69E-11	5.56E-09
GROW1	0.012	0.0071	1.700	0.0880	−0.00183	0.02611
GROW2	−9.6E-05	0.0002	−0.450	0.6510	−0.00051	0.00032
GFC	−0.021	0.0064	−3.210	0.0010	−0.03323	−0.00802
_cons	0.242	0.0308	7.870	0.0000	0.18203	0.30291

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