

Evaluating Resilience in Commercial Airlines through Supply Chain Flexibility

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ABSTRACT: *The concept of organizational resilience continues to grow in focus and importance, but there has yet to be an agreed upon measure of organizational resilience. Organizational resilience can be seen as a corporation's ability to adapt to change and maintain flexibility within their supply chain. Resilience and flexibility at all organizational levels is necessary, in a proactive manner, to turn resilience into a competitive advantage. This study investigates the relationship between factors of supply chain flexibility that may explain the success of some airline companies throughout various shocks and most recently the COVID-19 pandemic. The study focuses on the viability of the underlying supply chain models within major U.S. airline companies. Specifically, the study explores supply chain flexibility as a component of the Supply Chain Operations Reference metrics. Multiple regressions were performed and found the Supply Chain Flexibility Ratio being a predictive value of supply chain flexibility $p < .05$ and indicating supply chain flexibility which can be used as an indicator of organizational resilience in the Airline – Mainline Passenger industry.*

Keywords -Supply Chain Flexibility, COVID-19, Airline – Mainline Passenger Industry, Organizational Resilience

I. INTRODUCTION

The aviation industry has faced major crises and disruptive shocks throughout the past decades including the 9/11 terrorist attacks, the 2008 global economic crisis, and most recently the COVID-19 pandemic [1][2][3]. These shocks have brought greater consideration to the concept of resilience for organizations. Constructing organizational resilience is argued to reduce vulnerability to crisis, by ensuring the organization is more equipped to respond effectively to a shock with minimum disruption of the organization's operations [4][5]. Such events are bringing a greater focus to applying concepts of resilience to financial markets, organizations, business and organizational strategies, and to supply chain networks.

With the growing interest in the concept of organizational resilience, there has yet to be an agreed-upon measure of organizational resilience [5][6]. The majority of literature on resilience is predominantly conceptual, focused on the development of a definition of resilience in organizations, theories, and principles. Understanding what makes an organization resilient is critical to developing strategies, identifying attributes that signify potential resilience, and how to measure and test organizational resistance. The most typical approach, until recently, focused on developing and implementing organizational resilience defensively and reactively. Growing resilience at all organizational levels and in a proactive manner is necessary to make resilience a competitive advantage and not solely a reactive and defensive response to crises and disruptions [7].

An essential element of organizational resistance falls within the area of supply chain management (SCM). SCM places focus on movement and storage of all materials, processes in inventory, and transporting finished goods from their point of origin to the point of consumption [8]. An organization's performance [financial and operational], position in the supply chain, and overall resilience to shocks have a bearing on organizational strategy [8]. Organizations experience risk at many levels with uncertainty increasing in recent years in addition to the conventional disruptions of capacity constraints, supply-demand, and quality problems [9]. The ability to recover from a disruption may be improved if the organization builds flexibility into its supply chain [10][9].

This study investigates the management factors of supply chain flexibility that may explain the success of some airline companies throughout various shocks and most recently the COVID-19 pandemic, which also may indicate organizational resilience. The study focuses on the viability of the underlying supply chain models within major U.S. airline companies. Specifically, the study explores supply chain flexibility as a component of the Supply Chain Operations Reference metrics and the role of supply chain flexibility as an indicator of organizational resilience. The development of resilience into organizational operations is considered a strategic initiative to not only change how the firm operates but also increasing its competitiveness.

1.1 Research Questions

The following research questions guide this study.

- What is the relationship between supply chain flexibility and the SCF ratio?
- Are there any outliers in supply chain flexibility based on the SCF ratios for the time periods 2000-2020?

1.2 Research Hypothesis

Null Hypothesis [H_{1o}]: There is no statistically significant relationship between Supply Chain Flexibility and the SCF ratio.

Null Hypothesis [H_{2o}]: There are no statistically significant outliers identified by the SCF ratio for the time periods 2000-2020.

II. LITERATURE REVIEW

The flexibility and agility of a supply chain allow organizations to adjust to rapid changes by developing organizational and inter-organizational capabilities to detect disruptions and then being able to respond quickly [9][11]. These capabilities and practices can strengthen organizational resilience to disruptions while also contributing to the firm's competitive advantage [11]. Having a supply chain risk management system is key for achieving supply chain resilience by reducing the overall firm's supply chains susceptibility to risk and then increasing the resilience in the supply chain [12]. The evaluation of supply chain resilience requires a quantification of the levels before developing a response and recovery to disruptions. In a disruptive event, measures of the supply chain are needed to forecast, prepare, and understand the effect of the disruption. From this, strategies are developed to respond quickly and adapt resources. The reconfiguration and adaption allow for recovery from disruptions, which also can indicate levels of organizational resilience from supply chain resilience [13]

In aviation and air transport, resilience denotes the capabilities to prevent or mitigate disruptions to air traffic operations [14]. Studies have begun to emerge in recent years focusing on the resilience of air transportation systems which typically included cost-benefit analysis, risk assessment models, and disaster recovery. More inquiry and measures are needed to explore evaluation methods for resilience specific to air transportation systems [14]. Similar to the concept of resilience of any system and organizational resilience, the resilience of aviation and air transport networks that serve varying supply chains has been defined as the capability to withstand and remain operational at optimal safety levels during any given disruptive event. In comprehensive reviews of research on resilience within aviation and air transportation, the resilience of supply chains and its relationship to the organizational resilience of aviation firms has been identified as needed research [15][16]. There exists little data-driven evidence to support global supply chain resilience against disruptions, as well as how to measure supply chain resilience as an indicator of organizational resilience [13]. The increased research interest in resilience, both organizational and supply chain, notes the need for more empirical evidence on evaluating supply chains specifically during disruptive events [13]. Building a greater understanding of supply chain resilience concerning organizational resilience with aviation provides valuable lessons to other industries that are also coping with ongoing disruptions [13].

The organizations included in the study are publicly held commercial airlines that are headquartered and based within the United States of America. Using this sample of aviation firms allowed for sufficient access to financial data while also reducing discrepancies in financial reporting. The following aviation firms were included: Alaska Airlines, Allegiant Air, American Airlines, Delta Air Lines, Hawaiian Airlines, JetBlue Airlines, Southwest Airlines, Spirit Airlines, and United Airlines. The sample of aviation firms selected is among the leading aviation firms in terms of market capitalization. Additionally, the sample of aviation firms represent the aviation sector and industry regarding the overall financial performance for the prior two decades.

A predominant theme in the resilience literature is that resiliency is derived from access to adequate resources via the supply chain. The definitions of organizational resilience share a common perspective implying a definite level of flexibility and adaptation to both positive and negative changes in the external environment of the firm [17]. Lengnick-Hall et al. (2011) tied organizational resilience to the firm's aptitude to manage complexity and adjust as a result of the disruption to become stronger with a better capability to utilize resources available before and after the adverse or disruptive event. Vogus and Sutcliffe (2007) connected organizational resilience to the occurrence of underlying resources that then are activated, combined, and recombined as challenges arise from disruptions or new situations.

Supply chain resiliency as a component of organizational resilience has begun to be considered a fundamental assessment of how firms are doing in the unstable and ultra-competitive business environment [20][21]. Supply chain resilience is multi-dimensional and similar to organizational resilience in that there are multiple definitions. For purposes of this study, the definition of supply chain resilience from Falasca et al. (2008) is used as it aligns with the organizational resilience definition. According to Falasca et al (2008) supply

chain resilience is defined as “the ability of a supply chain system to reduce the probabilities of a disruption, to reduce the consequences of those disruptions once they occur, and to reduce the time to recover to normal performance”(p.1). Supply chain resilience facilitates organizations to quickly respond to unforeseen changes and in restoring operations by combining and reconfiguring the organization’s available resources, supply chain components, partners, and capabilities.

Assessing organizational resilience is complex and multi-dimensional in the same fashion as the multiple definitions of resilience in organizations. Kohno et al. (2012) recommended resilience be evaluated by considering the organization’s supply chains. Several scholars in the area of resilience have treated supply chain integration as a resilient capability of an organization. Supply chain performance serves as a crucial capability that helps companies to anticipate, prepare, and respond to market volatilities. Organizations with resilient capabilities, as measured through supply chain performance, should be able to survive in tumultuous and volatile conditions, and maybe more competitive. The present study considers supply chain management as an indicator of organizational resilience incorporating the organization’s ability to respond at the time of disruption, and the ability to connect and maintain control during the recovery stage of resilience.

Research in supply chain management has called for using existing organizational theories in application to supply chain problems. Despite this call for the increased study, the supply chain theories have not evolved to include such since the discipline’s inception 30 years prior [24]. Most organizational theories often use supply chain management concepts including the following: Transaction Cost Economics, Agency theory, Resource-Based View, Resource-Dependence Theory, Network Theory, and Relational Exchange Theory [24]. A contribution of this study is to answer the call for applying organizational theories in investigating the relationship between supply chain theory and organizational resilience.

In the 30 years since the inception of supply chain management, five points of view have emerged. First, supply chain awareness, which examines the product flow process [25][26][27][28]. Second, linkage and/or logistics that look at the relationship between functional areas [29][30]. The third is information, which refers to data flow within the supply chain [31]. Fourth, is the process integration of corporate functions [32][33]. Finally, the fifth is seamlessness, which focuses on eliminating challenges to the supply chain [34][35].

Although several theories related to the undercurrents of the supply chain have emerged in the SCM literature, research gaps still exist towards a unifying theory [36]. These gaps have led to the rise of several models as a way for researchers to explain the SCM phenomenon. The most prominent models in SCM research are (1) strategic; (2) operational; (3) network and (4) behavioral. Forehand et al. (2021) detailed that a major obstacle to the wide acceptance of existing models is the focus on an internal end-user. To address this obstacle, the authors developed a model based on the concept of financial ratios whose aim is to measure supply chain efficiency, but with an external stakeholder as the end-user. The Supply Chain Efficiency [SCE] Ratio uses publicly available information to gauge the efficiency of supply chains. Since organizational resilience is interlinked with supply chain efficiency, any simulation results that measure supply chain performance will give insights into the degree of organizational resilience.

The concept of organizational resilience in a business context refers to the degree to which corporations can withstand threats and maintain profitable operations. In essence, organizational resilience is considered the firm or organization’s ability to adapt to change, maintain flexibility, maximize reliability, and minimize risk whilst maximizing shareholder wealth [37][38]. The organizational resilience literature shows a lack of consensus on a unifying definition. However, consensus does exist on the impact sound organizational resilience has on business performance. Data suggests those companies that display strong organizational resilience tend to outperform those that do not [39].

According to Hillmann (2021), the functions of organizational resilience rest on five pillars, two of which are: (1) engineering; and (2) safety and reliability. The author stated these functions emerge from High-Reliability Theory (HRT), which states that organizational threats can be mitigated through sound organizational design and management. HRT is one of the foundations of business continuity management (BCM). BCM leads to organizational resilience through the implementation of three criteria: (1) personnel safety; (2) a secure business core; and [3] stable supply chains [40][41]. Resilience in the supply chain is built via redundancy and flexibility [42][43][39][44].

This study aims to develop a simple model measuring supply chain flexibility and then evaluating it from an organizational resilience theoretical lens. The model is based on the efficiency formula from physics and is an extension of the Supply Chain Efficiency (SCE) Ratio from Forehand et. al (2021). Research gaps exist on methods that measure supply chain resiliency [45][38]. The objective is to develop a supply chain flexibility indicator that will provide insights into the organizational resilience of publicly held U.S.-based airline companies.

Supply chain flexibility contributes to a competitive advantage in an organization’s operations [9]. Disruptions as a result of abrupt external changes cannot be eliminated nor controlled by an organization; thus,

responding to external changes require adjustments to the firm's internal responses [46]. Resilience is the organization's capability to survive and adjust during disruptions and then thriving after disruptions [47][48]. Within any system, there are four aspects of resilience according to the National Academy of Sciences: planning and preparation, ability to absorb, ability to respond, and ability to recover. Organizational resilience, as well as supply chain resilience, have similar aspects which include flexibility and improvisation [49].

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One criticism of the SCE Ratio is that its theoretical underpinnings are not tied to supply chain literature. The model has a sound mathematical base but lacks a clear link to contemporary supply chain theory. One of the most common and well-known metrics in supply chain management is the Supply Chain Operations Reference (SCOR) metrics. The SCOR metrics were developed in 1996 by the PRTM management consulting firm and later adopted by the Supply-Chain Council and the Association for Supply Chain Management (APICS). The SCOR model is one of the most widely accepted metrics to evaluate efficiency in supply chain processes, among them supply chain flexibility. However, the SCOR metrics have not been used as a benchmark to quantify results for an external user. The SCOR metrics are the foundation of the Supply Chain Flexibility (SCF) Ratio developed in this article.

The Supply Chain Council and APICS associate SCOR metrics with the following indicators: Responsiveness, reliability, flexibility, costs, and asset management. Flexibility is associated with supply chain response to the external environment, represented in the operating income and capital expenditures accounts. The Supply Chain Flexibility indicators can be grouped into the function:

$$f = [Operating\ Income, Capital\ Expenditures]$$

Using the SCE Ratio as a guide, we interpret which variables represent the work produced by the process (i.e., operational results) along with the work put into the process (i.e. resources needed/used). The results will also provide insight into the degree of organizational resilience. Table 1 below details the SCF formula with additional details.

Table 1. Supply Chain Operations Reference (SCOR) Flexibility Metrics

Attribute	Performance Attribute Definition	Level 1 Metric	Chart Accounts	of Ratio	Financial Statement
Supply Chain Flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain a competitive advantage.	Supply Chain Response Time Production Flexibility	Operating Income Capital Expenditures	Operating Income / Capital Expenditures	Income Statement Statement of Cash Flows

Source: Supply Chain Council [2017].

Figure 1 shows the conceptual outline of the SCOR ratios, including the variables in the model, the relationships among the variables, and estimations generated by the model.

Figure 1. SCF Ratio



Note: SCF Ratio Conceptual Map.

The SCF ratio is understood similarly as the SCE Ratio meaning if the result increases, this indicates greater flexibility the more flexible the supply chain and the stronger the organizational resilience. In the case of the ratio, a high figure indicates supply chain and organizational flexibility; however, a low ratio indicates the opposite suggesting inflexibility in the supply chain and organization.

III. METHOD

The objective of this study is to investigate SCOR ratios as a predictor of supply chain flexibility based on changes to Supply Chain Reliability, Supply Chain Responsiveness, Production Flexibility, Supply Chain Costs, Supply Chain Asset Management. The SCOR ratios drive this study's analysis as it combines numerous independent variables constructed on supply chain information. The model's variables allow the researchers to evaluate the supply chain performance through financial data. Indicators for the SCOR ratios are supply chain reliability, supply chain responsiveness, production flexibility, supply chain costs, supply chain asset management. The data analysis is done by testing the ability of the independent variables to determine supply chain flexibility.

The SCOR ratios generate a "score." This score is assessed in a comparative table to determine the significance of the score. Comparisons across sectors and industries are possible with the ratio results, which is akin to the sector and industry analysis. A context of categories is then used to interpret the score for analytic significance. Through multiple regression analysis, the research hypotheses were examined given the objective of the study is to determine a flexibility score from the various predictors [51].

3.1. Research Instrument

Secondary data from the annual reports for each of the organizations included in the study were collected for analysis via regression modeling within Excel at the .05 significance level. The approach utilized in the study mirrored the approach utilized by Forehand et al. (2021). Modifications to the regression model

were made to align the time period being examined. The focus of the analysis was to determine if the independent variables could be predicted at a statistically significant level at different points in time. It is noted that since publicly available secondary data was used within the study that organizational bias may have some level of minor influence on the findings. Similar to by Forehand et al. (2021), it was assumed that the published publicly available data was objective, accurate, and maintain neutrality.

IV. DATA

4.1 SCF Ratios for U.S.-Based Airline – Mainline Passenger Companies

Table 2. SCF Ratios

Year	Alaska SCF-Ratio	Allegiant SCF-Ratio	American SCF-Ratio	Delta SCF-Ratio	Hawaiian SCF-Ratio	JetBlue SCF-Ratio	Southwest SCF-Ratio	Spirit SCF-Ratio	United SCF-Ratio	Industry SCF-Ratio
2020	-8.617	-0.999	-5.322	-6.566	-6.149	-2.397	-0.741	-1.291	-3.682	-3.974
2019	1.527	0.718	0.718	1.341	0.824	0.858	0.288	1.498	0.950	0.969
2018	0.670	0.727	0.709	1.019	0.646	0.317	0.167	0.578	0.809	0.627
2017	1.228	0.406	0.709	1.533	1.359	0.925	0.160	0.612	0.918	0.872
2016	0.513	1.855	0.883	2.063	2.325	1.544	0.184	0.820	1.197	1.265
2015	1.562	1.471	1.009	2.649	3.586	1.453	0.140	0.928	2.055	1.650
2014	1.386	0.563	0.800	0.981	0.554	0.705	0.127	1.904	1.184	0.912
2013	1.481	0.872	0.449	1.349	0.391	0.696	0.089	14.249	0.577	2.239
2012	1.027	1.259	0.078	1.105	0.445	0.694	0.046	7.319	0.019	1.333
2011	1.160	0.987	-0.644	1.575	0.072	0.671	0.069	10.245	2.603	1.860
2010	2.549	1.063	0.157	1.652	0.650	1.337	0.200	.....	2.631	1.280
2009	0.610	3.861	-0.660	-0.270	2.675	0.657	0.045	.....	-0.508	0.801
2008	-0.417	1.032	-2.156	-5.463	6.168	0.167	0.049	.....	-9.343	-1.245
2007	0.254	1.046	1.352	1.058	0.274	0.274	0.059	.....	1.434	0.719
2006	-0.128	0.810	2.000	0.140	0.002	0.128	0.067	.....	1.223	0.530
2005	-0.017	0.564	-0.137	-2.458	0.100	0.052	0.060	.....	-0.466	-0.288
2004	-0.427	.....	-0.140	-4.353	.....	0.194	0.031	.....	-3.199	-1.316
2003	-0.030	.....	-1.241	-1.056	.....	0.310	0.039	.....	-13.267	-2.541
2002	-0.443	.....	-1.770	-1.018	.....	0.449	0.069	.....	-18.070	-3.464
2001	-0.268	.....	-0.679	-0.574	.....	.....	0.063	.....	-1.933	-0.678
2000	-0.046	.....	0.375	0.403	.....	.....	0.090	.....	0.258	0.216
Average	0.170	1.015	-0.167	-0.233	0.870	0.475	0.062	3.072	-1.648	0.084

Note: The SCF Ratios for U.S.-Based Airline – Mainline Passenger Companies.

4.1 Regression Results for the Investigation’s Hypotheses

Table 3. Regression Results

Variables	Coefficients	t-Stat	P-value	F-value	R Square	H1	H2
Alaska	Operating Income	3.3128E-09	8.562408275	9.1905E-08	38.7389	0.7905	Null hypothesis is rejected
	Capital Expenditures	-1.7297E-09	-3.30220776	0.00396195	.....	.....	Null hypothesis is rejected
Allegiant	Operating Income	4.2161E-09	3.477219948	0.00408885	8.0507	0.4846	Null hypothesis is rejected
	Capital Expenditures	-3.8714E-09	-3.30186478	0.00572714	.....	.....	Null hypothesis is rejected
American	Operating Income	4.8218E-10	9.448391098	2.123E-08	50.8081	0.8328	Null hypothesis is rejected
	Capital Expenditures	-2.8833E-10	-3.03189723	0.0071699	.....	.....	Null hypothesis is rejected
Delta	Operating Income	5.223E-10	10.86427695	2.4576E-09	71.6450	0.8760	Null hypothesis is rejected
	Capital Expenditures	-2.8224E-10	-1.6880935	0.00010864	.....	.....	Null hypothesis is rejected
Hawaiian	Operating Income	8.68E-09	5.682731373	7.5066E-05	16.6655	0.6762	Null hypothesis is rejected
	Capital Expenditures	-8.253E-09	-3.24882743	0.00634253	.....	.....	Null hypothesis is rejected
JetBlue	Operating Income	1.345E-09	23.03260531	1.0741E-13	265.6854	0.9671	Null hypothesis is rejected
	Capital Expenditures	-9.793E-10	-6.44601142	8.0813E-06	.....	.....	Null hypothesis is rejected
Southwest	Operating Income	1.4457E-09	8.729614928	6.9192E-08	44.8746	0.8144	Null hypothesis is rejected
	Capital Expenditures	-1.8514E-10	-4.01683801	0.00080892	.....	.....	Null hypothesis is rejected
Spirit	Operating Income	3.8388E-09	1.087367787	0.00031289	8.9638	0.6390	Null hypothesis is rejected
	Capital Expenditures	-1.7624E-08	-4.23148109	0.00388101	.....	.....	Null hypothesis is rejected
United	Operating Income	1.0084E-09	2.508951661	0.02189655	5.9064	0.3291	Null hypothesis is rejected
	Capital Expenditures	3.6906E-10	0.428786738	0.00067317	.....	.....	Null hypothesis is rejected

Note: Results of the regression model

V. RESULTS AND CONCLUSIONS

The first hypothesis was to determine if there was a statistically significant relationship between Supply Chain Flexibility and the SCF ratio. A multiple regression model in the form of an SCF Ratio was used to test the first hypothesis with the indicators in the regression model examined to disprove or prove the hypotheses. The results found the SCF Ratio as an indicator of supply chain flexibility in the airline – mainline passenger industry. After applying the SCF Ratio to test the hypothesis, the p -value was found to be less than 0.05 and that all results were statistically significant; thus, rejecting the first null hypothesis.

In the second hypothesis, the outliers were examined as to whether they could be identified in a statistically significant manner using the SCF ratios for the time periods 2000-2020. After analyzing the relevant indicators in the regression model, the model was found to show an association between SCF Ratios for the periods under study. After applying the SCF Ratio to test the hypothesis, the p -value was found to be less than 0.05 which indicates statistical significance; thus, rejecting the second null hypothesis.

4.1 Explanation of SCF Ratio Results

The model results indicate the SCF Ratio as an indicator of supply chain flexibility. The correlations between the SCF Ratio scores and supply chain flexibility identified in the model results connect to supply chain flexibility issues that are well-known and publicly documented. For instance, all companies suffered supply flexibility disruptions in 2020, likely a direct result of the COVID-19 pandemic. In addition, well-known economic disruptions like 9/11 and the 2008 Financial Crisis also had an impact on supply chain flexibility in most companies.

Looking at the SCF Ratios of each company, we also find interesting results. For instance, Southwest Airlines seems to have the most flexible supply chain only having one negative SCF score in the last 20 years [in 2020]. Southwest's supply chain appears to be flexible enough to withstand external economic trends, a notion aligned with recent independent assessments of Southwest's supply chain [52]. Resilient firms, such as Southwest, are less vulnerable to supply chain disruptions and then have more capability in absorbing the shocks and adversity resulting from such disruptions[53] as indicated with Southwest's supply chain flexibility ratio.

Allegiant, Hawaiian, JetBlue, and Spirit Airlines were also able to whether the downturn of the 2008 Financial Crisis [i.e. they were not yet public companies during the 9/11 attacks whilst Spirit incorporated in 2011] but they are newer companies and don't have the maturity in the industry as their competitors. Additionally, being new companies those airlines were likely in a newer stage in the organizational life cycle which allowed more flexibility and adaptability contributing to the supply chain flexibility ratio indicating resilience. Such firms that are in an earlier organizational life cycle tend to have growth, innovation, and flexibility [54]; whereas, the more mature firms are linked to decreasing flexibility and increased rigidity through strategic rigidities, bureaucracy, and often have difficulty in overcoming barriers to change and adaptation [55]. This aligns with the findings of the supply chain flexibility ratios indicating more flexibility in the newer aviation firms and decreased supply chain flexibility in the more mature firms of Delta, United, and American. According to Böhme(2009), newer companies tend to be more flexible because they have not yet reached the maturity in supply chain relationships that older companies experience, this may have been the catalyst to these companies withstanding the 2008 disruption. If true, this highlights the impact of COVID-19 on industry supply chains since the downturn was across the board.

4.2 Implications of SCF Results on Organizational Resiliency in the Airline – Mainline Passenger Industry

In comparing the Airline – Mainline Passenger Industry average SCF Ratio, the overall supply chain flexibility is down from 2019 into 2020 from 0.969 to -3.974 as presented in Table 3. This average decline in supply chain flexibility is a result supply chain inefficiencies across all observed companies. Concerning the COVID-19 pandemic, the results indicate all of the aviation firms studied had a reduction in supply chain flexibility during 2020 with the biggest one-year differences being Alaska, American, Delta, and Hawaiian Airlines. These figures suggest these companies may need to assess the flexibility of their current supply chains. Given the association between flexibility and supply resilience, the companies with the lowest SCF Ratio scores may need to adjust their strategies to improve organizational resilience.

The SCF Ratio results also reveal downturns in the score for the years 2001 through 2004, and 2008. These reductions in scores correlate with the 9/11 attacks and the 2008 Financial Crisis, both of which had an impact on the Airline – Mainline Passenger industry. The dramatic change in SCF Ratio scores from these three time periods affirms the current literature that the Airline – Mainline Passenger industry is highly volatile and susceptible to national economic trends.

4.3 Implications for Organizational Resilience

The above-mentioned results indicate levels of resilience of commercial airlines as a component of the levels of supply chain flexibility. This brings to question the strategies for organizations and specifically aviation firms to mitigate the effect of disruptive events on the airlines and their associated supply chains. Disruptions, specifically the external events noted in this study, should be viewed through the resilience lens as an opportunity to develop various organizational strategies for increasing resilience for the aviation firms and associated supply chains to then withstand risk associated with disruptive events. The strategies for this revolve around increasing flexibility, creating redundancy, and improving the agility of supply chains [15].

The analysis of SCF of the U.S.-based commercial airlines demonstrated the effect of disruptive events (i.e. 9/11 terrorist attacks, the Great Recession, and COVID-19). The analysis also shows how such disruptive events cannot be controlled by the firms; however, indicates the need for the firms to increase resilience by making the firms and supply chains able to withstand the risk associated with the impact of the disruption. The flexible capability indicates the ability to respond to uncertainties from disruptions [56].

The findings concerning the organizational life cycle and the newer aviation firms having greater supply chain flexibility imply the need for firms to be cognizant of the rigidities in the structures and strategies of the firm based on the organizational life cycle stage. Understanding that flexibility and adaptability are key to organizational resilience [15] implies that more mature firms should scan organizational structures and systems for rigidities that may inhibit supply chain flexibility and thus limit organizational resilience.

Southwest Airlines having a high supply chain flexibility also presents implications around human capital management strategies and organizational culture concerning building supply chain flexibility and organizational resilience. Southwest Airlines is often noted as a highly resilient company as it has been in existence for many years and has weathered many disruptions and crises whilst surviving and thriving during and after those disruptions [45]. High morale within the human capital and the organizational culture increases the likelihood and speed of an organization overcoming a crisis [45]. Human capital management strategies focused on individual capabilities and resilience can be aggregated to an organizational level which in turn then influences the organization's resilience development [57]. Southwest Airlines' organizational culture is described as encouraging employees to cooperate, focus on taking care of the customers, and have fun [58]. The results of this study showing the supply chain flexibility of Southwest Airlines indicates a correlation between the organizational culture and human capital focus at Southwest Airlines as a lever for organizational resilience. This particular finding warrants further research on the role of human capital management strategies concerning supply chain flexibility and organizational resilience.

Expanding the scope of knowledge on organizational resilience and the need for more empirical evidence on evaluating supply chains specifically during disruptive events [13], the findings of this study explore the relationship between resilience and key performance indicators such as supply chain flexibility. Monitoring non-financial KPIs helps managers and organizations generate resilience [59]. The results of this study can help managers to monitor supply chain flexibility indicators as a way of identifying early signs of risk and to take actions to mitigate operational impacts from a disruption.

VI. Conclusion

In conclusion, the correlations between the SCF Ratio scores and supply chain flexibility may provide empirical evidence of the supply chain deficiencies and potential effects on the airlines' organizational resilience. correlations were found between SCF Ratio scores and supply chain flexibility. The findings may provide empirical proof of supply chain impacts and deficiencies experienced by the airlines studied. The results may also provide insight into the degree of each company's organizational resilience and reveal the need for improvement in supply chain resilience. The supply chain rigidity can be traced and correlated to both Airline – Mainline Passenger industry concerning airline operations and publicly available financial results. In addition, the application of the SCF Ratio provides proof of supply chain flexibilities and possible organizational resilience. This study's results indicated that during the first year of the COVID-19 pandemic, all companies suffered supply chain flexibility difficulties but some more seriously than others. These differences in supply chain flexibility and possible resilience have an impact on corporate revenues.

The research of resilience of aviation firms and the supply chain should continue to develop the general definitions and measures of resilience to the aviation context. In addition to the airlines, studies should continue using supply chain flexibility as an evaluation of resilience for the networks associated with aviation. As previously noted, the literature suggests more research in supply chain performance and the impact on firm financials is needed. This study answers this call for further research as it is an initial attempt to investigate the impact of supply chain flexibility on firm performance within the Airline – Mainline Passenger industry. The foundational motivation of this study was to investigate the impact of COVID-19 on supply chain and firm finances. Additional research is needed to continue the investigation of the COVID-19 pandemic's influence on

supply chains within other industries and sectors. In addition, exploration of the measurement of SCOR metrics to other aspects of the supply chain is an important research gap.

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