Time Series Approaches to Forecast Air Freight Imports and Exports: Empirical from Sri Lanka.

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Abstract*—this paper establishes an approach to forecast Air freight exports and imports volumes in Sri Lanka for the period of 2008-2013. Further the paper also applies Granger Causality to test the causality between air cargo import and export and also between air cargo import-inflation and air cargo exports-inflation. The secondary data used in the analysis were obtained from Civil Aviation Authority, Sri Lanka, and Census and statistics department of Sri Lanka, Logistic and Freight Forwarder association and Central Bank Sri Lanka covering the period from 2008 2013 (Monthly figures). The variables used are Air freight export volumes; Air freight imports volumes, CCPI and USD exchange rate. The statistical software used in the analysis is E-views 7. Further the econometric techniques like ADF and PP tests for Stationary test of time series, B&J ARIMA modelling for constructing forecasting models, Johnson's co-integration test and Granger causality tests are used in analytical process and according to the results of all those studies and tests revealed a strong linkage between Air freight import volumes and export volumes in Sri Lanka. Furthermore it was also exposed that there is a bi-directional causality between Air freight export volumes and inflation rates in Sri Lanka.*

Key words *- Air freight imports, Air freight exports, Ganger Causality.*

I. INTRODUCTION

Today the air cargo industry is known to be one of the most booming industries in the world as more than 40% of the world trade is delivered by air. (World Air Cargo Forecast 2012-2013 by Boeing Commercial Airplanes). It is forecasted that the world air cargo Traffic will nurture 5.2% per year during the next 20. It is also expected that these advancements will lead to higher growth in world economy in terms of GDPs and investments. The purpose of this research is to test the causality between air cargo movements and economy. The study uses two time series model to forecast future air cargo volumes in Sri Lanka. Further the study aims to examine the causal relationship between air cargo volumes and two economic variables; average exchange rate and inflation. This research paper is based on monthly time series data which were obtained from period of year 2008 to 2013.

II. METHODOLOGY & EXPERIMENTAL DESIGN

Data used in this research paper is monthly figures covering the period of 2008-2013 and the variables are air freight exports, air freight imports and monthly inflation rates in Sri Lanka. Data were gathered from Central Bank, Sri Lanka, Sri Lanka Logistics and Freight Forwarders' Association and Airport and Aviation Services, Sri Lanka. E-views software is used as the statistical tool for all the below mentioned analysis.

Prior to the main analysis all the available data is converted into logarithms to ensure the stability of the variances of all the time series and to transform them in to normality. Further since this research is more interested in data sets with positive values, it is vital to convert data in to logarithms in advance of carrying out the analysis.

The first step of the econometric methodology that involves the analysis of data commences with tests of stationary and to test for the order of integration of the variables or the presence of the unit root of the series. And also ARIMA models are used for time series forecasting. The second step is to test for Granger Causality between the variables. Then the VEC model is used as the third step to estimate the causal relationships among the variables. The final step is to find the existence of co integration to check the long run equilibrium relationship among the time series variables.

A. Unit root test and providing stationarity

Before starting the analysis of the research, it is important to get the stationary status of each of the time series tested painstakingly to identify trends and seasonality in those time series. For a given time series to be stationary, its' properties has to be independent from the time at which the particular series is observed. Stationary time series look much the same at any time irrespective of the time that it is been observed. Therefore time series with trend and seasonality are not stationary as those time series will have different values at different times.

B. Differencing

Differencing is the process of computing the variance between two consecutive observances in order to stabilize the mean of the time series removing the changes in different time series values and minimizing the probabilities of trend and seasonality There are certain situations where de-trending is not sufficient to make a time series stationary. Because sometimes even after the de-trending mean, variance and autocorrelation (the correlation of a time series with its' past and future values) are not constant. In such cases it is essential to transmit it into series of period to period differences. Such time series said to be difference stationary. But sometimes it is difficult to identify trend stationary and difference stationary separately. In such situations unitroot test can be employed to get a better solution while determining the order of integration as well. Unit root can be tested through Augmented Dickey Fuller (ADF) test and Phillips Perron (PP) test under few different criteria's: At level, At first difference & at second difference

C. Test for normality

Under normality,

Skewness~ N (0, 6/n) and [kurtosis-3] ~N (0, 24/n)

Therefore t-tests can be used to test normality of the given time series. But for each series normality has to be tested separately. J&B test combines these two tests together and perform one single test to check for the normality.

H0: Data isNormal

H1: Data is not normal

D. Box- Jenkins ARIMA Modelling

Box Jenkins (B&J) models have the possibility of including both AR and MA terms. Therefore B&J models are said to be pretty much flexible than the other models. And for an effective modelling at least about 50 data points and good experience are requires in B&J modelling. The following table summarizes how sample autocorrelation function is applied for the detection of AR or MA model.

E. ACF & PACF plots

The ARIMA class of time models requires a certain degree of good experience to make it more accurately since they are quite complex and powerful forecasting tools in nature. The principal tools for doing this are ACF plots and PACF plots. The process of calculating sample ACF and PACF from the given series and match them with the theoretical ACF and PACF is vital for the identification of B&J time series modelling. The sample ACF computed using the observed series may not always match exactly with the true autocorrelation functions for any ARIMA as calculations are done using a limited sample of data. And therefore it is difficult to identify the exact ARIMA model fits with the observed time series since few patterns related to several ARIMA models can be seen there. Thus several economical models can be identified at this stage of the model selection process. Box and Jenkins gave seasonal ARIMA of the time series as,

ARIMA (p, d, q) × (P, D, Q)S.

Where p = non-seasonal AR order, d = non-seasonal differencing, q = non-seasonal MA order, P = seasonal AR order, D = seasonal differencing, Q = seasonal MA order, and S = time span of repeating seasonal pattern.

Table 1. Identifying AR and MA Models Separately

Shape	Indicated model
Exponential, decaying to zero	AR model. Use the partial autocorrelation plot to identify the order of the AR model
Altering positive and negative, decaying to zero	AR model. Use the partial autocorrelation plot to help identify the order.
One or more spikes, rest are essentially zero	MA model. Order identify by where plot becomes zero
Decay, starting after a few lags	Mixed AR and MA model
All zero or close to zero	Data is essentially random
High values at fixed intervals	Include seasonal AR model
No decay to Zero	Series is not stationary

F. Granger Causality Test

Granger Causality is a technique based on predictions rather than causation and was developed by Prof. Clive Granger (1969) to determining the causal relationship between two variables. This concept is used to determine whether one variable can be used to predict the other and if so, what the direction of that relationship is. Ordinarily regressions mirror "mere" co-relations. According to Poof.Clive Granger's definition (1969), "a variable Y is Causal for another Variable X if knowledge of the past history of Y is useful for predicting the future state of X over above knowledge of the past history of X itself. So if the prediction of X is improved by including Y as a predictor, then Y is said to be Granger causal for X."

III. RESULTS

A. Descriptive statistics

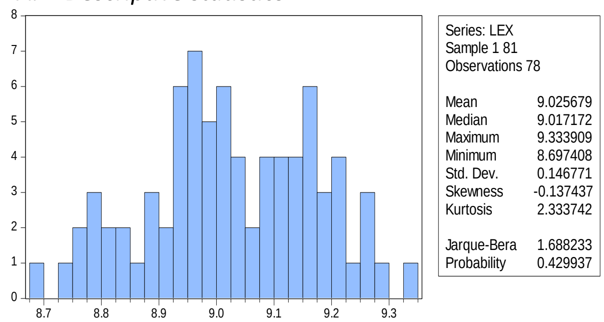


Figure3. Descriptive Statistics of LEX

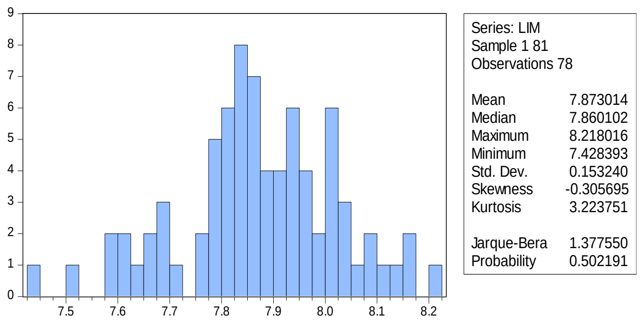


Figure2.Descriptive Statistics of LIM

As per descriptive statistics of two variables, it can be confirmed that both Logarithm of air freight imports (LIM) and Logarithm of air freight exports) has been distribute normally since Jarque-Bera value is greater than 0.05.

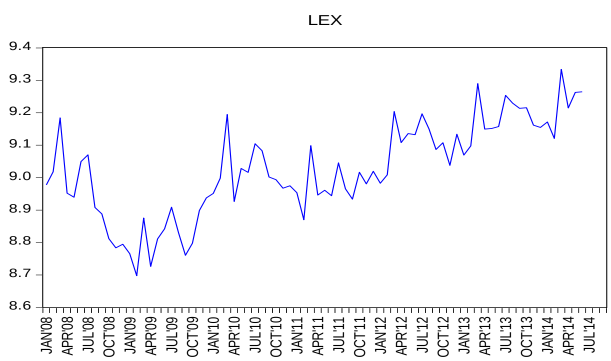


Figure3. Testing Seasonality of LEX

According to figure 3 & 4, it can be seen that the both LEX & LIM have increasing trends with a seasonal pattern over period of time where 2008- 2014.futher more it can be seen that seasonality at every month of April. Then it can be recommended seasonal ARIMA model for the forecasting model of air freight export of Sri Lanka.

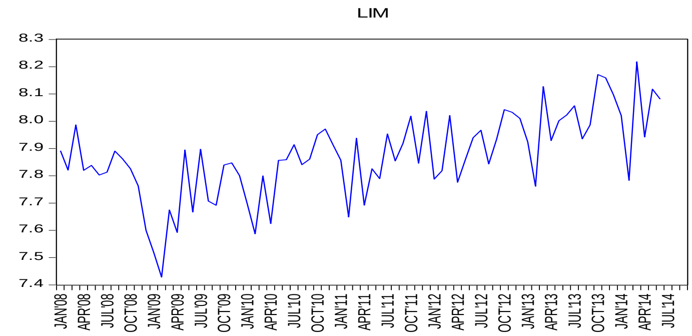


Figure 4. Testing Seasonality of LIM

B. Test for stationarity

Table 2. Results of stationarity test

Method used	Stationarity	Variable	P-Value	Significance
ADF	Level	exports	0.9639	Insignificant
		imports	0.1639	Insignificant
	1st difference	exports	0.0903	Insignificant
		imports	0.0000	significant
	2nd difference	exports	0.0001	significant
		imports	0.0000	significant
PP	Level	exports	0.0900	Insignificant
		imports	0.0001	significant
	1st difference	exports	0.0001	significant
		imports	0.0000	significant
	2nd difference	exports	0.0001	significant
		imports	0.0000	significant

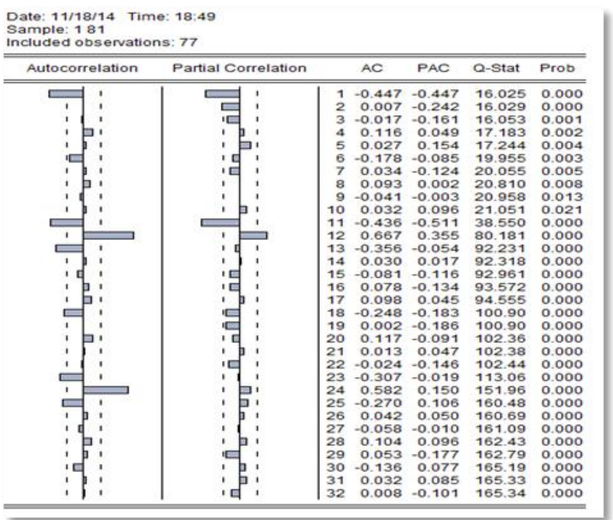
Note – Significant levels considered is 5%

As per the Phillips Perron Test, exports have been stationary at 1st difference. Since P.value of PP test was less than 0.05. It can be confirms that the export time series has a long term mean. Therefore time series of air freight export recommended for the model building. The imports data has also been stationary at level as per the Phillips Perron since P.value of PP test was less than 0.05. It can be confirms that the Imports time series has a long term mean. Then time series of air freight export recommended for the model building.

C. Auto Correlation and Partial Auto Correlation

Model building is depended on pattern of Sample ACF and Sample PACF. The Correlogram test (figure 1 &2) was carried to meet above mentioned condition. Auto correlation of exports (Figure 5) in 1st, 12th and 24th lags has been significantly different, and SPACF at lag 1 and lag 12 significantly different from zero, confirming that seasonality in the Exports at long term difference of lag 12, whereas partial correlation for non-seasonal part has been exponentially decaying confirming that the best fitted model for Exports is a MA model.

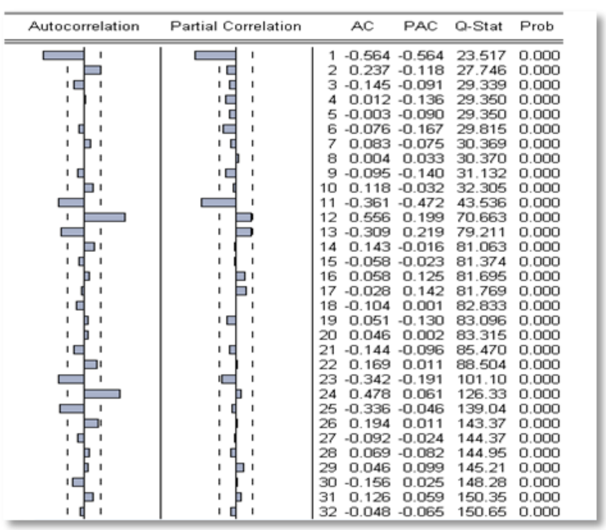
The auto correlation of Imports (Figure 6) in 1st, 12th and 24th lags has been significantly different, and SPACF at lag 1, lag 11 and lag 23 significantly different from zero, confirming that seasonality in the Imports at long term difference of lag 12, whereas partial correlation for non-seasonal part has been exponentially decaying confirming that the best fitted model for Import is also a MA model.



Date: 11/18/14 Time: 18:49
Sample: 1 81
Included observations: 77

	AC	PAC	Q-Stat	Prob
1	-0.447	-0.447	16.025	0.000
2	0.007	-0.242	16.029	0.000
3	-0.017	-0.161	16.053	0.001
4	0.116	0.049	17.183	0.002
5	0.027	0.154	17.244	0.004
6	-0.178	-0.085	19.955	0.003
7	0.034	-0.124	20.055	0.005
8	0.093	0.002	20.810	0.008
9	-0.041	-0.003	20.958	0.013
10	0.032	0.096	21.051	0.021
11	-0.436	-0.511	38.550	0.000
12	0.667	0.355	80.181	0.000
13	-0.356	-0.054	92.231	0.000
14	0.030	0.017	92.318	0.000
15	-0.081	-0.116	92.961	0.000
16	0.078	-0.134	93.572	0.000
17	0.098	0.045	94.555	0.000
18	-0.248	-0.183	100.90	0.000
19	0.002	-0.186	100.90	0.000
20	0.117	-0.091	102.36	0.000
21	0.013	0.047	102.38	0.000
22	-0.024	-0.146	102.44	0.000
23	-0.307	-0.019	113.06	0.000
24	0.582	0.150	151.96	0.000
25	-0.270	0.106	160.48	0.000
26	0.042	0.050	160.69	0.000
27	-0.058	-0.010	161.09	0.000
28	0.104	0.096	162.43	0.000
29	0.053	-0.177	162.79	0.000
30	-0.136	0.077	165.19	0.000
31	0.032	0.085	165.33	0.000
32	0.008	-0.101	165.34	0.000

Figure 5: Correlogram test – Exports



	AC	PAC	Q-Stat	Prob
1	-0.564	-0.564	23.517	0.000
2	0.237	-0.118	27.746	0.000
3	-0.145	-0.091	29.339	0.000
4	0.012	-0.136	29.350	0.000
5	-0.003	-0.090	29.350	0.000
6	-0.076	-0.167	29.815	0.000
7	0.083	-0.075	30.369	0.000
8	0.004	0.033	30.370	0.000
9	-0.095	-0.140	31.132	0.000
10	0.118	-0.032	32.305	0.000
11	-0.361	-0.472	43.536	0.000
12	0.556	0.199	70.663	0.000
13	-0.309	0.219	79.211	0.000
14	0.143	-0.016	81.063	0.000
15	-0.058	-0.023	81.374	0.000
16	0.058	0.125	81.695	0.000
17	-0.028	0.142	81.769	0.000
18	-0.104	0.001	82.833	0.000
19	0.051	-0.130	83.096	0.000
20	0.046	0.002	83.315	0.000
21	-0.144	-0.096	85.470	0.000
22	0.169	0.011	88.504	0.000
23	-0.342	-0.191	101.10	0.000
24	0.478	0.061	126.33	0.000
25	-0.336	-0.046	139.04	0.000
26	0.194	0.011	143.37	0.000
27	-0.092	-0.024	144.37	0.000
28	0.069	-0.082	144.95	0.000
29	0.046	0.099	145.21	0.000
30	-0.156	0.025	148.28	0.000
31	0.126	0.059	150.35	0.000
32	-0.048	-0.065	150.65	0.000

Figure 6

D. Developed model

Based on the simultaneous inspection of both ACF and PACF of series it can be postulated the several possible models for both imports and Exports. Out of the all the identified possible models, the following two models were selected as the best fitted models in forecasting both Air freight imports and exports depending on the values obtained for section criteria AIC, log likelihood and SC. Further Durbin Watson statistics and Jarque- Bera tests confirmed that residuals are normally distributed. The Parameters for both the models were estimated through the least square method.

Table 3: Best Fitted models

	Model	Significance	DW	Log Likelihood	AIC	SC	Jaque-Bera
Exports	(2,1,0)(0,1,2)12	0.0000	1.30418	85.58778	-2.82764	-2.6484	0.744077
Imports	(1,0,0)(1,0,0)12	0.0000	2.036181	59.21329	-1.93839	-1.83182	0.716172

The model estimated for Air freight Exports:

$$(1 - \beta)(1 - \beta^{12})(1 + 0.477526\beta) + 0.812844\beta^{2})Y_t = 1 - 0.225452\beta^{12} - 0.944658\beta^{12}$$

1,12

The model estimated for Air freight Imports:

$$1 + 0.959656\beta)Y_t = (1 + 0.002117\beta^{12})e_t$$

Where,

Yt is the data for the considered year

(1-β) = Yt- Yt-1 , the difference between considered year and value in previous year.

$(1-\beta^{12})$= Yt-12 – Yt– 13, the seasonal difference .

E. Residual Test

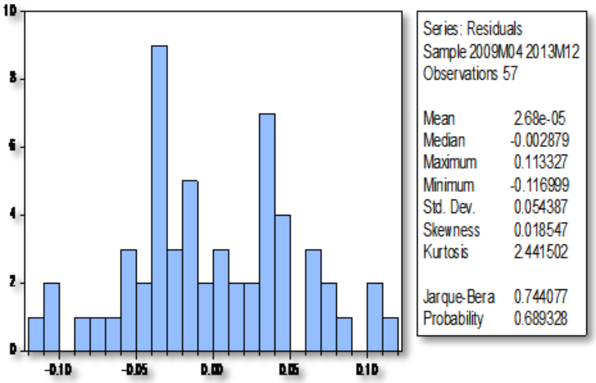


Figure 7: Residual Test – Exports

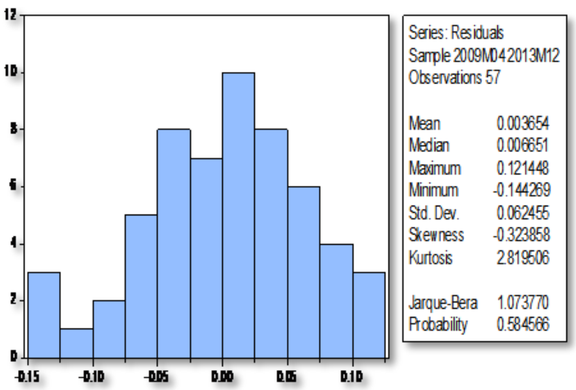


Figure 8: Residual Test – Imports

Both the residual tests for two models confirmed that the residuals are normally distributed. (Mainly using Jaque-Bera Value)

IV. CONCLUSION & DISCUSSION

A solid forecasting mechanism in import and export sector is a vital element for any state's economy. Therefore the two separate models were established for both airfreight exports and imports using the Box-Jenkins ARIMA Modelling can be used to forecast future Air freight volumes. The Granger causality test carried out considering lag 2, revealed that there are uni directional causality between Imports-Exports and Inflation-Imports and bidirectional causality between exports-inflation since the null hypothesis could be rejected as their probabilities were less than 0.05 (significant). Further it was also observed that imports and exports do not show causality with average exchange rate.

The estimated forecasting model can be used in making the decisions on air freight related infrastructure capacity expansions, planning new infrastructure, implementing marketing strategies and other related operations. Further the revealed causality relationships are vital in policy implementations and other administrative purposes. The econometric results indicated that LEX and LIM significantly effect on LINF, a quite strong economic indicator in Sri Lanka. It suggested the historical values of LEX can be used to predict the future values of LINF more accurately than LINF itself. Therefore this finding could be an important tool in forecasting future inflation rates in the country and making changes to the existing monetary policies prior to sudden changes in inflation rates to continue the inflation rates at an optimal level so that sudden booms in inflation would not disturb the smooth flow of economy. Further the results also revealed a strong linkage between LEX and LIM which suggests that the past LIM values help to predict the future LEX values. This linkage can be used in avoid future trade imbalances where the value paid of country's imports is greater than income they are receiving from their exports.

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