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The financial cost and profitability structures of the European air navigation service providers for Covid-19 period: a Monte Carlo analysis

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Abstract: Civil aviation activities are open to various ambiguities regarding air traffic flow. Small changes in political, economic and technological bodies of civil aviation can change the direction of air traffic flow and air navigation. Likewise, the civil aviation industry and its dependent branch air logistics lived through hard times during the COVID-19 period. The airlines, airports, and service providers suffered from a lot of negativities. It was an expected result for Air Traffic Flow Management to come near a financial crisis with capacity deficiencies. This paper aims to investigate this period of 2017-2021 one more time, but with a slightly different simulation methodology which assumes the period lasted for 300 years and with specific variables of Return on Investment (ROI), Return on Assets (ROA), Return on Equity (ROE), Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) in Air Navigation Service Provider Industry of Europe. According to findings, geographical location (for Central Europe, Turkey, the Mediterranean region and the United Kingdom) and the situation of states regarding development, routes and the situation of airports are the main variables of profitability and investment structures of Air Navigation Service Providers. It also concluded that the financial and economic situation of Air Navigation Service Providers in Europe cannot be changed considering these variables if this period continues for 300 years because of air the main air traffic routes and airflow order of Europe.

1 Introduction

The sustainability of a healthy financial structure is always a great hardship for airlines and air logistic companies, especially in critical and hard times such as the COVID-19 period for aviation. These critical times often occur in civil aviation such as epidemics and pandemics, security crises such as 9/11, and economic and financial crises such as oil price recessions. On the other side, the congruence of OPEX and CAPEX is subjected to different works. For instance, they are good indicators of future-oriented cost analysis, cost efficiency, cost-dependent risk orientation and performances of the current business-making activities and especially they are beneficial in producing sector-related financial information, they can give insightful views on infrastructure utilization. On the other side, ROA, ROE and ROI are good ratios of the financial value of a company and the profitability of business activities and its trading forces. If they are utilized correctly, the users (stakeholders) of them can make comparisons between financial units. Particularly in turbulent and dynamic times. At the same time, The ROA, ROE and ROI measures impact the calculation of market capitalization. For these causes, they are indispensable parts of the financial communication and public disclosures of companies in current and future possibilities.

This analysis simulates the COVID-19 period for 300 years (iteration numbers of Monte Carlo simulations) in air traffic services With more clear words, it is asked the research question is “What can the financial and economic situation be in the following 300 years if the COVID-19 period continues during that period regarding 5 important measures which are Operational Expenditures (OPEX), Capital Expenditures (CAPEX), Return on Assets (ROA), Return on Equity (ROE) and Return on Investment (ROI) in ANSP (Air Navigation Service Providers) industry of Europe?”. By doing so, it aims to show the importance of the period in terms of countries and the financial vulnerability of ANSP (Air Navigation Service Providers) industries and companies to this period empirically. Depending on their efficiency in showing the quality of earnings, EBITDA (Earnings Before Interest, Tax, Depression and Amortisation) measures are utilized for the calculations of ROA, ROE and ROI. Besides these, CAPEX and OPEX measures are so efficient in the determination of expenditures and investment power of high technology industries such as ANSP. The research serves to fill a gap regarding the utilization of simulation for 300 years in the aviation industries' financial and economic comprehension.

2 Literature review

ANSPs, by providing Air Navigation Services (ANS), establish a crucial link between airlines and airport operators, making them a significant variable in the airline industry [1]. ANSPs are highly effective in ensuring the smooth completion of flights by regulating air traffic [2] and the flow of air traffic. They offer services such as air traffic control, routing, landing, and ground operations and they support air logistic activities and air transport. Through improvements, ANSPs increase the efficiency of air traffic usage and reduce costs [3]. The activities of ANSPs are financed through air navigation service charges collected from airlines using the airspace [4]. These charges are levied on all flights using the airspace, except for demonstration flights, humanitarian aid, training, or military flights [5]. These fees are not only a revenue source for ANSPs but also play a crucial role in shaping Europe's passenger and cargo air transportation, so air traffic flow. Statistically, air navigation service charges constitute approximately 5% of the cost of each sold airline ticket [6]. The European Commission allows ANSPs to recover the costs incurred for the services they provide. However, during periods of crisis in aviation, this cost recovery approach exacerbated the crisis by dividing the costs among fewer flights, leading to regulatory changes [2]. Initially, ANSPs were only permitted to cover their costs, but later they were allowed to generate and retain profits to mitigate financial issues for airlines during crises. ANSPs derive revenues from three different types of flights: domestic, international, and transit flights [5]. ANSPs can be categorised into three different types in terms of ownership: state organisations, commercialized organisations, or privatized organisations [2]. Initially established with state involvement, ANSPs have been commercialized and privatized over time due to issues like technological equipment inadequacies, facility deficiencies, and financial resource problems [6]. Many publications have examined the impact of privatisations on ANS. It has been found that ANSPs' capabilities are directly related to the privatization processes [7]. Additionally, in the long term, the privatization of ANSPs has reduced the charges paid by users for service acquisition due to commercial competition [3,7]. The commercialisation of ANSPs began with initiatives in New Zealand in 1987, followed by Australia and Canada adopting similar methods. A state-owned business was established, refunding the government's per cent [5].

To achieve higher profitability rates in the airline market and air logistics, the focus is mainly on aircraft and human resource efficiency levels. To achieve this goal, fleet planning departments of airline companies play an active role. Fleet and schedule planners first plan an effective flight schedule design. The design of the flight schedule is the starting point of airlines' planning and operations. Flight schedule: It shows the departure-arrival time of each flight leg, the flight points when the flights take place and the fleet type to be used in the flight. Therefore, tariff components determine the competitiveness and position of the airline among its flight destinations. It is an important criterion in the continuity of the efficiency and profitability structure of the airline business. The basis of design components; is operational suitability, economic efficiency and passenger satisfaction. Airlines want to minimize flight costs and achieve safety goals with high efficiency by focusing on the aircraft utilization rate in their fleet structures, grounding times of aircraft, flight network structures, flight frequencies, occupancy rates, and on-time departure and arrival factors. In addition, airport passenger and ground services activities, where airlines' flight operations are carried out, must be established following aviation safety rules and air traffic flow management rules.

EUROCONTROL is a significant organization in the integration and coordination of ANSPs in Europe [5]. EUROCONTROL focuses on advancing the constitution of the Single European Sky (SES), a European Union initiative, to address topics such as increasing traffic levels, high ANSP service costs, heterogeneous operational practices, and air network constraints faced by the European Air Traffic Management (ATM) system. Therefore, EUROCONTROL ensures an infrastructure for air traffic flow and air logistics.

In this analysis, to measure the financial capabilities of ANSP companies across Europe, Operational Expenditures (OPEX) raised as the first important variable as an indicator of project investments [8], although they do not directly contribute to the base and they correspond to the price of keeping the business functional and involve costs of technical and commercial functionals, management [9]. So, OPEX is the main answer to the question of how an ANSP sustain its production with cost [10] which can be counted as labour, machinery and equipment, property costs and administration [11]. With its financial nature and consistency in the indication of operational strength, OPEX is the main element in business processes and the efforts toward continual process improvement for years of big industries such as Toyota [12].

On the other side, Capital expenditures (CAPEX) are utilized in the situations of disposition, modification and replacement of settled assets and it has a direct impact on the company's future cost structure [13]. Govender et al, [14] underline that capital expenditure (CAPEX) is explained as an initial investment that involves the capital costs of all fixed assets (plant and machinery) and non-fixed assets (design and commissioning costs). Other negative cash flows, classified as expenditure, are accounted for in terms of operating expenditure (OPEX), tax, and depreciation.

In a financial statement analysis, revenue can be calculated through different methodologies such as EBIT (Earnings Before Interest and Tax) and EBITDA (Earnings Before Interest, Tax, Depression and Amortisation). It is also clearly emphasised that distinctions between EBIT and EBITDA can resource from the industrial context. If this criticism is intensified here, for example, after stating their importance, It can be underlined that EBITDA can be a clear and consistent indicator for manufacturing companies against service companies [15]. It utilizes the net profit ratio to account for the main differences in variables such as ROA and EBITDA margin [16]. Lukason [17] utilises EBIT for European micro-level manufacturing companies' gain. EBIT and EBITDA measures are utilized also by Andres [18] to understand founding-family ownership structures. As he realizes his deep analysis, he underlines particularly these two typical assessments to calculate the Return on Asset (ROA) ratio. Lopez et al. [19] give place to EBITDA values to calculate ROA in the profitability structure analysis of cheese-producing companies in Spain. According to the analysis of Bouwens et al. [20], EBITDA-reporting firms are relatively smaller, more leveraged, more capital intensive, less profitable and have longer operating cycles than non-EBITDA reporting firms. It should be underlined the importance of EBITDA in financial and value-dependent decision-making.

3 Methodology

There are five important financial indicators ratios in this analysis. They are Operational Expenditures (OPEX), Capital Expenditures (CAPEX), Return on Equity (ROE), Return on Asset (ROA) and Return on Investment (ROI) of 33 ANSP companies or air traffic flow regulators. In the calculation process of ROE, ROA and ROI, EBITDA (Earnings Before Investment, Depreciation and Amortisation) values are utilised for the periods of 2017 and 2021 as argued in the writing review section. After ROE, ROA and ROI values are calculated, the values are simulated with the Pseudo Monte Carlo Method for 300 iteration numbers as in the Al-Kharusi & Murthy [21] work in Excel program by the utilization parametres of standard deviation, mean and random numbers. Their average, variance, standard deviations, maximum and minimum values are given in the following Tables. It should be noted here that there are several approaches in a huge literature regarding iteration numbers.

Monte Carlo Models are a strong tool in many fields of different sciences. It is known that the algorithms based on this method give statistical estimates for any linear function of the solution by performing random sampling of a certain random variable whose mathematical expectation is the desired function [22]. They can be utilized for risk management regarding different viewpoints [23] and even psychological research with correct sample sizes [24]. In designing a Monte Carlo analysis, the events that take their describing forces from a case or a simulation are very important. The logic of a Monte Carlo method takes a last shape with different types, Bonate [25] underlines that the sampling distribution of the model inputs should be defined a priori (before-experiment processes), for example, a normal distribution with mean μ and variance σ2. Monte Carlo simulation can explain the model repeatedly, each time drawing a different random set of inputs from the sampling distribution of the model parameters, the result of which will be a set of possible outputs and underlines the critical importance of Random Number generation or Law of Random number in computer science. At the same time, Random Number Generation is named as Pseudo-random Generators. With the utilization of a Monte Carlo Model, the users and theorists overcome the uncertainty [26]. Nonetheless, the main questions of the Monte Carlo Model are the validity of the algorithms in principle, as well as the accuracy of the results that can be obtained in practice [27]. Ferson [28] underlines the problems of the Monte Carlo methods underlying 4 important emphases; i) Like most methods based on probability theory, Monte Carlo methods are data intensive. Consequently, they usually cannot produce results unless a considerable body of empirical information has been collected, or unless the analyst is willing to make several assumptions in the place of such empirical information. ii) Although appropriate for handling variability and stochasticity, Monte Carlo methods cannot be used to propagate partial ignorance under any frequentist interpretation of probability. iii) Monte Carlo methods cannot be used to conclude that exceedance risks are no larger than a particular level. iv) Finally, Monte Carlo methods cannot be used to effect deconvolutions to solve back calculation problems such as often arise in remediation planning. Besides their advantages in the detection of optimality problems in finance [29], For Chen and Hong [30], Monte Carlo simulations utilise financial decision analysis, financial risk assessment, financial risk management, monetary portfolio management and optimisation, and financial strategic planning can be realised with Monte Carlo Methods. In classical evaluation criteria, a Monte Carlo method can be described regarding two dimensions such as data conformity of the analytical model and validation of the Mathematical model [31].

Nevertheless, the nature of the science branch and the intensity of risk gain importance in this context. In clearer words, there can be differences between social sciences, natural and engineering sciences regarding iteration numbers.

4 Findings

The main findings of 5 ratios are presented in the following 5 tables. The ROA, ROE and ROI scores are calculated by benefiting EBITDA values. At the end of the day, they are specific measures of how a company utilize its resources to create more value. These resources are assets, shareholders equity and investments. The planning, retaining and conducting of these resources are problematic, accordingly, the transformation of these resources to a return is another problem for countries. ANSPs are strategic companies for states and governments, nevertheless, the last form of Air Traffic Management is designed by regulators and authorities. In cases of emergencies, like COVID-19, the situation and results can be complex for states. The only financial resources of ANSP are flights, flight rates and air traffic flow tremendously decreased during the COVID-19 times. Without the financial aid of the states and effective financial management, the ANSP would suffer from the crisis. For this cause, the research findings gain importance for the future. Table 1 shows the OPEX (Operational Expenditures) predictions of ANSPs.

Table 1 OPEX (Operational Expenditures) Predictions

	Mean	Variance	Standart Dev.	Maks	Min	Country
Albcontrol	-2122.9	391038.1	625.330432	-76.451	-4141.38	Albania
ANS CR	-2886.31	235535	485.3194542	-1298.05	-4452.85	Czech
Fintraffic	-64.8163	65.51633	8.094216134	-38.3273	-90.9433	Finland
ARMATS	-3508.2	131902.3	363.1835421	-2319.65	-4680.5	Armenia
Austro Control	-237.861	2509.53	50.09521175	-73.9204	-399.561	Austria
Avinor Flysikring	-1892.48	29727.01	172.4152213	-1330.05	-2448.14	Norway
BULATSA	-167.104	739.2837	27.18977156	-78.4085	-254.73	Bulgaria
Croatia Control	-551.04	954.8651	30.90089091	-450.238	-650.626	Croatia
DFS	-1096.71	4860.481	69.71714964	-869.287	-1321.39	Germany
DHMI	-2.7939	0.839766	0.91638747	0.195435	-5.7472	Türkiye
DSNA	-1481.54	625.4605	25.009209	-1399.7	-1562.27	France
EANS	-16.8469	2.379024	1.542408352	-11.7992	-21.8256	Estonia
ENAIRE	-655.968	3239.44	56.91607706	-469.705	-839.684	Spain
ENAV	-608.849	336.0728	18.33228849	-548.855	-668.023	Italy
Hungaro Control	-27.0253	1.68764	1.299092019	-22.774	-31.2186	Hungary
IAA	-147.708	22.82272	4.777313116	-132.074	-163.128	Ireland
LFV	-2625.68	118639.3	344.4404987	-1498.47	-3737.49	Sweden
LGS	-21.5436	5.119026	2.262526477	-14.1393	-28.8467	Latvia
LPS	-53.4893	173.0126	13.15342497	-10.4435	-95.9466	Slovak republic
LVNL	-218.627	417.3622	20.42944413	-151.77	-284.57	Netherlands
MATS	-19.0232	1.271858	1.12776698	-15.3325	-22.6634	Malta
M-NAV	-824.124	13441.64	115.938102	-444.707	-1198.36	North Macedonia
MOLDATSA	-157.529	407.4915	20.18641843	-91.4676	-222.688	Moldova
NATS	-619.046	708.1677	26.61142021	-531.958	-704.944	United Kingdom
NAV Portugal	-175.179	118.9642	10.90706989	-139.485	-210.385	Portugal
NAVIAIR	-976.292	17789.18	133.3760681	-539.807	-1406.81	Denmark
Oro Navigacija	-21.1055	9.791503	3.129137685	-10.8652	-31.2059	Lithuania
PANSA	-761.572	4089.291	63.94756783	-552.298	-967.986	Poland
ROMATSA	-893.877	478.6348	21.87772387	-822.28	-964.495	Romania
Skyguide	-392.148	532.3552	23.07282469	-316.64	-466.624	Switzerland
Slovenia Control	-30.3055	5.95982	2.441274319	-22.3162	-38.1856	Slovenia
SMATSA	-7.81604	0.404822	0.636255861	-5.73384	-9.86978	Serbia and Montenegro

Operational expenditures (OPEX) show a clear picture of an ANSP's activities-dependent expenditures regarding maintenance, rent, equipment, inventory costs, marketing, payroll, insurance, step costs, and funds allocated for research and development. According to our Monte Carlo analysis results on OPEX, all of the countries will be subjected to operational costs for the research period. On the other side, developed countries and aviation countries such as Germany, France, Sweden, Denmark and Norway Air Navigation Service Providers (ANSP) tend to realise more operational costs than other countries. Table 2 shows the results of the simulation for CAPEX (Capital Expenditures) predictions.

Table 2 Capex (Capital Expenditures) Predictions

	Mean	Variance	Standart Dev.	Maks	Min	Country
Albcontrol	-506.866	137840.9	371.269312	708.1457	-1705.27	Albania
ANS CR	-802.549	36419.25	190.8382711	-178.014	-1418.55	Czech
Fintraffic	-3.92931	3.997475	1.999368752	2.613806	-10.383	Finland
ARMATS	-525.01	80084.19	282.9915104	401.1049	-1438.47	Armenia
Austro Control	-26.5795	27.45004	5.239278551	-9.43346	-43.4911	Austria
Avinor Flysikring	-385.298	10065.92	100.329069	-58.0151	-708.634	Norway
BULATSA	-23.8277	38.64405	6.216434145	-3.54912	-43.8617	Bulgaria
Croatia Control	-95.3044	867.4117	29.45185362	0.770208	-190.22	Croatia
DFS	-103.522	227.4705	15.08212451	-54.3225	-152.128	Germany
DHMI	-1.20216	0.076174	0.275996413	-0.30183	-2.09162	Türkiye
DSNA	-198.966	174.0552	13.19299933	-155.791	-241.551	France
EANS	-4.64272	6.798849	2.607460232	3.890426	-13.0592	Estonia
ENAIRE	-97.0058	400.7021	20.01754357	-31.4966	-161.62	Spain
ENAV	-105.988	333.6197	18.26525808	-46.2137	-164.946	Italy
HungaroControl	-5.46383	2.454688	1.566744494	-0.33652	-10.5211	Hungary
IAA	-19.2714	90.05216	9.489581859	11.78415	-49.9023	Ireland
LFV	-393.803	19172.69	138.4654995	59.33794	-840.749	Sweden
LGS	-5.56363	4.661598	2.159073381	1.502132	-12.5328	Latvia
LPS	-6.08391	7.77634	2.788608991	3.042065	-15.0851	Slovak republic
LVNL	-49.0818	316.8936	17.80150437	9.175243	-106.542	Netherlands
MATS	-2.0796	1.826213	1.35137457	2.342896	-6.44164	Malta
M-NAV	-62.9512	3706.096	60.87771038	136.2765	-259.456	North Macedonia
DATSA	-12.7091	92.8623	9.636508634	18.82721	-43.8144	Moldova
NATS	-137.565	1749.455	41.82648664	-0.68365	-272.574	United Kingdom
NAV Portugal	-23.5221	40.75122	6.383668308	-2.63094	-44.1276	Portugal
NAVIAIR	-102.377	556.6386	23.59319011	-25.1662	-178.532	Denmark
Oro Navigacija	-4.95836	17.43561	4.175596526	8.706648	-18.4366	Lithuania
PANSA	-165.723	2218.34	47.099252	-11.5863	-317.752	Poland
ROMATSA	-44.1069	147.5389	12.14656119	-4.35618	-83.3142	Romania
Skyguide	-59.6107	279.5858	16.72082066	-4.89032	-113.583	Switzerland
Slovenia Control	-2.73126	4.432513	2.105353313	4.158699	-9.52703	Slovenia
SMATSA	-2.04063	0.064881	0.25471692	-1.20704	-2.86282	Serbia and Montenegro

Capital Expenditure (CAPEX) includes the investment projects of ANSP companies. According to our Monte Carlo results developed and aviation countries realized investments in the projects of ANSP-related activities such as Germany, France, Sweden, Denmark and Norway Air Navigation Service Providers (ANSP). ROA (Return on Assets) predictions are given in Table 3.

Table 3 ROA (Return on Asset) predictions

	Mean	Variance	Standart Dev.	Maks	Min	Country
Albcontrol	0.122947	0.002305	0.048011183	0.280068	-0.03203	Albania
ANS CR	0.036821	0.015504	0.124513749	0.444304	-0.36509	Czech
Fintraffic	0.077852	0.065852	0.256615935	0.917651	-0.75047	Finland
ARMATS	0.199721	0.035039	0.187187735	0.81231	-0.40449	Armenia
Austro Control	0.018968	0.005323	0.07295958	0.257734	-0.21654	Austria
Avinor Flysikring	0.004397	0.005462	0.073905408	0.245483	-0.23378	Norway
BULATSA	0.096997	0.001098	0.033141901	0.205109	-0.00981	Bulgaria
Croatia Control	0.117879	0.008307	0.091143357	0.415197	-0.17585	Croatia
DFS	0.045992	0.000905	0.030083454	0.144127	-0.05096	Germany
DHMI	0.214072	0.01309	0.114411505	0.587293	-0.15465	Türkiye
DSNA	0.123595	0.001476	0.038417267	0.249319	-0.00041	France
EANS	0.176904	2.379024	1.542408352	5.224573	-4.80176	Estonia
ENAIRE	0.048282	0.101237	0.318177794	1.089547	-0.97875	Spain

ENAV	0.114381	0.000882	0.029696301	0.211565	0.018526	Italy
HungaroControl	0.055496	0.026256	0.162037759	0.58578	-0.46754	Hungary
IAA	0.083237	0.002139	0.046254117	0.234608	-0.06606	Ireland
LFV	0.040208	0.000816	0.028561529	0.133678	-0.05198	Sweden
LGS	0.095908	0.017025	0.130479105	0.522912	-0.32526	Latvia
LPS	0.017585	0.013974	0.11821327	0.404448	-0.36399	Slovak republic
LVNL	-0.03276	0.026543	0.162921717	0.500412	-0.55865	Netherlands
MATS	0.06555	0.007447	0.086296104	0.347962	-0.213	Malta
M-NAV	0.03589	0.040386	0.200963157	0.69356	-0.61279	North Macedonia
MOLDATSA	0.03783	0.025847	0.160769479	0.563963	-0.48111	Moldova
NATS	0.114474	0.001333	0.036506266	0.233944	-0.00336	United Kingdom
NAV Portugal	0.046009	0.001428	0.037793199	0.16969	-0.07598	Portugal
NAVIAIR	0.064777	0.00079	0.028108212	0.156764	-0.02595	Denmark
Oro Navigacija	0.081961	0.004502	0.067099796	0.301551	-0.13463	Lithuania
PANSA	0.116673	0.008256	0.090862924	0.41403	-0.17662	Poland
ROMATSA	0.027912	0.004569	0.067597634	0.249131	-0.19028	Romania
Skyguide	0.013969	0.016954	0.130208358	0.440088	-0.40632	Switzerland
Slovenia Control	0.0457	0.074755	0.273413565	0.94047	-0.83684	Slovenia
SMATSA	0.027242	0.012887	0.113522085	0.398753	-0.33919	Serbia and Montenegro

According to ROA results, The ANSPs of Armenia, Türkiye, and Poland realized high asset utilization regarding EBITDA. ROE (Return on Equity) prediction results are shown in Table 4.

Table 4 ROE (Return on Equity) predictions

	Mean	Variance	Standart Dev.	Maks	Min	Country
Albcontrol	0.143047	0.003228	0.056814884	0.328978	-0.04034	Albania
ANS CR	0.028638	0.028195	0.167913317	0.578149	-0.51336	Czech
Fintraffic	0.078425	0.883347	0.939865591	3.154219	-2.95532	Finland
ARMATS	0.232204	0.046132	0.214782706	0.935099	-0.46108	Armenia
Austro Control	1.55244	12.80519	3.578433567	13.26318	-9.99822	Austria
Avinor Flysikring	0.031695	0.469784	0.685407639	2.267557	-2.17721	Norway
BULATSA	0.117189	0.001727	0.041554099	0.252742	-0.01673	Bulgaria
Croatia Control	0.200961	0.024763	0.157361876	0.714289	-0.30618	Croatia
DFS	-0.14898	0.01559	0.124860562	0.258331	-0.55137	Germany
DHMI	0.307747	0.021539	0.146760251	0.786492	-0.16523	Türkiye
DSNA	0.353489	0.004522	0.067246032	0.573557	0.136428	France
EANS	0.369796	0.121409	0.34843746	1.510089	-0.75491	Estonia
ENAIRE	0.02138	0.222579	0.47178258	1.565331	-1.50146	Spain
ENAV	0.216205	0.001747	0.041796933	0.352989	0.08129	Italy
HungaroControl	0.046271	0.05713	0.239018974	0.828482	-0.72525	Hungary
IAA	0.150617	0.0069	0.08306864	0.422467	-0.11752	Ireland
LFV	-0.97314	0.401276	0.633463557	1.099921	-3.01787	Sweden
LGS	-0.34428	2.108381	1.452026402	4.407604	-5.03121	Latvia
LPS	-2.94201	34.20485	5.848491402	16.1977	-21.8201	Slovak republic
LVNL	0.639071	0.966004	0.982854879	3.855552	-2.53344	Netherlands
MATS	0.099283	0.029575	0.171974781	0.662086	-0.45583	Malta
M-NAV	0.035346	0.058141	0.241124632	0.824448	-0.74297	North Macedonia
MOLDATSA	0.049451	0.031921	0.178663568	0.634143	-0.52725	Moldova
NATS	0.29885	0.003407	0.058369826	0.48987	0.11044	United Kingdom
NAV Portugal	0.149641	0.014145	0.118931551	0.538855	-0.23425	Portugal
NAVIAIR	0.111629	0.001672	0.040887001	0.245435	-0.02035	Denmark
Oro Navigacija	0.104294	0.007945	0.089133389	0.395991	-0.18342	Lithuania
PANSA	0.210895	0.024161	0.155438453	0.719581	-0.29084	Poland
ROMATSA	1.221329	26.15086	5.11379073	17.95667	-15.2852	Romania
Skyguide	0.009219	0.085911	0.293105029	0.968431	-0.93688	Switzerland

Slovenia Control	-0.07361	0.43374	0.658589689	2.081685	-2.19944	Slovenia
SMATSA	0.019692	0.038909	0.197253926	0.665223	-0.61701	Serbia and Montenegro

According to ROE results, the ANSPs of Austria, Romania, Italy, and Croatia realised high equity utilisation regarding EBITDA. ROI (Return on Investment) prediction results are given in Table 5.

Table 5 ROI (Return on Investment) predictions

	Mean	Variance	Standart Dev.	Maks	Min	Country
Albcontrol	-2.94104	19.34883	4.398730612	11.4542	-17.1395	Albania
ANS CR	-0.28274	1.279359	1.131087445	3.418843	-3.93373	Czech
Fintraffic	-0.47002	19.49105	4.414866908	13.97803	-14.7206	Finland
ARMATS	-8.93839	89.63603	9.467630731	22.04527	-39.4985	Armenia
Austro Control	0.741382	4.890644	2.21148	7.978648	-6.39695	Austria
Avinor Flysikring	0.018397	1.030456	1.01511381	3.32979	-3.25307	Norway
BULATSA	-0.27974	1.285521	1.133808043	3.418843	-3.93373	Bulgaria
Croatia Control	-0.58755	4.525179	2.127246716	6.351723	-7.44314	Croatia
DFS	-1.07768	0.655478	0.809615963	1.563359	-3.68687	Germany
DHMI	-2.24606	1.251536	1.118720527	1.40331	-5.85142	Türkiye
DSNA	-1.08128	0.073853	0.271759217	-0.19192	-1.95847	France
EANS	-1.42266	1.559276	1.248709803	2.663858	-5.45331	Estonia
ENAIRE	0.020227	0.241147	0.491066994	1.627288	-1.56487	Spain
ENAV	-3.04413	0.311606	0.558216555	-1.21732	-4.84597	Italy
HungaroControl	-1.17612	0.268692	0.518355126	0.520244	-2.84929	Hungary
IAA	-0.48121	0.454357	0.674059988	1.724709	-2.65698	Ireland
LFV	0.594221	0.292871	0.541175559	2.365267	-1.15261	Sweden
LGS	0.105532	0.022929	0.151423736	0.601079	-0.38324	Latvia
LPS	0.026364	0.023507	0.153320715	0.52812	-0.46853	Slovak republic
LVNL	0.241947	2.421094	1.555986522	5.334052	-4.78055	Netherlands
MATS	-1.35314	2.839509	1.68508428	4.161444	-6.79235	Malta
M-NAV	-2.61935	26.74442	5.171500655	14.30484	-19.3122	North Macedonia
MOLDATSA	1.248736	28.70816	5.358000042	18.78327	-16.0461	Moldova
NATS	-4.02552	32.00269	5.657091968	14.48781	-22.2858	United Kingdom
NAV Portugal	-0.79436	0.400074	0.632514039	1.275599	-2.83602	Portugal
NAVIAIR	-0.5463	0.793294	0.8906703	2.368497	-3.42125	Denmark
Oro Navigacija	-1.66601	3.135605	1.770763958	4.128972	-7.38178	Lithuania
PANSA	-1.91655	6.142803	2.47846781	6.194454	-9.91668	Poland
ROMATSA	0.088222	0.036086	0.18996277	0.709892	-0.52495	Romania
Skyguide	0.04633	2.400141	1.549238945	5.116353	-4.95439	Switzerland
Slovenia Control	-0.71803	18.09658	4.254007864	13.20359	-14.4493	Slovenia
SMATSA	-0.33218	1.125599	1.060942399	3.139851	-3.75674	Serbia and Montenegro

According to ROI results, the ANSPs of the Netherlands, Latvia, and Slovak Republic realized high investment utilization regarding EBITDA.

5 Discussion and conclusions

As seen in the findings section, geographic locations have great importance for Air Navigation Service Providers' financial profitability and investments. Considering the reality that taxes and fees for air carriers have deep impacts on the economic structures of these state-based companies, flights and route selection are determinative variables. Besides these geographical location impacts, tax and fee regimes of countries, correct and definite high-technology selection should be the subject of more detailed analysis. In the Figure 1, there is an explanation of European air traffic. According to it, Central Europe, Turkey and Mediterranean region and the United Kingdom are important geographies in the defining of air transport and air transit ways of the European continent, therefore the findings are expected and desired results regarding financial profitability and investment (expenditure) structures.

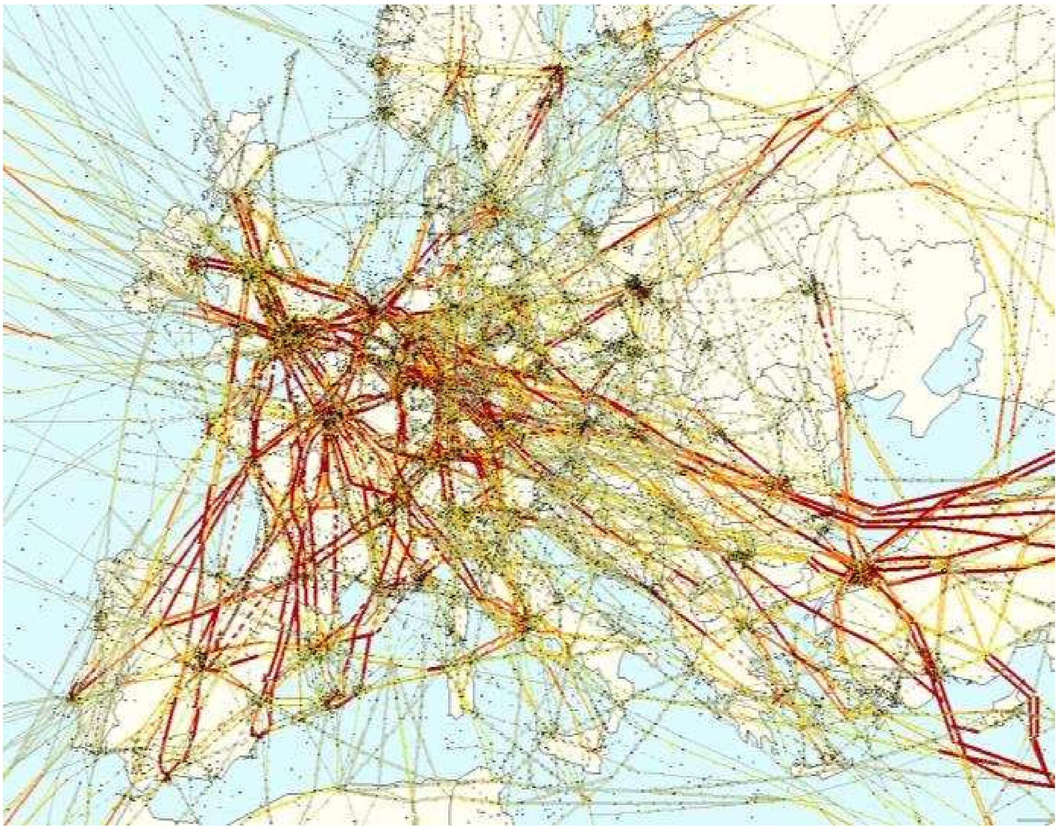

Figure 1 Density plot of European air traffic
Source: [32]

On the other hand, the airport's utilization in the European Zone approves the importance of findings one more time considering the busiest airports of the European continent in Figure 2. Nevertheless, the timespan of 2017-2022 is so complex because of the reality of Covid-19. Depending on the reality of cargo transportation and cargo-related logistics, the busy airspace regions did not feel the crisis but profitability and investment values are so low for other countries. The research presents that some states governed the crisis period better than other states regarding OPEX, CAPEX, ROA, ROE and ROI. If this period continues for 300 years, the results should be so dark for other countries that are out of the main routes regarding Air Navigation Services.

It should be underlined that the governance and management of ANSP structures, air traffic flow and capacity management and air logistic activities have a lot of dynamics, today there are different projects in the air traffic governance body of Europe such as SESAR (Single European Sky Air Traffic Management Research). As in every logistic and civil air transportation activity, standardization [33], and the selection of correct, efficient, effective routes can be considered some important items for future safety, securely, environmentally friendly, and economic [34]. To ensure these items one by one, more widespread and comprehensive governance is a necessity in political, legal, technological and economic dimensions. Another important dilemma is to prepare for the next crisis.

As stated many times, civil air transportation and air logistics can be easily manipulated with a crisis structure because of its highly political, technological and economic components. The states should protect their independence in the air, while they protect their financial and technological development regarding air flow and air traffic. Therefore, the balance between the value of the main determinants (safety and security) of civil aviation and profit-seeking motivation will gain importance in the next steps for Europe which suffered from international conflicts such as the Russia-Ukraine War, and the Israel-Palestine War and competition with the United States and China. The existence of AIRBUS should be used as an opportunity and all European countries should benefit from the advantages of AIRBUS climate like in the example of BOEING and the impacts of the BOEING networks on the world. The effective contribution of African and Asian governments to civil air transportation and air logistics activities will change the main routes and the financial position of ANSPs in Europe.

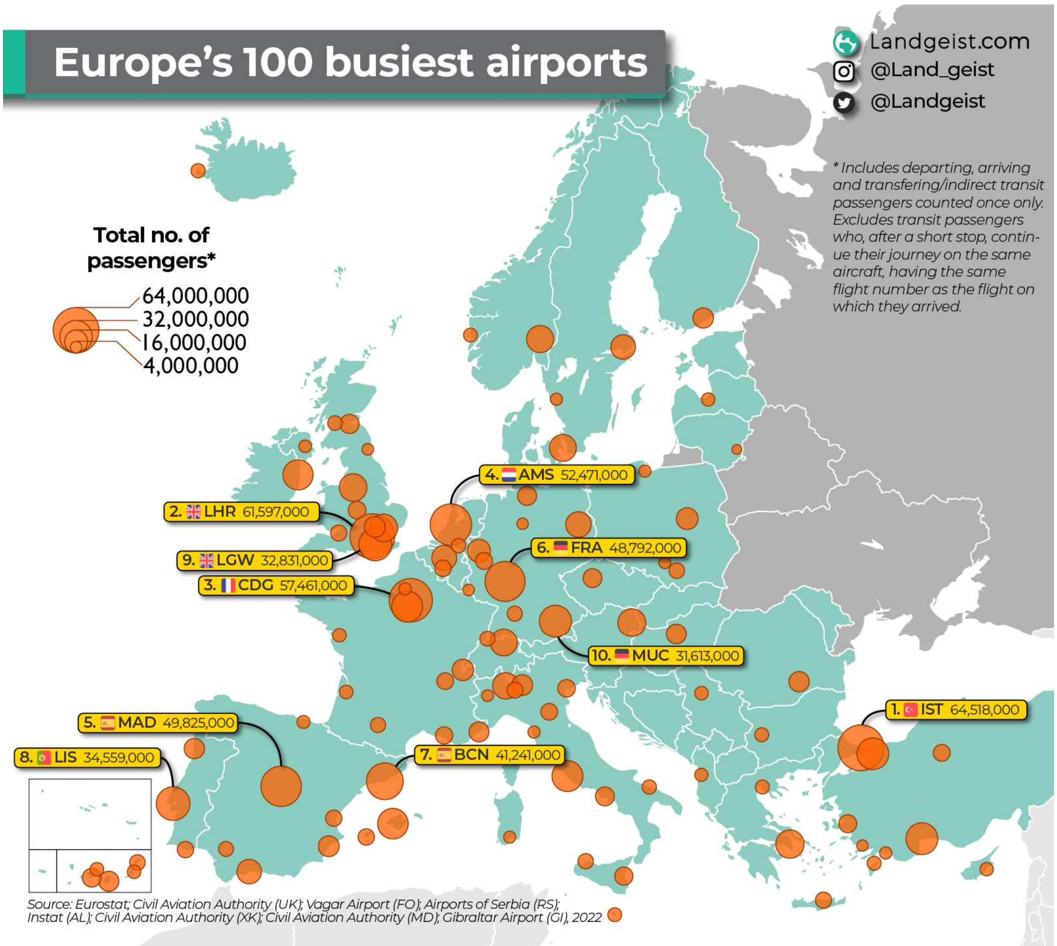

Figure 2 Europe's 100 busiest airports
Source: [35]

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