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Unit Root Tests of Airline's Stock Returns Considering Alliances

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Abstract

The purpose of this study is to make a unit root analysis of the stock return time series of 18 air carrier companies due to alliance membership in this paper because of the importance of the unit roots in the detection of time-related matters. Five important unit root tests, which can be classified as Fourier or classical utilized. According to the findings, there is no unit root in the stock return series regardless of airline alliances but there are differences on a regional basis depending on the test and test power, specific Asian airlines stocks' return series show linearity. These results will shed more light on the efficient market hypothesis on aviation management in the next research.

1. Introduction

Finance was the art of money management at the beginning of this century. But, after the statistical explanations of Markowitz and especially after Fama's great contribution "Efficient Market Hypothesis", it became a knowledge-based science. When it is looked at it closely, it can be seen that there is no one financial situation, there are a lot of financial situations according to knowledge in the hands of players in each financial market.

The period between 2007 and 2021 had got so dramatic impacts on these financial markets. The world witnessed a great, long, re-destructive and re-descriptive financial and economic depression. In terms of the aviation world, this period also includes a lot of bitter experiences on a large scale and in different dimensions. First of all, it should be accepted that the civil aviation world's main assumptions and hypothetical acceptances were shocked and waved deeply. For example, security gained its importance one more time after the extraordinary 9/11 terrorist attacks in the USA in a mad trend, on the other side SARS, and COVID-19 widened definitions of safety principles in civil aviation, and safety transformed and became a specific instrument in a manner that includes human health. The science of sustainability has positive and negative impacts on the civil aviation world from different points of view. New aircraft designs, new engine designs and new airports have been the main subjects of this sustainability age. Air carriers' communication techniques with the public and other companies have changed at an intensive pace and rapidity (Koçak, 2021). They transformed into an indispensable reality with integrated reporting and sustainable reporting. On one hand, the competition that was inherited from the Airlines Deregulation Act of 1978, sustained its impacts on the industry, on the other hand, all civil aviation market participants can utilize hedging policies densely and widely. If it is concentrated on statistical figures of the aviation industry, these events also have got disruptive impacts on investors' decisions and decision-making processes, because they are resources of volatility structures.

It is a scientific reality that volatility structures include a lot of unambiguity depending on white noise. With more open words, unit roots can be formed around every stochastic movement (random walk) within the border of white noise. It can be shown also with the following classical econometric stochastic arguments (Gourieroux and Robert, 2001),

$$Y_t = Y_{t-1} + \varepsilon_t \text{ , with probability } \pi(Y_{t-1})$$
$$Y_t = \varepsilon_t \qquad \text{ , with probability } 1 - \pi(Y_{t-1})$$

Where

ε_t= strong white noise,

π = is a non-decreasing function.

If a financial market has more white noise unit roots, it means that it is more open to financial risks, crises and opportunities depending on the deep impacts of knowledge on unit roots. Detection of unit roots and difference-stationary is the open and frank purpose of this paper in the air carrier world. To reach this purpose, five important complementary unit root and non-stationary tests will be utilized.

In light of these arguments, a classification will be made between air carriers depending on alliances. As one of the important matters in civil aviation, air carriers and their stock price structures will be discussed and there is a short explanation of the alliances' concept, alliances, and their impacts on air carriers in the first part of the research. The second part of the research will give a short explanation of the unit root test. Lastly, five important unit root tests are made, and their conclusions, discussions and suggestions will be utilized meticulously.

2. Literature

2.1. Air Carriers and Alliances

2.1.1. Air Carriers

The air carrier industry is so an important part of civil aviation, their financial decision-making styles should have many more different changes depending on the endemical world of the airlines. Their accounting policies, cost management strategies, cash flow management styles and risk variables are also authentic. For example, they are vulnerable to financial and economic crises and slowdowns (Maitra et al., 2021), and other stochastic and unexpected events such as meteorological variables, accidents and terrorist attacks disrupt the financial structure of air carriers. Therefore, they should follow hedging strategies and policies easily and densely to decrease costs in future. (Swidan and Merkert, 2019). Oil price changes can negatively impact the airline industry and are exact and open resources of volatility (Yun and Yoon, 2019; Wang and Gao, 2020) like other parts of the transportation and logistics industry. Efficiency is another important variable in airline financial management, and it is connected to operational efficiency (Pineda et al., 2018), however, it should be also added here that the impacts of oil prices could change depending on the nature of different segments such as low costs, full service etc. and it can be one of the causes of reinterpretation. (Wolter, 2021). State economic and financial politics and monetary and budgetary actions can have also different impacts on the US airline industry with a volatility-creating structure (Sobieralski, 2021).

Regional impacts and regionalism show their faces in the airline industry, Loudon (2004) and Tsai (2008) maintain different financial risk measures for Australian and South African Regions, and Yashodha et al. (2016) clarify and compare different financial risk exposure in Australian major airlines, Cathay Pacific Airways, and China Airlines. It is so important here to underline the main impacts of financial management styles of the airline companies, Alıcı and Sevil (2021a) and Alıcı and Sevil (2022b) argue these relationships in terms of operational ratios on national and low-cost air carriers.

2.2.2. Airline Alliances

Airline alliances are so important part of the civil aviation system. There are a lot of advantages and disadvantages of alliances (Daşçı ve Orhan, 2019). Besides, it can seem their impact different parts of the world from Africa (Button, Porta and Scotti, 2020) to the American continent. Besides, they have sound and strict impacts on strategic business-making styles, marketing policies and other determinants of the airline industry.

According to Morrish and Hamilton (2002), alliances are the results of internal dynamics of the airline industry with low margins and low profitability. Brueckner and Singer (2019) state that airline alliances impact the industry to connect passengers, making alliances beneficial on balance. For Calzada, Fageda and Safronov (2022), airline alliances affect the frequency of flights and profits indirectly. Klophaus and Lordan (2018) state that networking activities also increase with alliances and Brueckner and Whalen (2000) emphasize the positive impacts of alliances on airfares in competition. Ivaldi, Petrova and Urdanoz (2022) show that alliances re-describe the cost structure of air carriers with the impacts of digital technology. Yimga (2022) states that related activities like

codesharing have deep impacts on prices in the short-haul and

long-haul markets. Wang et al. (2022) conclude that profitability improves with alliances' impacts. Declaration of alliance membership for airline/air carriers causes many changes in the mind of consumers and institutional and individual investors according to daily media.

The impacts of memberships of the air-carrier companies to the alliances are in question.

3. Econometrical Methodology

3.1. Unit root

In the probability theorem, the unit root test is a problem that arises from the random walk process of a times series. After Güriş (2019) stated that unit root tests are an important part of empirical analysis, he put some exclamation points on their historical development. According to him, unit root tests began with Phillips and Perron tests, and they are developed due to conditions of linearity, structural breaks and cointegration of data.

3.2. Augmented Dickey-Fuller Unit Root Test

The augmented Dickey-Fuller Unit Root Test is the extended version of the simple Dickey-Fuller test depending on white noise problems. They extended their test by including extra lags in terms of the dependent variables to eliminate the problem of autocorrelation (Mustaq, 2011). To eliminate autocorrelation, the Augmented Dickey-Fuller test depends on the estimation of the equations below (Çil, 2018).

$$\Delta y_t = \theta y_{t-1} + \sum_{i}^{p} \beta_i \Delta y_{t-1+1} + \varepsilon_i \quad (1)$$

$$\Delta y_t = \mu + \theta y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-1+1} + \varepsilon_i \quad (2)$$

$$\Delta y_t = \mu + \theta y_{t-1} + \beta_t \sum_{i=2}^{p} \beta_i \Delta y_{t-1+1} + \varepsilon_i \quad (3)$$

In these equations,
μ = constant,
p= lag order of autoregressive process,
The unit root test is then carried out under the null hypothesis $\theta = 0$ against the alternative hypothesis $\theta < 0$.

$$DF_{\tau} = \frac{\theta}{SE(\theta)} \quad (4)$$

And equation 4 give us coefficient of Augmented Dickey Fuller Test.

Kwiatkowski, Phillips, Schmint and Schin (KPSS) Unit Root Test

KPSS Unit Root Test tests the estimation under the null hypothesis of stationary. It can be described as follows (Çil, 2018):

$$s_t = \sum_i^t e_i \tag{5}$$

$$\sigma^2 = \lim_{T\to\infty} T^{-1} E(S_T^2) \tag{6}$$

$$\mathrm{LM} = \sum_{t=1}^{T} \frac{s_t^2}{\sigma^2} \tag{7}$$

$$s^2(l) = T^{-1}\sum_{t=1}^{T} e_t^2 + 2T^{-1}\sum_{s=1}^{t} w(s,l)\sum_{t=s+1}^{T} e_t\, e_{t-s} \tag{8}$$

$$\acute{\eta} = T^{-2}\sum_{t=1}^{T}\frac{S_t^2}{s^2(l)} \tag{9}$$

In these equations,

St = the sum of residuals,

σ2 = long term variance,

LM = Lagrange Multiplier Test,

s2 = weighted sum

l= lag,

ή = Test statistic of KPSS.

3.4. The Flexible Fourier Form and Dickey-Fuller Type Unit Root Tests

Enders and Lee (2012) criticized the Lagrange multiplier (LM) detrending methods[1] and the Dickey-Fuller Generalized Least Squares (DF–GLS) detrending methods[2] because these detrending methods can result in a significant loss of power when the initial value is large. Not only is the standard DF methodology straightforward to use, but DF-type unit root tests are also free of this initial-value problem. They provided an F-test that can be used to pretest for the presence of nonlinearity. Such pretesting can be useful, since utilizing the Fourier tests when non-nonlinearity is present can result in a substantial loss of power **(Enders and Lee, 2012).**

$$\Delta y_t = \rho y_{t-1} + c_0 + \sum_i^l c\Delta y_{t-1} + e_i \tag{10}$$

$$\Delta y_t = \alpha + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta y_{t-1} + \varepsilon_t \tag{11}$$

$$\Delta y_t = \alpha + \beta t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta y_{t-1} + \varepsilon_t \tag{12}$$

It can be seen in equations 1.6 and 1.7, the only trend and trend and intercept added versions of Enders and Lee Fourier test equations respectively.

3.5. The Flexible Fourier ADF Type Unit Root Tests

The basic idea behind these tests developed in this section is to use trigonometric variables that capture large changes with smooth transition functions that allow capturing non-linear adjustment to this deterministic component (Christopoulos and Leon-Ledesma, 2010). The equations behind Fourier- ADF can be shown as follows.

$$\hat{\varepsilon}_t = \hat{y}_t - \hat{\alpha} - \hat{\gamma}_1 \sin\left(\frac{2\pi kt}{T}\right) - \hat{\gamma}_2 \cos\left(\frac{2\pi kt}{T}\right) \tag{13}$$

$$\Delta_{vt} = a_1 + v_{t-1} + \sum_{j=1}^{p} \beta_j\, \Delta_{vt-j} + u_t \tag{14}$$

3.6. The Flexible Fourier KSS Type Unit Root Tests

Flexible Fourier KSS Type Unit Root Test is structured on Fourier ADF test, so equations of 1.8 and 1.9. The following two equations were developed by again Christopoulos and Leon-Ledesma, 2010 on articles of Kapetanios et al. (2003) to form a new type of Fourier Test.

$$\Delta\hat{\varepsilon}_t = \delta\hat{\varepsilon}_{t-1}^3 + \sum_{i=1}^{k} \Psi_i\, \Delta\hat{\varepsilon}_{t-i} + v_i \tag{15}$$

$$\Delta\hat{\varepsilon}_t = \delta\hat{\varepsilon}_{t-1} + \sum_{i=1}^{k} \Psi_i\, \Delta\hat{\varepsilon}_{t-i} + v_i \tag{16}$$

Table 1. The Comparison of Unit Root Tests and Research Design

UNIT ROOT TEST	Hypothesis	FEATURES	ARTICLES
Augmented Dickey-Fuller	H_0: There are no unit roots in time series data. H_1: There are unit roots in time-series data	ADF unit root regression specification does not consider structural breaks. It can be utilized in both trend and trend and intercept.	Yaya et. al (2019)
Kwiatkowski, Phillips, Schmint and Schin	H_0: Time series is stationary H_1: Time series is not stationary	KPSS unit root regression specification considers stationary in Null Hypothesis. For this reason, it is a strong stationary test. It can be utilized both of trend and trend and trend and intercept.	Kızılkaya and Konat (2019)
Enders and Lee Fourier Unit Root Test	There are two stages: A. F TEST H_0: There is linearity in time-series data H_1: There is no linearity in time series data. B. T-TEST H0: There are no unit roots in time series data. H1: There are unit roots in time-series data	With this unit root test, it is possible to take more detailed information on unit root and stationary. This information also includes structural breaks in time series.	Enders and Lee, 2012

[1] KPSS

[2] ADF or ADF-GLS

Fourier ADF	There are two stages: A. F-TEST H_0: There is linearity in time series data. H_1: There is no linearity in time series data. B. T-TEST H0: There are no unit roots in time series data. H1: There are unit roots in time-series data	It was developed for unit roots that account jointly for structural breaks and non-linear adjustment. Structural breaks are modelled using a Fourier function that allows for infrequent smooth temporary mean changes.	Christopoulos and Leon-Ledesma (2010)
Fourier KSS	There are two stages: A. F-TEST H_0: There is linearity in time series data. H_1: There is no linearity in time series data. B. T-TEST H_0: There are no unit roots in time series data. H_1: There are unit roots in time-series data	This model is derived from models for testing for a unit root in the original series after removing the breaks in the deterministic component. In addition to temporary breaks, testing for a unit root against a non-linear alternative.	Christopoulos and Leon-Ledesma (2010)

4. Research Data and Design

Time series data of the research has been collected from investing.com on daily basis., Fourier unit root and stationary analysis is so contemporary and strong way to determine unit roots with their dependence on linearity (Hepsağ, 2022).

Individual or corporal investors, companies, and regulators can take a lot of information and knowledge from these tests about their investments such as immunity and strength of stock prices against financial shocks or breaks. Although basic unit root tests give us restricted information on these matters, Fourier Type-Tests, if they are utilized correctly, are causes of wider and more comprehensive information.

In the light of these arguments, there are five important unit root tests in this paper. Unit root tests are utilized on 18 airline companies that have been classified due to membership of one of three alliances, Star Alliances, Sky Alliances and One World Airlines. Data, time intervals and observations can be seen in the following table. There can be time interval problems due to country holidays and resources. WinRAT package program is utilized for analysis. The descriptive statistics can be seen in Table 2.

Table 2. Descriptive Statistics

ALLIANCES	AIRLINES	DATA	
		TIME INTERVALS	OBSERVATIONS
ONE WORLD AIRLINES	Cathay	06.01.2014 - 24.06.2022	2086
	Finnair	02.01.2014 - 23.06.2022	2130
	Japon Air	06.01.2014 - 24.06.2022	2070
	Qantas	07.05.2014 - 24.06.2022	2061
SKY AIRLINES	Aeroflot	06.01.2014 - 24.06.2022	2118
	China Eastern Airlines	06.01.2014 - 24.06.2022	2133
	China Airlines	06.01.2014 - 24.06.2022	2074
	Delta Airlines	06.01.2014 - 24.06.2022	2206
	Garuda - Indonesia Airlines	06.01.2014 - 17.06.2022	1808
	Korean Airlines	06.01.2014 - 24.06.2022	2436
	American Airlines	06.01.2014 - 24.06.2022	2206
STAR ALLIANCE	Aegean Airlines	06.01.2014 - 24.06.2022	2082
	Air Canada	06.01.2014 - 24.06.2022	2106
	Air China	06.01.2014 - 24.06.2022	2066
	All Nippon Airways	06.01.2014 - 24.06.2022	2118
	Asiana Airlines	06.01.2014 - 24.06.2022	2354
	Lufthansa	06.01.2014 - 24.06.2022	2145
	Turkish Airlines	06.01.2014 - 24.06.2022	2107

To calculate return, we utilized following equations.

$$R_i = (R_t - R_{t-1})/R_{t-1} \qquad (17)$$

5. Empirical Findings

Unit root tests are so systematic and wide part of financial time series analysis. According to Wang and Tomek (2007), Augmented Dickey-Fuller (ADF) tests frankly give biased results, if there is a structural break in time series. Therefore, it can be concluded here that this most widespread test can be ineffective in some situations. The ADF analysis results of data can be shown as follows, and in the level of time series and it can be concluded that daily time series of selected air carriers do not include unit root. The ADF results are observed in Table 3.

Table 3. ADF Test Results

ALLIANCES	AIRLINES	ADF TEST RESULTS
ONE WORLD AIRLINES	Cathay	-45.149*
	Finnair	-46.857*
	Japon Air	-46.325*
	Qantas	-41.411*
SKY AIRLINES	Aeroflot	-41.556*
	China Eastern Airlines	-47.519*
	China Airlines	-42.699*
	Delta Airlines	-18.062*
	Garuda - Indonesia Airlines	-40.447*
	Korean Airlines	-5.873*
	American Airlines	-29.073*
STAR ALLIANCE	Aegean Airlines	-45.614*
	Air Canada	-28.869*
	Air China	-45.556*
	All Nippon Airways	-41.556*
	Asiana Airlines	-3.187**
	Lufthansa	-46.719*
	Turkish Airlines	-47.438*

**0.01, ** 0.05, ***0.10 significance. *0.01, ** 0.05, ***0.10 significance. (McKinnon (1996) one-sided p-values, Schwarz Information Criteria)*

The second unit root test results are given in the following table with trend and trend and constant is Kwiatkowski, Phillips, Schmidt, and Shin (1992) test. It can be said here that structural breaks can gain a little bit more importance in this analysis. The main determinative factor of KPSS analysis is that KPSS intends to consider structural breaks. According to KPSS analysis, the % return series of airline companies is also stationary. The results of the analysis can be seen in Table 4.

Table 4. KPSS Test Results

ALLIANCES	AIRLINES	KPSS TEST RESULTS
ONE WORLD AIRLINES	Cathay	0.041
	Finnair	0.156*
	Japon Air	0.145
	Qantas	0.361*
SKY AIRLINES	Aeroflot	0.414**
	China Eastern Airlines	0.138
	China Airlines	0.234
	Delta Airlines	0.086
	Garuda - Indonesia Airlines	0.044
	Korean Airlines	0.910*
STAR ALLIANCE	American Airlines	0.080
	Aegean Airlines	0.045
	Air Canada	0.125
	Air China	0.054
	All Nippon Airways	0.414**
	Asiana Airlines	2.046
	Lufthansa	0.114
	Turkish Airlines	0.354**

**0.01, ** 0.05, ***0.10 significance at level*

Enders and Lee type unit root tests are other dynamic type unit root tests, they are designed for detecting and analyzing unit roots in more detailed forms in Table 5.

According to findings in 5. Table, for all of airlines out of Aeroflot, Turkish Airlines, Asiana Airlines, All Nippon Airways and Korean Airlines are suitable to interpret with Dickey-Fuller tests because of F-value is smaller than the value determined in Enders and Lee (2012). On the other side, Aeroflot, Turkish Airlines, Asiana Airlines, All Nippon Airways and Korean Airlines have got higher F-values. They are suitable to work Enders and Lee (2012), again if it is looked at test statistics of these (taudf_c) airline companies, it easily accepted that there is no unit root for these values are larger than table values of Enders and Lee (2012).

The two other important tests are Fourier ADF and Fourier KSS. They are utilized according to linearity situations of time series. The results of the Fourier KSS and Fourier ADF test can be shown Table 6.

According to the findings in Table 6. Fourier ADF, larger Fm(k) values of Qantas, Aeroflot, Garuda Indonesia Airlines, Korean Airlines, All Nippon Airways, Asiana Airlines and Turkish Airlines show that these airline companies are suitable to continue with these tests. Besides, if it is concentrated to test values (FADF-m values) it can easily seem that Dickey-Fuller type evaluations are suitable to evaluate unit root situations of returns. So, for these 7 airline companies, it can be concluded that there is no unit root in series.

On the other side, from Fourier KSS test results in Table 6, it can be inferred that Finnair, Qantas, Aeroflot, Garuda Indonesia Airlines, Korean Airlines, All Nippon Airways, Asiana Airlines and Turkish Airlines are suitable for this test depending on larger Fm(k) values. KPSS tests are suitable for this returns' stationary analysis. Besides, it can be said from larger test values (F-tnl-m), that all of the series are stationary with different significance levels

Table 5. Enders and Lee (2012) Fourier Unit Root Tests

ENDERS AND LEE (2012) FOURIER UNIT ROOT TESTS				
ALLIANCES	**AIRLINES**	**k**	**UNIT ROOT TESTS (CONSTANT)** *0.01, ** 0.05, ***0.10 significance.	
ONE WORLD AIRLINES	Cathay	k= 4	F(k)=1.393	taudf_c=-42.09464* optimallag= 0 Min RSS= 0.62203
	Finair	k= 5	F(k)= 4.329	taudf_c=-32.76523* optimallag= 1 Min RSS= 2.48626
	Japon Air	k= 4	F(k)=1.169	taudf_c=-31.00729* optimallag= 1 Min RSS= 0.67942
	Quantas	k= 4	F(k)= 2.310	taudf_c= -29.84620* optimallag= 1 Min RSS= 1.03875
SKY AIRLINES	Aeroflot	k= 2	F(k)= 7.240(**)	taudf_c=-30.30489* optimallag= 1 Min RSS= 0.89615
	China Eastern Airlines	k= 3	F(k)= 0.781	taudf_c=-30.40743* optimallag= 1 Min RSS=1.43647
	China Airlines	k= 1	F(k)= 2.623	taudf_c=-30.66452* optimallag= 1 Min RSS=0.79034
	Delta Airlines	k= 5	F(k)= 1.174	taudf_c=-31.18960* optimallag= 1 Min RSS=1.29217
	Garuda - Indonesia Airlines	k= 4	F(k)= 3.962	taudf_c=-29.33922* optimallag= 1 Min RSS=1.48710
	Korean Airlines	k= 2	F(k)= 23.710(*)	taudf_c=-37.44341* optimallag= 1 Min RSS= 9.99601
STAR ALLIANCE	American Airlines	k= 4	F(k)= 1.111	taudf_c=-31.47100* optimallag= 1 Min RSS=2.12558
	Aegean Airlines	k= 4	F(k)= 1.083	taudf_c=-30.02112* optimallag= 1 Min RSS=1.35184
	Air Canada	k= 4	F(k)= 2.030	taudf_c=-26.75773* optimallag= 1 Min RSS=1.77468
	Air China	k= 4	F(k)=2.721	taudf_c=-29.59702* optimallag= 1 Min RSS=1.22165
	All Nippon Airways	k= 2	F(k)=7.240**	taudf_c=-30.30491* optimallag= 1 Min RSS=0.89615
	Asiana Airlines	k= 1	F(k)=88.966(*)	taudf_c=-36.24461* optimallag= 1 Min RSS=265.26205
	Lufthansa	k= 5	F(k)=2.077	taudf_c=-31.23286* optimallag= 1 Min RSS=1.27211
	Turkish Airlines	k= 2	F(k)=7.226(*)	taudf_c=-31.50382* optimallag= 1 Min RSS=1.22288

6. Discussions and Conclusions

It can be stated here that the random walk process, whether or not the time series is volatile, is one of the main results of the interaction of random walk, unit root and stationary. It is selected two important subjects, one of them is the membership of the alliances and the other one the behaviour of the returns in time. According to main findings, there is no structural evidence if alliances have impacts on the financial structure of airline returns, on the other side, in randomly selected airline companies regional factor can raise as an important factor.

Tiwari and Kyophilavong (2014) make some unit root analyses of the random walk process on a large scale in BRICS countries in terms of the random walk process. According to them, random walk, so stationary or unit root, is an indicator of market efficiency but the time interval is important. Gözbasi, Küçükkaplan and Nazlıoğlu (2014) found that the Borsa Istanbul stock price index series have nonlinear behaviour and follow a random walk (non-stationary) process, but they are again in weak-form efficiency. Narayan and Smyth (2007) and Narayan (2008) stated that stock prices are stationary processes, inconsistent with the efficient market hypothesis. Aggarwal and Kyaw (2005) stock prices are non-stationary but stock return series is stationary for NAFTA. Wang, Zhang and Zhang (2015) stated that stock prices can be characterized as a random walk or mean reversion process over the period December 1990 to March 2013. For Hasanov (2009) the nonlinear unit root test rejects the null hypothesis of unit root, suggesting that South Korea's stock market is not weak-form efficient, contrary to the findings of Narayan and Smyth (2004).

In light of the arguments above, there is a stationary in all of the time series in linear form root tests such as ADF and KPSS. Enders and Lee Fourier Type Unit Root Tests are designed for measuring non-linearity in the light of Fourier Transformations, but their preconditions are non-linear. For this reason, Fourier ADF and Fourier KSS tests outshined as problem-solving methodologies of their linearity-depended nature, Fourier ADF can be described as an ADF example in a total of Fourier analyses, on the other hand, Fourier KSS can be accepted as an example of KPSS in these analyses. However, they are both stronger and more explanative than the classical ADF test and classical KPSS test. Although all of the return series are stationary some series can also be shown this feature with more powerful tests.

The unit roots, on the other side, can be considered as an indicator of market efficiency, a strong form of market efficiency is related to the absence of unit root or stationary in time series in determined articles in this section, but this does not mean that it is an absolute financial form. In light of these arguments, it can be inferred that airline company return series are stationary, but it is not possible to realize a classification in terms of efficient market hypotheses, these series can be shown differences in terms of efficiency due to the power of stationary tests. These results can be beneficial for the next research, especially for the ones which is related to macro-economic analysis.

Table 6. Fourier ADF and Fourier KSS results

FOURIER ADF and KSS UNIT ROOT TESTS RESULTS						
ALLIANCES	**AIRLINES**	**k**	**FOURIER ADF UNIT ROOT TEST (CONSTANT AND TREND)**	**AIRLINES**	**k**	**FOURIER KSS UNIT ROOT TEST (TREND AND CONSTANT)**
ONE WORLD AIRLINES	Cathay	k= 2	FADF-m= -29.79165 Fm(k)=1.27894 optimallag= 1 MinSSR=0.69498	Cathay	k=2	F-tnl-m= -9.79200 Fm(k)=1.25619 optimallag= 1 MinSSR=0.69521
	Finnair	k= 4	FADF-m= -31.63683 Fm(k)= 1.07649 optimallag= 1 MinSSR=1.41434	Finnair	k=5	F-tnl-m=-13.36628 Fm(k)= 3.77405* optimallag= 1 MinSSR=2.69397
	Japan Air	k= 4	FADF-m= -31.44067 Fm(k)= 1.58809 optimallag= 1 MinSSR=0.77322	Japan Air	k=4	F-tnl-m=-9.88016 Fm(k)=1.58043 optimallag= 1 MinSSR=0.77320
	Qantas	k= 4	FADF-m= -30.66910 Fm(k)= 3.82974* optimallag= 1 MinSSR=1.13488	Qantas	k=4	F-tnl-m=-12.18640 Fm(k)= 3.75295* optimallag= 1 MinSSR=1.03958
SKY AIRLINES	Aeroflot	k= 2	FADF-m= -32.56487 Fm(k)= 6.11841* optimallag= 1 MinSSR=1.22016	Aeroflot	k=2	F-tnl-m= -14.16901 Fm(k)= 6.16993* optimallag= 1 MinSSR=1.22031
	China Eastern Airlines	k= 3	FADF-m= -31.20239 Fm(k)=1.61279 optimallag= 1 MinSSR=1.60010	China Eastern Airlines	k=3	F-tnl-m= -11.19158 Fm(k)= 1.61157 optimallag= 1 MinSSR= 1.60033
	China Airlines	k= 2	FADF-m= -31.84450 Fm(k)= 2.31086 optimallag= 1 MinSSR=0.91747	China Airlines	k=2	F-tnl-m=-19.69852 Fm(k)= 2.31610 optimallag= 1 MinSSR= 0.91769
	Delta Airlines	k= 4	FADF-m= -31.59696 Fm(k)=1.12850 optimallag= 1 MinSSR=1.41731	Delta Airlines	k=4	F-tnl-m=-11.52264 Fm(k)=1.11867 optimallag= 1 MinSSR=1.41755
	Garuda - Indonesia Airlines	k= 5	FADF-m=-29.77694 Fm(k)= 4.08206* optimallag= 1 MinSSR=1.71189	Garuda - Indonesia Airlines	k=5	F-tnl-m= -13.03811 Fm(k)= 3.74768* optimallag= 1 MinSSR=1.73812
	Korean Airlines	k= 2	FADF-m= -38.24893 Fm(k)=14.06305* optimallag= 1 MinSSR=11.86901	Korean Airlines	k=2	F-tnl-m=-24.62193 Fm(k)=14.05758* optimallag= 1 MinSSR=11.86906
STAR ALLIANCE	American Airlines	k= 4	FADF-m= -31.82000 Fm(k)=1.22007 optimallag= 1 MinSSR=2.32038	American Airlines	k=4	F-tnl-m=-7.18188 Fm(k)=1.21063 optimallag= 1 MinSSR=2.32063
	Aegean Airlines	k= 4	FADF-m= -30.67766 Fm(k)=1.04102 optimallag= 1 MinSSR=1.52943	Aegean Airlines	k=4	F-tnl-m=-8.73407 Fm(k)=1.06367 optimallag= 1 MinSSR=1.52962
	Air Canada	k= 4	FADF-m= -27.41959 Fm(k)= 3.15092 optimallag= 1 MinSSR=1.94074	Air Canada	k=4	F-tnl-m= -8.41347 Fm(k)= 3.59729 optimallag= 1 MinSSR=1.94017
	Air China	k= 4	FADF-m=-30.41308 Fm(k)= 2.23193 optimallag= 1 MinSSR=1.39532	Air China	k=4	F-tnl-m= -7.13146 Fm(k)= 2.25758 optimallag= 1 MinSSR=1.39552
	All Nippon Airways	k= 2	FADF-m=-32.56589 Fm(k)=6.11841* optimallag= 1 MinSSR=1.22016	All Nippon Airways	k=2	F-tnl-m= -14.16803 Fm(k)= 6.16993* optimallag= 1 MinSSR=1.22031
	Asiana Airlines	k= 1	FADF-m=-36.76151 Fm(k)=72.22630* optimallag= 1 MinSSR=287.90108	Asiana Airlines	k=1	F-tnl-m= -27.44025 Fm(k)= 72.28480* optimallag= 1 MinSSR=287.90253
	Lufthansa	k= 2	FADF-m=-32.09547 Fm(k)= 2.60845 optimallag= 1 MinSSR=1.39070	Lufthansa	k=2	F-tnl-m= -7.92861 Fm(k)= 2.61316 optimallag= 1 MinSSR= 1.39066
	Turkish Airlines	k= 2	FADF-m=-31.52445 Fm(k)= 6.22963* optimallag= 1 MinSSR=1.26608	Turkish Airlines	k=2	F-tnl-m= -15.35416 Fm(k)= 6.24593* optimallag= 1 MinSSR= 1.26603

Ethical approval

Not applicable.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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