Master’s degree thesis

LOG953 Logistics

Operational and financial factors for reducing price exposure of Northern European airlines to fluctuations in the fuel market

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Preface

First of all, this work would not have been possible without the sensitive guidance, advice and support of a supervisor. Dr. ing. Svein Bråthen – Professor in Transport Economics at Molde University College – made a huge contribution to the formulation and clarification of the objectives of the work, the definition of the structure, adjustments and additional theoretical support.

I thank the entire team and the leader of the Molde University College Library – Mr. Timo Brøyn, for their assistance and comprehensive support in providing access to various sources of information and databases.

I also want to thank my family, who supported me morally during difficult times, even though we are separated by long distances. I thank my student friends Mikhail and Denis for their moral and theoretical support, long study nights and shared meals.

Summary

The work is aimed at studying financial and operational hedging methods in companies in the North European region. 4 companies - Ryanair, Norwegian, Easyjet and SAS, were taken as a case. The observation period ranged from 20 to 17 years quarterly. Thanks to the first regression model, the coefficients of vulnerability of companies to jumps in the fuel market were calculated. The second regression model allowed us to determine the impact of operational and financial actions of companies on their fuel vulnerability.

In contrast to other works, calculations have shown that the unification of fleets has a positive effect only when carried out by the factor of families. The hypothesis about the different effects of hedging for low-cost carriers and for value-carriers has been confirmed. The hypothesis about the significant influence of the strategy of unification of the fleet of propulsion systems by the factor of models and families is confirmed. The importance of the average length of routes as an operational method of hedging is determined. An attempt was made to account for changes in the trade-weighted index of national currencies when calculating the financial stability of companies.

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Contents

1.0 Introduction

1.1 Background of the thesis

The aviation business has always been an extremely complex and sensitive sector – capable of being stimulated or excited by external agents – in financial, legislative (environmental and technical standards), political and other aspects of global activities that have a serious impact on the industry. In the current millennium, aviation has undergone many changes caused by such shock events as the terrorist attacks of 09.11, price fluctuations for fuel (oil crises), changes in the policy of CO_2 emissions, etc. Along with global changes, companies are introducing new methods of managing their assets and reducing risk dependence – unification of technical solutions, more fuel-efficient aircraft, tankering, etc.

The most recent crisis – COVID19 pandemic – hit the European transport (aviation including) sector in the spring of 2020, stopping almost all flights between the countries. As can be seen from the graph in Figure 1, in some months the decline reached 89% (compared to the same month of 2019).

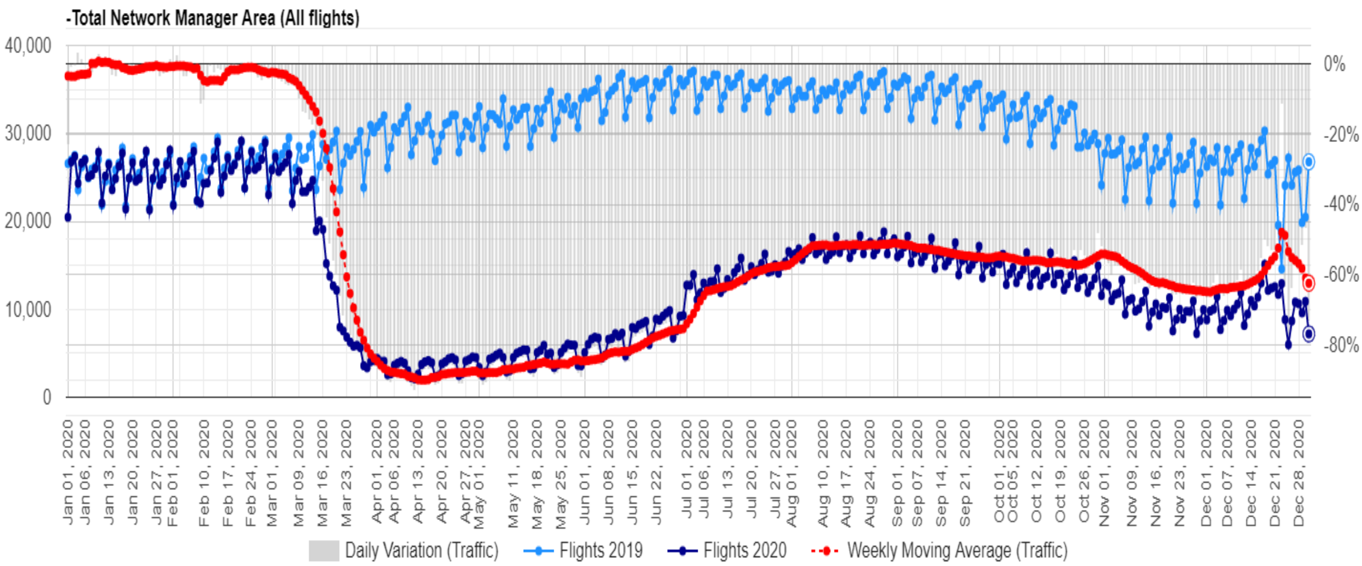

Figure 1. Daily EU aviation traffic in 2020. Source: (EUROCONTROL)

Not only the European, but global transport market (including aviation) is interdependent with the oil market and petroleum products. Changes in one certainly affect the other. Many scientific papers confirm the dependence of oil products on the quotations of oil itself, although changes in the price of processed products do not always directly react to supply shocks of the oil market, remaining more dependent on shocks in the commodity market, but react to demand shocks of the oil market (Ederington 2021). In total, airline stock prices also depend on oil prices (Dar 2022). Investor sentiment plays an important role here. Stakeholders, observing an increase in oil prices (demand shock), expect an increase in prices for kerosene (as a product of oil refining), an increase in airline costs, and, accordingly, a decrease in net revenue of enterprises, accompanied by the closure of non-profitable routes, a reduction in the frequency of flights, etc.

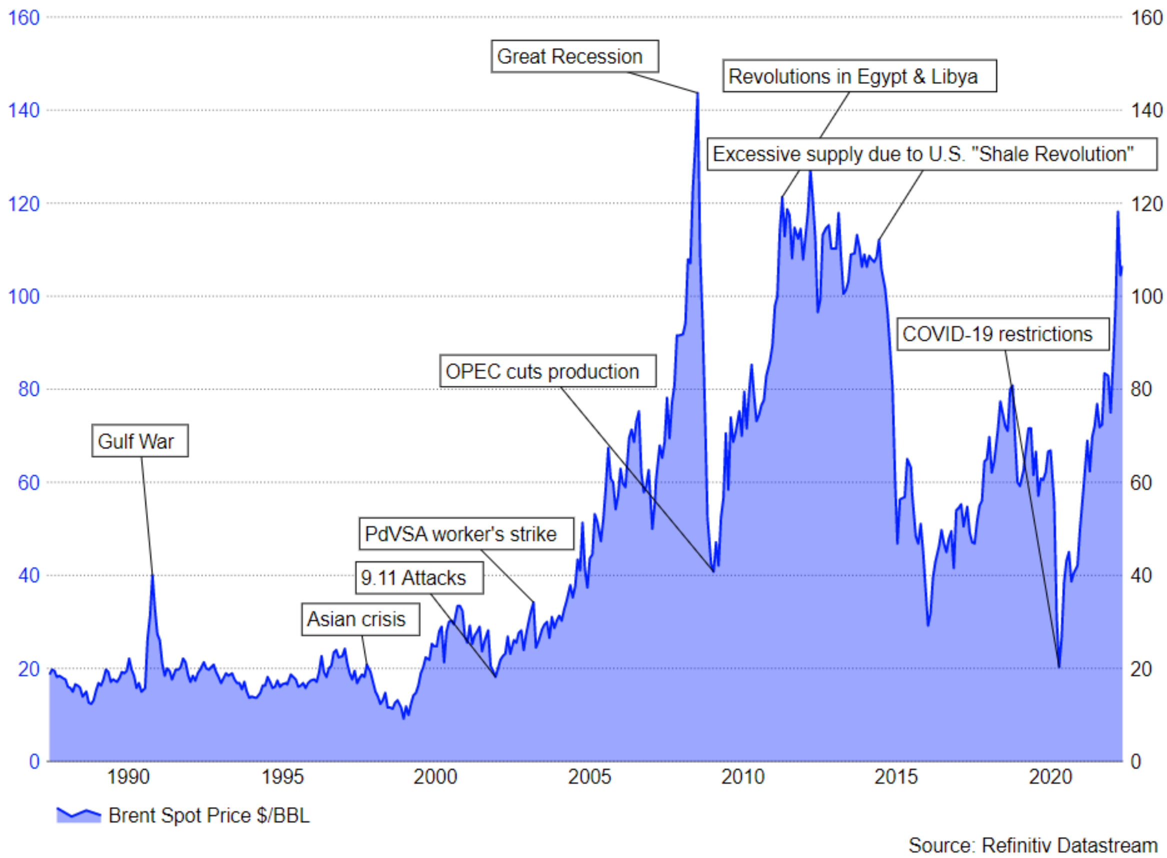

Figure 2. Historical oil-price shocks.

The oil market has always been as sensitive to global events, for many years showing a strong degree of volatility (Figure 2). Despite the restrictions imposed, cargo transportation did not experience the same dramatic shocks as it was observed in passenger transportation. As can be seen from the Figure 3 below, short (within a city or another locality) and long (intercountry) routes suffered only slightly. The rest experienced only a 1-2% decrease. In the field of air transportation, it is important to separate cargo and passenger transportation. As can be seen from Figure 4, the movement of cargo has practically not changed, in contrast to a significant drawdown in the number of passenger flights.

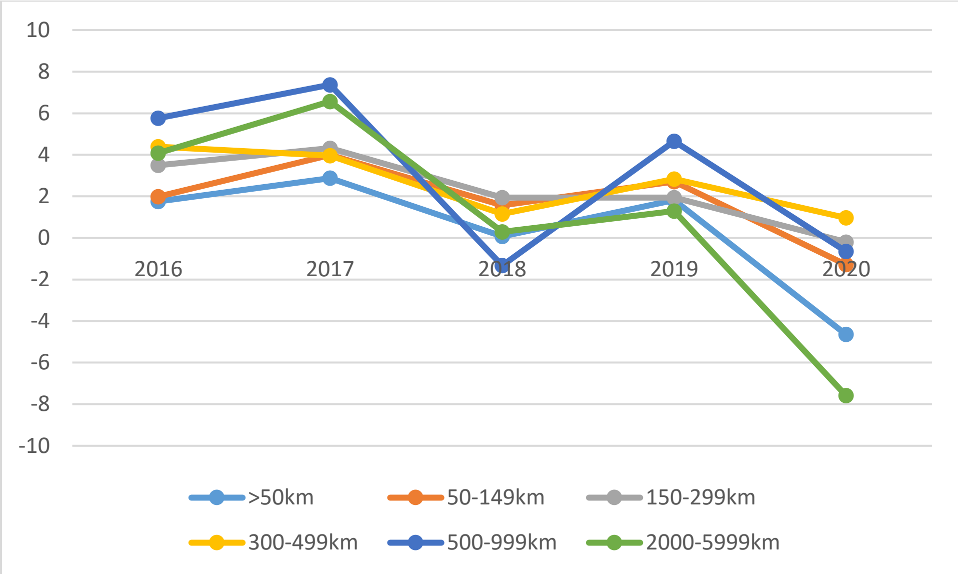

Figure 3. Percentage changes in cargo transportation (by route-length) across the EU. Source: (eurostat)

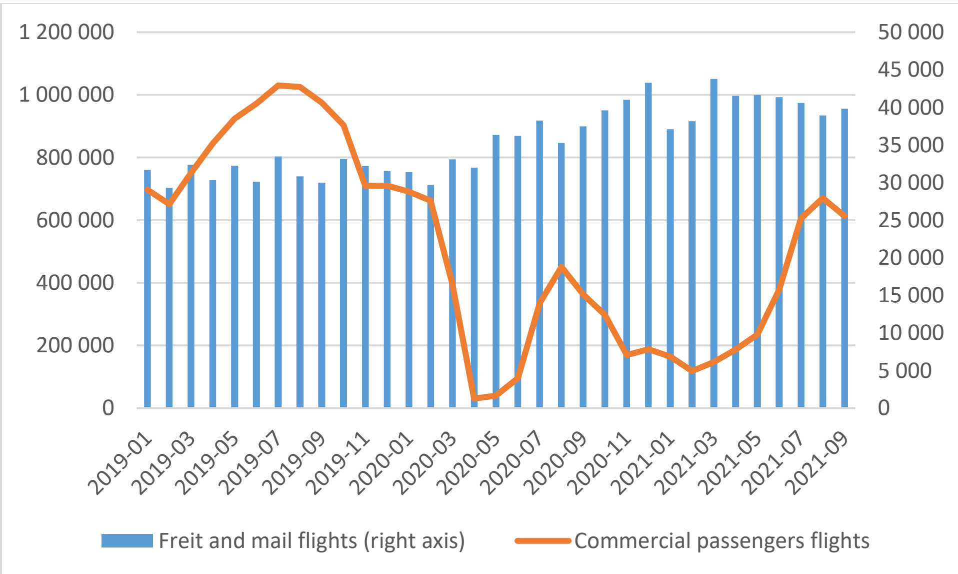

Figure 4. EU flight numbers statistic. Source: (eurostat)

Nevertheless, the general economic slowdown and the weakening of the work of transport has led to a significant decrease in the consumption of energy by mankind as such, of course, affected the demand for energy resources.

The nature of the oil production process does not allow to instantly shut down the well, or instantly reactivate it. In the sequel, inventory management is a key issue in the subsequent supply chain, especially given the fragmented nature of operations (Venkat 2020). Refineries are complex, resource-intensive enterprises, operating with maximum efficiency to reduce unit cost and downtime costs. As a result of the nature of this production model, products are produced continuously and must be periodically removed from the refinery to avoid tank overflow situations. Therefore, the entire supply chain for them differs from the inventory management of storage facilities and reacts to changes in the trade balance of crude oil and its products with some delay. So that been said, the physical oil market, unlike the financial one, reacts with a lag, which at the beginning of the pandemic resulted in oversupply and overcrowding of storage facilities for both oil and its products. There were even strange situations when the prices for some types of contracts of the American WTI (West Texas Intermediate) blende became negative – the owners wanted to get rid of the paper before the maturity date expired, since in this case they would have to accept a physical batch of oil, and all the storages were already filled (Kearney 2020) (Ma 2022).

Be that as it may, at the beginning of this year, the air transportation industry is desperately trying to recover, companies are trying to stay afloat, competing for each passenger. Many companies collapsed – among them Italian Ernest Airlines 5 April 2020, Trans States Airlines, Turkish AtlasGlobal on 12 February 2020, Miami Air International, United States regional carrier Compass Airlines and many others). Many companies have received serious assistance from government agencies, some have gone through the restructuring process (Norwegian Air Shuttle). The crisis of the industry did not prevent some new players from entering the market. Many sub-brands have been launched (with the financial support of parent companies, this seems quite possible), for example in China and Canada, and a new carrier (Flyr) has entered the market in Norway.

Nevertheless, the recovery in demand is outpacing the growth rate of oil production (Figure 5), which, apparently, is hindered by the restrictions on production (Reuters 2020) adopted during the pandemic. This is evidenced by the words of the US President Joe Biden, who stated that "the production cuts made during the pandemic should be reversed" (Hunnicutt 2021).

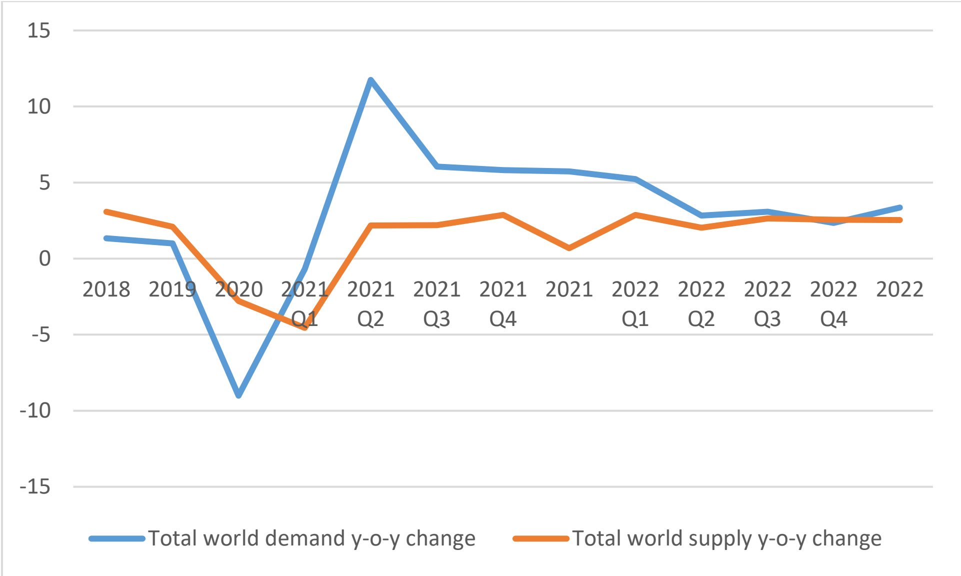

Figure 5. Oil Demand / Supply year-over-year change in percent. Source: (OPEC 2022)

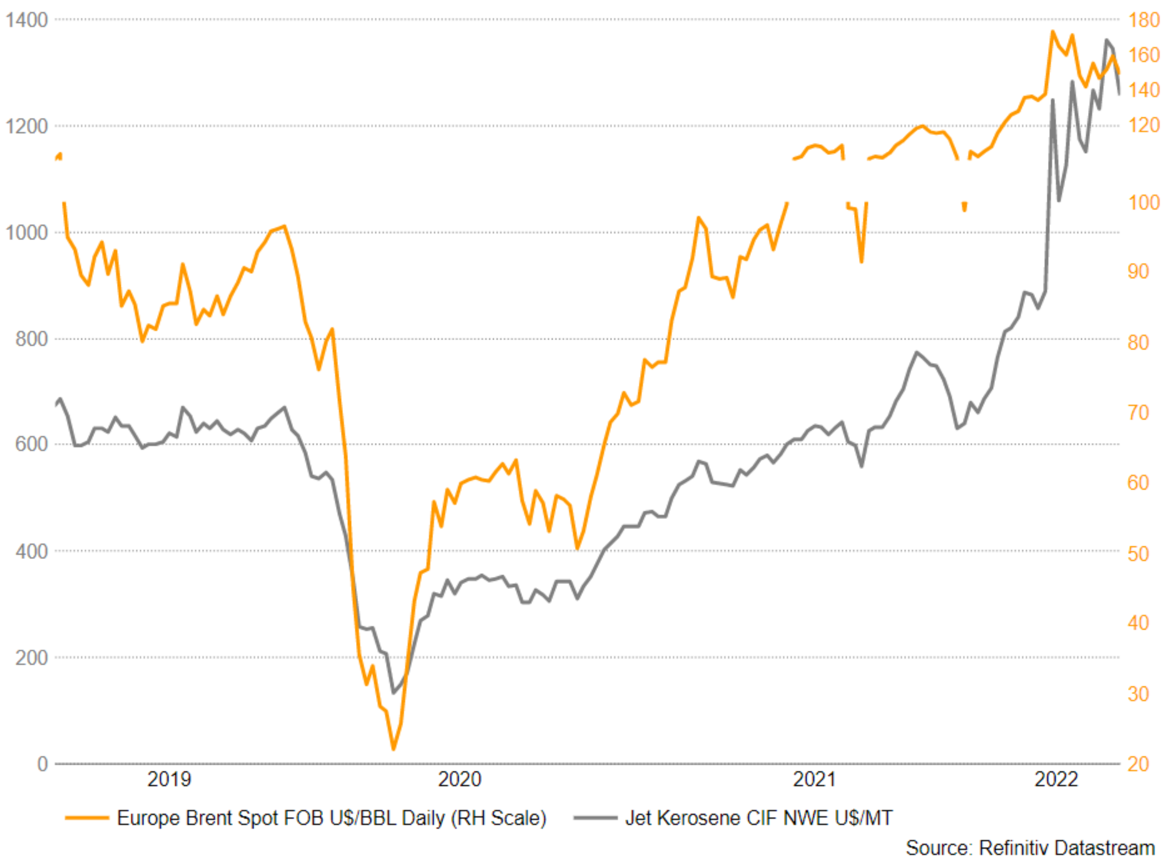

Figure 6. Historical statistics of prices for Brent crude oil and aviation kerosene, considering cost, insurance, and freight (CIF) in Northwest Europe (NWE).

At the beginning of 2022, oil prices continued to grow steadily, and military actions in Eastern Europe only added to uncertainty. As a result, aviation fuel prices show a significant increase, approaching the indicators of the so-called Great Recession of 2008 (then the price was $1884 per ton, taking into account inflation calculated by the Consumer price index), which will allow us to declare almost the highest price levels in the 21st century. In April, according to (IATA) the price per ton of kerosene has reached $1152, which puts unprecedented financial pressure on airlines, whose unit fuel costs can range from 30 to 40% (Swidan & Merkert 2019).

Any large business requires predictability of financial results, allowing it to plan a budget for future periods, make adjustments and invest in innovative solutions. In order to increase predictability and reduce the risk burden due to price fluctuations of a key item of operating costs, airlines have been operating since about the 1980s (Berghöfer & Lucey 2014) began to use the technique of hedging future supplies. Classical supply hedging theories postulate that during periods of price fluctuations, such strategies can give a company a significant advantage by fixing current prices for future supplies, which will lead to more favorable price conditions compared to competitors operating in the spot market (more details about this at the beginning of the Literature Review section). Nevertheless, if the spot prices fall below the contract prices, the company will begin to incur losses and lose any competitive advantage, because in this case competitors will pay less. There are many examples in history (Cathay Pacific lost HK$ 6.45 billion on fuel hedging in 2017 (Park & Whitley 2018)), proving the ambiguity of the seemingly simple at first glance hedging process. To effectively use hedging instruments, company managers need to assess future fuel consumption with a certain degree of confidence, whereas the price situation on the oil market can be predicted with a much lower chance of success.

In normal periods, companies have a certain strategy that determines the volume and maturity of hedging. The company's policy may allow managers to hedge from 0 to 100% for a period sometimes reaching 36 months, but this is quite rare. According to (IATA 2018), European carriers on average hedged about half of their fuel needs.

The current conditions of the global conjuncture create a double-edged situation for carriers. On the one hand, we are seeing a steady increase in fuel prices, which creates a favorable ground for obtaining a competitive advantage by hedging, and on the other hand industry experts note that the pace and prospects of growth in demand for transportation remain extremely uncertain. (Williams 2022), ACC Aviation's leasing director, reports that – "...nothing is certain for 2022". This uncertainty does not allow companies to soberly assess the future consumption of kerosene.

Experts point to the fact that companies with fuel volumes already fixed in the price plan will have a serious advantage against the background of rising prices (Ekeseth

& Fredrick 2021). So Ryanair reports covering 60% of its fuel needs in 2022 at a price of approximately $545 per ton (Ryanair 2021), EasyJet has contracts covering 55% of the needs for the fiscal year 2022 at a price of $498 per ton (easyJet plc 2021) while neither SAS nor Norwegian in their documents report on any tools used to fix the price of fuel supplies, which can cause serious damage to the possibilities of price maneuvering and competition of these companies. All four of them somehow work on the same routes of Scandinavia and the countries of Northern Europe.

1.2 Research objectives

The purpose of this work is a selective assessment of the financial and operational activities affecting fuel efficiency of the listed airlines (Norwegian, Ryanair, EasyJet and SAS) in the current century. This case is an excellent example for identifying differences in hedging strategies for low-cost carriers and value-oriented airlines, since both business models operating with different fleets are represented among the companies. Norwegian has also gone through the process of restructuring and bankruptcy protection, which also brings diversity to the sample in the field of various financial stability of companies. Hedging is certainly a key tool for reducing the exposure of airlines to price shocks, however, other changes in operating activities increase financial stability. Testing hypotheses about the impact of non–obvious factors on jet-fuel price exposure – unification of the airline's fleet, average route length, unification of the engine range – is an important part of the study. The assessment of the interaction between these indicators and the general price exposure of the airline in the regression model is designed to shed light on the differences in the concept of airline business models, to show their current fuel exposure, and to determine the impact of hedging on the financial and fuel consumption aspects of the business. In addition, companies naturally operating in the environment of their national currencies can receive both problems and advantages associated with the strengthening or weakening of exchange rates, so this factor has also been taken into account and verified in the above case.

Based on the attention towards financial hedging, we will assess the following four research questions (RQs):

RQ1: What impact does financial hedging have on selected companies using different business models?

RQ2: What impact do operational hedging methods have on selected airlines?

RQ3: What is the difference in the magnitude of the impact of financial and operational methods of fuel hedging on companies using different business models?

RQ4: What is the impact of changes in the exchange rates of national currencies on the vulnerability of the company to fuel prices?

1.3 Structure of the thesis

This work is structured as follows: Section 2 describes the case chosen for the study, characteristics and historical background of the companies selected for the study, and also puts hypotheses that form the further skeleton of the work and methods of study. The verification of these hypotheses is an important part of the final contribution to the scientific literature. Section 3 is an overview of the theoretical basis that underlies this study, justifying the use of the methods chosen for the study, methods of data collection, processing and interpretation. Section 4 details the types of data, methods of their collection and processing. Data sources, financial models and their variables are described. Section number 5 provides the results of intermediate and final results of calculations, which are then used for discussion in Section 6. The conclusions of the work, limitations, suggestions for future research and contributions to the scientific literature are discussed in the final Section number 7.

2.0 Case description

As a case study, this paper considers 4 companies in different financial positions using different financial models and hedging strategies. Based on the data from the financial reports of the companies, all the players are under serious pressure, but they have received different financial results. Table 1 at the bottom presents information on key performance indicators of airlines. The number of passengers transported is represented in millions. The colors indicate how the indicator has changed to the previous period (improved – green, worsened – red). RASK – Total traffic revenue divided by Total ASK (scheduled + charter). CASK – Total payroll expenses, other operating expenses, leasing costs for aircraft and depreciation adjusted for currency and items affecting comparability, less other operating revenue per ASK (scheduled and charter). ASK – The total number of seats available for passengers multiplied by the number of kilometers which they are flown.

Table 1. Key performance indicators of airlines. Source: Annual financial reports.

	SAS		
	2019	2020	2021
Traffic	28,45	12,31	7,38
CASK (SEK)	0,6	0,85	0,86
RASK (SEK)	0,73	0,62	0,51
Revenue (MSEK)	46112	20513	13958
Profit /Loss (MSEK)	621	-9275	-6523

	Easyjet		
	2019	2020	2021
Traffic	96,1	55,1	28,2
CASK (£)	5,13	6,86	7,34
RASK (£)	5,5	4,82	4,37
Revenue (M£)	6385	3009	1458
Profit /Loss (M£)	427	-1273	-1036

	Norwegian		
	2019	2020	2021
Traffic	36,2	6,87	6,2
CASK (NOK)	0,44	0,94	0,91
RASK (NOK)	0,35	0,36	0,41
Revenue (MNOK)	43522	9096	5068
Profit /Loss (MNOK)	-1609	-2304	1871

	Ryanair		
	2019	2020	2021
Traffic	142	149	28
CASK (€)	3,62	3,83	5,02
RASK (€)	4,17	4,42	3,31
Revenue (M€)	7697	8494	1635
Profit /Loss (M€)	1016	1127	-839

Ryanair reported losses of 839 million euros received by the end of 2021. EasyJet lost 1.036 million pounds. SAS lost 6.523 million Swedish kronor. Norwegian, on the contrary, after the restructuring showed a profit of 1.871 million Norwegian kroner. Also, at the beginning of 2022, companies found themselves in various competitive positions in terms of input prices. Companies that have not taken care of their fuel needs in advance will experience a serious price burden compared to their competitors, as the price situation in the aviation fuel market remains difficult.

Ryanair is one of the price leaders in the European region and can be considered a pioneer in the field of low-cost transportation in Europe, presenting the strategy of a pure low-cost carrier, which is similar to the ultra low-cost (ULCC) model in the U.S. (Bachwich & Wittman 2017). The company conducts an aggressive pricing policy, seeking to reduce the unit cost of one seat by all classical methods – the configuration of high-capacity salons, the minimum allowable cabin crew, only paid on-board services, and so on. Over the history of observations, the company operated a truly unified fleet until 2018, after which, in addition to the impressive 400+ Boeing-737-800 boards, 29 new Airbus A-320-200 were added. The company has bases in many cities, but it is worth noting the company's recent expansion into the Scandinavian market, which occurred in October 2021, when the Irish low-cost carrier opened a base in Stockholm and replenished its portfolio of routes with 21 new destinations, entering into a clear competition with the locals of Scandinavia – SAS. Detailed maps with airline routes are in the Appendix (Figures 10-13).

The company usually hedges 88% (mean) percent of its consumption with forward contracts for up to 24 months (average 15.8). For fiscal year 2022, the company provided 60% of the estimated consumption at a price of 545 USD/ton and about 35% in 2023 at a price of about 600 USD/ton.

Despite this and the difficult situation in the industry, the giant has a serious margin of safety, as evidenced by the BBB credit ratings from S&P and Fitch with neutral forecasts for future periods. The company's shares are traded on the Ireland Stock Market with the ticker RYA.I in euros. The ticker of the exchange is .ISEQ.

SAS or Scandinavian Airlines System is a classic example of legacy carrier and operates a hub-and-spoke route system (108 destinations). The company is based in Scandinavia, having its main bases at the airports of Copenhagen, Stockholm and Oslo (in descending order of size). As noted in the work (Graham & Vowles 2006), the company responds to threats from the growing market of low-cost carriers, and applies the CWC-strategy "carrier-within-carrier", which allows full-service carriers to pursue a strategy of price leadership and focus on certain market niches, operating their own low-budget and regional carriers as part of the group (Widerøe, Blue1). The group also includes the SAS Cargo division, which provides cargo transportation services "to" and "from" Scandinavia, and the SAS Ground Handling division provides ground services for receiving aircraft at the main home airports.

It is also worth noting own sub-company, providing aircraft and engine maintenance services – SAS Maintenance Production, operating in Scandinavia, which seems logical when taking into account the diversity of the company's fleet, which at the end of the fiscal year 2021 amounted to 107 Boeing and Airbus aircraft manufacturers, and numbering 5 different models. The relative uniformity of the fleet was achieved through "wet" leasing (the company leases regional Bombardier CRJ-900 and ATR 72-600 from (CityJet and Xfly), which implies financial responsibility for the technical support of the aircraft by the lessor, so we exclude the aircraft leased in this way from the analysis. Based on the previous data on engines stated in the annual reports, by the end of 2021 the company is working with 5 types of propulsion systems.

According to Standard & Poor's, the Group's corporate credit rating is set as CCC with negative development. The company's shares are traded on the Stockholm Stock

Exchange with the ticker SAS ST in Swedish krona. The ticker of the exchange 's market index is .OMXS30.

In times of instability, the company's management adopted a number of amendments and exceptions to the hedging rules. Previously, the company's policy was to hedge 40-80% of kerosene needs for a period of 12 months. In the last reporting and current years, management is allowed to hedge from 0 to 80%. Thus, the report for fiscal year 2021 indicates that the company has no financial instruments in its portfolio to hedge fuel needs for 2022. The work has been monitoring the company's historical data since 2000. The average hedging percentage for these years was 46% with an average duration of 10.7 months. Traditional hedging instruments for the company were swaps and options.

EasyJet is the second largest player in the European low–cost market, though it also adopts some features of ultra-low-cost carriers (Bachwich & Wittman 2017). During the pandemic, the company reported losses for the first time in its 25-year history. Like their competitors Ryanair, the company operates a large number of bases (28) throughout Europe. Currently, the airline's fleet consists of an impressive 310 aircrafts, including 4 models from the same manufacturer – Airbus. In fiscal year 2021, the net loss was 858 million pounds. The S&P Global rating set the credit rating as BBB and changed the outlook from "negative" to "stable", which also indicates both the trend of recovery of the industry and the safety margin of the company itself. The company's shares are traded on the London Stock Exchange in British pounds with the ticker EZJ.L. The shares are included in the FTSE100 index (Financial Times Stock Exchange 100 Index). Index ticker is .FTSE.

When reporting hedging, the company uses the term "derivatives" without specifying the underlying instruments, but it is more likely that jet fuel forward swaps and jet fuel options are used. During the observation period, the company on average hedged 71% of its fuel needs, with an average period of 17 months. In the latter report (easyJet plc 2021), the company reports hedging 55% of fuel needs until September 30, 2022 with a price of 498 USD/Ton.

Norwegian Air Shuttle ASA is the second largest airline in Scandinavia and positions itself as a low-cost carrier. It is comparable in size and rivalry with Wizz Air. During its history, the company has moved from a fleet of obsolete Fokkers F50s to modern Boeing-737 / 737- MAX and 787. At the end of 2021, due to financial difficulties, the group sold part of its assets (mainly new aircraft). The fleet consisted of 51 units. The aircraft are based in Bergen, Oslo and Stavanger.

Since the beginning of the pandemic, the company has experienced serious difficulties and risks of bankruptcy, as the period of launching new business lines coincided with the COVID crisis. The company has restructured and used state bankruptcy protection mechanisms, however, in a recent April report (Norwegian Air Shuttle 2022) the company announces the restoration of business, replenishment of the fleet to 80 liners for the summer period. However, the company's credit rating is at CCC (low) level. The shares are traded on the Oslo Stock Exchange in Norwegian kroner with the ticker NAS.OL. The ticker of the exchange index is .OBX.

During the observation period, the company hedged an average of 19% of fuel requirements for up to 18 months (4 months on average). For the period of 2022, the company has not announced any volumes of hedged fuel, which is confirmed by sources in the Danish business newspaper (Eisenberg 2021).

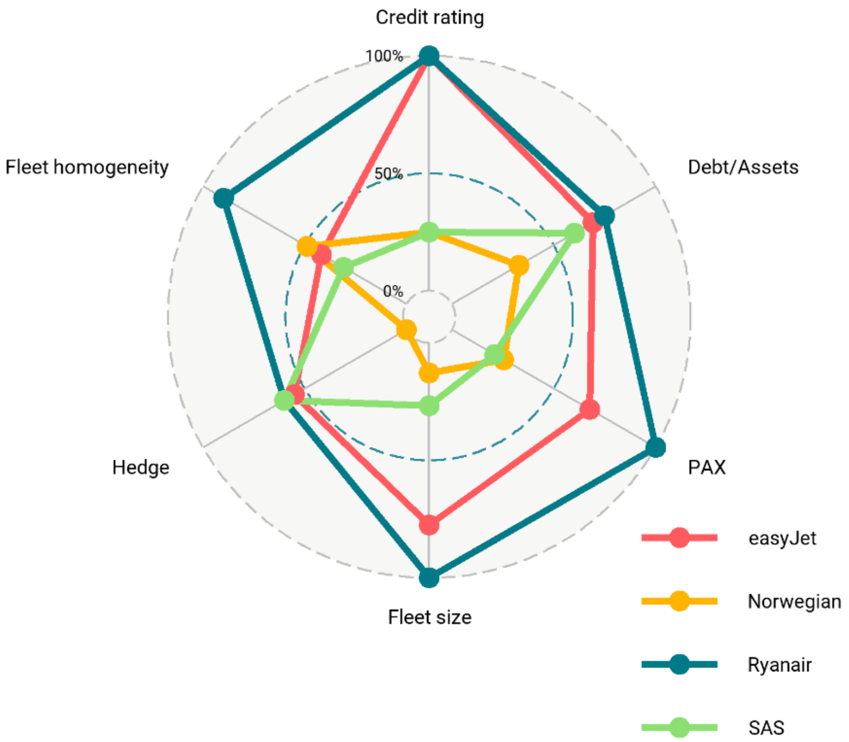

Figure7. Companies’ profiles for the end of 2020 fiscal year. Own figure.

Figure 7 above reflects the results of the companies' pre-covid activities. The best indicators among the participants were taken for 100%. As can be observed, Norwegian is going through a difficult situation – the debt-to-assets ratio is below 50%. Positions on hedged volumes of fuel before the pandemic for companies were about the same, except, again, Norwegian.

3.0 Literature review

3.1 Financial hedging

One of the methods of reducing dependence on price changes is the financial hedging of aviation kerosene directly, or the use of related financial instruments. The work of (Cobbs & Wolf 2004) gives a detailed view of the hedging strategies and financial instruments used by airlines. Modern airline risk managers tend to use over-the-counter instruments that provide greater variability and flexibility in hedging. The use of various instruments in different market scenarios increases financial stability and can protect the company from both increases and decreases in fuel prices, and in some cases can provide additional income.

To begin with, it should be clarified that the oil industry follows certain cycles described by (Rapier 2015):

- At the bottom of the cycle, oil prices are minimal, which stimulates demand. Low investment in the industry is also affected;
- Demand is growing faster than supply due to the lag, which we already discussed at the beginning of this work. Prices goes up. Investments in production do not increase it instantly;
- With the increase in oil prices, mining companies are beginning to make a profit, which they invest in increasing their capacity, accelerating the supply more;
- Supply exceeds demand, prices are falling, companies are canning wells, laying off employees, production is falling. Return to Stage 1.

For example, at the moment of reaching the price bottom (Stage 1), when it is considered that further price reduction is already unlikely, it is reasonable to use fixed income swaps that allow companies to fix the current low price. A swap is an agreement under which one party exchanges its floating financial obligations (often a spot, index or market price) for fuel for a fixed fuel price for a certain period (periods) of time (Mercatus Energy Advisors 2012).

During the period of average and stable prices, collars can fix a certain price range, protecting against a strong jump. An option allows the owner of a financial instrument the right, BUT not the obligation, to buy or sell (call / put option) a certain quantity of a certain commodity (fuel, or its financial equivalent) on or before a certain date or time period.

At times of high and volatile prices, caps both provide protection against further spikes and allow to benefit from lower prices.

In addition, the author points out the non-obvious advantage of hedging in the face of rising fuel prices. During periods of increased financial burden, as has already been pointed out by many authors companies cannot constantly shift the rising costs onto the shoulders of passengers (Zea 2002). This can also be confirmed because existing competition on intra-European routes, and the increasing competition on routes within the Scandinavian countries, suggests that the transfer of costs to the price is a problem for weak airlines. Competition promotes the transfer of costs to the price of goods only with a change in input costs common to the entire industry (Kate & Niels 2005). In our case, when some companies will receive their fuel at a reduced (hedged) price over the next year, the overall increase in prices in the industry will not affect all players at once, which will not allow the rest to significantly increase the price of tickets.

This situation pushes weak companies to bankruptcy, forcing them to sell their assets at reduced prices to avoid this fate. More stable companies (with hedged fuel volumes) have more free assets, allowing them to use this situation for growth and strengthening by investing in new aircraft or other assets.

Companies are not inclined to hedge 100% of their fuel needs, as due to accounting rules, frequent errors in forecasting their own consumption can lead to penalties with subsequent refusal to execute financial hedging mechanisms (Cobbs & Wolf 2004). Thus, companies declaring one hundred percent hedging either have very complex and accurate internal forecasting mechanisms or operate with indicators for the sake of good-looking statements for their stakeholders.

Based on a worldwide sample of company data, the authors of the paper (Berghöfer & Lucey 2014) pointed that the shared part of fuel costs in the total costs for low-cost carriers are higher than for value carrier. Based on various scientific papers (Boyle 2022), reports from companies and consulting agencies, it becomes clear that for low-cost airlines, fuel costs have always occupied a larger share of operating costs than for value-carriers. The share of kerosene costs from the total operating expenses of low-cost airlines is in the range of 30-35%, whereas for legacy airlines it is in the range of 20 to 25 percent. The degree of influence of hedging (or non-hedging) on two business models can be assessed by the example of selected companies.

3.2 Operational hedging

The authors of scientific papers talk about the fleet as a kind of operational hedging method. Multiple scientists (Treanor 2012) (Naumann et al. 2012) pointed out in their works the importance of the characteristics of the airline's fleet, since it is directly related to the critical large items as operating (fuel, operational) and capital (the planes themselves are extremely expensive property) costs. While the importance of fleet size is a relatively understandable indicator that directly correlates with the occupied market share (the number of routes served) and the projected volumes of passenger traffic, the composition and model range of the fleet remains an unobvious variable that manifests itself differently in different situations. Large aircraft are designed to operate on busy and/or long routes, while achieving the best indicators of specific kerosene combustion per passenger seat, and regional jets operate on short routes (Figure 8).

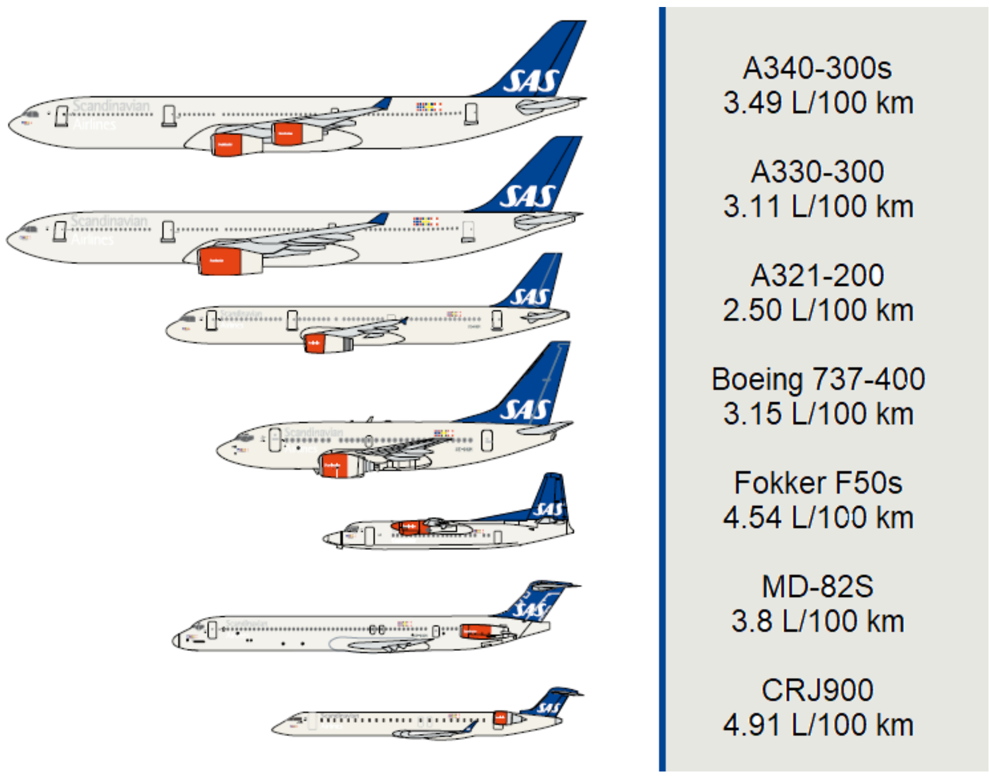

Figure 8. Differences in fuel efficiency per passenger seat per 100 kilometers. Source: SAS 2009.

And this is logically justified by the different demand on different routes – half-empty liners (waste of kerosene for transporting empty seats) just as bad as the regionals filled to capacity (demand not fully satisfied). On the one hand, in their business models, low-cost carriers (LCCs) constantly emphasize the importance of uniformity of their fleet as a key cost reduction mechanism (Mason & Morrison 2008). A fleet consisting of a single aircraft model greatly simplifies technical supervision, maintenance and repair (Merkert 2022). Availability of qualified technicians and spare parts at all bases of the company, unification of documents are indisputable advantages. The unification of pilot teams is also an important advantage of this approach (Berghöfer & Lucey 2014), as it allows to flexibly redistribute human resources in case of any emergency situations (illness of the pilot, delay in the journey of the initially assigned team). To counteract delays in such cases, companies always have "waiting" teams at the airport ready to immediately replace colleagues who have left for various reasons. In this case, there is no need to keep pilots of various specializations ready (for different types of aircraft), which reduces personnel costs. On the other hand, as already mentioned, it reduces the flexibility of the fleet in terms of demand – on some routes, planes will remain unfilled, and on some demand may exceed the number of seats offered. Another threat to companies with such a fleet composition may be technical flaws. An example of a basic technical flaw at the design (and / or programming) stage there was a case with the Boeing 737 Max (Gertner 2021). Then, after several disasters with a large number of human casualties, a flaw was found in the autopilot systems, which in some cases could lead to automatic nose-down trim command. Aviation administrations of all jurisdictions banned flights of this model until troubleshooting, and the entire fleet was idle from March 2019 to December 2020 (in some countries and longer). If the fleet of any airline consisted only of these machines, it could lead to bankruptcy.

However, diversified fleets also have their undeniable advantages, which work in times of crisis. Flexibility allows them to better meet the demand, using small planes in cases of widespread decrease in passenger traffic, thereby maintaining a break-even load factor. And, of course, this approach has all the disadvantages arising from the advantages described for unified fleets. According to (Swidan & Merkert 2019), companies can influence their fuel and operational efficiency or by increasing the diversification of models (to adapt to the demand on routes of different lengths) or by lowering diversification (lowering maintenance costs). In our case, SAS (as legacy carrier), with its fleet scattered in terms of models and manufacturers, is opposed to low-cost carriers Ryanair, EasyJet and Norwegian, operating either single or more unified fleets. Thus, by observing the regression results of the fleet homogeneity index for corresponding airlines, we can get a better understanding about the competitive advantage of one or another approach of a fleet strategy in the current crisis.

Aircraft manufacturing companies are also busy with unification problems. The creation of new machines based on already proven models is a widespread practice. Such model ranges are called "families" of aircraft. It is obvious that many parts of machines from the same series are the same, and training technicians to work with a certain line is a much simpler and cheaper task than complete retraining or hiring new specialists. In the same way, the situation develops with teams of pilots whose qualifications allow (or with a small training course) to pilot several models in the family. An example of such a company in our study is EasyJet, which operates 4 models of aircraft from the same manufacturer, unlike its main competitor Ryanair with their fleet unified to one model. Thus, an important part is also to get an idea of the possible impact of the fleet unification by combining machines into families.

When purchasing and operating complex and expensive facilities (be it an airplane, ship or other complex equipment), it is always necessary to clearly understand the structural scheme of both current capital and future depreciation costs. With the increase in fuel prices and competition among airlines, managers continue to improve cost reduction strategies, expanding unification methods, applying them not only on the aircraft themselves, but also on engines, which are a significant part of the capital and operating costs of aircraft ownership (Merkert 2022). The authors also pointed to the fact that the costs of the aviation industry for maintenance, overhaul and repair (MRO) are growing from year to year, as is the share of money going specifically to engines. The market for used aircraft engines is as highly developed as it is developed with aircraft. It is also a common practice to sell/lease engines and fuselages separately from each other. At the moment, the topic of harmonization of the motor fleet of companies is clearly not sufficiently sanctified in the scientific literature. Nevertheless, the authors of the work point to a strong positive impact of unification on the overall performance of the company, technical and economic efficiency. Thus, unification of the engine fleet and its impact on the overall vulnerability of the company to price fluctuations should be attributed to the operational hedging method and included in the structure of the work

Similarly, as with aircraft manufacturer families, models with engine grouping by class and manufacturer should be tested (which will be discussed in more detail in the next chapter) to determine more general unification possibilities.

One of the factors of influence (in terms of operational variables) on the fuel efficiency of companies is the average length of routes, as this is directly related to the composition of fleets (regional aircraft cannot perform long-distance flights, and mainline aircraft created for trans-Atlantic routes are not effectively used on short flights), and also affects the possibility of tankering, which will be discussed in detail further. Thus, this indicator in the form of an operational hedging method can be applied for different airlines focused on different market niches and should be mentioned in the research.

Turning to the assessment of the company's vulnerability to price fluctuations, it can be noted that many scientists developed the theory and practical methods of evaluating the financial performance of companies at the end of the 20th century. Simple regression can be an effective tool in assessing a firm's vulnerabilities to various factors. (Adler et al. 1994) proposed to assess openness to risks by regressing changes in the value of a firm's shares to changes in another parameter (in the case of their study, it was a change in the exchange rate), which made it possible to consider the coefficient as a vulnerability of the firm. Since all companies operate on and depend on the state of the general national market, the influence of macroeconomic factors should also be taken into account. To do this, the authors of the work included in the regression model the profitability of the market corresponding to the selected companies. Additionally, it is necessary to take into account the work in the zones of national currencies. The addition of a weighted currency index variable can bring a significant impact in determining the price vulnerability intercept.

Further development of work in this direction showed various results. Some authors stated a lag in the impact of changes in exchange rates, and some authors (Nydahl 1999) refuted the delay in influence.

Moreover, scientists (Loudon 2004) (Treanor et al. 2014) began using this mechanism to evaluate airlines. It was found that this method is suitable for assessing the vulnerabilities of companies to fuel prices, and price risks negatively affect the company's performance in the short term. Studies were also conducted on the dependencies of the firm's vulnerability with the hedging policy and the total value of the firm.

In the beginning of the 21st century, the authors of the studies included the assessment of various types of hedging in their models. Often, the results of the work conflicted with each other. Many studies have rejected the hypothesis that financial hedging reduces vulnerability to fuel prices, while, for example, work (Treanor et al. 2014) speaks of a clear positive impact of financial hedging, and an even more significant impact of operational hedging.

Thus, we can talk about this method of measuring exposure to risks as a proven method of research, which is well developed and supported by many scientific papers.

Based on the theory and literature review, we propose to put forward the following hypotheses:

- **H1**: The impact of hedging on financial stability for companies using a low-cost business model is larger than for a full-service business model;
- **H2**: A unified fleet strategy (by families or models) gives the airline a competitive advantage – $a_7 < 0$;
- **H3**: A unified engine park (by families, models or manufacturer) gives the airline a competitive advantage – $a_8 > 0$;
- **H4**: Airlines with longer average route lengths are more exposed to fuel risks – $a_2 > 0$;
- **H5**: Changes in the value of national currencies have a significant impact on the vulnerability of companies to fuel prices.

4.0 Data, Method and Variables

4.1 Data

The main sources of data were the annual and quartile reports of airlines and the Datastream service from (Refinitiv). Airline quarterly reports were processed manually to obtain information about the percentages of hedging, their duration, financial hedging mechanisms, changes in the composition of the airline's fleet, as well as the range of engines used by airlines. The main indicators of the operational efficiency of companies, such as load factor, total assets, average travel distance, etc. Information about the positioning of the company (its business model) it was also extracted empirically from reports. All financial indicators were received in national currencies – Euro (EUR) for Ryanair, Norwegian krone (NOK) for Norwegian, Swedish krone (SEK) for SAS and British pound (GBP) for EasyJet.

In some periods, the companies did not specify some indicators (percentage / duration of hedging), in these cases, data from the previous adjusted year / quartile were used.

To determine the company's vulnerabilities to price spikes, financial information was obtained from Datastream. Historical values of company shares, indices of trading platforms on which these shares are traded, as well as aviation fuel prices for the North European Region (NWE) were obtained and processed except for some values that could damage the stability of the regression ("emissions" values).

The Trade-weighted USD Index was extracted from the (Federal Reserve Economic Data) website, however, the data set stopped being updated in 2020, and its best replacement is the Nominal Broad U.S. Dollar Index, whose indicators were also taken from the FRED website. Table 2 shows the statistics of observations of financial indicators. The observation period *n* shows the number of weeks. TWEXB – trade-weighted dollar index. JET-C-NEW – the price of aviation fuel futures contracts. SAS ST.; RYA.I; NAS.OL; EZJ.L – stock tickers of SAS, Ryanair, Norwegian and EasyJet, respectively. Tickers of exchanges are also presented.

Table 2. Descriptive statistics of financial data (in native currencies). Own table.

Ticker / Statistic	n	mean	sd	median	min	max	range	skew	se
TWEXB	1163	113	10	113	94	132	38	-0,04	0,30
JET-C-NWE	1165	615	271	604	133	1440	1308	0,42	7,93
.OMXS30 (For SAS)	992	1232	419	1173	452	2420	1968	0,49	13,32
SAS ST.	992	17	21	6	1	93	93	1,58	0,65
RYA.I	992	8	5	5	2	19	17	0,66	0,16
.ISEQ (For Ryanair)	992	5531	1875	5981	1950	9963	8014	0,00	59,53
NAS.OL	942	3424	2686	2748	9	10334	10326	0,57	87,50
.OBX (For Norwegian)	992	476	234	419	85	1096	1011	0,52	7,43
EZJ.L	1044	643	423	477	98	1612	1515	0,62	13,08
.FTSE (For Easyjet)	992	6021	1016	6100	3492	7779	4287	-0,42	32,25

Figure 9 clearly shows how important it is to give a general assessment of the observed data, take into account macroeconomic trends and understand the causal relationship of changes occurring at different levels. So called "outliers" values can be observed during 2020+ years. The nature of the changes taking place in the market is well understood – the prices of aviation kerosene are falling, along with the share price of companies, as countries have imposed restrictions on movement associated with the spread of the COVID-19 virus, however, in a normal market situation, a drop in the cost of fuel is not a factor in reducing the value of companies. Thus, the data of fiscal 2020 and 2021 was excluded from the study.

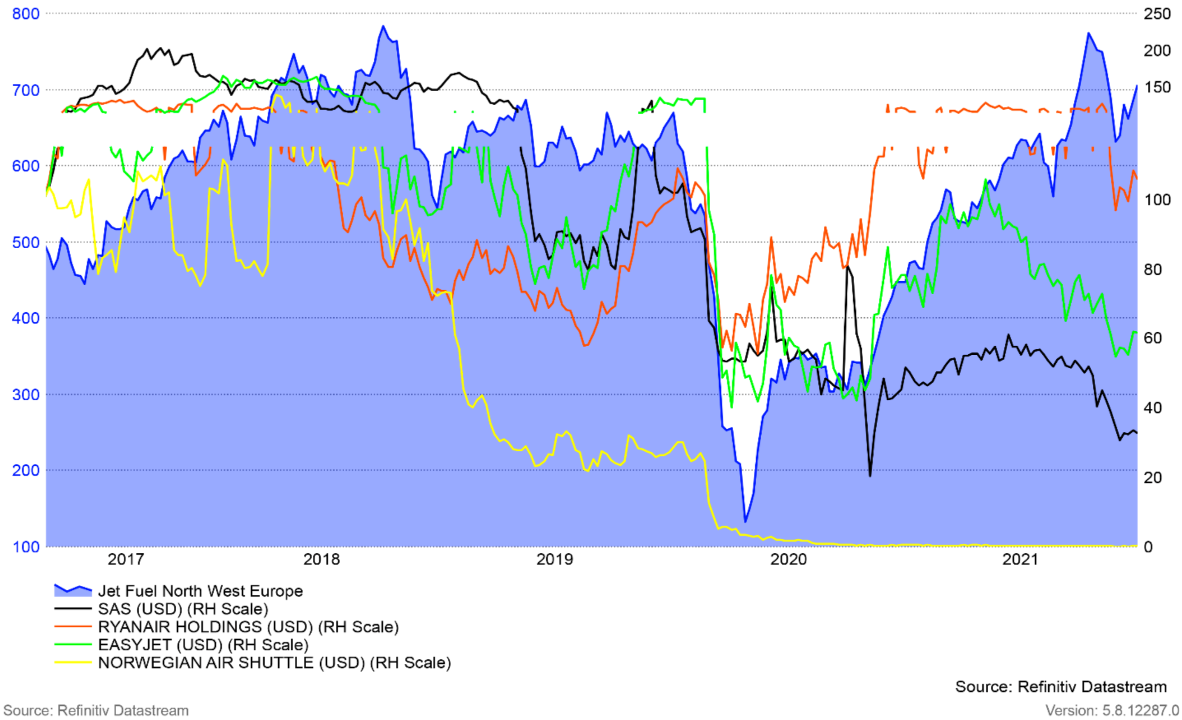

Figure 9. Company stock prices and fuel prices in COVID-crisis.

The exchange rate index compares various bilateral exchange rates to create an effective (or average) exchange rate. By studying the exchange rate index, one can observe real changes in the value of the currency relative to the global market. KIX (for SEK) and I-44 (for NOK) indexes were taken as indexes for the study. «KIX ("krona index") is a geometric index, where the weights are based on total flows of processed goods and commodities for 32 countries.» – (Sveriges Riksbank 2022). I-44 is a similar index for the Norwegian krone, showing the aggregated exchange rate of the krona to other currencies of Norway's main and most important trading partners, including 44 states. Data received from (Norges Bank 2020).

4.2 Method and Variables

The computational part of the work is represented by two linear regression models. First, the price exposure is calculated for each quarter of each company, and then this index is used in the second model, where financial and operational spectrum indicators are regressed to it.

To assess the exposure of the companies selected for the study, it is worth turning to the concept of risk exposure, which is defined as the elasticity of a firm to changes in certain assets. Simply put, this elasticity is expressed by percentage changes in some assets, due to changes in others. Since fuel accounts for a significant part of airline costs, it is obvious that the company's activities depend on the price index for this energy resource. Thus, the simplest OSL regression can be used on a two-factor model to estimate the vulnerability coefficient, regressing the indicators of stock returns to the cost of aviation fuel.

However, in the work (Sotthisopa 2016) the authors point out that it is also necessary to include in the research the macroeconomic indicators of the state of the market on which the company's shares are traded, since it directly affects the final income.

Following on, the authors of other works noted that companies operating in their national currencies depend on exchange rates. Since oil and its derivatives are traded on the world market mainly in US dollars, the trade waited USD index should be taken into account. Nevertheless, for more accurate observations of individual companies, it seems logical to replace this variable in the model with a trade-weighted index of the national currency of the business unit under study.

Thus, the equation for calculating the risk exposure of companies looks as follow:

$$R_{i,w} = \alpha_i + \beta_{i,q} R_{mkt,w} + \gamma_{i,q} R_{JF,w} + R_{USD,w} + \varepsilon_{i,w} \quad (1)$$

where:

$R_{i,w}$

is the natural logarithm of weekly stock price return of the airline *i* for week *w*;

$R_{mkt,w}$

is the natural logarithm of weekly price return of the market index related to a specific company;

$R_{JF,w}$

is the natural logarithm of weekly price change of the European Jet Kerosene Cargoes Futures calculated by Platts for week *w*;

$R_{USD,w}$

Is the natural logarithm of the price change in trade weighted U.S. dollar index (after 01.01.2020 the Nominal Broad U.S. Dollar Index) for week *w*;

$\beta_{i,q}$

is coefficient shows the market risk factor (which is not used in this work) for the corresponding airline *i* for quarter *q*;

$\gamma_{i,q}$

is the jet fuel risk factor (in other words – jet fuel risk exposure) for corresponding airline *i* for quarter *q*.

Thus, the vulnerability coefficient is calculated for each quarter for each airline, which is further regressed to other financial and operational indicators, which makes it possible to assess the impact of various mechanisms for stabilizing business processes in the company.

Moving on to the next model, first of all, we are interested in the impact of hedging (or not hedging) on stability. Airlines usually publish hedging strategies, methods and data in their annual financial reports for investors and stakeholders. Fortunately for this study, all the companies selected for the study tend to publish complete information (term and percentage of hedging) about their methods of work. In cases where the company did not provide information for a single fiscal year, data from the previous period were used. The HDGPER and HDGMAT variables determine the characteristics of the company's strategies, indicating the percentage of hedged fuel and the maximum hedging period (in months), respectively.

Operational methods of business stabilization, as already noted, include strategies for the harmonization of the flight fleet. To calculate the coefficient of variance, several scientists have already (Allayannis et al. 2001) (Berghöfer & Lucey 2014) used a modified Hirschman – Herfindahl concentration index, which has shown its suitability for use in such studies. The unification of the fleet brings with it both its disadvantages and its advantages as seen in the literature review, but undoubtedly affects the entire value chain, as it contributes both to maintaining the critical load factor (by better compatibility of supply and demand) and reduces operating costs. Information about the aircraft used was obtained from annual reports and airline websites, as well as news aggregators and statements from top managers of companies and the industry to clarify and confirm changes (sale, delivery, leasing / wet leasing) in the fleet during the observed period. Aircraft operated under the "wet" leasing scheme, which implies financial responsibility for maintenance and cabin crew on the part of the lessor, were excluded from the observations. In cases where it was not possible to establish the exact composition and number of units of equipment for a certain period, the values of the previous period were used. The expression for calculating the fleet dispersion index looks like this:

$$ADI1_i = 1 - \sum_{j=1}^{N} \frac{(N\ of\ aicraft\ model\ j)^2}{(Total\ fleet\ size\ j)^2} \qquad (2)$$

where N is the total number of aircraft models in the fleet of the corresponding company i. Obviously, modifications of planes in the field of cabin layout, such as the Boeing 737-700 and 600 differ only in the number of seats in the cabin. This allows airlines using a unified fleet to better meet the demand on various routes, although not as efficiently as it is possible to achieve using the suitable regional aircraft, since this can work well in case of an increase in demand, but with its decrease, the aircraft will still have a constant increased fuel consumption even for a minimum number of seats, compared to an airliner of a smaller fuselage (and weight), which would still be able to meet demand. In this paper, such variations are considered as aircraft of the same model, with some exceptions, when the models in the family have crucial differences – for example, the third (NG) and fourth (MAX) generations of the Boeing 737 family are seriously different from their older counterparts – there are different options for possible engines, new types of winglets, chevrons on the back of the fan – all these technical aspects can seriously affect fuel efficiency, vehicles can meet new environmental requirements, etc. Thus, were placed in a separate category.

As mentioned above, the unification of the fleet can be carried out not only by implementing a single model for the entire fleet, but also by using a single manufacturer (Boeing / Airbus) or by using separate families of aircraft, such as, for example, the Airbus A320 family, which includes A318, A319, A321 and their modifications such as LR, neo, Enhanced, etc. On such models, pilots can obtain a dual-type license, which allows them to control different modifications in the family. It is also obvious that cargo models are not taken into account in the study, as they have minimal impact on these airlines that mainly or completely focuses on passenger transportation with belly freight as the freight mode. Similarly, to the previous variance index, the index was calculated taking into account the family of aircraft in the fleet:

$$ADI2_i = 1 - \sum_{j=1}^{N} \frac{(N\ of\ aicraft\ families\ j)^2}{(Total\ fleet\ size\ j)^2} \tag{3}$$

Further standardization and unification lies in the plane of propulsion systems. The noted and proven effectiveness of such a strategy in terms of airlines efficiency and competitive advantage has been proven by scientist (Merkert 2022) in his work. Based on the Data Envelopment Analysis (DEA) efficiency assessment methodology with a large number of stages and add-ons, the authors investigated the effect of engine characteristics on operational activity, using variables such as the average age of the fleet, the size of the airlines, stage length, fleet size, etc. However, none of this was used in this study, except to confirm information about the "families" of engines. Taking into account this information, we should also check the influence factor of the engine fleet in our case. An ideal example for observations is SAS, which not only has a diversified fleet of various aircraft, which has changed over time, but also provides in its reports extended statistics of the installations used for each model of its aircrafts. This is a key factor in terms of collecting and processing information, as few companies provide such detailed and structured data. The task of evaluating the fleet of engines of companies operating one type of aircraft may seem simple and non-trivial, but not everything is so simple here. Depending on the date of delivery, age or past owner, the same types of aircraft can carry a fairly wide range of propulsion systems under the wing, so without specific data, the composition of the engine fleet can be determined only with a sufficiently strong spread of values, which is not suitable for use in our work. During the observation period, the maximum number of different types of engines reached 14 (2002), the minimum – 5 (in the current period ended 2021 fiscal year).

Similarly, as well as dispersion indices for airliner models, the dispersion index for the airline's engine fleet was calculated. The expression looks like this:

$$EDI1_i = 1 - \sum_{j=1}^{N} \frac{(N\ of\ engines\ model\ j)^2}{(Total\ engine\ park\ size\ j)^2} \quad (4)$$

Using data from open sources, such as the websites of leading engine manufacturers, technical specifications on profile projects and some scientific papers (Merkert 2022), the engine fleet was grouped into families by analogy with the families of aircraft that we discussed above. The development of engine systems took place together with the development of aircraft, and in this area there are also gradual moments of evolution from the simplest turboprop engines to large turbofan engines within their families and companies, which allows us to make an assumption about the possible effect of grouped types of engines. The number of families ranged from 9 to 3. The largest in terms of the number of installations were P&W Canada 100, CFM56 (the largest group for the current period) and P&W JT8D. The expression looks like:

$$EDI2_i = 1 - \sum_{j=1}^{N} \frac{(N\ of\ engine\ families\ j)^2}{(Total\ engine\ park\ size\ j)^2} \quad (5)$$

The owner-companies perform B and C checks on their own (Merkert 2022) and therefore can benefit from the use of a single base of spare parts, documents and maintenance personnel. In addition, manufacturing companies usually provide an after-sales range of services for the maintenance and repair of their products. The scale effect, in theory, will allow companies to achieve better conditions for major repair contracts (D-check, every 5-6 years) from one manufacturer or another outsource repair company. Therefore, the engines were also grouped by manufacturer, which is shown by the *EDI3* index calculated in a similar way as the previous indexes.

The following financial and operational variables are mainly based on work (Berghöfer & Lucey 2014), but, nevertheless, require additional definition and clarification when used in our particular case with selected airlines.

As it was proved by the authors of the work (Swidan et al. 2019), although hedging reduces the vulnerability of companies to price risks, but, nevertheless, not all airlines have such financial mechanisms available. Financial derivatives, such as put and call options (see Literature Review), which are most likely used by top managers of companies selected for research, are often concluded over the counter (OTC), that is, outside of markets and platforms, between two separate legal parties, which exposes both to risks in the event of bankruptcy of one of the parties. To counteract these risks and to cover possible losses in the event of a fall in the futures price, a mechanism has been adopted when a company deposits a certain amount into a cash security account designed to counteract such financial risks. Thus, when hedging, part of the airline's cash flow is "blocked", and their liquidity decreases.

Table 3. Fuel statistics for 2020 fiscal year. Source: Annual financial reports of companies.

	SAS	Ryanair	Norwegian	EasyJet
Ktonns	572	1789	362	1344
Share in Direct Operational Costs	18%	33%	17%	17%

Since the volumes of kerosene consumed are substantial (Table 3), the price of collateral is also tangible, especially for companies with low free cash flows. In this case, companies have the option to take out a loan to ensure operational activities, but for firms in a difficult financial situation, or in circumstances close to situations for accepting bankruptcy / bankruptcy protection procedures, independent analysts usually set low credit ratings, which increases the interest rate on loans, and further limits the possibilities hedging. For example, we can track the average yields of bonds of companies with AAA and BAA ratings (according to Moody's). (Federal Reserve Economic Data) publishes timeseries for both indicators. The average indicator for bonds of AAA-rated companies was 3.42 percent, while for bonds of BAA-rated companies the indicator was 4.66 percent.

Thus, to account for the indicator of creditworthiness and the financial position of the company, the variable of the ratio of long–term liabilities to total assets – LDTA (long-term debt / total assets) is used.

In our case, the selected companies are quite clearly different in all indicators, revenue, size, etc. Following the financial theory described above, large firms have more free financial flows and opportunities to use hedging programs. Also, scientists have noted that, depending on the size, firms use various financial instruments. For example, in the work (Walker et al. 2014) the authors claim differences in preferred strategies for firms of different dimensions, but do not confirm the findings of others by the author that hedging is a way to increase the value of the firm. However, LNTA (natural logarithm of total assets) is an important indicator, and it was included in the regression model in this study.

The load factor and average sector length are important operational factors of companies' activities in the field of aviation passenger transportation. It is quite obvious that the airliner occupancy rate is a general indicator of the company's success. While value-carriers can maintain the payback of operating costs for fuel, cabin crew and maintenance even with the lower load factor indicators, for low-cost carriers the break-even value of this indicator is much higher. The weight of transported passengers and their luggage, at first glance, has a direct and understandable effect on the company's fuel consumption indicator – the greater the mass of the aircraft, the more fuel burns for the route traveled. However, when the aircraft approaches the maximum values of its take-off weight, the possibilities for so-called tankering decrease. Tankering is a fairly common practice today in Europe. Fuel managers have broad and in-depth tools for analyzing fuel prices at points on all routes of their company. If the price of fuel at the destination is higher than the price at the initial point of the route (among the reasons may be: contractual arrangements of air carriers with fuel companies; base airports; conglomerates of companies jointly purchasing fuel; competitive conditions, etc.), managers decide to take a larger amount of fuel on a flight than is necessary according to minimum safety requirements (fuel for the route is obtained + a reserve of safety standards + part of the fuel for the return trip) in order to reduce the volume of kerosene purchased at a high price. Based on the data (EUROCONTROL 2019) the practice of partial or full tankering is practiced in about 30% of all flights. Similarly, the tankering capability is affected by the average length of the route. The closer an airliner approaches the indicators of its maximum flight range, the lower the opportunities for saving on cheap fuel.

Additionally, the route length indicator allows for determining the possible limitations faced by airlines with different business models. For example, in our case, Ryanair operates a single fleet of Boeing 737, and cannot perform ultra–long flights (for example, the route across the Atlantic – Copenhagen - New York), which, however, is quite successfully performed by SAS using its Airbus A340. Fuel efficiency per seat in such large aircrafts, and on such long-distance routes is much higher than, for example, when using a standard Boeing 737 on medium and short routes. Thus, the LF (Load factor) and LNDIS (natural logarithm of distance) indicators are included in the regression.

Table 4. Example of the collected data on operational and financial indicators (SAS).

Date	LF	LTDA	TA (MSEK)	HDGPER	HDGMAT	ADI1	ADI2	DIS (km)
2003 Q1	0,675	0,418327	61275	0,8	9	0,821685	0,764517	1016,099
2003 Q2	0,686	0,437287	57612	0,8	9	0,821685	0,764517	1079,314
2003 Q3	0,714	0,406922	58016	0,8	9	0,821685	0,764517	1086,101
2003 Q4	0,736	0,3488	51164	0,8	9	0,821685	0,764517	1084,195
2004 Q1	0,745	0,231167	48770	0,16	12	0,864882	0,848787	1054,205
2004 Q2	0,723	0,441841	48770	0,16	12	0,864882	0,848787	1069,854
2004 Q3	0,727	0,307542	48770	0,16	12	0,864882	0,848787	1076,315
2004 Q4	0,756	0,333102	41825	0,16	12	0,864882	0,848787	1084,699
2005 Q1	0,749	0,354447	41825	0,54	12	0,736264	0,658193	1057,882
2005 Q2	0,767	0,329515	41825	0,54	12	0,736264	0,658193	1068,915
2005 Q3	0,75	0,379406	26813	0,54	12	0,736264	0,658193	1099,06
2005 Q4	0,769	0,354101	29325	0,54	12	0,736264	0,658193	1180,427
2006 Q1	0,763	0,33949	29325	0	12	0,48569	0,433076	1169,54
2006 Q2	0,76	0,309315	31754	0	12	0,48569	0,433076	1254,372
2006 Q3	0,768	0,287606	32555	0	12	0,48569	0,433076	1333,045
2006 Q4	0,757	0,351209	34199	0	12	0,48569	0,433076	1327,904
2007 Q1	0,752	0,397654	34012	0,53	9	0,692672	0,497344	1323,04
2007 Q2	0,605	0,493114	57433	0,53	9	0,692672	0,497344	1120,301
2007 Q3	0,479	0,56964	52721	0,53	9	0,692672	0,497344	1088,464

Thus, we regress the annual indicators of airline price risk calculated in the first stage to the selected indicators of operational and financial activity. The second regression expression looks like this:

$$\gamma_{i,q} = \alpha_0 + \alpha_1(LF) + \alpha_2(LNDIS) + \alpha_3(LNTA) + \alpha_4(LTDA) + \alpha_5\left(HDGMAT_{i,q}\right) + \alpha_6\left(HDGPER_{i,q}\right) + \alpha_7(ADI1_{i,q}) + \alpha_8(EDI1_{i,q}) + \varepsilon_{i,q}. \quad (6)$$

LF

is the load factor for corresponding company for quartile q;

$LNDIS$

is the natural logarithm of average flight distance for corresponding company for quartile q;

$LNTA$

is the natural logarithm of total assets for corresponding company for quartile q;

$LTDA$

is the ratio of total long-term liabilities to total assets for corresponding company for quartile *q*;

$HDGMAT$

shows maximum hedging maturity in months for corresponding company for quartile *q*;

$HDGPER$

is the percentile of the fuel being hedged for corresponding company for quartile *q*;

$ADI1_{i,q}$

is the fleet dispersion index for corresponding company *i* for quartile *q*;

$EDI1_{i,q}$

is the engines dispersion index for corresponding company *i* for quartile *q*.

Important clarifications: Despite the fact that the average route length (LNDIS) was provided directly by the airlines in the annual operating reports, all values were calculated directly by the author using the formula $\ln\left(\frac{RPK}{Total\ PAX}\right)$ (7). PAX – number of passengers carried by an airline. RPK stands for revenue passenger kilometers (or miles).

5.0 Results and Discussion

The first step in the study is to calculate the price vulnerability coefficients for each observed year for each company through the first regression model (1). SAS and Norwegian were chosen as examples to determine the impact of the weighted index of the national currency. To assess the feasibility of supplementing models with coefficients, a VIF test (Variation inflation factors) was conducted, which measures the inflation of deviations in the parameters of the model caused by possible collinearity between predictor variables. The variance of the coefficient may be overestimated, which must be excluded in order to obtain an "authentic" result. The VIF indicator equal to 1 indicates the absence of correlation between the predictors, an indicator greater than 4 indicates an acceptable correlation, but requiring attention and additional evaluation. An indicator greater than 7 indicates that an adjustment is required.

Table 5. VIF test results for NOK (left) and SEK (right). Own figure.

```
  Variables  Tolerance       VIF  Variables Tolerance      VIF
1    Market 0.19267706  5.190032 1    Market 0.3985786 2.508915
2       USD 0.11313650  8.838880 2       USD 0.2011757 4.970779
3      Fuel 0.22539488  4.436658 3      Fuel 0.2309417 4.330097
4       NOK 0.04889102 20.453653 4       SEK 0.6736623 1.484423
```

In our case, determining the admissibility of inclusion in the study of the impact of national currencies, two models were launched for SAS and Norwegian. Results for SEK (Table 5) are acceptable, whereas the results for the Norwegian Krona (VIF=20) exclude it from further study.

Table 6. Summary statistics for airlines exposure coefficients. Own figure.

	SAS (NC)	SAS	Ryanair	Easyjet	Norwegian
N of observation	76	76	76	76	68
Mean	-0,595586608	-0,595586608	0,075034	0,129137	-0,370109
Median	-0,4552	-0,4751	0,058995	0,13498	-0,1138
Max	1,167	1,46455	0,45454	0,6037	10,62118
Min	-1,4247	-1,7967	-0,2681	-2,1834	-1,5933
Segnificance median	0,000108	0,000895	0,057978	0,000782	0,00772
N of segnificant observations at 5%	73,60%	68,40%	61,10%	84,20%	58,80%
Median Adj.R2	0,6846	0,6067	0,7819	0,6738	0,6304

Table 6 shows mean values for variables studied comparing high and low exposed airlines. SAS (NC) in Table 6 stands for National Currency and reflects the calculation of fuel vulnerability with the included factor of changes in the Swedish krona index. Since the second currency (the Norwegian krone) did not pass the correlation test, it was decided to leave this topic for another study for a more correct approach. More on this in the Summary chapter.

While many papers consider the impact of fuel prices on companies in the context of symmetrical distribution, the work (Sotthisopa 2016) it also points to the possible asymmetric impact of prices on companies that, in conditions of rising prices, may apply a more stringent financial policy, which may lead to more positive forecasts of stakeholders and, accordingly, to a higher share price. The asymmetry of influence is confirmed by the results of the first regression (1). The result from the regression agrees with the result from literature – large low-cost carriers Ryanair and EasyJet are exposed to positive risk, whereas for SAS and Norwegian the risk sign is negative. The result obtained for

Norwegian, as well as the large spread of Min-Max, speaks, rather, about the financial difficulties that the company faced, as well as with small volumes of hedging (19% on average) compared to the rest of the companies studied. Nevertheless, for use in the second model, the risk exposure coefficients were used in absolute values (modulus of the number), since it is implied that the operational and financial hedging methods used should reduce the risk to zero, eliminating the company's business results from dependence on oil quotes (kerosene prices).

In confirmation of the findings described in the work (Treanor et al. 2014), but contrary to (Berghöfer & Lucey 2014) large players tend to hedge more fuel based on the economy of scale theory, have a lower positive exposure compared to smaller players), a higher load factor and a more unified fleet.

Also, during the calculations, significant effects of delayed changes in the dollar price and fuel price on the stock price of companies were found, which has already been discovered by the authors (Nydahl 1999), which also, in contrast, report a significant impact of exchange rates on the value of companies. The trade-weighted dollar index showed significant indicators for the model with a delay of one week, which may be explained by the difference in the final days of the index calculation occurring at the end of the working week (Friday), whereas the average-weighted prices for fuel futures or stock prices occur at the beginning of the week (Monday), however, fuel futures prices also, in some years of observations, significant results were shown with a lag of 1 week, which is not explained in any way in the scientific literature, and requires additional study.

During the observation period, the companies showed different reactions to the crises – the Great Recession (2008), the collapse of oil prices in 2014 and the pandemic recession of 2019-2020. In 2008-2010, for Norwegian, the fuel price intercept had a negligible effect (P-value > 0.05) in the general model, although the models themselves showed a fairly significant level of R-square reliability. EasyJet mainly show significant resilience to global financial shocks, maintaining stability even in 2020 and 21 years. For Ryanair in 2019 and 2020, the P-value for fuel turned out to be insignificant with even a 10% test. SAS showed negligible fuel ratios in 2013 and 2014. However, all companies underwent significant shocks in 2020 and 2021, where the reliability values of the model in some cases turned out to be below the acceptable level, and the fuel vulnerability intercept showed abnormal values, and therefore, in most further steps, the time series was "cut off" until 2020, excluding "abnormal" values to obtain stable modeling results.

Table 7. Overall results for the companies.

```
Residuals:
    Min      1Q  Median      3Q     Max 
-2.2675 -0.4643 -0.0625  0.4123  5.3925 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) -10.03641    3.30362  -3.038  0.00354 ** 
LNDIS         1.34742    0.60703   2.220  0.03030 *  
LNTA          0.66300    0.17297   3.833  0.00031 ***
LF           -2.28057    2.17681  -1.048  0.29907    
LTDA         -7.82709    1.45496  -5.380 1.35e-06 ***
HDGPER       -1.93121    0.70866  -2.725  0.00845 ** 
HDGMAT        0.01019    0.03309   0.308  0.75920    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.008 on 325 degrees of freedom
Multiple R-squared:  0.5072,	Adjusted R-squared:  0.4981 
F-statistic: 55.75 on 6 and 325 DF,  p-value: < 1.486e-06
```

The overall results for all four companies are shown in Table 7 and reflect the overall situation for selected North European companies. The significant impact of total assets on financial stability once again confirms the observations of other scientists (Nelson et al. 2005) – larger firms have a greater tendency to hedge, a larger margin of financial and credit strength, and are less exposed to risks.

The total debt / assets ratio is also a significant indicator in the model. To provide financial hedging, companies often require substantial financial resources. «…if an airline needs to hedge 70% to 100% of its future jet fuel requirements, it needs to raise significant amount of cash…» – (Swidan et al. 2019). In many cases, loans can serve as a source of such funds, which is directly reflected in the financial statements in total current / long-term liabilities, and, accordingly, is reflected in the LTDA ratio indicator. In addition, the influence can be caused by the Norwegian Air Shuttle situation, which experienced difficulties with doing business during the observation period and high indicators of this ratio (0.4-0.5). Moreover, this indicator is noted among the determinants of hedging (Sotthisopa 2016), since with an increase in the risk of financial distress, management begins to squeeze the budget, use more cost reduction strategies, reducing vulnerability.

The intercept for LNDIS is greater than zero and a significant p-value indicates that with an increase in the average flight length, the company's sensitivity to fuel prices is growing, confirming the theory and results of other works on incoherent ticket pricing and reduced tankering capabilities. Thus, hypothesis **H4** is accepted. Legacy-carriers should pay close attention to more effective management of transcontinental flights, especially in the context of crises in the industry.

The significance of the Load Factor turned out to be insignificant. The explanation of these results is more likely to be in the hands of operational management of the company. With the decrease in passenger traffic, companies, of course, adapt to the new conditions, using smaller aircraft, reducing the number of flights per day or the number of routes in general. Simplifying – the company reduces operating costs when demand decreases, adjusting business processes to acceptable levels required to work in the prevailing market conditions.

The hedging strategy indicators showed different results, while the duration of hedging does not contribute much to increasing stability, the percentage of hedged fuel has a strong impact on companies. An increase in hedging volumes by 1% reduces the impact of volatility on companies by 1.49%. The calculations were carried out as follows:

$$\frac{(Average\ Hedging\ Percent\ \times HDGPER\ Coefficient)}{Average\ Exposure\ Coefficient} \quad (8)$$

Table 8. Results for modeling with fleet dispersion factors.

```
Residuals:
    Min      1Q  Median      3Q     Max 
-2.2479 -0.4138 -0.0604  0.4336  5.3262 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept) -12.817888   4.405765  -2.909  0.00513 ** 
LNDIS         2.001640   0.915528   2.186  0.03284 *  
LNTA          0.421905   0.306069   1.378  0.17335    
LF           -2.313327   2.178703  -1.062  0.29273    
LTDA         -7.331089   1.545876  -4.742 1.42e-05 ***
HDGPER       -1.963306   0.709986  -2.765  0.00761 ** 
HDGMAT        0.005766   0.033442   0.172  0.86372    
ADI1          0.894483   0.936505   0.955  0.34348    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9993 on 324 degrees of freedom
Multiple R-squared:  0.5167,	Adjusted R-squared:  0.5063 
F-statistic: 49.49 on 7 and 324 DF,  p-value: < 3.044e-06

Residuals:
    Min      1Q  Median      3Q     Max 
-1.6684 -0.5352 -0.1310  0.4543  4.5717 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -2.72756    4.07038  -0.670  0.50545    
LNDIS       -0.18365    0.79254  -0.232  0.81757    
LNTA         1.14659    0.23777   4.822 1.07e-05 ***
LF          -2.32441    2.06030  -1.128  0.26389    
LTDA        -8.79282    1.41945  -6.195 6.50e-08 ***
HDGPER      -1.28367    0.70934  -1.810  0.07553 .  
HDGMAT      -0.02399    0.03361  -0.714  0.47824    
ADI2        -2.12661    0.75828  -2.805  0.00684 ** 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9597 on 324 degrees of freedom
Multiple R-squared:  0.5542,	Adjusted R-squared:  0.5446 
F-statistic: 57.55 on 7 and 324 DF,  p-value: < 1.561e-07
```

The value of the fleet unification factors was verified by running two models for each factor (AD1 and AD2). The results are presented in Table 8 above.

As can be observed as a result, in contrast to many observations before, the diversification of the fleet in terms of models increases the vulnerability of companies to risks (a positive intercept for ADI1). The difference from previous scientific papers can be explained by the selected observation interval. Whereas in previous studies, the authors could observe more stable intervals of oil prices, the 21st century is characterized by frequent price shocks. As mentioned above, a significant factor is the average length of routes, which is directly related to the use of large types of long-haul aircraft. In contrast to the operational flexibility of using different types of vessels, there are increased costs for maintaining technical condition and a wide variety of pilot teams for their direct use. Crisis situations also introduce problems with the payback and occupancy of long routes, which does not allow companies to operate large aircrafts effectively, reducing the competitiveness of such an approach. However, these shortcomings are not critical and can be leveled by operational management. So that been said, this conclusion leads us to reject hypothesis **H2** about the advantage of companies using unified fleets – an increase in the number of different machines carries greater operational (technical) costs than savings caused by flexibility in use.

Nevertheless, the unification of the fleet by reducing the number of families of aircraft (ADI2) has brought significantly stronger results and reduce the exposure. Most likely, this phenomenon is obtained due to a small sample of airlines. One of the air carriers selected for the study (EasyJet) during the observations is in the global process of expanding the fleet with new aircraft models, with increased fuel efficiency and the ability to flexibly approach the choice of routes and, in general, increased final utilization. This fact could affect the result of this indicator in the general model.

However, since propulsion systems can account for up to 30% of the total cost of an aircraft, the degree of their influence in the context of unification by technical families and models has shown a significant impact, but with a positive sign, which indicates an increase in the vulnerability of companies with the increase of an engine park diversification, which is supported by previous studies. In terms of motor systems, diversification does not matter, whereas unification will mean reducing vulnerability to risks by the same intercept value, only with a negative sign (since in the modeling we use indexes, that shows diversification, but not unification). It is possible to confirm the statements of previous scientists about the presence of a clear impact of unification (or its absence) on the cost efficiency of companies. Thus, **H3** hypothesis is accepted. Engines unification strategy has a strong positive impact on selected companies.

Table 9. Overall modeling results for engine diversification factors.

```
Residuals:
    Min      1Q  Median      3Q     Max
-2.1084 -0.3659 -0.0449  0.3541  4.8847

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -16.424616   4.303010  -3.817 0.000331 ***
LNDIS         2.727865   0.855731   3.188 0.002311 **
LNTA          0.290390   0.237133   1.225 0.225683
LF           -2.973194   2.130772  -1.395 0.168227
LTDA         -7.354689   1.424817  -5.162 3.12e-06 ***
HDGPER       -1.975299   0.686482  -2.877 0.005603 **
HDGMAT       -0.005865   0.032852  -0.179 0.858938
EDI1          1.639712   0.738726   2.220 0.030367 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.962 on 324 degrees of freedom
Multiple R-squared:  0.5521,    Adjusted R-squared:  0.5424
F-statistic: 57.06 on 7 and 324 DF,  p-value: < 5.299e-07

Residuals:
    Min      1Q  Median      3Q     Max
-2.0946 -0.3471 -0.0254  0.3465  4.7924

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -16.576262   4.184102  -3.962 0.000206 ***
LNDIS         2.758889   0.828281   3.331 0.001510 **
LNTA          0.295596   0.225977   1.308 0.196006
LF           -3.114123   2.122331  -1.467 0.147693
LTDA         -7.415435   1.409912  -5.260 2.18e-06 ***
HDGPER       -1.963882   0.681767  -2.881 0.005554 **
HDGMAT       -0.006584   0.032589  -0.202 0.840593
EDI2          1.747328   0.727280   2.403 0.019502 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9554 on 324 degrees of freedom
Multiple R-squared:  0.5582,    Adjusted R-squared:  0.5487
F-statistic: 58.49 on 7 and 324 DF,  p-value: < 3.71e-07

Residuals:
    Min      1Q  Median      3Q     Max
-2.2684 -0.3849 -0.0687  0.4663  5.2528

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -12.796298   4.287383  -2.985  0.00415 **
LNDIS         1.913496   0.826241   2.316  0.02412 *
LNTA          0.537584   0.212925   2.525  0.01434 *
LF           -2.676738   2.211538  -1.210  0.23105
LTDA         -7.814526   1.454773  -5.372 1.44e-06 ***
HDGPER       -1.975708   0.709915  -2.783  0.00726 **
HDGMAT        0.009393   0.033099   0.284  0.77758
EDI3          0.761278   0.753965   1.010  0.31683
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9968 on 324 degrees of freedom
Multiple R-squared:  0.5191,    Adjusted R-squared:  0.5087
F-statistic: 49.96 on 7 and 324 DF,  p-value: < 2.902e-06
```

Turning to the discussion of the activities of individual airlines, tests were conducted for all indexes in the context of selected airlines.

5.1 Norwegian Air Shuttle

Table 10. Overall modeling results for Norwegian.

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -24.44030   15.86965  -1.540  0.15457
LNDIS         2.64183    2.92557   0.903  0.38775
LNTA          1.37377    0.77086   1.782  0.10506
LF           -0.18276   12.26608  -0.015  0.98841
LTDA        -15.21779    3.33333  -4.565  0.00103 **
HDGPER        1.84969    3.20252   0.578  0.57632
HDGMAT       -0.09202    0.09947  -0.925  0.37669
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.129 on 61 degrees of freedom
Multiple R-squared:  0.8417,    Adjusted R-squared:  0.8262
F-statistic: 54.08 on 6 and 61 DF,  p-value: < 0.001874
```

Table 11. Overall modeling results with fleet dispersion variables for Norwegian.

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -18.91527   19.08279  -0.991  0.34748
LNDIS         2.12194    3.16415   0.671  0.51930
LNTA          1.31307    0.80537   1.630  0.13746
LF           -2.51194   13.34439  -0.188  0.85486
LTDA        -14.18567    3.89852  -3.639  0.00541 **
HDGPER        0.21897    4.38103   0.050  0.96123
HDGMAT       -0.05161    0.12507  -0.413  0.68951
ADI1          1.49592    2.62594   0.570  0.58284
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.093 on 60 degrees of freedom
Multiple R-squared:  0.8539,    Adjusted R-squared:  0.8369
F-statistic:  50.1 on 7 and 60 DF,  p-value: < 0.005163
```

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -27.28787   17.50737  -1.559  0.15351
LNDIS         3.50238    3.51592   0.996  0.34520
LNTA          1.20265    0.87502   1.374  0.20256
LF           -2.64212   13.71679  -0.193  0.85153
LTDA        -14.70519    3.62290  -4.059  0.00285 **
HDGPER        0.46314    4.37529   0.106  0.91802
HDGMAT       -0.05902    0.12354  -0.478  0.64423
ADI2          1.65847    3.39202   0.489  0.63658
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.09 on 60 degrees of freedom
Multiple R-squared:  0.8548,    Adjusted R-squared:  0.8378
F-statistic: 50.45 on 7 and 60 DF,  p-value: < 0.005363
```

As we can see from the table above, the hedging strategy indicators were not significant for Norwegian. This is mainly due to the low indicators of this side of financial activity, as we have already noted earlier. In the same way, the results reflect the problems in the financial component of the company's work during the observation period. After the stage of active growth, the capture of new markets (the opening of new long-haul routes, for example, between London and Singapore in April 2017) and the purchase of new modern aircraft (Boeing 737 MAX delivery in June 2017 and an order for a large batch of Airbus A320neo), the company faced financial difficulties, exacerbated by the pandemic. The opinion of investors (and, accordingly, the value of shares) in this case is mostly influenced by the pace of the company's exit from this state, therefore, the p-value for the ratio of long-term liabilities to fixed assets indicates such a significant role.

In turn, the indicators for the dispersion indices of the fleet diversification, as well as the indicators for similar indices concerning the fleet of propulsion systems, also did not bring significant results, which is reflected in Table 11. This is partly due to a significant part of the zero values for the ADI2 index (in the main part of the observations, the company used Boeing aircraft models, which reflects the zero-index) and small changes in the fleet model range (in the ADI1 index).

5.2 Ryanair

Ryanair also operates a single fleet, so the dispersion indices of the fleet and engine fleet for this company were not carried out (due to zero values). Even though, as we have already noticed, engines on one model of aircraft may differ depending on the model of production and the previous owner, the company does not disclose data on the models used, and therefore it is not possible to assess the real and exact condition without directly receiving data from the company itself.

Table 12. Overall modeling results for Ryanair.

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 18.24291   13.30122   1.372   0.2638
LNDIS       -3.16274    1.96041  -1.613   0.2051
LNTA         0.65920    0.32859   2.006   0.1385
LF          -1.58064    1.01193  -1.562   0.2162
LTDA        -2.10899    1.39079  -1.516   0.2267
HDGPER       1.43647    0.45433   3.162   0.0508 .
HDGMAT      -0.05698    0.02702  -2.109   0.1255
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.04355 on 63 degrees of freedom
  (10 observations deleted due to missingness)
Multiple R-squared:  0.8592,    Adjusted R-squared:  0.5777
F-statistic: 64.1 on 6 and 63 DF,  p-value: 0.194
```

Nevertheless, general tests were carried out (Table 12) showing some positive dependence of the exposure coefficient depending on the percent of hedged fuel. A more likely explanation for this phenomenon lies in the cost of hedging itself. The more fuel the company hedges, the more amount of free cash it is required to leave as collateral, as stated by (Swidan et al. 2019) and disscussed a bit in previous sections. The authors claim that with a hedge of 70-100%, the required amount of collateral can nullify all the benefits of hedging. Ryanair hedges the most fuel (88% on average), and the share of fuel costs from all direct operating expenses is the highest for it (Table 3), which speaks in favor of such an explanation.

5.3 SAS Group

SAS Group, as already noted, provides expanded information about the composition of its fleet and the engines used, which makes determining the degree of influence of these factors on the company the most accurate, indicative and important in this study.

As with the study of general data, the intercept for all EDI (Table 9) indicators has a positive sign, and the p-value turns out to be significant at 5% or lower using one-sided t-test. Although the engine dispersion indices have changed over the entire observation period, they do not differ much from the indicators of the initial years of observations. The company has commissioned several modern types of aircraft with a new type of engine, which increases the diversification of these indicators both in the field of individual models and in the field of families and manufacturers. We can also talk about rather weak indicators of the unification of the engine fleet in comparison with competitors – the EDI indices are 0.71; 0.69 and 0.49, respectively, for the first, second and third indices. Nevertheless, the data obtained indicate the importance of these variables and opportunities for further research in this area.

The magnitude of the intercept for the factors of the unification strategies by models, families and manufacturers also looks logical, reporting an increased positive impact for the unification strategy to a single engine model (intercept 3.38), followed by the magnitude of the influence of the unification of engines by manufacturers (intercept 3.1). The least significant magnitude of the influence of the three factors was shown by the strategy of combining the fleet of propulsion systems by families with intercept value 2.7.

Proving the difference in the value-carriers and low-costers business models, the modeling results for SAS show a certain level of significance of indicators such as Total Assets and Load Factor, the increase of which reduces risks. This may be explained by a lower break-even load factor for value-carriers.

Indicators for factors determining hedging strategies did not bring significant results in this case.

Table 13. Overall modeling results with engine dispersion factors for SAS.

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 30.38479   10.17489   2.986  0.02444 *
LNDIS       -0.04395    0.77266  -0.057  0.95648
LNTA        -2.41159    0.52338  -4.608  0.00366 **
LF          -6.68605    2.33675  -2.861  0.02875 *
LTDA        -1.98051    1.23915  -1.598  0.16110
HDGPER      -0.11149    0.29995  -0.372  0.72289
HDGMAT      -0.02778    0.02329  -1.193  0.27785
EDI1         3.38382    0.84401   4.009  0.00704 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2078 on 62 degrees of freedom
  (5 observations deleted due to missingness)
Multiple R-squared:  0.8463,    Adjusted R-squared:  0.667
F-statistic: 26.41 on 7 and 62 DF,  p-value: 0.03866

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 29.85632   10.06890   2.965  0.02511 *
LNDIS       -0.02271    0.76829  -0.030  0.97738
LNTA        -2.33791    0.50775  -4.605  0.00367 **
LF          -6.47143    2.29644  -2.818  0.03043 *
LTDA        -1.88984    1.22725  -1.540  0.17451
HDGPER      -0.18541    0.29823  -0.622  0.55701
HDGMAT      -0.02255    0.02335  -0.966  0.37152
EDI2         2.70367    0.66800   4.047  0.00675 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2014 on 62 degrees of freedom
  (5 observations deleted due to missingness)
Multiple R-squared:  0.8484,    Adjusted R-squared:  0.6716
F-statistic: 28.69 on 7 and 62 DF,  p-value: 0.03725

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 15.77586   12.93717   1.219   0.2684
LNDIS        1.93008    1.39892   1.380   0.2169
LNTA        -2.08863    0.65607  -3.184   0.0190 *
LF          -9.40634    3.80410  -2.473   0.0483 *
LTDA        -1.96298    1.63113  -1.203   0.2741
HDGPER      -0.20427    0.39449  -0.518   0.6231
HDGMAT      -0.03429    0.03033  -1.130   0.3014
EDI3         3.16485    1.21063   2.614   0.0399 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1986 on 62 degrees of freedom
  (5 observations deleted due to missingness)
Multiple R-squared:  0.7357,    Adjusted R-squared:  0.4273
F-statistic: 29.76 on 7 and 62 DF,  p-value: 0.1546
```

Table 14 shows results for the fleet dispersion indicators (ADI1), that confirm the conclusions made earlier about the inexpediency of expanding the fleet of companies in terms of the variability of the model range, since with increasing diversification, the vulnerability of the company also increases. Modeling with the ADI2 index did not show significant results.

Table 14. Modeling results with fleet dispersion factor for SAS.

```
Residuals:
     Min       1Q   Median       3Q      Max
-0.37627 -0.12700  0.01871  0.13239  0.33891

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  26.06502   19.89182   1.310   0.2380
LNDIS         1.98882    1.65110   1.205   0.2737
LNTA         -2.89146    0.97028  -2.980   0.0246 *
LF          -12.56411    4.59870  -2.732   0.0341 *
LTDA         -4.71134    2.48779  -1.894   0.1071
HDGPER        0.43161    0.61254   0.705   0.5075
HDGMAT       -0.03734    0.04658  -0.802   0.4533
ADI1          3.70977    1.26646   2.929   0.0263 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2127 on 62 degrees of freedom
  (5 observations deleted due to missingness)
Multiple R-squared:  0.737,     Adjusted R-squared:  0.4301
F-statistic: 24.82 on 7 and 62 DF,  p-value: 0.1528
```

5.4 EasyJet

For EasyJet, the modeling results show some impact (at 5% t-test) of the Debt/Assets and percentage of the fuel been hedged factors. The variance index for the strategy of combining the engine fleet by manufacturer showed the opposite result to other companies, having a positive impact (reducing) fuel vulnerability with an increase in the number of engines from different manufacturers (Table 15).

Table 15. Overall modeling results with engine dispersion factor for EasyJet.

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.336888   4.795545   0.487   0.6391
LNDIS       -0.373243   0.824929  -0.452   0.6630
LNTA        -0.015394   0.156987  -0.098   0.9243
LF           0.990461   0.966093   1.025   0.3353
LTDA         1.677867   0.611874   2.742   0.0254 *
HDGPER      -0.571418   0.260200  -2.196   0.0594 .
HDGMAT       0.001560   0.007111   0.219   0.8319
EDI3        -0.820912   0.277849  -2.955   0.0183 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.07663 on 56 degrees of freedom
Multiple R-squared:  0.7004,    Adjusted R-squared:  0.4382
F-statistic:  18.7 on 7 and 56 DF,  p-value: 0.0960512
```

Such a result is explained by the selected observation period, during which the company expanded the fleet of aircraft with new modern models (since 2017, the company has received 37 Airbus A320neo and 14 A321neo boards) with increased fuel efficiency and the ability to meet fluctuations in demand more flexibly, and thus opened additional routes. For 5 years – 2012 to 2017 – the number of routes grew by 6% every year (on average for the period), and in just 1 year from 2017 to 2018, this growth was 13.5% (Table 16). These actions resulted in a positive impact on the overall state of the business. Thus, in this particular case (in isolation from the general picture in the industry), with the commissioning of new boards an increase (to a certain level) in the dispersion in the engine fleet has a positive impact.

Table 16. Changes in routes number of EasyJet Plc. Source: Company’s annual reports.

Years	2012	2013	2014	2015	2016	2017	2018
N routes	605	633	675	735	803	862	979

The remaining indicators for fleet and engines dispersion did not bring significant results in this case.

6.0 Summary

Table 17 below contains data on the intercept coefficients of the percent of hedged fuel, presented in the form of the magnitude of their impact on the vulnerability of companies calculated by the Formula (8).

Table 17. Statistics of intercept indicators and the significance of the HDGPER factor.

Company / Indicator	Magnitude	Sagnificance
SAS	0,24%	10%
Ryanair	4,89%	5%
Easyjet	-1,74%	10%
Norwegian	0,28%	10%

Hedging has the greatest impact on Ryanair (p-value < 0.05) and also has the greatest positive effect on stability. P-value for other companies < 0.1 shows not so serious importance of this financial mechanism of cost reduction. The amount of influence exerted for SAS and Norwegian is less than one percent. Since Norwegian always hedges only small amounts of its needs, this is reflected in this indicator. SAS, more likely, as a value-carrier, is able to smooth out part of its increasing fuel costs by other operational methods. For EasyJet, the dynamics turned out to be negative. Perhaps this is due to the insufficient success of the forecasts of the company's analysts. Although the company hedges a large volume of kerosene (average 71%), the duration of hedging is mainly about 20 months, which is the largest indicator among all companies. Predicting the price movements of fuel over such a time interval is a difficult task, and high volatility in the markets in the 21st century adds risks with such a long hedge. However, this problem requires additional reanimation.

Thus, there is a noticeable tendency of large players to hedge a larger amount of fuel, and clearly large influence interceptions allow us to conclude that the strategies of financial fixing of fuel prices for low-cost carriers are of increased importance. Hypothesis **H1** is accepted.

The results of the SAS (NC) calculations (in Table 6) show the values obtained for modeling with the inclusion of the national currency in the regression. The values of the average adjusted R square compared to the modeling without inclusion turned out to be better, which indicates a more accurate prediction, and, accordingly, more accurate values of the intercept for the fuel price, therefore, in the second stage of the modeling, calculations were also carried out for both options, even though individual researchers (Smithson & Simkins 2005) received information that only a small percentage of firms from the total depend heavily on exchange rates. Hypothesis **H5** is accepted. Taking into account such a variable as the change in the price of the national currency can have a positive impact on the accuracy of models for assessing the financial performance of companies, however, it is necessary to take into account the emerging problems with auto-correlation.

Returning to the research questions that were raised at the beginning of the work, we can pay attention to the differences in the impact of hedging on companies.

SAS Group, that present the legacy-carriers strategy in this study, has the highest risk ratio among all other participants in the work, but uses fuel hedging rather as a secondary measure in maintaining stability, relying more on its operational hedging methods, such as a flexible fleet, a “carrier-within-carrier” structure and other cost reduction methods related to the work of other divisions of the group.

Low-cost carriers, represented by Ryanair and EasyJet, showed minimal or positive vulnerability to price spikes in the fuel market. They use more fuel, and pay great attention to maintaining reasonable prices, since part of the kerosene from direct operating costs is much higher for them than for value carriers. Booking kerosene for them, as already noted, is quite an important tool for maintaining competitive positions in the intra-niche struggle. Financial stability and a high credit rating allows managers to spend substantial funds on financial derivatives. With high hedging volumes, the impact of the success or failure of price and demand estimates on the overall well-being of companies also increases.

Nevertheless, high hedging rates can also have a negative impact due to the required financial investments, as it was noted in the analysis of indicators for Ryanair, whose vulnerability index increased with an increase in the percentage of hedged fuel. In the conditions of extreme volatility in recent years, the management of all 4 companies studied have adopted amendments to their strategies, now allowing them to reserve 0% of kerosene from the expected needs. Most likely, in the near future, companies will either reduce the duration of hedging, or they will book significantly smaller volumes in long-term periods to reduce risks.

It is impossible not to note both the significant impact of operational methods to reduce fuel vulnerability, and a significant difference in the impact of these factors on the selected airlines.

The unification of fleets, although it brings significant benefits to companies, leaves them in somewhat limited positions regarding the flexibility of operating this unified fleet. In the case of EasyJet, the use of aircraft from the same manufacturer, but with different models, allowed, apparently, to increase flexibility, while retaining some benefits of unification, which had a positive impact on the fuel efficiency of the company, from which it can be concluded that choosing a balance of operational flexibility and unification is key when making decisions about the future expansion of the fleet.

The assumptions about the significant influence of the composition of the fleet of propulsion systems turned out to be significant. The unification of the diverse composition of engines by models and families has a positive effect on the fuel vulnerability of companies, and may be even more significant than the unification of aircraft (Merkert 2022). Both carriers such as SAS, which have different machines, and companies with a unified fleet, such as Ryanair (the company received its machines at different times from different suppliers, which means different types of propulsion systems), may be interested in maintaining an optimal number of models or families.

All in all, extensive number of models of both aircraft and propulsion systems in listed companies, leave great opportunities for managers for further optimization of these indicators. Maintaining the successful pace of recovery after COVID-crisis, making decisions on increasing the fleet, leadership can pay attention to the well-sanctified in the scientific literature, and confirmed by this study, the strategy of unification of the fleet, while focusing on maintaining a balance more important in our opinion in the indicators of unification of the engine fleet.

As it was noted, an increase in the distance of routes can negatively affect stability. The influence of this factor may indicate the specifics of long-haul routes, their difference from short- and medium-range routes. First of all, in order for the company to effectively perform such flights, it is necessary to use suitable (large) aircraft, which reduces the unification of the fleet. The possibilities of tankering on such routes are reduced. With a decrease in demand in such a direction, the company often cannot replace the aircraft with a model with fewer seats due to the significant flight distance, which reduces disposal on such routes. All these conditions allow us to conclude about the importance of competent management of the company's route network. As a result, tankering and break-even load factor are the main indicators that are affected by the average length of routes.

7.0 Conclusion

7.1 Research summary

This work focuses on the elaboration and application of a two-stage approach to modeling the financial and operational performance of the company, correlated with its vulnerability to changes in the fuel market. The multi-linear regression model is used in the context of the historical modeling case study and allows us to re-examine the degree and significance of the influence of certain factors in the airline's business model, designed to reduce the uncertainty of financial flows. Narrowing the sample of companies and their separate consideration allows us to evaluate various business strategies in the context of their fuel efficiency, as well as to identify weaknesses and potential growth points for air carriers in the North European region.

The results of the work confirm the permissibility of applying the hypotheses of past studies about the positive impact of fleet unification to selected companies. Nevertheless, contradictory results were also found when, for some players, the expansion of families in the fleet had a positive effect on their fuel vulnerability, indicating the need to achieve a certain degree of operational flexibility in terms of choosing optimal models for specific types of routes – regional, long-range.

The patterns of determining factors for various strategies of the aviation business are determined. Large and stable airlines tend to hedge more fuel, whereas companies with low free financial flow or complex overall financial condition are not inclined to hedge large amounts of fuel. Low-cost airlines have a lower vulnerability coefficients but are more dependent on the volume of fuel booked, vise-versa value-carriers, which are more vulnerable to changes in kerosene prices, but not so much dependent on financial hedging strategies, relying more on operational methods to improve fuel efficiency. Also, the strengths of legacy-carriers' business strategy include their flexibility in using plane sizes suitable for routes, in contrast to which trends towards decreasing stability with increasing average route length have been identified, which also indicates the need for careful optimization of both the fleet and the route network, since such companies usually present their services in the long-haul transportation sector.

General indicators allow us to judge the method of financial hedging of fuel as a fairly effective way to reduce costs, although it did not show much effectiveness for some players with a more detailed analysis. Also, its use is not always available, especially in the current crisis state of the industry and some companies, when contractors have become less willing to provide security services to the industry (Swidan et al. 2019).

The most significant contribution of this work to the scientific literature is the study of the impact of engine standardization strategies. Currently, only a small number of works are presented, where standardization is evaluated by combining propulsion systems by Manufacturer. Developing this direction, this work also evaluates the possibilities of unification on the basis of the engine family and their model, which, as far as we know, has not been done by anyone yet. An increased, more significant (than on the basis of the Manufacturer) influence of combining this asset of companies on the basis of families and on the basis of individual models was found. Complementing and expanding the results of the work (Merkert 2022), the observed indicators of the conducted modeling allow us to propose a new approach to the study of this topic, opening up opportunities for new scientific papers.

7.2 Limitations of the study

The study is limited to only 4 companies, and it would be possible to investigate the behavior of a larger number of companies to determine the dependence of the company's strategy on decision-making in the field of hedging and fleet composition.

Since the indicators of financial and operational activity in the study of individual companies are taken in the form of quarterly changes, the composition of fleets, hedging indicators and propulsion systems do not change much in the interval of quarters, which reduces the sensitivity of the study in this aspect.

The factors of the hedging strategy are also expressed in just two variables, not all companies report hedging quarterly, some report information for the whole year at once.

Only SAS Group details the composition of the engine fleet in its reports. Information about other companies has been accumulated empirically and does not fully reflect reality. It is required to use more specific information databases, or to receive information directly from the technical departments of companies.

7.3 Suggestions for further research

Since the study showed that the diversification or unification of fleets can have both a positive and negative impact on various air carriers with different strategies, company managers and authors of scientific papers should pay attention to the development of fleet optimization systems that take into account many of the parameters used in the work – the business model, the average length of routes, etc. However, many variables can be included in the modeling to account for the full variety of business units of companies. Additional important variables can be accounting for cargo-type aircrafts, the amount of cargo transported both in the original cargo variants and using the "belly freight" option.

The topic of the impact on average length routes on companies is seen as important. A separate modeling, considering the number of home airports, tankering capabilities and the cost of the company's environmental contributions to the EU-ETS (European Union Emission Trading System), can become a serious and significant study for further optimization of the business.

Although hedging optimization systems and various strategies are certainly a well-researched and developed topic both in the scientific literature and in the field of corporate strategic and operational management, a deep understanding and analysis of all variables can bring significant benefits, given the enormous cash flows involved in this method of operational hedging. Optimization with the use of accounting for the required collateral (cost of hedging), various financial instruments (call, put, etc.) can be applied. More detailed description of the hedging strategy (breakdown by quarter) can be added.

The attempt to implement the currency exchange rate change factor failed, but it can be applied with other research methods where it is possible to avoid data auto-correlation. Accounting for all currencies that affect the company's activities in one way or another (for SAS, for example, it is Norwegian, Danish and Swedish krona in various proportions) can be an important component of evaluating methods of hedging funds (dollars for the purchase of kerosene) or fuel.

When further working with economic data, especially in the “time-series” format, attention should be paid to the detected delay in the impact of changes in trade-weighted exchange rates, as well as the cost of fuel futures on the value of the company's shares.

In our opinion, the topic of various strategies for the unification of the engine fleet should receive the greatest development, since it remains not fully disclosed in the scientific literature.

References

A. Kate, G. Niels. 2005. «To What Extent are Cost Savings Passed on to Consumers? An Oligopoly Approach.» *European Journal of Law and Economics* 323–337.

A. R. Bachwich, M. D. Wittman. 2017. «The emergence and effects of the ultra-low cost carrier (ULCC) business model in the U.S. airline industry.» *Journal of Air Transport Management* 155-164.

Adler, Michael, B. Dumas. 1994. «Exposure To Currency Risk: Definition And Measurement.» *Financial Management.*

B. Berghöfer, B. Lucey. 2014. "Fuel hedging, operational hedging and risk exposure — Evidence from the global airline industry." *International Review of Financial Analysis* 124-139.

B. Graham, T. M. Vowles. 2006. «Carriers within Carriers: A Strategic Response to Low-cost Airline Competition.» *Transport Reviews* 105-126.

Boyle, R. 2022. «Will the oil price hike derail the airline recovery?» *Gridpoint Consulting.* 13 March. Funnet May 14, 2022. https://www.gridpoint.consulting/blog/will-oil-prices-derail-the-recovery.

C. Smithson, B. J. Simkins. 2005. «Does Risk Management Add Value? A Survey of the Evidence.» *Applide Corporate Finance* 8-17.

D. Treanor, J. Simkins, A. Rogers, A. Carter. 2014. «Does Operational and Financial Hedging Reduce Exposure? Evidence from the U.S. Airline Industry.» *The Financial Review* 149-172.

Dar, Arif Billah. 2022. «On the Sustainable Nexus between Oil Prices and Aviation Stocks.» *Sustainable Operations and Computers* 168-175.

easyJet plc. 2021. "Results for the year ending 30 September 2021 ." *easyJet Corporate.* November 30. Accessed 04 15, 2022. https://corporate.easyjet.com/~/media/Files/E/Easyjet/pdf/investors/results-centre/2021/2021-full-year-results-release.pdf.

—. 2021. «Results for the year ending 30 September 2021 .» *corporate.easyjet.* 30 November. Funnet May 15, 2022. https://corporate.easyjet.com/~/media/Files/E/Easyjet/pdf/investors/results-centre/2021/2021-full-year-results-release.pdf.

Eisenberg, E. 2021. «SAS og Norwegians nye udfordring: Prisen på brændstof stiger drastisk – og ingen kender passagertallet i næste måned.» *Børsen.* 13 October. Funnet May 15, 2022. https://borsen.dk/nyheder/virksomheder/luftfartens-nye-presbold-prisen-paa-jetbenzin-stiger .

Ekeseth, Fredrick. 2021. *Oljeprisbykset rammer SAS og Norwegian hardt.* october 19. Accessed 04 15, 2022. https://e24.no/boers-og-finans/i/47RlQo/oljeprisbykset-rammer-sas-og-norwegian-hardt.

EUROCONTROL. n.d. *Daily Traffic Variation - States (2020).* Accessed 11 26, 2021. https://www.eurocontrol.int/Economics/2020-DailyTrafficVariation-States.html.

EUROCONTROL. 2019. *Fuel Tankering: economic benefits and environmental impact.* Think Paper, EUROCONTROL.

eurostat. u.d. *eurostat Data Browser.* Funnet 05 13, 2022. https://ec.europa.eu/eurostat/databrowser/.

Federal Reserve Economic Data. u.d. *Moody's Seasoned Aaa Corporate Bond Yield.* Funnet May 15, 2022. https://fred.stlouisfed.org/tags/series?t=interest+rate%3Bmoody%27s.

—. u.d. *Nominal Broad U.S. Dollar Index.* Funnet February 1, 2022. https://fred.stlouisfed.org/series/DTWEXBGS.

flightconnections.com. u.d. *Route Map.* Funnet May 16, 2022. https://www.flightconnections.com/route-map.

G. Allayannis, J. Ihrig, J. P. Weston. 2001. «Exchange-Rate Hedging: Financial versus Operational Strategies.» *American Economic Review* 391-395.

Gertner, J. 2021. «When Boeing put profit over quality in the 737 Max, the result was tragedy.» *The Washington Post.* 17 December. Funnet May 15, 2022. https://www.washingtonpost.com/outlook/when-boeing-put-profit-over-quality-in-the-737-max-the-result-was-tragedy/2021/12/15/69adefde-5397-11ec-9267-17ae3bde2f26_story.html.

H. Swidan, R. Merkert. 2019. «The relative effect of operational hedging on airline operating costs.» *Transport Policy* 70-77.

H. Swidan, R. Merkert, O. K. Kwon. 2019. «Designing optimal jet fuel hedging strategies for airlines – Why hedging will not always reduce risk exposure.» *Transportation Research Part A: Policy and Practice* 20-36.

Hassan Swidan, Rico Merkert. 2019. "The relative effect of operational hedging on airline operating costs." *Transport Policy* 70-77.

IATA. 2018. "IATA ECONOMICS' CHART OF THE WEEK." *IATA.* November 30. Accessed 04 15, 2022. https://www.iata.org/en/iata-repository/publications/economic-reports/fuel-hedging-large-differences-by-region-fewer-by-market/.

—. n.d. *Jet Fuel Price Monitor.* Accessed 04 15, 2022. https://www.iata.org/en/publications/economics/fuel-monitor .

K. Park, A. Whitley. 2018. *Cathay Pacific's CEO Has Some Broken Parts to Fix.* 07 03. Accessed 04 15, 2022. https://www.bloomberg.com/news/articles/2018-03-05/cathay-pacific-s-hogg-has-parts-to-fix-and-these-charts-show-why.

Kearney, Laila. 2020. *Explainer: What is a negative crude future and does it mean anything for consumers?* 21 April. Funnet May 13, 2022. https://www.reuters.com/article/us-global-oil-crash-explainer-idUSKBN22301M.

Keith J. Mason, William G. Morrison. 2008. «Towards a means of consistently comparing airline business models with an application to the 'low cost' airline sector.» *Research in Transportation Economics* 75-84.

Loudon, G. F. 2004. «Financial Risk Exposures In The Airline Industry: Evidence From Australia And New Zealand.» *Australian Journal of Management.*

Louis H. Ederington, Chitru S. Fernando, Thomas K. Lee, Scott C. Linn, Huiming Zhang. 2021. «The relation between petroleum product prices and crude oil prices.» *Energy Economics* Volume 94.

M. Naumann, L. Suhl, M. Friedemann. 2012. «A Stochastic Programming Model for Integrated Planning of Re-fleeting and Financial Hedging Under Fuel Price and Demand Uncertainty.» *Procedia - Social and Behavioral Sciences* 47-55.

Ma, Lingjie. 2022. «Negative WTI Price: What Really Happened and What Can We Learn?» *The Journal of Derivatives.*

Mercatus Energy Advisors. 2012. «A Beginners Guide to Fuel Hedging - Swaps.» *Mercatus Energy Advisors.* August. Funnet May 15, 2022. https://www.mercatusenergy.com/blog/bid/81907/a-beginners-guide-to-fuel-hedging-swaps.

Merkert, R. 2022. «The impact of engine standardization on the cost efficiency of airlines.» *Research in Transportation Business & Management.*

Nelson, Moffitt, Graves. 2005. «The impact of hedging on the market value of equity.» *Journal of Corporate Finance* 851-881.

Norges Bank. 2020. *I-44, Import-weighted krone exchange rate.* 2 September. Funnet May 15, 2022. https://www.norges-bank.no/en/topics/Statistics/i44 .

Norwegian Air Shuttle. 2022. «Norwegian Air Shuttle – Investor Presentation.» *norwegian.com.* April. Funnet May 15, 2022. https://www.norwegian.com/globalassets/ip/documents/about-us/company/investor-relations/reports-and-presentations/investor-presentations/norwegian-air-shuttle---investor-presentation-april-2022.pdf .

Nydahl, S. 1999. «Exchange rate exposure, foreigninvolvement and currency hedging offirms: some Swedish evidence.» *European Financial Management* 241-257.

OPEC. 2022. *Monthly Oil Market Report - May 2022.* 1 May. Funnet May 13, 2022. https://www.opec.org/opec_web/en/publications/338.htm.

Q. Walker, J. Kruger, S. Migiro, L. Sulaiman. 2014. «Hedging and Company Value – A Comparison between South Africa and United States of America.» *Asian Journal of Business and Management.*

R. Cobbs, A. Wolf. 2004. «Jet Fuel Hedging Strategies: Options Available for Airlines and a Survey of Industry Practices .» *Finance 467.*

Rapier, R. 2015. *The Boom-Bust Cycle - Five Stages of the Oil Industry.* 5 November.

Refinitiv. u.d. *Datastream.* Funnet February 1, 2022. https://solutions.refinitiv.com/datastream-macroeconomic-analysis?utm_content=Refinitiv%20Brand%20Product-OTHER-EMEA-G-EN-Exact&utm_medium=cpc&utm_source=google&utm_campaign=596226_PaidSearchInvestmentSolutionsBAU&elqCampaignId=16987&utm_term=refinitiv%20.

Reuters. 2020. «FACTBOX-Non OPEC+ crude oil supply cuts.» *Reuters.* 13 April. Funnet May 13, 2022. https://www.reuters.com/article/global-oil-non-opec-cuts-idUSL2N2C10SC.

Ryanair. 2021. "Ryanair Group Annual Report 2021." *Ryanair Group Corporate Web Site.* Accessed 04 15, 2022. https://investor.ryanair.com/wp-content/uploads/2021/08/FINAL_Ryanair-Holdings-plc-Annual-Report-FY21.pdf.

S. D. Treanor, D. A. Rogers, D. A. Carter, Simkins. 2014. «Exposure, Hedging, and Value: New Evidence from the U.S. Airline Industry.» *International Review of Financial Analysis.*

Sotthisopa, P. 2016. *FUEL PRICE EXPOSURE IN AIRLINE INDUSTRY.* THE DEGREE OF MASTER OF SCIENCE, THAMMASAT UNIVERSITY .

Sveriges Riksbank. 2022. *Effective exchange rate index - KIX and TCW.* 28 03. Funnet May 15, 2022. https://www.riksbank.se/en-gb/statistics/search-interest--exchange-rates/explanation-of-the-series/effective-exchange-rate-indices/.

Treanor, S.D. 2012. «The flexibility and benefits of operating a diverse fleet: An analysis using real options.» *Management Research Review* 462-472.

Trevor Hunnicutt, Jeff Mason. 2021. *U.S. calls on OPEC and its allies to pump more oil.* August 11. Accessed 04 15, 2022. https://www.reuters.com/world/middle-east/us-call-opec-its-allies-increase-oil-production-cnbc-2021-08-11/.

Venkat, M. 2020. «Inventory Managment in the Oil & Gas Industry & Business 4.0.» *IT is the Supply Chain.* 11 February. Funnet May 13, 2022. https://itsupplychain.com/inventory-management-in-oil-gas-industry-incorporating-business-4-0-behaviours/.

Williams, D. 2022. «ACMI LEASING APPEARS THE WAY TO GO FOR AIRLINES AS THE MARKET REMAINS UNCERTAIN.» *ACC Aviation.* 5 January. Funnet May 15, 2022. https://www.accaviation.com/acmi-leasing-appears-the-way-to-go-for-airlines-as-the-market-remains-uncertain/.

Zea, M. 2002. «Is Airline Risk Unmanageable?» *Mercer on Travel and Transport.*

Appendix

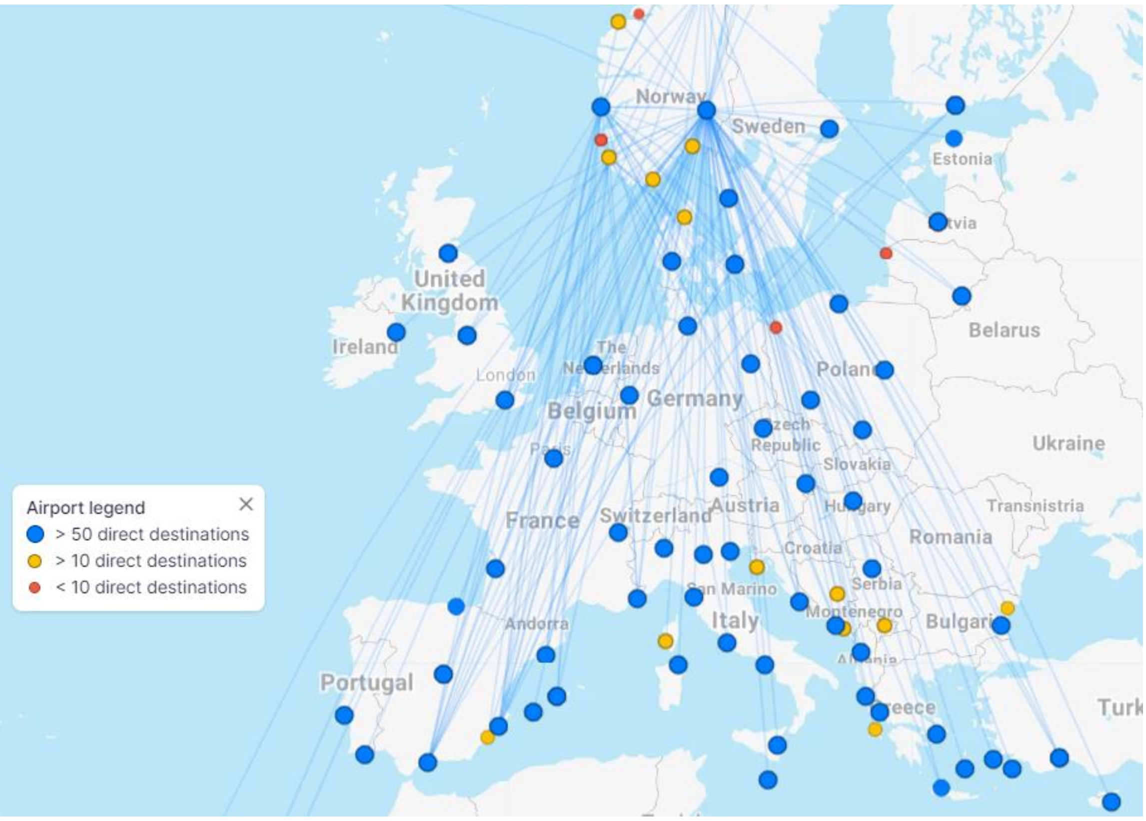

Figure 7. Norwegian Air Shuttle routes. Source: flightconnections

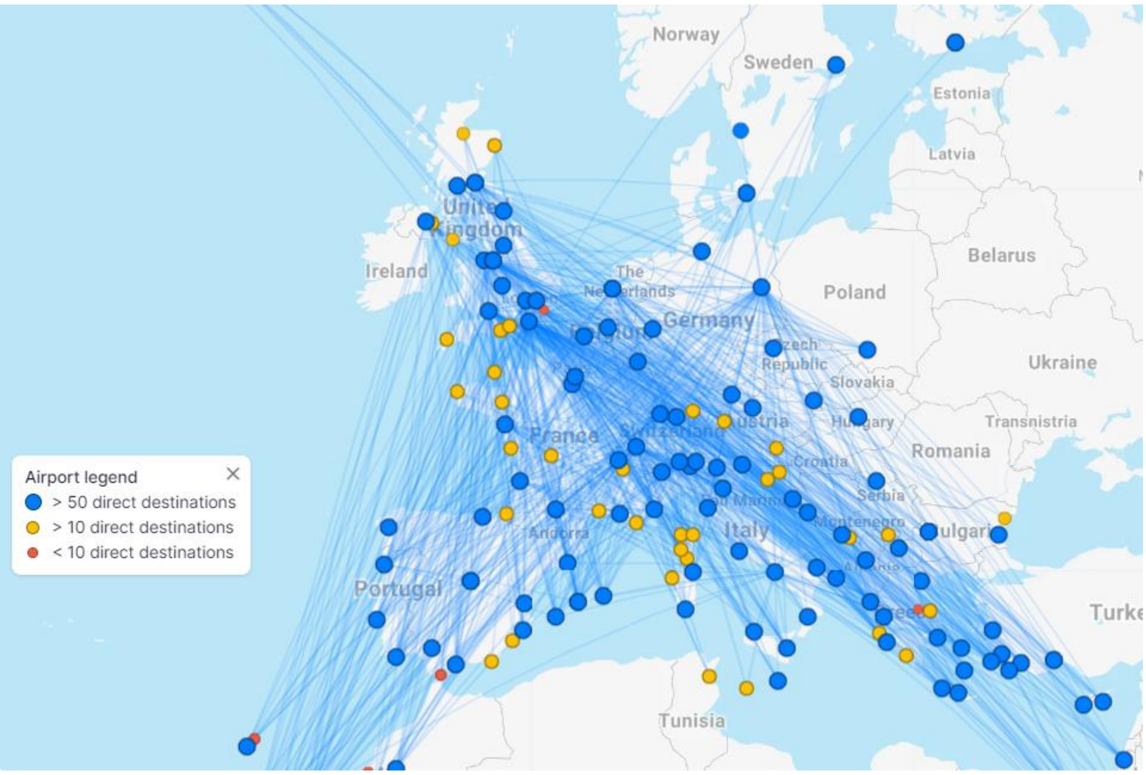

Figure 8. EasyJet routes. Source: flightconnections

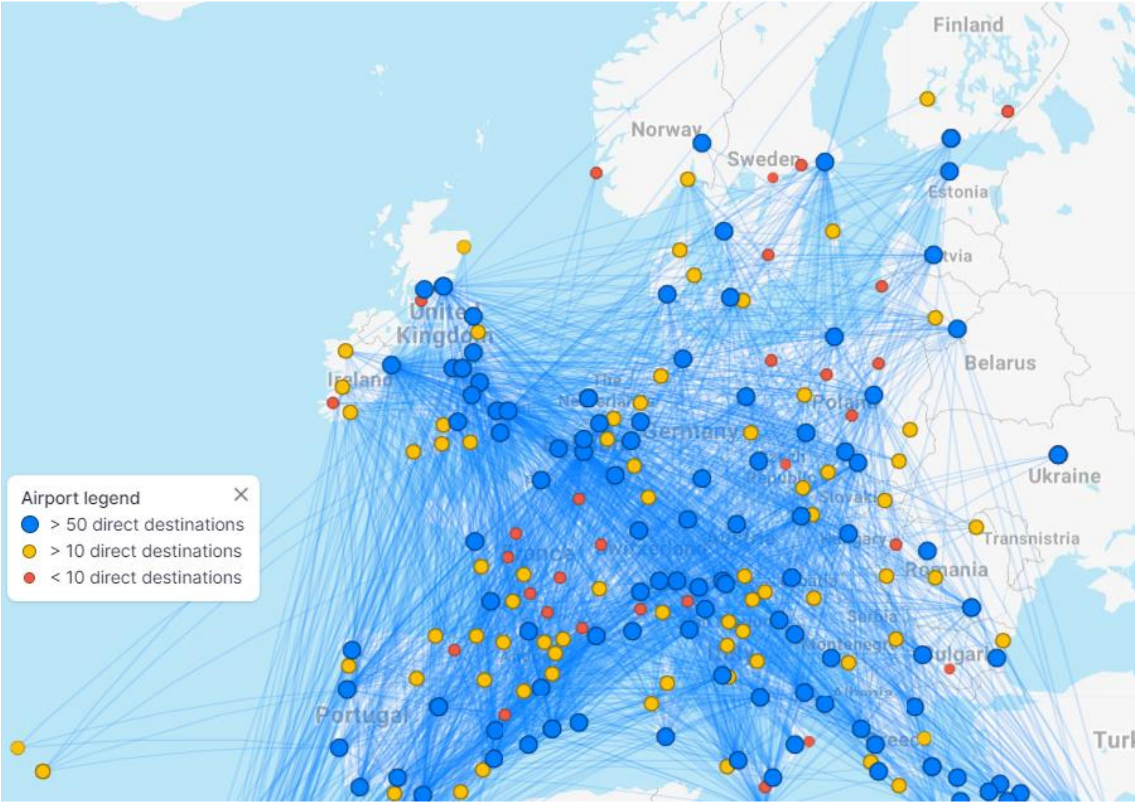

Figure 9. Ryanair routes. Source: flightconnections

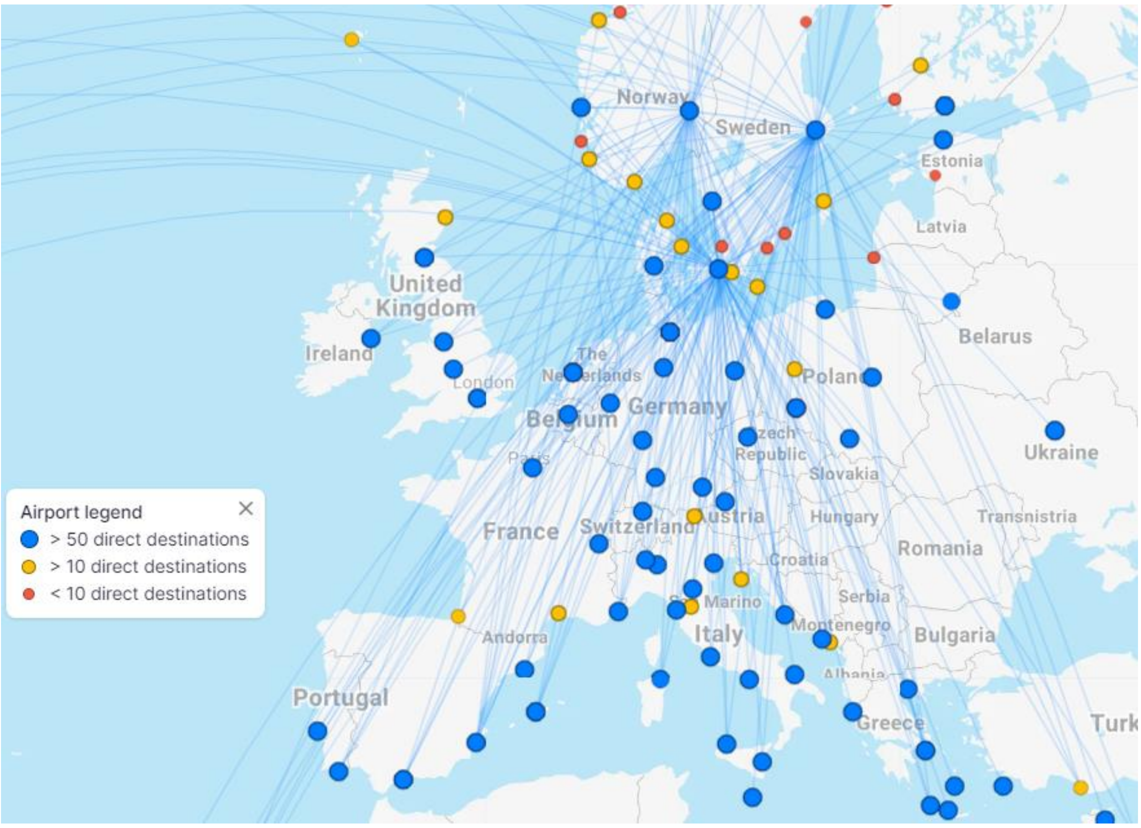

Figure 10. SAS Group routes. Source: flightconnections