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15, Mesogeion Avenue, Athens 115 26, Greece.
Telephone: +30 210 64 24 401
Facsimile: +30 210 64 24 401
Website: http://www.aviationsociety.gr

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Book Reviews should be between 1,000 and 1,500 words. They should provide factual information (e.g. book publisher, number of pages and ISBN, price on the publisher's website) and critically discuss the contents of a book mainly in terms of its strengths and weaknesses.

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EDITORIAL

This issue collects four papers focusing on a variety of topics related with the contemporary air transport environment.

In the first paper, **Rebecca Gili and Luis A. Gil-ALana** investigate whether Covid-19 has had a temporary or permanent impact on the air traffic trends, using a long memory class of models that uses fractional integration in RPKs and flight data in a European scale. Results indicate that the trend was mean reverting when considering data before Covid-19, but the shock was so strong and long-lasting, that it produced a change to non-mean-reversion results after Covid-19, thus requiring intervention on the part of authorities or external factors since the series will not return by themselves to their original long-term projections.

Eugene Pik, in the second paper, provides a comprehensive overview, including a historical background, current situation analysis, and an exploration of potential future consequences, presenting case studies to showcase strategies employed by airlines and organizations to combat the problem, such as training local individuals, expanding flight capacities, partnering with flight schools, implementing autonomous aircraft plans, and introducing innovative training programs, thus delivering valuable insights and influence decision-makers and stakeholders to take proactive measures in addressing the pilot shortage

Academic literature gap on the issue of neuromarketing application in the aviation sector has been observed by **Marietta Fragkogianni, Elen Paraskevi Paraschi and Eirini Vlassi**, who reviewed in this paper more than eight hundred scientific publications to present neuromarketing in its constituents, highlighting psychological, emotional, decision-making areas, and advantages, challenges and ethics. The authors propose a theoretical framework for further research against the backdrop of the relationship between neuromarketing methods application marketing mix and airline passengers' decisions.

The fourth and last paper examines the transportation network and connections of the eastern Greek island, Kastellorizo. **Petros Zenelis** suggests specific solutions for the upgrading of the island's transportation linkages. These include ideas for increasing the local transportation demand, promoting the island's natural beauty, introducing sustainable tourism practices and offering incentives to transportation providers to include Kastellorizo in their routes, while future research recommend the investigation of transportation challenges that remote islands face; and solutions based on their unique characteristics.

To all the authors and reviewers who contributed to this issue of Journal of Air Transport Studies, we would like to express our gratitude for your efforts. We feel that these publications make a meaningful contribution to aviation practitioners and academia while also promoting further research in relevant subject areas.

Dr. Ioulia Poulaki
JATS Executive Editorial Team
Department of Business Administration
University of the Aegean
Chios, Greece

AIR TRAFFIC MODELING BASED ON A LONG MEMORY APPROACH

Rebecca Gili
University of Torino, Faculty of Mathematics, Via Carlo Alberto 10, Torino, 10123, Italy

Luis A. Gil-Alana
University of Navarra, Faculty of Economics, NCID and DATAI, Pamplona, 31009, Spain and Facultad de Ciencias Empresariales y Jurídicas, Universidad Francisco de Vitoria, Madrid, 28223, Spain.

ABSTRACT

This paper deals with modeling air traffic data using a long memory class of models that uses fractional integration. Two datasets have been considered: monthly global Revenue Passenger Kilometers and the number of monthly flights in Europe. The objective of this paper is to investigate whether Covid-19 has had a temporary or permanent impact on the air traffic trends. To do so, we investigate the orders integration of the series. Both datasets produced the same results: the trend was mean reverting when considering data before Covid-19, but the shock was so strong and long-lasting, that it produced a change to non-mean-reversion results after Covid-19. That said, if it is desirable to bring the air traffic trend back to its values before Covid-19, it will require intervention on the part of authorities or external factors since the series will not return by themselves to their original long-term projections.

Keywords: Time series; nonstationarity; unit roots; long memory; fractional integration

1. INTRODUCTION

This paper deals with the analysis of air traffic data across time using updated time series techniques that will allow us to determine if shocks in the series will have permanent or transitory effects. There is one big event (the Covid-19 pandemic) that shook the air traffic trend more than others, and we are still perceiving the effects of it today. In fact, it seems, looking at studies on the trend, that Covid-19 was a bigger shock to air traffic than the terrorist attack of 9/11 and the world recession of 2008, causing a 60% drop in the number of international flights on expected figures, in just a few weeks, (Fraherty et al., 2022).

Air traffic can be divided into transport for passengers and cargo. Since the Covid pandemic did not have a direct effect on the movement of freight, we will be concentrating on the trends of passenger transport. The objective of this paper is to analyze the trend in the number of flights and RPK per month in Europe and on a global scale, and to find a model for it, using long memory processes; in particular, we use fractional integration, to see if the shocks are mean reverting or not. This technique seems to be very appropriate for our purpose since with a single parameter (i.e., the order of differentiation of the series) we can determine the nature (transitory or permanent) of the shock, and, if it is mean reverting, the speed of the adjustment to its original trend or long-term projection (Solarin et al., 2021). As far as we know, there are very few studies that use fractional integration in the analysis of air transport data (Barros et al., 2016; Dingari et al., 2019), and none of them use the data used in this application.

We will also examine in detail the most recent shock in the air traffic data, the one produced by the Covid-19 pandemic. While the 9/11 terrorist attacks and the 2008 financial recession were proven to be mean reverting in many air traffic time series (Cunado et al., 2008; Ahmed et al., 2018), we find that the shock produced by Covid is not, since it seems to be more significant and with a longer effect on the series. Some recent studies, in fact, have proved this result, or at least have shown that its effect is very persistent, analyzing specifically the cases of the tourism sector in Spain (Gil-Alana and Poza, 2020) and in Croatia (Payne et al., 2021).

The main contribution of the present paper is to employ updated time series techniques based on fractional integration in the analysis of air transportation data in order to determine if the shocks in the series have transitory or permanent effects. Fractional integration is an appropriate technique for this purpose based on its flexibility which allows us consider cases of series which are nonstationary though with reversion to the mean (Solarin et al., 2021).

The structure of the paper is as follows: Section 2 deals with the literature review on

air traffic modeling; Section 3 presents the methodology based on fractional integration; Section 4 displays the dataset examined; Section 5 is devoted to the empirical results, while in Section 6 we discuss the results and main conclusions of the paper.

2. LITERATURE REVIEW

Recent studies regarding the Covid shock in air traffic trends prove that the chance of mean reversion is very probable though usually slow (Gudmundsson, 2021), while others focus on the economic and social consequences of such a drastic drop in air traffic due to the present Covid-19 pandemic (Iacus, 2020).

Some recent studies focus on the other two big events already mentioned that significantly changed the trend of air traffic: the world financial recession of 2008/2009 and subsequent recovery, and the 9/11 terrorist attack, and its effects on monthly arrivals in the US (Gil-Alana et al., 2008), on international air traffic demand (Ito and Lee, 2005), on US domestic flights (Blunk et al., 2006), on US tourists compared to those in Hawaii (Bonham et al., 2006) and on the Spanish air traveling data (Inglada and Rey, 2004).

Air traffic has already been studied through time series processes, showing that this methodology is quite efficient. Some examples of the existing works include: forecasts based on a seasonal Box–Jenkins model (SARIMA) (Jungmittag et al., 2016); long memory processes using ARFIMA (Dingari et al., 2019) and fractional integration in dual memory processes (Karlaftis and Vlahogianni, 2009).[1]

Other time series methods have been used in more specific environments of air traffic, and the analysis of these can be useful to observe the methodology employed, which is based, for example, on modeling monthly flows of global air travel passengers (Mao et al., 2015); or on the number of passengers carried by selected routes and a market share comparison (Pitfield, 2008), and on the reversibility of air transport demand based on airfare, fuel prices and price transmission (Wadud, 2015).

Other time series methods which are found to be quite appropriate for modeling air traffic data are the seasonal univariate long memory processes (Gil-Alana, 2005), that employ seasonality in fractionally integrated ARMA (ARFIMA) models. In non-fractional contexts, we can also observe some examples of applications of ARIMA on air modeling in more local studies, such as Chai (2021), investigating Hong Kong's passenger traffic; Al Sultan et al. (2021), forecasting air traffic in Kuwait; Bougas (2013) for the case of Canada; Tsui et al.

[1] Another interesting study is the general forecasting framework proposed in Phillips (1996) in the presence of large shocks in time series.

(2014) for Hong Kong; Oh et al. (2005) for Singapore and Lim and McAleer (2002) in the case of Australia. Fractional integration approaches, on the other hand, have been also employed, being more general than the above-mentioned applications since they allow for non-integer degrees of differentiation (Sutcliffe, 1994). These have been employed for modeling traffic (Liu et al., 1999); for forecasting general tourism demand (Chu et al., 2008), and for forecasting air traffic in Thailand (Chokethaworn et al., 2010).

Focussing more specifically on a similar approach to the one used in this work, Dingari et al. (2019) examined the number of Air India domestic air passengers using ARIMA and ARFIMA models, and their results seem to indicate that the fractional models perform better than the non-fractional ones in terms of forecasting. Our model differs from the one used in Dingari et al. (2019) in the treatment of the error term, that, given the monthly nature of the data, is based on a seasonal autoregressive process.

3. METHODOLOGY

We model air traffic data by using long memory, which seems to be very adequate for the purpose of our analysis. Long memory can be described either in the time domain or in the frequency domain. In the time domain, we say that a covariance stationary process, say {x(t), t = 0, ±1, …} displays this property if the infinite sum of its autocovariances, defined as γ(u) = E[(x(t)- Ex(t)) (x(t+u)- Ex(t))] is infinite, i.e.,

$$\sum_{u=-\infty}^{\infty} | \gamma(u) | = \infty. \quad (1)$$

Within this category of long memory processes, we have many models, including, for example, the fractional Gaussian noise (fGn) model described in Mandelbrot and Wallis (1965a,b,c) and others. Another one, very common within the time series analysts, is the one based on fractional integration, that means that the number of differences required in a series to render it stationary I(0) may be a fractional number. Thus, we say that a process is fractionally integrated or integrated of order d, and denoted as I(d), if it can be represented as:

$$(1 - B)^d x(t) = u(t) , \quad t = 0, \pm 1, \pm 2, \quad \ldots, \quad (2)$$

where B represents the backshift operator, i.e., Bx(t) = x(t-1) and with the differenced series, u(t), displaying a short memory or integrated of order 0 (I(0)) pattern described by:

$$\sum_{u=-\infty}^{\infty} | \gamma(u) | < \infty. \quad (3)$$

The differencing parameter d becomes crucial since it indicates the degree of persistence or dependence in the data, as the higher its value is, the higher the level of association is between observations far apart in time. Moreover, it allows us to consider a

large degree of flexibility in the dynamic specification of the model, including the specification of the following processes:

i) anti-persistence: $d < 0$,

ii) short memory: $d = 0$,

iii) stationary long memory and mean reversion: $0 < d < 0.5$,

iv) non stationarity and mean reversion: $0.5 \leq d < 1$,

v) unit roots: $d = 1$, and

vi) explosive patterns: $d > 1$.

In this context, it is crucial to know if the value of $d = 1$, since $d < 1$ implies mean reversion while $d \geq 1$ implies lack of it. To see this, note that the polynomial in the left-hand side in Equation (2) can be expressed in its Mc Laurin's form:

$$(1-B)^d = \sum_{j=0}^{\infty} \binom{d}{j} (-1)^j B^j = 1 - dB + \frac{d(d-1)}{2} B^2 - \cdots, \quad (4)$$

and then, x(t) can be expressed in terms of an infinite Moving Average (MA) process, with the coefficients decaying hyperbolically to zero as long as d is smaller than 1. If $d \geq 1$, this condition does not hold. Thus, if $d = 1$, for example, Equation (1) becomes

$$(1-B)\, x(t) = u(t), \quad t = 0, \pm 1, \pm 2, \ldots, \quad (5)$$

and noting that

$$\frac{1}{(1-B)} = 1 + B + B^2 + \ldots \quad (6)$$

Equation (2) can be written as:

$$x(t) = u(t) + u(t-1) + u(t-2) + \ldots \quad (7)$$

which proves that shocks keep having permanent effects on the series across time, and the trend is not mean reverting.

After a sudden event that significantly changes the trend in time series, determining if such time series is mean reverting or not requires knowing if the trend will recover automatically or if it will be necessary to employ external factors to bring the trend back to its original values before the shock. It is very important in political and financial situations to find out as soon as possible if the trend is mean reverting, so the competent authorities know if it is necessary to invest in the recovery from the shock or not.

A clear example of this was examined in terms of the arrivals in the US after the terrorist attack of 9/11/2001 (Gil-Alana et al., 2008). It was found in the paper that the estimated differencing parameter d was close to 0.5 for most of the origin locations. Therefore,

there was no urgent need to invest in efforts to recover tourism in the US, since it would have gone back to its previous trend sometime in the near future. Another meaningful study regarding the importance of mean reversion focuses on linkages between Central Bank Policy Rates in Africa and other significant bank systems worldwide (Gil-Alana et al., 2020). The analysis proves that many African countries will not be able to undertake independent monetary policies without taking into consideration global policies, since the coefficient of integration was found to be significantly higher than 1.

In order to allow for potential trends in the data, allowing also for seasonality, and based on a fractional integration process, we consider the following model,

$$y(t) = \alpha + \beta\, t + x(t);\ \ (1-B)^d x(t) = u(t),\ \ \ u(t) = \rho\, u(t-12) + \varepsilon(t) \qquad (8)$$

where y(t) represents the observed data; α and β are unknown coefficients dealing with an intercept and a (linear) time trend; t represents the trend, and ρ is a seasonal AR coefficient such that ε(t) is a white noise process.

4. DATA

Two different datasets have been analyzed, both with monthly samples collected in nearly the same range of years: the number of passengers in Europe and a dataset regarding the global RPK (Revenue Passenger Kilometers).

The monthly global RPK data was collected by ICAO (International Civil Aviation Organization**,** (https://www.icao.int).

RPK stands for Revenue Passenger Kilometers, which is a unit of measurement widely used in aviation; it shows the number of kilometers traveled by paying passengers, and it is calculated as the number of passengers carried multiplied by the total distance traveled. See Figure 1.

The period of the data collected extends from July 2012 to December 2021, resulting in 114 observations. The data, as expected, show seasonal peaks during the months of July, August and December, and a sudden drop in the number of RPK. It is easy to understand that this drop corresponds with the start of the sanitary emergency period, in April 2020, due to the Covid-19 pandemic. (See, Figure 1 below). Another factor which is noticeable from the analysis of this dataset is that it reveals a growth in air traffic, proving that this industry keeps improving and getting bigger year by year.

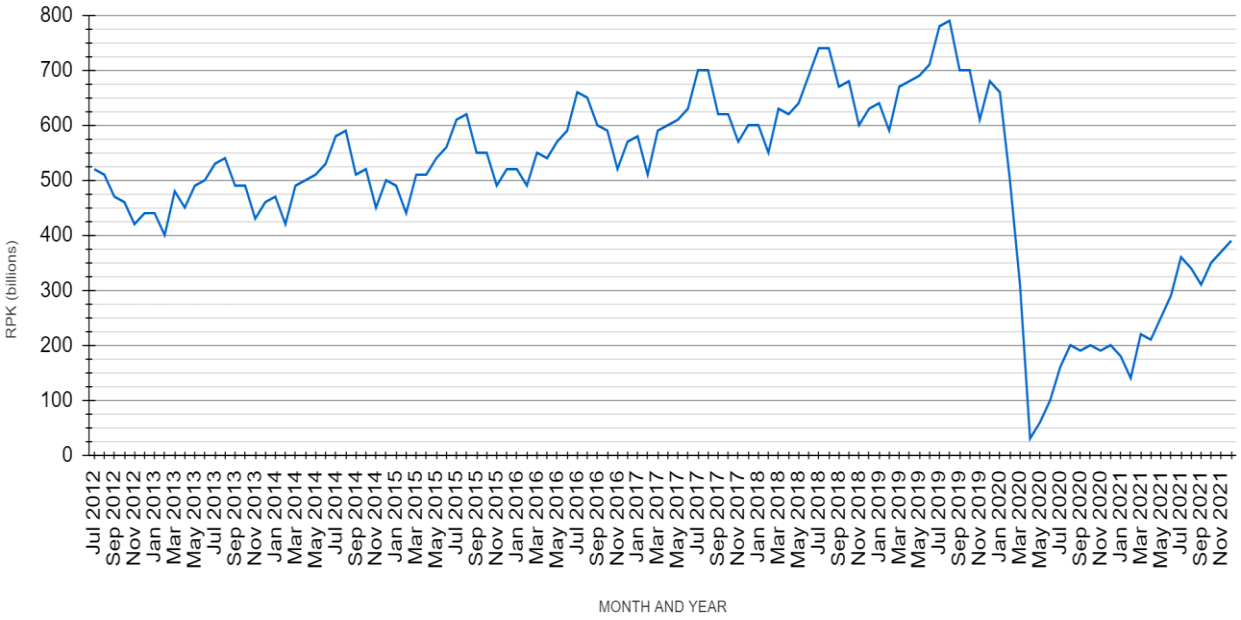

Figure. 1 Monthly global RPK starting from July 2012 to December 2021

The monthly number of passengers carried by EU flights was sourced from the Eurostat database, the accessible-to-all database for all European concerns, including politics, economics, demographics and geography. This data starts in January 2009 and continues to July 2021, resulting in 151 observations, (see Figure 2), and it shows the same trend and seasonality as the global monthly RPK data, proving European air travel follows the global trend, though on a smaller scale.[2]

[2] European air travel stands for the entirety of flights within the European Union, so flights from EU countries to EU countries. This includes domestic flights as well.

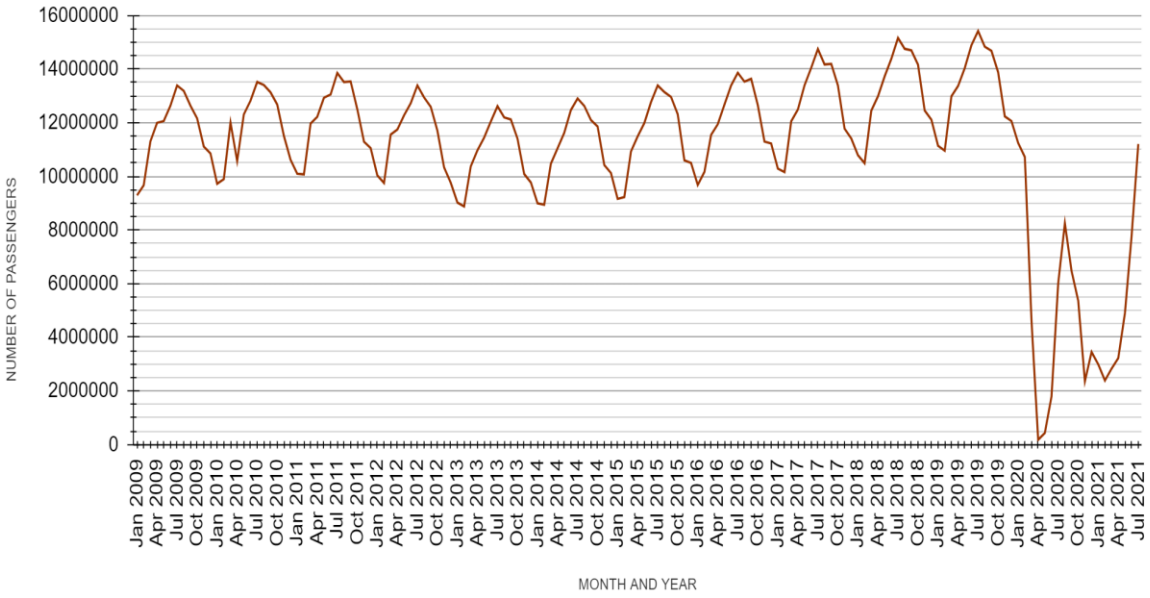

Figure 2. Monthly number of passengers carried by EU flights from January 2009 to July 2021

Descriptive statistics of the two series are reported in Table 1, containing statistical values, such as maximum and minimum values, range, mean, mode (when applicable), median and standard deviation.

Table 1: Descriptive statistics of RPK

SERIES	RPK	N. PASSENGERS IN EUROPE
NUMBER OF SAMPLES	114	151
MAXIMUM VALUE	790	15423290
MINIMUM VALUE	30	174964
RANGE	760	15248326
MEAN VALUE	503.5	11146685.3
MODE	490	---
MEDIAN	520	11944207
STANDARD DEVIATION	162.3	2978578,8

The seasonality of the trend can be studied through a deterministic approach or by using

a stochastic method, whether the effect we want to model is fixed across the years, or is changing over time. In this case, we choose the stochastic approach since the trend presents some differences from year to year. In addition, there are two stochastic models to choose from: the autoregressive process and the seasonal unit root process, which is used, like first differences, when the seasonal component of the time series seems nonstationary, for example if the seasonal effect increases with time.

For this study we use an autoregressive stochastic model and for simplicity, we consider a monthly seasonal AR process, which is described by the last equality in Equation (8), where ρ is the only not null coefficient of the AR(12) model.[3]

5. EMPIRICAL RESULTS AND DISCUSSION

To examine if the Covid-19 pandemic has produced any effect on the degree of persistence of the series, the first thing we do is to consider a sample ending in December 2019, that is, only a few months before the start of the pandemic. Table 2 reports the estimates of d in the above equation under three potential scenarios: i) with no deterministic terms, that is, imposing a priori that α and β are both equal to zero; ii) including only an intercept, i.e., with β = 0; and iii) including both the intercept and a linear time trend. The values in bold in Table 2 refer to the selected specification according to these three specifications. Along with the estimates of d we also include the 95% confidence bands for the values of d. Panel i) refers to the original data, while Panel ii) displays the results for the logged values. Table 3 displays the estimated coefficients of the selected model for each series.

Table 2. Estimates of the differencing parameter with data ending at December 2019

Series	No deterministic terms	With an intercept	With an intercept and a linear time trend
i) Original data			
Number of passengers carried in EU flights	0.98 (0.85, 1.15)	**0.52** **(0.46, 0.64)**	0.56 (0.46, 0.72)
Global Revenue Passenger Kilometers	0.86 (0.68, 1.13)	0.70 (0.60, 0.86)	**0.56** **(0.17, 0.84)**
ii) Logged data			

[3] Testing for seasonal unit roots, using various tests (Dickey et al., 1984; Hylleberg et al., 2001), the results reject the null of nonstationarity in favour of stationary seasonality.

Number of passengers carried in EU flights	0.98 (0.86, 1.12)	**0.51 (0.44, 0.67)**	0.60 (0.48, 0.76)
Global Revenue Passenger Kilometers	0.95 (0.81, 1.14)	0.70 (0.60, 0.85)	**0.54 (0.09, 0.82)**

The values in parenthesis are the 95% confidence intervals for the non-rejection values of d. In bold, the selected specification for each series is selected.

Table 3. Estimate coefficients of the selected models in Table 2

Series	D (95% interval)	Intercept (tvalue)	Time trend (tvalue)	Seasonal AR coefficient
i) Original data				
Number of passengers carried in EU flights	0.52 (0.46, 0.64)	1110302 (16.68)	---	0.943
Global Revenue Passenger Kilometers	0.56 (0.17, 0.84)	480.381 (13.63)	2.362 (2.74)	0.945
ii) Logged data				
Number of passengers carried in EU flights	0.51 (0.44, 0.67)	16.216 (287.79)	---	0.942
Global Revenue Passenger Kilometers	0.54 (0.09, 0.82)	6.1727 (101.18)	2.892 (115.62)	0.944

In parenthesis, in column 2, the 95% interval for the estimated value of d. In columns 3 and 4 the corresponding t-values.

The first thing we observe in Table 2 is that the time trend is found to be statistically insignificant for the EU data using both original and logged values, while it is significant (and positive, see Table 3) for the global data. If we focus now on the estimates of d, we observe that they are constrained between 0 and 1 in the four series, supporting the hypothesis of fractional integration and long memory characteristics. Using the original data, the estimates of d are 0.52 for the EU data and 0.56 for the global revenues respectively, and they are slightly smaller (0.51 and 0.54) with the logged values. In any case, the estimates are significantly smaller than 1, supporting thus the hypothesis of mean reversion and transitory shocks. In addition, seasonality seems to play an important role, with the seasonal AR coefficient being close to 1 in the four series (see last column in Table 3).

Table 4. Estimates of the differencing parameter with data ending at the end of the sample

Series	No deterministic terms	With an intercept	With an intercept and a linear time trend
i) Original data			
Number of passengers carried in EU flights	1.35 (1.21, 1.53)	**1.41 (1.21, 1.65)**	1.41 (1.21, 1.64)
Global Revenue Passenger Kilometers	1.10 (0.95, 1.30)	**1.30 (1.10, 1.56)**	1.30 (1.10, 1.56)
ii) Logged data			
Number of passengers carried in EU flights	1.01 (0.90, 1.15)	**0.93 (0.68, 1.27)**	0.93 (0.68, 1.25)
Global Revenue Passenger Kilometers	0.97 (0.85, 1.13)	**0.88 (0.71, 1.12)**	0.88 (0.71, 1.12)

The values in parenthesis are the 95% confidence intervals for the non-rejection values of d. In bold, the selected specification for each series is selected.

Table 5. Estimate coefficients of the selected models in Table 3

Series	D (95% interval)	Intercept (tvalue)	Time trend (tvalue)	Seasonal AR coefficient
i) Original data				
Number of passengers carried in EU flights	1.41 (1.21, 1.65)	9.036 (8.65)	---	0.450
Global Revenue Passenger Kilometers	1.30 (1.10, 1.56)	525.74 (9.82)	---	0.544
ii) Logged data				
Number of passengers carried in EU flights	0.93 (0.68, 1.27)	16.055 (46.58)	---	0.091
Global Revenue Passenger Kilometers	0.88 (0.71, 1.12)	6.242 (24.44)	---	0.078

In parenthesis, in column 2, the 95% interval for the estimated value of d. In columns 3 and 4 the corresponding t-values.

The results, however, change completely once the data are extended until December 2021. They are reported across Tables 4 and 5. First, the time trend that was previously significant in case of the global revenues now becomes statistically insignificant. Moreover, we observe a significant increase in the value of d. Thus, the estimates are now significantly higher than 1 in both series with the original data (1.41 for EU data and 1.30 for global revenues) while the unit root null hypothesis (i.e., d = 1) cannot be rejected with their corresponding logged values. Thus, the former property of mean reversion has disappeared once the Covid-19 pandemic has been taken into account. Finally, the characteristic of

seasonality has reduced in importance, becoming insignificant when the logged values are used. These results are consistent with other studies that also investigated the effects of the Covid-19 pandemic on tourism series such as Gil-Alana and Poza (2020) and Payne et al. (2021).

Looking at these results it seems that there is a clear difference between the shock provoked by the 9/11 terrorist attacks and the Covid-19 pandemic: following the observation of one academic colleague belonging to this journal, in the former shock, the passenger demand needed to return to the system, but the passengers were "*alive*" but simply "*unwilling to fly*" until they felt safe and comfortable to fly again. In the case of Covid-19, as sad and as morbid as it is, the passengers are now "*dead*" and "*unable to fly*" now or in the future. It is very sad, but a fact. Thus, it would be very interesting to look at the number of people that died because of Covid-19 in certain markets (e.g., the US, EU, etc.) to look that demand profile as a function of age, and to see if that portion of the demand is "*forever lost*" due to Covid-19. In spite of the difficulty for this time of analysis, work in this direction is now in progress.

6. CONCLUSIONS

In this article we have examined the air traffic data on a global and an European scale by using long memory methods. Specifically, we use fractional integration since it is a technique that allows us to investigate the nature of exogenous shocks in the data.

The Global and European air traffic trends were first analyzed using data starting from July 2012, in the global case, and from January 2009, in the European case, both until December 2019, to see how the series evolved before the pandemic. There were slight differences between the two trends, the Global one, for example, had not only a significant intercept coefficient but also a significant time trend, meaning that the trend was growing over time.[4] The European trend presented significance only in the intercept coefficient. It appears, though, that they were both mean reverting since the orders of integration of the series were significantly smaller than 1 in the two series. The results were robust to the use of logged values.

Repeating the computation with the data extended until December 2021, the results were quite different. Both trends, European and Global, only have relevant intercept coefficients, and most importantly, they no longer are mean reverting, meaning that the shock

[4] A significant time trend coefficient has been usually related with technological progress.

induced by the sanitary crisis was so persistent over time that it produced a complete change in the trends, and became a permanent shock.

Among the limitations of the present work we can mention its linear structure. Other forms of long memory processes, including for example, seasonality (seasonal fractional integration (Gil-Alana and Robinson, 2001) or cyclicity (Gil-Alana, 2001) can be employed in these and in other air traffic data. Along similar lines, non-linear structures still within a long memory model, such as those based on the Chebyshev polynomials and proposed in Cuestas and Gil-Alana (2016), Fourier functions in time (Gil-Alana and Yaya, 2021) or neural networks (Yaya et al., 2021) can be adopted. These methods describe cyclical structures and can be taken as alternative approaches to the potential presence of breaks in the data (Bierens, 1997), approximating them in a much smoother way. Also, it might be interesting to determine the change in the degree of persistence just after the irruption of the Covid-19 pandemic and see how it has evolved observation by observation until the end of the sample. Work in all these directions is now under progress.

CONFLICT OF INTEREST

The authors do not have any conflict of interest with other entities or researchers.

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AUTHORS' BIO

Prof. Luis Alberiko Gil-Alana completed his Ph.D. at the London School of Economics in 1997. He has published more than 500 papers in theoretical and applied econometrics and works as a Professor at the University of Navarra, Pamplona, Spain and as a Senior Resarcher at the Navarra Centre for International Development and at the University Francisco de Vitoria in Madrid, Spain.

Rebecca Gili has a background in scientific studies. She is currently concluding her career for her B.Sc. degree in mathematics at the Università degli Studi di Torino (Italy). She has strong interests in the field of statistics and computer science, which she would like to embrace for her M.Sc. degree.

THE PILOT SHORTAGE: IMPLICATIONS, REPERCUSSIONS, AND TRIED SOLUTIONS

Eugene Pik

College of Aviation, Embry-Riddle Aeronautical University, United States of America

ABSTRACT

The global pilot shortage in the aviation industry is a growing concern, affecting airlines worldwide as they struggle to meet the demand for qualified pilots. This article delves into the causes and implications of the shortage, highlighting its impact on airline operations, travel costs, and safety. It provides a comprehensive overview, including a historical background, current situation analysis, and an exploration of potential future consequences. Case studies are presented to showcase strategies employed by airlines and organizations to combat the problem, such as training local individuals, expanding flight capacities, partnering with flight schools, implementing autonomous aircraft plans, and introducing innovative training programs. The intended audience comprises aviation industry professionals, policymakers, educators, and stakeholders like airline executives, regulators, training organizations, schools, government officials, and researchers. The article aims to deliver valuable insights and influence decision-makers and stakeholders to take proactive measures in addressing the pilot shortage.

KEYWORDS

Pilot Shortage; Aviation industry; Aging Workforce; Airline Safety; Autonomous eVTOL; Regional Airlines

1. INTRODUCTION

The pilot shortage has become a growing concern within the aviation industry as airlines struggle to meet the demand for qualified pilots. This issue is not limited to a particular region or country but is a global phenomenon. Factors contributing to the shortage include an aging workforce, increased competition for pilots from emerging markets, and changes in pilot training and certification requirements. The implications of the pilot shortage are significant and will affect airline operations, air travel costs, and ultimately, the safety of air travel. Failure to address the shortage will result in reduced flight schedules, higher ticket prices, and potential safety hazards.

The article highlights the global pilot shortage in the aviation industry, explores its causes and implications, and emphasizes how it affects airline operations, travel costs, and safety. It presents a historical background, discusses the current situation, and examines the potential future consequences of the pilot shortage. Case studies are provided to illustrate various strategies adopted by airlines and organizations to tackle the problem, including training local individuals, expanding flight capacities, partnering with flight schools, implementing plans for autonomous aircraft, and introducing innovative training programs.

Targeted at aviation professionals, policymakers, educators, and stakeholders such as airline executives, regulators, and academic leaders, this article seeks to provide insightful information and encourage those in decision-making positions to take proactive steps towards mitigating the pilot shortage.

2. HISTORY AND CAUSES OF THE PILOT SHORTAGE

Carey et al. (2012) reported that U.S. airlines are facing an imminent pilot shortage, which is considered the most severe scarcity of skilled aviators since the 1960s. The previous significant shortage of pilots during the 1960s was attributed to the fact that a large portion of the trainable population was engaged in the Vietnam War, leaving a limited pool of individuals available for pilot training.

In November 2012, leaders from major airlines such as United, JetBlue, and American, along with the Embry-Riddle Aeronautical University, came together to address the impending shortage of qualified pilots. According to reports, including one from Boeing, there will be a global need for approximately 460,000 pilots and over 600,000 aircraft maintenance technicians in the next two decades. Experts in the U.S. industry warn that the expected rise in pilot retirements and upcoming stricter pilot qualification standards could have a significant impact on domestic airlines (Hanns, 2012).

Further exacerbating the situation, Lutte's 2014 study highlighted alarming retirement projections showing that more than 45,000 pilots are expected to retire from major airlines over the next 20 years. At the time of the study, there were only about 18,000 regional pilots, underscoring a dire need for substantial new pilot recruitment to avoid a critical shortage. The data points to a pressing need for strategic initiatives to bolster pilot numbers in order to maintain industry stability.

3. CURRENT STATE OF THE SHORTAGE

The pilot shortage in the U.S. airline industry had been a growing concern for several years, significantly worsened by the COVID-19 pandemic. The shortage, which is estimated at around 8,000 pilots, has resulted in the loss of air service to communities across the country with 76% of U.S. airports experiencing a reduction or complete loss of air service since October 2019 (Hardee, 2022).

The pandemic has had a significant impact on the rate of newly qualified pilots entering the industry. According to Axelrod et al. (2022), the year 2021 saw only 4,300 pilots graduate, a stark decrease from previous years. Simultaneously, the pandemic induced many seasoned pilots to accept buyout offers, further depleting the pool of experienced aviators.

Looking forward, recent studies, such as the analysis conducted on the United States airline pilot labour supply, predict an impending shortage of approximately 35,000 pilots over the next two decades, driven by retirements, attrition, and increasing demands from new aircraft growth and regulatory changes. This significant forecasted deficit highlights the urgent need for innovative recruitment and retention strategies that can efficiently address the shortfall. Lutte (2014) emphasizes the influence of training costs, the availability of qualified candidates, and the impact of regulatory requirements on the pilot supply, suggesting that addressing these factors could mitigate the looming shortage and ensure operational continuity for the airline industry.

To address the pilot shortage, airlines are taking proactive measures. They are actively increasing their hiring efforts and exploring long-term solutions for the pilot pipeline. One approach mentioned by Axelrod et al. (2022) is the establishment of in-house flight schools to train new pilots. This enables airlines to develop a dedicated pool of talent to meet their future needs. Furthermore, programs are being implemented to assist existing staff members in transitioning to pilot careers, allowing them to contribute to filling the shortage.

Segal (2023) states that in 2023 the pilot shortage became more severe as airlines incentivized pilots to retire early during the decline in air travel in 2020. Throughout this decade, there will be an average of approximately 18,100 job openings annually for airline and commercial pilots, with a significant portion of these positions being replacements for retirees.

Wolfsteller (2021) demonstrated that in 2021 airlines that were previously struggling financially due to the pandemic suddenly found themselves facing a surge in passenger traffic. This unexpected growth led to a shortage of experienced pilots, as many senior captains had retired during the pandemic.

The industry had previously anticipated a pilot shortage due to factors such as retirements, weak pilot pipelines, and high training costs. Airlines had implemented training schemes and offered incentives to attract recruits, but the pandemic disrupted these efforts. As air travel bounced back, airlines had to adopt new strategies, including recalling pilots and promoting first officers to captain positions. However, the recovery remains uneven, with regions like North America and Asia-Pacific projected to face the largest shortages. The high cost of pilot training continues to be a barrier, and efforts are being made to find solutions, such as sponsorships and funding options.

Baldwin (2023) indicated that the nation is currently facing a significant pilot shortage that poses risks to both our economic stability and the welfare of our people. Airline pilots must undergo training that is regulated by the Federal Aviation Administration (FAA), and this training comes with a considerable price tag. The University Aviation Association estimates that the average cost

of pilot training, including a four-year degree, amounts to around $80,000. However, existing federal loan limits do not cover the full expense of pilot training, making it challenging for students who cannot afford to pay upfront or take on expensive private loans.

The detrimental effects of the pilot shortage were underscored during a 2023 subcommittee hearing of the House Transportation and Infrastructure. The decline in air service is widespread across the United States, with 42 states reporting a decrease in airline operations to levels below those seen before the pandemic (Black, 2023). Approximately 136 airports have experienced significant reductions in service, and 11 airports that serve as connections between smaller cities and major hubs have had to completely suspend flights.

Regional airlines have been hit particularly hard. More than 500 of their aircraft are currently grounded, a direct result of the acute shortage of pilots. This has led to a substantial 40% reduction in their flight operations, severely impacting their service and operational capacity (Turing, 2023). The ongoing pilot shortage continues to strain the aviation industry, necessitating urgent and effective solutions to stabilize and enhance air connectivity.

Amidst a backdrop of rapid airline industry growth, the escalating cost of pilot training emerges as a pivotal challenge compounding the global pilot shortage. The research by Valenta (2018) highlights a significant rise in training expenses, nearly doubling over a decade, thus posing substantial barriers to entry for prospective pilots. This financial burden, coupled with the stringent requirements imposed by regulatory bodies, necessitates a re-evaluation of funding models and sponsorship opportunities in pilot training programs. By addressing these economic hurdles, the aviation industry can enhance accessibility to training, thereby expanding the pool of qualified pilots and mitigating the ongoing shortage.

4. SAFETY RISKS AND PILOT FATIGUE AMIDST SEVERE SHORTAGES

The aviation industry is currently experiencing its most severe pilot shortage, which has resulted in airlines pushing pilots to their maximum limits. On August 15th, 2022, an Ethiopian Airlines Boeing 737-800 operating flight ET-343 from Khartoum, Sudan, to Addis Ababa, Ethiopia, experienced a situation where the pilots fell asleep while the aircraft was at FL370. Instead of descending as required, the aircraft continued at the same altitude and followed the pre-set route for an approach to runway 25L. Despite attempts by air traffic control (ATC) to contact the crew, they were unsuccessful in establishing communication. The incident was confirmed by the airline on August 20th, 2022, and it was announced that both pilots have been suspended pending further investigation (Hradecky, 2022).

This occurrence is not an isolated event. Another incident involved pilots from ITA Airways who also fell asleep for approximately 10 minutes during a flight from New York to Rome. Their failure to respond to radio calls triggered a terror alert (Ganesh, 2022). The incidents highlight the grave consequences of the pilot shortage. Airlines are grappling with the challenge of meeting the escalating demand for qualified pilots, leading to overworked and exhausted flight crews. Falling asleep at the controls poses serious risks to the safety of passengers and the aircraft. It underscores the urgent need for the aviation industry to address the pilot shortage comprehensively and implement measures to prevent such incidents from occurring in the future.

5. 1,500-HOUR RULE AND THE IMPACT ON AIRLINE SAFETY

The pilot shortage in the aviation industry has been further aggravated by the implementation of the 1,500-Hour Rule. This regulation has significantly raised the bar for aspiring pilots, as they are now required to accumulate a substantially higher number of flight hours before they can obtain a license. Consequently, the pool of qualified pilots has dwindled, intensifying the shortage and posing significant challenges for airlines in meeting the growing demand for pilots.

A proposal to change the 1,500-hour rule in the U.S., which mandates that airline pilots must fly for 1,500 hours before obtaining a license, has been put forward by the transportation committee of the Senate (Silk, 2017). The current 1,500-hour rule was enacted after Colgan Air Flight 3407 crashed in February 2009. This incident resulted in the loss of 49 individuals who were on board. The National Transportation Safety Board (NTSB) determined that the crash occurred because the plane's two pilots did not appropriately react to the cockpit alerts indicating an imminent stall of the aircraft (Spangler & Park, 2010). Following the tragic incident, the entry-level requirements for U.S. airline pilots were reviewed, and, as a result, the FAA raised the minimum flight training hours for commercial pilots from 250 to 1,500 hours (FAA, 2010).

However, when considering it from a policy perspective, the justification behind the law is weak. Firstly, it is worth noting that both the captain and the first officer on the Colgan flight had significantly more than the mandated 1,500 hours of flight experience. Additionally, studies such as the Pilot Source studies, conducted by universities before and after the new requirements were introduced, have revealed that trainees with fewer than 1,500 logged flight hours demonstrated better performance in regional airline pilot training compared to those with more than 1,500 hours. This suggests that the correlation between flight hours and training proficiency may not be as straightforward as presumed (Silk, 2017). There is no other country with a comparable mandate for pilot training (Wolfsteller, 2022).

A study by Wang et al. (2023) explored the relationship between pilot s' age, flight exposure, and their performance in terms of exceedance rates. The findings indicated that pilots' flight exposure and exceedance rates increased from ages 21 to 40 before stabilizing. Age had a positive impact on exceedance rates for pilots over 40, while flight exposure mediated the relationship between age and exceedance rates for young pilots aged 21-35. The study emphasizes the need to consider age and flight exposure throughout pilots' careers to manage exceedance risks effectively, incorporating psychological competence and fluid intelligence factors in pilot training and matching processes. Evaluating the risk associated with age and flight exposure throughout pilots' professional lifecycle can help address shortcomings and improve professionalism and safety in the aviation industry.

6. POTENTIAL IMPACT ON THE FUTURE OF THE AVIATION INDUSTRY

A shortage of pilots in the regional airline industry is likely to lead to fewer aircraft being operated, causing major airlines losses of passengers and revenue, and contractual issues for regional airlines (Klapper & Ruff-Stahl, 2019). These results are part of a larger reduction in the regional airline industry, where larger planes are being used by major airlines rather than regional airlines, leading to a decrease in regional airline passenger enplanements.

The bankruptcy of Republic Airways serves as an illustration of how an airline can experience a pilot shortage that is particular to the industry, which resulted from a deadlock with a critical

labour union during a significant period of transformation in the sector. When regional airlines lack adequate pilots to operate their contracted routes, they may be forced to ground their planes, leading to a reduction in the number of passengers who they can transport (Klapper & Ruff-Stahl, 2019).

7. CASE STUDIES

The purpose of the case studies in this article is to provide real-world examples and illustrate various approaches that are being taken to address the global pilot shortage within the aviation industry. These case studies highlight different strategies employed by organizations, airlines, and flight schools to tackle the shortage of qualified pilots. By examining these examples, readers can gain insights into the diverse initiatives being undertaken to mitigate the effects of the pilot shortage and ensure a sustainable workforce for the future. These case studies shed light on the proactive measures taken by industry players, the use of innovative technologies, collaborations with flight schools, and other creative solutions aimed at addressing the ongoing pilot shortage issue.

An empirical study on C-130J pilot upgrade training underscores the importance of stringent, uniformly applied training standards across geographical locations to enhance pilot proficiency and safety outcomes. By applying a rigorous Six Sigma methodology, Slottje et al. (2022) identify substantial variances in training quality that affect pilot performance. These findings emphasize the necessity of implementing standardized training procedures that ensure all pilots, regardless of their training base, achieve the same high levels of skill and operational competence. Integrating such methodologies could significantly bolster the effectiveness of strategies aimed at alleviating the global pilot shortage by optimizing training outcomes and ensuring consistent safety standards.

In addressing the persistent pilot shortage, an exploratory study of pilot training and recruitment practices across Europe reveals critical deficiencies in current training programs, where a significant number of Commercial Pilot's License applicants fail to meet airline assessment standards. Adanov et al. (2020) identify primary shortcomings in preparation, technical knowledge, and soft skills such as communication and teamwork. The study proposes enhanced regulatory oversight and the adoption of the Airline Pilot Standard Multi Crew-Cooperation system to elevate training quality. Implementing these recommendations could significantly improve the success rate of pilot candidates, thereby helping to mitigate the pilot shortage and ensuring that new pilots are better prepared to meet the demanding requirements of commercial aviation.

In light of the evolving dynamics within the aviation industry, effective human resource management plays a pivotal role in addressing the pilot shortage crisis (Mızrak, 2023). Strategies such as targeted recruitment, specialized training programs, and enhanced employee engagement initiatives are critical. These measures not only aim to attract and develop skilled pilots but also focus on retaining them by improving job satisfaction and operational efficacy. By implementing robust HR strategies that prioritize continuous learning and career development, airlines can mitigate the impact of the pilot shortage on their operations. This integration of strategic HR management not only supports the stabilization of workforce levels but also ensures the maintenance of safety and service quality in the face of growing industry demands.

As the aviation industry grapples with a severe pilot shortage, innovative partnerships between higher education institutions and airlines have emerged as a pivotal strategy (Lutte & Mills, 2019).

These partnerships, often framed as cadet programs, provide a structured pathway for aspiring pilots, integrating academic education with hands-on training and guaranteed career progression. This collaborative approach not only ensures a steady supply of well-trained pilots but also enhances the appeal of a piloting career by lowering barriers to entry and aligning educational outcomes with industry needs. Such programs are instrumental in sustaining the aviation industry's growth and operational capacity by directly addressing both the quantity and quality of the pilot pipeline.

7.1 Yuut Yaqungviat LLC - Local Pilot Training in Bethel, Alaska

Yuut Yaqungviat LLC, based in Bethel, Alaska, addresses the pilot shortage by training local residents to meet airline standards and promoting regional employment (Stapleton, 2005). Directed by William Johnson, former owner of Yute Air Alaska, the school significantly supports the local economy by employing pilots trained in Alaska's unique flight conditions, saving air taxi operators around $50,000 annually per pilot.

The initiative began through a collaboration between the local tribal college and regional air taxi operators to combat pilot turnover to major airlines. By employing local residents, the school fosters a deep connection between pilots and their community, enhancing job retention.

With substantial financial aid from organizations like the Association of Village Council Presidents, the school makes pilot training accessible, with programs costing around $30,000. Current facilities include four aircraft and plans for expansion to accommodate larger aircraft and an A&P apprenticeship program.

Yuut Yaqungviat's approach not only mitigates the pilot shortage but also strengthens the local economy by training and employing residents, making it a model of community-focused vocational education.

7.2 American Airlines' Strategic Response to Pilot Shortage

During the COVID-19 pandemic, American Airlines faced a significant pilot shortage when 1,000 out of its 15,000 pilots accepted early retirement packages (ch-aviation, 2022). This shortage was exacerbated by a subsequent surge in air travel, prompting the airline to recruit pilots from regional carriers. However, this solution strained these carriers, as they struggled to train new pilots quickly enough to meet demand. The situation is poised to worsen, with over 700 pilots expected to retire annually from American Airlines between 2023 and 2026.

As a result, approximately 100 regional jets, about one-sixth of those operated under the American Eagle brand by subsidiaries such as Envoy Air, Piedmont Airlines, and PSA Airlines, as well as independent providers like Mesa Airlines, Republic Airways, and SkyWest Airlines, are currently grounded. This shortfall in available pilots has led American Airlines to adapt by upgauging - replacing smaller regional flights with larger mainline aircraft. This strategy, while necessary, has led to reduced frequencies to some of the airline's less-traveled destinations.

The ongoing pilot shortage highlights a critical challenge facing not only American Airlines but also other major carriers. For instance, Republic Airways and SkyWest have expressed difficulties in meeting operational demands due to pilot deficits, with United Airlines suspending 15 regional routes due to similar issues. These adaptations underline the broader impacts of the pilot shortage on service provision and operational strategies within the aviation industry.

7.3 Delta Air Lines Collaborating With Flight Schools

Delta Air Lines is actively addressing an imminent pilot shortage, exacerbated by the COVID-19 pandemic, which accelerated retirements and reduced the pilot workforce (AirGuide Business, 2021). This situation was further strained by an aging pilot demographic and fewer military-to-civilian pilot transitions, traditionally a key recruitment avenue.

Recognizing the severity of the impending shortage, highlighted by a Boeing report predicting a demand for over 637,000 pilots in the next 20 years, Delta's CEO Ed Bastian has taken proactive steps. The airline has partnered with flight schools to ensure a continuous influx of qualified pilots, addressing both immediate needs and future demands. This initiative is part of Delta's broader strategy to mitigate workforce challenges, discussed by Bastian at the U.S. Travel Association's conference, and includes tackling barriers such as the high cost of pilot training.

Delta's approach demonstrates a strategic response to the pilot shortage, emphasizing the need for airlines to engage with educational institutions to maintain a sustainable pilot supply amidst ongoing industry challenges.

7.4 Wisk Aero Plans to Go Autonomous

Wisk Aero, backed by Boeing, is pushing forward with a fully autonomous air taxi model, diverging from competitors who plan to start with piloted crafts (AirGuide Business, 2022). Wisk's design philosophy focuses on building air taxis specifically for autonomy, which they believe leads to better performance and safety than retrofitting later. Jonathan Lovegren, leading Wisk's autonomy efforts, argues that designing for autonomy from the start simplifies the integration of safety systems, contrasting with the industry trend of starting with piloted EVTOLs (Electric Vertical Takeoff and Landing aircraft) due to regulatory and public trust barriers.

Wisk's new design features a four-seat air taxi with tilting rotors, intended to operate without a pilot. Equipped with sensors to autonomously detect and avoid obstacles, these air taxis will be monitored by ground control, with human supervisors able to intervene in emergencies.

Though Wisk's entry to market might lag behind peers like Joby Aviation and Archer Aviation, targeting a launch by 2024, Wisk focuses on a long-term vision for urban mobility without exacerbating pilot shortages. Leveraging advanced autopilot technologies, Wisk is enhancing systems to handle all piloting operations, including emergencies. This ambitious approach positions Wisk to potentially redefine urban air mobility by pioneering standards in autonomous aviation technology.

7.5 Uber Vacating the Pilot's Seat

Partnering with Bell and other industry leaders, Uber plans to launch urban air taxi operations in Dallas and Los Angeles by 2023, with initial tests starting in 2020 (Benson, 2018). The company envisions a high-frequency operation, aiming for 400 to 1,000 takeoffs and landings per hour at each vertiport.

To accommodate this rapid throughput, Uber's vertiports will feature innovative designs with multiple landing pads and conveyor systems to move and recharge air taxis quickly. These facilities will require significant electrical power and substantial infrastructure development, underscoring the scale of Uber's vision.

However, the project's success hinges on several factors, including regulatory approvals and public acceptance. The design and operation of Uber's air taxis begin with human pilots, but the plan includes a transition to semi-autonomous and then fully autonomous control. This progression aims to enhance operational efficiency by increasing seat capacity and reducing pilot dependency, which is crucial given the ongoing pilot shortage.

Autonomy in air taxis is part of Uber's broader strategy to increase productivity and manage operational costs effectively. By eliminating the need for a pilot, each air taxi can carry more passengers, potentially increasing revenue per flight. Uber is advocating for eVTOL aircraft to be certified under lighter regulations similar to those for light sport aircraft, arguing that the simpler design and reduced pilot workload justify less stringent certification.

Uber's approach reflects a proactive adaptation to the challenges of modern urban transport, leveraging advanced technology to redefine mobility. The transition towards autonomous air taxis represents a significant step in this direction, promising to reshape how cities handle congestion and mobility.

7.6 Mesa Air Group Introduces New Pilot Training Programs

Mesa Air Group Inc., a regional airline flying for major carriers like United Airlines and American Airlines, has launched an innovative training program to address the critical pilot shortage (Sider, 2022). The airline has purchased 29 small two-seat planes, with an option to buy up to 75 more, to provide aspiring pilots with a cost-effective way to accumulate the necessary flying hours for airline certification.

The program is a response to the fierce competition for pilots and the difficulties regional carriers face in maintaining adequate staffing levels. To attract more candidates, Mesa is offering interest-free loans to pilots to fly these planes, allowing them to build up their required 1,500 flying hours more rapidly. This strategy is particularly crucial as many pilots struggle to accumulate hours through traditional methods such as flight instructing or charter flights, which can be both time-consuming and expensive.

Jonathan Ornstein, CEO of Mesa, believes this program will significantly impact the industry by providing a quicker pathway for pilots to enter the workforce. Mesa's pilots can fly up to 40 hours a week at a rate of $25 per hour—far below typical rental costs. This accelerated pace means pilots could potentially complete their hour accumulation in less than a year, a significant reduction from the usual timeframe.

Mesa also offers pilots who join the program benefits like building seniority and "priority status" for future employment with the airline once they meet the qualifications. This not only helps pilots financially but also integrates them into Mesa's operations early on, fostering loyalty and reducing turnover.

This program is set to start in Florida and expand to Arizona, aiming to support over 1,000 pilots annually. Despite not resolving the broader debates around the 1,500-hour rule, Mesa's initiative presents a proactive approach to easing pilot shortages by making flight time more accessible and affordable.

8. CONCLUSION

The global pilot shortage is an ongoing concern in the aviation industry due to factors such as an aging workforce, increased competition, and changes in training and certification requirements. The shortage has led to the loss of air service, reduced flight schedules, higher ticket prices, and potential safety hazards. The industry must take action to increase the number of qualified pilots and ensure a sustainable workforce.

Various strategies are being implemented to address the pilot shortage such as in-house flight schools, covering the cost of pilot training, and attracting more young people to the cockpit. The implications of the pilot shortage issue are significant for the aviation industry and society. The shortage could lead to reductions in flights, which could affect businesses and individuals who depend on air travel.

The article emphasizes the need to address the pilot shortage promptly by raising awareness about the issue, identifying its causes and implications, and showcasing various strategies and initiatives being undertaken by industry stakeholders. By understanding the scope and complexity of the problem, stakeholders can work together to develop comprehensive solutions that ensure a sustainable workforce and the continued growth and safety of the aviation industry.

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AUTHORS' BIO

Eugene Pik holds an MSc in Aviation and Aerospace Sustainability from Embry-Riddle Aeronautical University, specializing in Aviation Cybersecurity. He studied Robotics Engineering at BNTU and Software Engineering at the Open University of Israel. Eugene co-founded startups supporting medical research and led eVTOL aircraft conceptual design at Uniqopter. He launched Mevocopter Aerospace, offering consultancy in aviation sustainability and cybersecurity.

NEUROMARKETING IN THE CORE OF ANALYSING AND ANTICIPATING CONSUMER BEHAVIOUR IN THE AIRLINE BUSINESS SECTOR. APPEALING OR REPULSIVE FOR THE AIRLINE CUSTOMER?

Marietta Fragkogianni

School of Hospitality and Tourism Management, Faculty of Arts and Social Sciences, University of Surrey, United Kingdom

Dr. Elen Paraskevi Paraschi

Department of Tourism Management, Faculty of Business Administration, University of Patras, Greece

Dr Eirini Vlassi

School of Economics and Management, Neapolis University Pafos

ABSTRACT

In parallel to the medical and psychological science, human brain has long been in the epicentre of modern business practice. 'Neuromarketing' constitutes a fundamental means to this process. Thus, notwithstanding the first signs of its genesis being viewed in medical terms in early 70s, it is only in recent years that neuromarketing research has grown exponentially. Yet, academic literature remains silent on the issue of neuromarketing application in the aviation sector. More precisely, the psychological resonance that practices of the kind could exert in prospective airline passengers' psychology is not represented in current literature, mainly considering that successful promotion and profitability are of paramount importance in the airline business. In this study 874 scientific publications have been reviewed. Neuromarketing is presented in its constituents while the following areas of extant scholarship are highlighted: psychological, emotional, decision-making, advantages, challenges and ethics. The study ends up to a proposed theoretical framework paving the way for further research against the backdrop of the relationship between neuromarketing methods application marketing mix and airline passengers' decisions.

KEYWORDS

Neuromarketing; consumer behaviour; psychology; emotions; ethics

1. INTRODUCTION

In current business practice decision-making is the milestone that brings customer into a profitable contact with business (Ouzir et al., 2024). One of the constituents of its value is its complexity which involves a breadth of cognitive processes, attention, learning and working memory of stimuli attracting an extended interest of marketers (Goulet-Kennedy et al., 2016). Especially the previous factors along with engagement and memorization are fundamental in decision-making, consequently scrutinising them can lead to constructive conclusions and effective decisions (Royo-Vela and Varga, 2022), an effort further empowered by neuroscience's observations that the majority of our decisions are made unconsciously in no more than 4 s (Royo-Vela and Varga, 2022). Thus, interestingly, while current consumer is not always aware of what actually motivates them to form a decision or choice, through this unconscious mental processing, surprisingly they frequently overestimate their evaluation being self-led to misleading estimates about the actual value of a good, service or outcome, a phenomenon highly expected in a situation heavily depending on 'perceptions' (Alsmadi and Hailat, 2021).

Neuromarketing is deemed as having the quality of a cutting-edge method, means and field on a scientific effort to uncover the potential intricacies and implications of external agents and stimuli in the human decision-making and preference formulation process thus, progressively, consumer responses towards products and services (Sebastian, 2014). However, although modern neuromarketing research has not yet approached and scrutinised a large extent of the brain operation and its relationship with human decision making it is regarded core and promising on the effort to 'decrypt' the totality of factors and processes that influence decisions' and choices' formation (Khurana et al., 2021). As a consequence, non-paradoxically, it is widely employed in the creation and development of product likeability as well as pricing strategies, even in the formation of effective promotional and social campaigns (Cherubino et al., 2019). It is therefore not by accident that it is witnessed in various domains – the vast majority of them related to business marketing and strategy - including advertising, packaging and branding, even politics (Kalaganis, et al., 2021).

The main purpose of this research is to analyse the degree of appeal that the employment of neuromarketing methods by aviation companies can exert on prospective airline customers. In order to serve the main aim, the following objectives have been set:

a. The identification of physiological and neuronic processes
b. The identification of the positive and negative aspects of neuromarketing employment
c. The identification of psychology-related aspects concerning neuromarketing methods
d. The identification of ethical implications upon neuromarketing practices

In order to better serve the above aim and objectives the research is organised on a systematic review of the literature, followed by a special section on the theoretical and empirical contributions of the study. In this section a theoretical framework will be created and proposed for further research. Finally, a brief summary and conclusions' part will complement the scientific effort.

2. LITERATURE REVIEW

In order to systematically review the literature, a related search was realised in two databases: Science Direct and Google Scholar. The research was conducted between 15 October 2023 – 24 January 2024. The words that have been employed in the search engines were: 'neuromarketing', 'neuromarketing and business', 'neurones and business', 'neuromarketing and ethics', 'neuromarketing and emotions', 'neuromarketing and branding'. The research unveiled 1,268 scientific publications. In order to avoid duplication 394 articles were excluded, thus the 874 accepted publications were classified in the following categories delineated below. For the analysis that follows the articles that relate most to the designated themes are those that are referenced below:

2.1. Physiological and neuronic processes

Being regarded as the 'child' born from the unification of 'neurology' and 'marketing' as a term 'Neuromarketing' was first heard in 1990s in the department of Applied Therapies in Harvard University and non paradoxically it has alternatively been named 'consumer neuroscience' directly paving the way for the customisation and adaptation of business offer towards customers' demands. However it was much later, in 2000 when scientific research reached its peak (Harrell, 2019). Undoubtedly, neuromarketing focuses on 'neurones', groups of human brain cells and studies the messages they release either in terms of neural functions and related chemical substances or through physiological characteristics such as eye-tracking movements (Harrell, 2019).

2.2. Psychology and emotions

As a result of the previous processes human brain incorporates multiple areas each one related to diverse feelings, where external stimuli stemming from the demonstration of products, services or messages address (Nakamura et al., 2016). Thus, in this way human brain is placed in the epicentre both of modern scientific research and business practice (Öberg, 2023).

However, the aim is not new. Marketers and business executives always wanted to penetrate and scrutinise the hidden areas of customers' human brain (Harrell, 2019). To this end, neuroscience played a pivotal role focusing on two types of neural networks: a. natural and b. artificial (Big Blue Data Academy, 2023). While the latter is on a promising ongoing stage mainly through the evolution of artificial intelligence, the former constitutes the current area of focus for neuromarketing (Grimm et al., 2024).

As a result, because of the systematic approach of human feelings and cognitive processes, the employment of neuromarketing methods facilitates precision in predictions, effective market segmentation and management of human behaviour and decision-making process (Venkatraman, et al., 2012). In this way, it can override any potential uncertainty and biases of the to date applied quantitative and qualitative methods, even the level of self-consciousness of the customer per se (Harrell, 2019).

2.3. Positive and negative aspects

Despite the benefits that emanate from the application of neuromarketing methods and the elimination of bias factors their application is not immune from drawbacks and

following the standards of rigorousness scientific literature stresses the positive and negative aspects of various types of the previous methods. The initial point on an effort to distinguish the two-faceted value is to identify the two main pathways to investigate neurones, a. brain scanning and b. physiological measurements. The first category is mainly represented by i. EEG – electroencephalogram which although scans and "reads" neuronic activity in parts of seconds still cannot provide a 100% analysis and investigate neurones in full (Greenblatt et al., 2023) and ii. fMRI – functional magnetic resonance imaging – equipment which detects blood flow alterations in human brain (Biondetti et al., 2024) which although being more precise it is at least 20 times more costly than EEG ($5 million against $20,000) and should always be performed in a lab (Harrell, 2019). The second category mainly incorporates: i. eye-tracking methods, ii. pupil-arousal methods, iii. Facial expression coding, and iv. Galvanic skin response/biometrics which are much cheaper than the methods of the first category however, resilient and could be combined with more traditional ones such as focus groups (Harrell, 2019). The fMRI is not new and has already been employed in experiments indicatively in beverages such as Coca-Cola vs. Pepsi to measure reactions before and after the awareness of a brand and in 2008 before and after price awareness at the School of Business Management, INSEAD, France. Neuromarketing companies are spread all over the world with main focus on U.S.A and Europe such as France and Greece and at a lower level neuromarketing is employed by companies active in various sectors such as Google, Facebook, Samsung, Apple, NBC News, Time Warner Broadcasting, British Airways (NMSBA, 2023).

Thus, it could be concluded that the methods of the second category are less penetrative than those of the first one, mainly focusing purely on human gaze, facial, heart rate and respiration reactions (Comu et al., 2021). However they do not provide detailed emotional measurements, being constraint to positive/negative responses, speed of recognition and level of engagement which are regarded as more superficial (Wilson et al., 1996). Additionally, each method is ideal for different aims e.g. fMRI and EEG are recommended for setting prices and branding strategies, while, biometrics and facial coding are ideal for advertising content (Hamelin et al., 2020) and eye and pupil tracking fit more to website design, advertisement improvement and branding.

In this way, it could be understood that not by accident the employment of neuromarketing methods has led scientists and marketeers to safe predictions of customers' final decisions, generating the so-called "neuronic indices of market forecasts", such as it happened in 2007 when neuromarketing experts from 3 top American universities successfully predicted consumers' decisions during an online elaboration of prices (I Kathimerini, 2008). In relation to this capacity it has been noticed that 'product', 'price' and 'promotion' are the elements of the marketing mix that are most soundly represented in academic scholarship (Scuderi and Sturiale, 2014; Córdova et al., 2022; Sawe, 2022). Thus, neuronic marketing could fairly be deemed a proper investment for the current business.

2.4. Ethical Considerations

However, every investment contains its own risk and in the case of neuromarketing the risk lies upon ethical considerations that are raised by experts and scholars in the field. One of the most crucial aspects is consumer's protection especially regarding the application of invasive methods is the lawfulness even of the circumstances under which they provide their consent (Clarke, 2013). As it always happens with any research activity

observing the standards of rigorousness, professionalism and ethics, specific aspects and protocol should be considered so as a predetermined objective designated committee to provide the required consent for the process to take place (Clarke, 2013). It is therefore fairly anticipated that such complicated procedures with ethical character should be conducted and run by proficient neuroscientists specialised in Marketing with suitable track record of successful applications of neuromarketing methods and tools also confirmed and published in highly esteemed journals (González-Morales, 2020). Part of the ethical dimension is the suitability of questions and representativity of samples, which adds greater value to the established superiority of the generated feedback against that of the traditional methods (Ariely and Berns, 2010). Thus, even if the previous elements link ethics with "technical" aspects of neuromarketing processes, there is one more substantial aspect related to the content of the provided messages, namely, the way that social and Corporate Social Responsibility messages are transferred, elaborated, interpreted and shared because of strongly influencing decisions and practices on sustainability (Alsharif et al. 2021).

3. THEORETICAL AND EMPIRICAL CONTRIBUTIONS

Regarding the theoretical contribution of the study, as a result of the extant scholarship on neuromarketing, a gap in the literature could be identified in relation to the perceptions of airline customers on the application of neuromarketing methods and the influence their perceptions could exert on their decisions as depicted in the following figure:

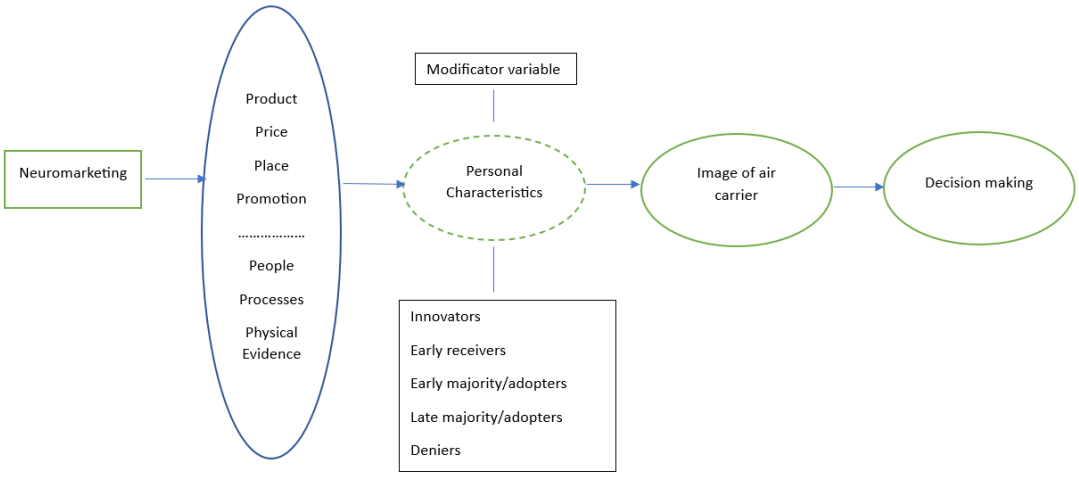

Figure 1: The proposed framework

In Figure 1 the independent variables are placed in square and the dependent in oval frames. The variable of air carrier image is regarded as 'perceived'. According to the figure, the feedback from Neuromarketing practices influences the construction of the marketing mix in which the first 4 Ps namely, Product, Price, Place and Promotion are complemented by the last 3Ps namely, People, Processes, Physical Evidence as applied in the case of service-related sectors (Kwok et al., 2020) such as the airline one. Thus, by means of the

customers' personal characteristics, the image about an air carrier employing neuromarketing methods is shaped in consumer's mind leading to respective decisions. Undoubtedly customers' personal characteristics relate to their quality as either 'innovators' – those to whom new inventions are applied, or 'early receivers' – those who adopt modern creations because of admiring the advantages of science and new technologies, or 'early majority/adopters' – those who adopt new achievements because of being informed about positive aspects, or 'late majority/adopters' – those who adopt new inventions because of being informed that advantages overrun potential drawbacks, or 'deniers' – those who will never see scientific inventions positively (Dimitriades and Tzortzaki, 2010). Finally, depending on the perceived image of the air carrier related decisions are taken supportive or non-supportive towards the company, progressively either supporting the company's product or abstain from being a customer.

Regarding the empirical contributions of the study, the systematic presentation of the literature highlights multiple aspects of neuromarketing methods employability, while the proposed research will provide constructive conclusions in order for the airline decision-makers to be aware of and respect ethical aspects which customers consider. Information of the kind is crucial in a sector which covers a substantial part in global GDP, namely $3.5 trillion - 4,1% (Statistics, 2024) while at the same time is vulnerable to crises as has been proved in the case of COVID-19 (IATA, 2021).

4. CONCLUSIONS

As showcased, neuromarketing is undoubtedly a tool of multi-level value and contribution for current business. In an era when business offer acquires an enhanced personalised character while operating within a globally competitive environment it seems being severely challenged by the modern sophisticated and savvy consumer who along with the producer has a powerful means of cutting-edge technology in their hands. In this critical and delicate process the extant 'safety nets' safeguard the observation of ethical and procedural rigorous standards to reinforce the scope of a company's image and appeal, airline companies not being an exception. In a world where Artificial Intelligence is thriving and customers of various cultural backgrounds and types of technology adoption levels are classified at a range from full acceptance to non-acceptance of what is regarded 'innovative' the endeavour is certainly not easy. Still, this process is not the only one of the kind. In the way that artificial neuronic networks imitate the operation of the natural ones, 'biomimics' in modern technology pave a parallel way for the resolution of managerial problems through the imitation of nature's functions. However, what should be considered is that while human brain has not fully been investigated further space is created to improve neuromarketing elements and to examine its role in air transport under multiple agents such as gender, culture and type of air carriers, generating the hope that the bright side of the initiative will overweigh the dark one.

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AUTHORS' BIO

Marietta Fragkogianni is a PhD candidate at the School of Hospitality and Tourism Management, Faculty of Arts and Applied Sciences, University of Surrey, United Kingdom. Her thesis focuses on the area of destination management. She holds two Masters' (MSc) degrees, the first one in Tourism Policy and Planning (University of Aegean, Greece), and the second one in International Marketing Management (University of Leeds, U.K.) and a Post-graduate Certificate in Academic Practice (University of Suffoolk, U.K.). Since 2016 her research work has been presented in various international conferences and has been published in esteemed journals. Her research interests include tourism marketing management, consumer behaviour, and sustainable destination development.
E-mail: m.fragkogianni@gmail.com

Dr. Paraschi is an adjunct lecturer at the Department of Tourism Management of the University of Patras, Greece and an airport officer in the Hellenic Aviation Service Provider (HASP). Her scientific work focusing on air transport management has been published in prestigious peer-reviewed journals and presented in international conferences.
E-mail: elen_pa@yahoo.com

Dr. Eirini Vlassi is currently a lecturer in Neapolis University Pafos in the field of management and marketing of tourism business and tourism destinations. She holds a Ph.D. from the University of the Aegean.
E-mail: e.vlassi.2@nup.ac.cy

TRANSPORT CONNECTIVITY OF REMOTE ISLANDS: THE CASE OF KASTELLORIZO, GREECE

Petros Zenelis

Hellenic Ministry of Finance, Athens, Greece

ABSTRACT

This paper examines the transportation network and connections of the eastern Greek island, Kastellorizo. The major factors related to the island's connectivity have to do with its remote location, the existing transportation infrastructure and the economic and political conditions. Kastellorizo faces significant challenges the most important of which is the insufficiency of the existing infrastructure to satisfy a potential increase in transportation volumes. Specific solutions are suggested for the upgrading of the island's transportation linkages. These include ideas for increasing the local transportation demand, promoting the island's natural beauty, introducing sustainable tourism practices and offering incentives to transportation providers to include Kastellorizo in their routes. The importance of the transportation infrastructure and sustainability for the residents is highlighted in this paper's conclusions. Future research is needed to further explore the transportation challenges that remote islands face and recommend targeted solutions taking into account the unique characteristics of the regions in question.

KEYWORDS

Connectivity; remote islands; air transport; sea transport; Kastellorizo

1. INTRODUCTION

Remote areas due to their geographical distance from metropolitan areas are heavily dependent upon transportation services for the greater part of their everyday life needs (Pungetti, 2012). Remote communities quite often find it difficult to access important services because of the inadequate transportation infrastructure, which could result in worsening their well being. Transportation linkages and the respective networks of all types could play a critical role for the economic and tourism development of such areas (Agius et al., 2020). In most of the cases of remote regions, both island and mainland, the development of a sound transportation network could be the main driver behind a possible significant improvement of private and public aspect of locals' routine. In most cases of remote regions, especially during difficult meteorological periods of the year, the transportation network and the available means of transport play a significant role in facing several types of emergency incidents. Overall, transportation networks and connections are essential for the endurance and development of remote communities (Castanho et al., 2021).

Kastellorizo is a small remote Greek island of the eastern Aegean Sea, near the coast of Turkey (Figure 1). The population is slightly more than 500 (2021 population census) with the ferry services being the most common mode of transportation to and from the island connecting Kastellorizo with the nearby islands of Rhodes and Kos and the Greek major port of Piraeus. There are also seasonal ferry services to the island of Samos and the Turkish port of Kaş. The island is also being served by a small airport connecting Kastellorizo with Rhodes and Athens but these flights are not daily. Sea taxis are also available but the frequency of the services provided is rather limited. Kastellorizo is also connected to the small neighbouring island of Ro by a daily scheduled boat service.

This paper that presents an assessment of how the remote geographical position of Kastellorizo and the existing transportation linkages impede the accessibility and mobility of residents and visitors is divided into five sections. After the introduction comes section two which provides a brief review of relevant literature. Section three explains the empirical methodology applied which is based on data descriptive analysis while section four combines the results of the study and the discussion part of this research commenting on the significant challenges Kastellorizo faces in transportation connectivity. The paper concludes by briefly presenting the conclusions and providing recommendations for future research.

Figure 1. Map of Kastellorizo

Source: Wikipedia

2. LITERATURE REVIEW

2.1 Remote islands' connectivity

Previous research on transportation networks and connections in remote island areas has focused on several key themes including the challenges and limitations of transportation infrastructure and the economic and social impacts of transportation access (Button and Taylor, 2000; Brueckner, 2003; Percoco, 2010; Arvis and Shepard, 2011; Bilotkach, 2015; Albalate and Fageda, 2016) and the potential for sustainable transportation solutions.

One major challenge faced by remote island areas is the lack of infrastructure and connectivity to mainland transportation networks (Cross, 1996). This can make it difficult for residents and visitors to access essential goods and services (Surya, 2015) and can also limit economic development opportunities (Andriotis, 2004; Baker, Merkert, & Kamruzzaman, 2015). The inefficiency of the transportation network and infrastructure has been proven a crucial negative factor on the overall well-being of the residents of remote regions (Karampela et al., 2014; Asian Development Bank, 2012) mainly because of the limited access to healthcare services (EC, 2022; Kavroudakis and Penteridou, 2017) and other services that are considered important for their everyday life. Another key theme in previous research on transportation networks and connections in remote island areas is the economic and social impacts of transportation access (Hilvano et al., 2022). It has been observed in most cases that initiatives related to significant infrastructure upgrading were among the most important reasons for increased economic activity and employment (World Bank, 2018) together with better education and healthcare options. However, increased transportation mobility, in some cases where development schemes were realized without proper awareness, there were negative impacts on the environment. Research has revealed that implementing sustainable transportation options should not only be financially viable and beneficial for the environment

but also enhance the well-being of people living on islands (Cross & Nutley, 1999; Forni & Bennett, 2017).

Overall, previous research on transportation issues directed related to remote island regions has proved important the need for efficient, restructured and sustainable transportation infrastructure and networks for the economic and social prosperity of the residents (EC, 2022).

2.2. Challenges and barriers to transportation in remote areas

Transportation in remote island areas can pose several challenges and barriers including geography (Spilanis, Kezos, & Petsiote, 2012; Sunarti, 2018), limited resources, weather, (Mendas, 2015), limited connectivity, environmental and political concerns. The isolation and the complicatedness to access remote island regions are considered two of the most important reasons behind the complexity and the lack of determination to build and preserve the transportation infrastructure needed (Makkonen et al, 2013). Remote island communities often have limited resources, both financial and human, which can make it difficult to invest in transportation infrastructure and maintain it. The intense weather conditions that many of the remote island regions deal with can cause severe damage to the transportation infrastructure and make access to the island even more difficult than it already is (Forni & Bennett, 2017). The population of such remote regions usually have limited access to the decision centres making even more difficult for them to put significant pressure upon decisions that concern better transportation infrastructure and increased funding. Transportation services for remote islands could be a continuous challenge that can be mainly dealt with functioning infrastructure initiatives that could help minimize the interruptions of the transportation activity (Zenelis et al., 2011).

3. METHODOLOGY

Purpose of this paper is to study the connectivity status of Kastellorizo through the existing transportation options to and from the remote island in question. Through the analysis of transport itineraries and schedules, travel timetables and several other relevant data sources, we try to examine the accessibility conditions that the locals and the visitors of Kastellorizo are facing. Through this analysis we aim to shed light on the implications of isolation on connectivity and mobility and to identify potential solutions to improve transportation to and from Kastellorizo.

In this paper that has to do with the transportation connection of Kastellorizo the main method that was used to gather and analyze data was data collection through different databases and sites directly or indirectly related to the field in question. To gather data on transportation connections of Kastellorizo various databases were accessed including the Hellenic Statistical Authority, the Hellenic Civil Aviation Authority, the Bank of Greece and the Institute of SETE. The data collected had to do with information on transportation infrastructure, transportation services and passenger traffic in Kastellorizo. The research of this paper was based upon a combination of data collection through databases and application of various analysis techniques so as to provide a comprehensive understanding of the transportation connections and identify any potential areas for improvement concerning the connectivity of the remote island of Kastellorizo.

4. RESULTS AND DISCUSSION

Because of the fact that Kastellorizo is one of Greece's remotest locations, transport connectivity to and from the island is a constant challenge despite the seasonal positive fluctuations. Some of the major factors that influence transport connectivity to Kastellorizo include its geographical location, the availability of adequate transportation infrastructure and the economic and political conditions.

The island of Kastellorizo is the easternmost island of Greece, a remote location that makes it difficult for transportation companies to reach the island regularly while the island's small population makes it less profitable for transportation companies to include relevant regular services in their business and operational plans.

Table 1 includes information on the locations that have regular air or sea connections to the island of Kastellorizo including the straight-line distance from Kastellorizo, the frequency of air or sea connections per week during low and high seasons and the average duration of the journeys.

Table 1. Distance, connection frequency and average journey duration of three destinations that are connected to Kastellorizo.

City / Port	Distance (in km)	Flights per week (low/high season)	Duration of flight (net)	Ferry journeys per week (low/high season)[1]	Duration of trip
Athens, Greece	560	3 / 4	1hr 40min[2]	2 / 2	>20 hrs
Rhodes, Greece	125	3 / 4[3]	40min	2[4] / 6	2 - 5 hrs[5]
Kaş, Turkey	8	Ø	Ø	7 /7	20 min

Source: Olympic Air, Google maps and Ferryscanner. Data processed by the author.

According to the information presented in Table 1, the travel options between Athens and Kastellorizo are limited with ferry trips taking almost a day. The number of flights and the low-season ferry journeys per week between Kastellorizo and Rhodes are close to the respective figures of the Athens – Kastellorizo air and sea travel options since the vast majority of the flights and ferry journeys between the two destinations includes a stopover at Rhodes. The geographical position of the island of Kastellorizo is the main reason behind the numerous ferry connections to Kaş, Turkey, throughout the year because of its proximity to the island.

The remote location of Kastellorizo is the main reason behind the struggle of the island with enduring limited transport connectivity phenomena. Apart from the island's "marginalized" location, the insufficiency of adequate infrastructure such as a contemporary airport and harbor capable of meeting modern transportation requirements further aggravates the abovementioned situation.

The dock, which is situated in Megisti Bay, home to the main village, has a length of 82m and a useful depth of 6,30m (MPFSD, 2022). It caters to ferries, cruise ships and catamarans visiting the island. The current condition of the port infrastructure necessitates interventions aimed at enhancing the overall serviceability and safety of shipping operations as well as increasing the volume and frequency of passenger traffic to the island of Kastellorizo while also promoting more evenly distributed visitors' volumes throughout the year. Additionally, there should be initiatives to make the port operationally more secure, preserve and protect the environment and safeguard the ecosystem from pollution, contamination, and destructive human interventions.

[1] Changes in schedules/frequency due to weather conditions may occur.

[2] The flight itinerary includes a stopover in Rhodes and only itineraries with a stopover duration of less than 5 hours have been considered.

[3] The frequency of flights between Athens and Kastellorizo, as well as between Rhodes and Kastellorizo, is congruent as a result of the established flight itinerary structure between Athens and Kastellorizo, which incorporates a layover in Rhodes.

[4] The ferry journey from Piraeus to Kastellorizo includes a stop in Rhodes.

[5] The duration of the journeys depends on the type of boat (ferry or high-speed ship).

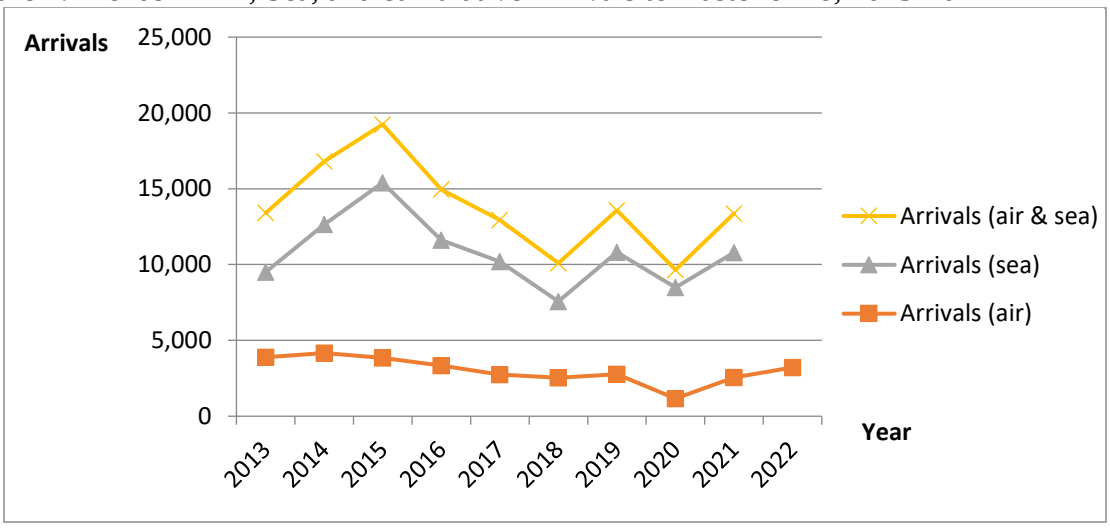
The Municipal Airport of Kastellorizo which has been in operation since 1986 is situated four kilometers from the port of Megisti. It works as an airport for domestic flights with only one passenger terminal, four parking spaces for aircraft and is exclusively designed to accommodate small aircraft with a maximum seating capacity of 20 passengers. The airport's runway has a length of 798m and 25m in width while the terminal building is 150m^2. The Civil Aviation Authority which is responsible for the management of the airport is planning to extend the runway by 250m together with an increase in its width by 30m. There are also plans for the construction of a new passenger building of 500m^2 so as to achieve the airport's overall operations and activities improvement (HCCA, 2023).

The limited capacity for simultaneous aircraft operations and the lack of sufficient infrastructure to support medium and large aircraft at the Kastellorizo airport are major obstacles to increasing tourist traffic, particularly in light of the prolonged travel time via ferries as an alternative mode of transportation to the island.

The economic crisis that Greece was facing during the second decade of the 21st century caused significant setbacks to the island's infrastructure development plans and the quality upgrading of the island's transportation services. One of the primary ways in which the economic downturn has affected transportation on Kastellorizo is through decreased funding for infrastructure projects. The Greek government, through the memoranda reforms that were decided to be incorporated in the national budget's implementations, tried to improve the economy's performance but the agreed public expenses cutting included reduced investments in transportation infrastructure.

The COVID-19 pandemic has had a significant impact on the economy of the island of Kastellorizo. It has greatly impacted the air and ferry transportation service to and from the island of Kastellorizo in several ways, a situation that directly affected both the locals and the visitors.

Figure 2. Trends in Air, Sea, and cumulative Arrivals to Kastellorizo, 2013-2022[6]



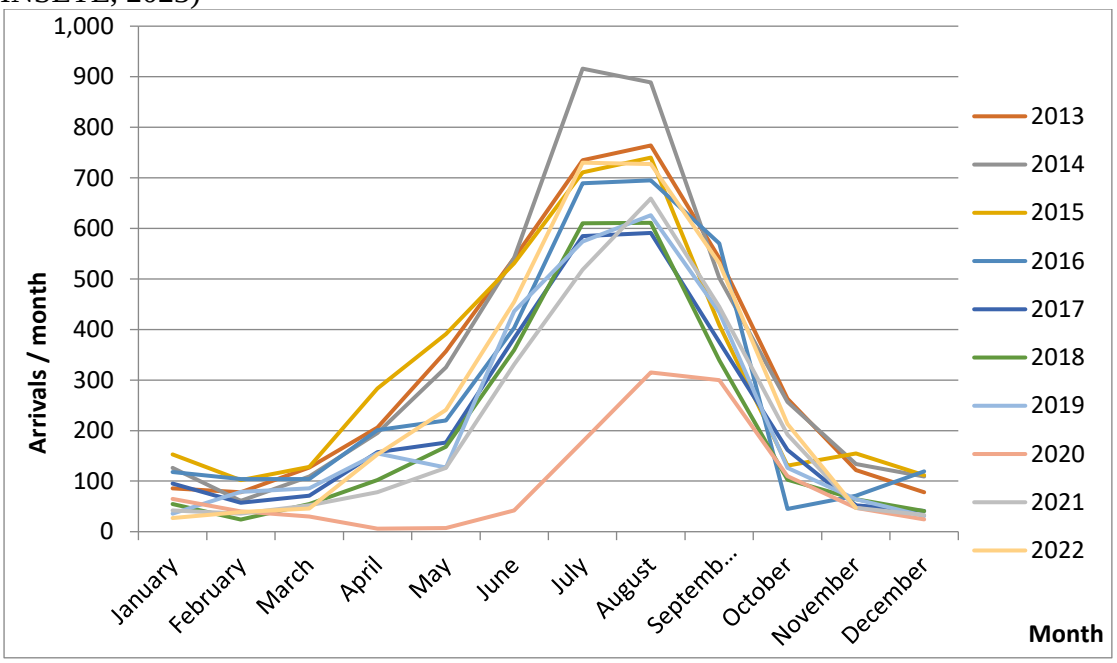
Source: Bank of Greece, 2023; INSETE, 2023. Data processed by the author.

The arrivals volumes varied over the last 10 years though there is a slight increase trend after the Covid-19 pandemic and the relaxation of the lockdown measures (Figure 2). This increase is observed at the air, sea, and air and sea combined categories. The arrivals by air

[6] At the time of writing this paper, no data had been published regarding the number of visitors arriving by sea on the island of Kastellorizo in 2022 while the data for the 2022 arrivals by air refers to the period Jan – Nov 2022

were almost four thousand in 2013 while the respective arrivals by sea were almost ten thousand. The combined number of arrivals was almost fourteen thousand. The shares' trend presented above continued over the next couple of years despite the increased number of arrivals with a peak in 2015 with almost twenty thousand combined arrivals. During the following two years, the arrivals by sea also decreased, with 11.607 (2016) and 10.199 (2017) arrivals. As a result, the combined number of arrivals also decreased in these years. The trend of fluctuations in the number of arrivals continued in 2018 and 2019, with the combined number of arrivals being 10.101 and 13.583 respectively. In 2020, there was a significant decrease in the number of arrivals due to the COVID-19 pandemic with only 1.164 arrivals by air and 8.492 arrivals by sea. The combined number of arrivals was 9.656. After the initial year of the pandemic breakout (2021) there was a small increase in the number of arrivals both by air and sea. The combined number of arrivals was 13.359. Finally, in 2022, there was only data available for arrivals by air, with 3.208 arrivals for the period January to November (HAS, 2022; INSETE, 2022). The data presented above indicate that the number of arrivals to Kastellorizo has been fluctuating over the years with a slight increasing trend.

Figure 3. Seasonality of the Arrivals by air to Kastellorizo, 2013-2022[7](Bank of Greece, 2023; INSETE, 2023)



Source: Bank of Greece, 2023; INSETE, 2023. Data processed by the author.

In Figure 3 is more than obvious that there is clear seasonality in the number of arrivals by air to Kastellorizo from 2013 to 2022 with higher numbers occurring during the summer months of June to August and lower numbers during the winter and early spring months of January to March. August was the busiest month of each single year during the last decade in terms of arrivals with an average of 662 arrivals while February on the contrary scored rather low for the same years with an average number of arrivals slightly higher than 60. Overall, the data highlights the importance of the summer season for the tourism industry in Kastellorizo with most of the arrivals occurring during the months of June to August, a phenomenon that remained unchanged in 2020 despite the extraordinary situation of the

[7] The data for the 2022 arrivals by air refers to the period Jan – Nov 2022

pandemic. Understanding the seasonality of arrivals can help to inform the tourism industry and local businesses in planning and preparing for the peak tourism season.

The decreasing trend of the second half of the previous decade in air traffic to Kastellorizo and the current low volumes can be partially attributed to the necessity for a stopover in Rhodes and the transfer to a smaller aircraft for the second leg of the flight from Athens. This requirement results in increased inconvenience for travelers, as it necessitates additional time and resources. The limited availability of seats on the Athens to Rhodes leg of the flight mainly happens because of the high demand for travel to Rhodes because of diachronically being a popular tourist destination. This results in a scarcity of affordable seats for travellers with Kastellorizo as their final destination, thereby deterring potential travellers from opting for air travel to Kastellorizo and contributing to the low volumes of air arrivals.

The financial burden of accessing the island of Kastellorizo including the escalating expenses associated with fuel prices and ferry and air transportation fares, acted as a deterrent for prospective tourists over the past few years. The increased inflation that continuously puts pressure upon the cost of fuel affects the total cost for both ferry and air transport services. As a result of the significant increase in fuel prices the transportation cost also increased making it more expensive for visitors to travel to Kastellorizo (Hope, 2008). Another factor contributing to high transportation costs is the limited options available, as a lack of competition in ferry and air transport services results in higher ticket prices (Papatheodorou & Zenelis, 2013). The limited number of arrivals to Kastellorizo led to an increase in transportation costs since the overall cost of the transportation services had to be spread over lower passenger load factors. The Public Service Obligation (PSO) subsidy scheme that was put in place by governments to support air transport services to remote or underserved areas, that is the case of the Rhodes - Kastellorizo flights, was intended to help keep ticket prices affordable for residents and visitors to the island. However, despite the implementation of this scheme the cost of air transport tickets remained high mainly because of the limited number of flights available together with the long distance of Kastellorizo from the major ports of the mainland.

The political factors that influence the transport connectivity of Kastellorizo include the island's location in the Eastern Mediterranean which has led to tension and disputes between Greece and Turkey over maritime borders and territory. This may have caused insecurity feelings among potential visitors resulting in decreased demand for transportation services. On the other hand the island's status as a European Union member state's territory has attracted European funds such as the PSO scheme and funding for improvement initiatives for transportation infrastructure and services. However, the island's small population and remote location could be a reason for making it a low priority for the government to invest in Kastellorizo's transportation infrastructure upgrading.

The meteorological conditions in the Eastern Mediterranean where Kastellorizo is situated, especially in the autumn-winter months, are determined by increased wind velocity and high seas, conditions that quite often impede the transportation network's scheduled operation and services' unobstructed frequency.

4.1. Limited infrastructure and travel challenges affect Kastellorizo's accessibility

The limited capacity for aircraft operations and the lack of adequate infrastructure to support medium and large aircraft at the Kastellorizo airport are considered to be the major obstacles to satisfying increased tourist traffic given the prolonged travel time via ferries as an alternative way to access the island. Kastellorizo's main dock which is situated in Megisti Bay does not meet modern transportation prerequisites and needs significant upgrade so as to provide serviceability and safety for shipping operations.

The arrivals volumes at Kastellorizo reveal that there has been a fluctuating trend over the years. According to the data available August was the busiest month for Kastellorizo while

June and July also score high compared to the rest of the year. Furthermore, there was a significant decrease in 2020 due to the COVID-19 pandemic. Low volumes in the air traffic to Kastellorizo are partially attributed to the itineraries' structure which includes a stopover in Rhodes and the transfer to a smaller aircraft a situation that results in increased inconvenience for travelers. The limited number of seats on the Athens-Rhodes leg of the flight can be attributed to the high demand for travel to Rhodes which has as a result increased fares and low volumes of air arrivals to Kastellorizo.

The economic downturn in Greece and the COVID-19 pandemic have had a significant impact on the island's transportation infrastructure and services. The insufficient and postponed funding for infrastructure projects and the travel restrictions imposed as a result of the pandemic outbreak have further shrunk travel to and from the island. The increased cost to get to the island which is heavily dependent on the rising expenses associated with fuel prices and transportation viability acted as a disincentive for prospective visitors.

4.2. Kastellorizo's potential for development through a combination of sustainable tourism and improved connectivity

An increase of the demand for transportation services to and from the island of Kastellorizo could trigger connectivity upgrading for the island, a positive outcome that could be materialized through more regular and consistent transportation services, a conclusion that is in line with Angelopoulos et al. (2013). Significant demand growth could also stir up the improvement of the existing infrastructure such as the island's main port and the municipal airport, an argument that is consistent with the European Strategy for the Outermost Regions (EC, 2022).

The diverse and unspoiled natural landscapes of Kastellorizo have boosted dynamics for the attraction of a significant number of visitors. Natural beauty marketing campaigns and social media can be utilized to attract to Kastellorizo visitors seeking peaceful and remote holidays, as argued by Hays et al. (2012). Furthermore, personalized activities can be offered to attract visitors (Buhalis & Aditya, 2015) such as guided walks, snorkeling and diving lessons to explore the island's marine life.

Eco-friendly accommodations that do not harm the island's natural environment such as sustainable hotels and rooms could boost volumes of environmentally conscious travelers. This is also supported by past findings on green consumer behaviour (Kim et al., 2021; Rahman & Reynolds, 2019). By promoting their products and services to tourists and encouraging their active participation in traditional projects local businesses could create a sense of social contribution among the island residents and visitors. Sharing photos and travel information of the island through social media could also create additional demand for including Kastellorizo in holiday itineraries. Developing and implementing sustainable policies related to the tourism activity is considered to be rather important in attracting several different types of tourists (Grilli et al., 2021). This could be accomplished primarily by developing environment protection initiatives and informing visitors about the island's environment and the need to be preserved.

Kastellorizo could also become a short-break destination for people living or visiting the neighbouring islands. The most common practices towards achieving this hybrid tourism activity, among others, could be a) by offering discounted rates in several services for groups or families and b) by creating package deals that include transportation, accommodation and leisure activities on the island (Murphy et al., 2010). Kastellorizo could also host special events/themed weekends to attract visitors, develop an initiative where current excursion guests can refer friends and family for discounts on their next trip and offer a loyalty program where frequent visitors can earn rewards. The island of Kastellorizo could launch a social media campaign highlighting the unique characteristics and activities available, collaborate

with influencers or travel bloggers to include places at Kastellorizo on their platforms and offer special deals for last-minute bookings.

A way to increase the frequency of transport services to Kastellorizo would be to provide incentives to private transport companies to include Kastellorizo in their routes, an argument that is consistent with the results of the study of Malina et al. (2012). The development and implementation of economic incentives and discounts that could help the transport companies of the private sector to respond to the increased cost of providing transportation services to remote regions could be a way to start (Bråthen & Halpern, 2012). The introduction of measures could include subsidies or reliefs for fuel supplies and maintenance services and/or funding directly related to the purchase of new means of transportation. Another incentive would be to offer tax reliefs to private transport companies that include remote islands in their network such as reduced corporate tax rates or proportional exemptions from certain taxes. As illustrated in previous research (Currie & Falconer, 2014), public authorities in charge could also provide different types of support for the improvement of the existing infrastructure such as funding for the maintenance and/or upgrade of the existing port and airport. Sambracos (2001) has also studied the Greek insular market regarding the Air-Sea Transport and his results also indicated that one way to support the transport companies is by removing the regulatory burden they have to deal with by reducing the bureaucracy and the obligations that spring from the current polynomial regime. Lastly, giving priority access to private transport companies operating on remote islands for contracts and tenders for transportation services in the region, combined to other incentives granted, could contribute to an increase in the volumes of visitors accessing Kastellorizo.

5. CONCLUSIONS

This paper discusses the challenges the transportation services have to deal with in remote island areas specifically focusing on the island of Kastellorizo. The major challenges include geography (isolation and difficulty in accessing the destination in question), limited resources, severe weather conditions, limited connectivity to the mainland and environmental issues. Transportation connectivity of Kastellorizo is limited due to insufficient transportation infrastructure, limited air and sea connections and restricted capacity to handle simultaneous aircraft operations flying to the local airport. The economic downturn in Greece and the COVID-19 pandemic have further disturbed travel to and from the island by increasing financial burden and travel limitations for both tourists and locals. Therefore, the infrequent and limited transport services to and from Kastellorizo, facing additional constraints due to recent economic challenges and the COVID-19 pandemic, hamper the local economic growth and development and the social cohesion of the island.

Future research could focus on several key areas one of which could be the development of alternative transportation options such as seaplanes or helicopter services so as to improve the connectivity of the islands. The impact of increased tourism volumes on the transportation connectivity of Kastellorizo could also be studied including an analysis of the seasonality of the relevant demand (Zenelis & Papatheodorou, 2008) and capacity of the existing infrastructure. The possibility of developing renewable energy sources for the sea services to and from Kastellorizo combined to the development of charging stations for electric boats and yachts could also be a topic for further research. Last but not least, it could be interesting for the island connectivity prospects to examine different scenarios of more environmentally friendly transportation infrastructure and services that could significantly lessen carbon emissions and minimize the impact of leisure activities on the environment.

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AUTHOR'S BIO

Petros Zenelis was awarded a PhD from the University of the Aegean in 2011, specializing in the fields of air transportation and tourism economics. Prior to this, he completed an MSc in International Banking and Financial Services at the University of Reading, UK, and a BSc in Economics from the University of Athens, Greece. Zenelis has over five years of experience in the Greek banking industry and has been working as an Economist for the Hellenic Ministry of Finance since 2013.