A Multivariate Co-integration Analysis of Air Passenger Movement: Empirical Evidence from in Sri Lanka

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Abstract - *Air transportation has been recognized as a key industry in Sri Lanka since most of tourists travel by air and tourism plays a vital role in the economy. The purpose of this research is to test the causality between air passenger movements and economy. The study uses four-variate model of air passenger arrivals, departures, exchange rate and GDP to examine the long run and short run dynamic relationship among variables. This research paper is based on annual time series data which were obtained from period of year 1976 to 2012.Econometric tests were applied such as unit root tests, co-integration test, VEC modal and granger causality test. The result of Johansan co-integration test shows the existence of two co-integrating equations. VEC model was applied since co-integration test reveals that existence of the long run relationship between variables. Air passenger arrivals and departures forecasting models have been estimated. Finally, granger causality test was applied. It reveals that, uni-directional causality is running from air passenger arrivals to air passenger departures, from exchange rate to air passenger arrivals and from exchange rate to departures. Bi-directional causality is running between air passenger arrivals and GDP, exchange rate and GDP, air passenger departures and GDP. Analysis provide guideline for policy makers to create new policies which affecting the development of the aviation sector .Also air transportation affect for the economic growth by providing more and more direct and indirect employment. Further researchers should focus on analysis which is used panel data; provide more information.*

Key words - Air transportation, GDP, Co-integration, VEC model

1. INTRODUCTION

A. Background of the Study

Global air transportation industry provides access to every country in the world virtually. It plays a vital role in the global economy. It is required for global business and tourism. Around 2 billion passengers use air transportation to travel between countries annually. Also it carries 40% of international tourists around the world. The global airline industry provides 29 million jobs. There are 900 airlines with 22000 aircrafts in the world and they provide access 1670 airports through network system (ATAG2004).

Air passenger flow increased 5.3% in 2012 (IATA 2013). Also the connectivity between origin and destination is developed by improved network system. With the rapid globalization there is a highly competitive market in air transportation industry (Button.k2008). Largest air passenger transportation markets are Asia- Pacific airlines, North American airlines and Europe airlines. Now relevant airport regulatory bodies in the world take actions to build new infrastructures, expanding runways, terminal expansions. These investments increase the airport capacity. Also airlines operate new aircrafts with high capacity to cater the large market in the world. High demand for air travel makes congestion at airport. Therefore, relevant authorities have to continue their investments for the air transportation industry. Global economic activities depend on commercial air transportation significantly (ATAG2004). Air connectivity between cities gives more economic benefits to the world, transporting goods, people, technology and ideas easily. City pair connectivity is doubled with compared to last 20 years. It affects to the trade and global supply chains and FDI (foreign direct investment) (IATA2013).

Sri Lankan Airlines and Mihin Lanka are the national carriers of Sri Lanka. Now most of airlines in the world joint for new alliances. Sri Lankan Airlines joined one of the largest airline alliance which is called as One World. Bandaranayake International Airport (BIA) passenger movements were amounting to 50,802 in 2013. It is increased by 3% with compared to last year. In Mahinda Rajapaksha International Airport (MRIA) handled 36137 passengers and Ratmalana Airport (RMA) handled 7435 domestic passengers (AASL 2013). More air connectivity increases the economic benefits of the country. It also helps to attract foreign direct investment. For an example, Sri Lankan Airlines is trying to expand their route network through code share agreement with other airlines. It helps to increase the volume of passenger arrivals and enhance the air connectivity between countries. Passenger load factor is increased up to 82% in 2013(C.B 2013).

Most previous studies had been examined the relationship between air transport development and economic growth in demand perspective. Some researchers presented an econometric model that estimate the aggregate demand for airline. The key determinants of air transport by using panel data. Only few literatures had examined the casual relationship between air transport traffic and economic growth. Some studies used granger causality technique to examine the relationship between air transport and regional economic growth.

Marazzo (2010) et al studied on relationship between air transport demand and economic growth in Brazil. It had been proposed an econometric approach to analyze the linkage between two variables. Hu.Y(2014) discovered that 1% Increase in the air passenger traffic was found to guide to an increase of 0.943% in GDP. Mehmood.B (2014) found existence of the co-integration between air passenger traffic and economic growth. Van De Vijver.M (2010) investigated on the causal relationship between air passenger traffic and trade in Asia – Pacific. Granger causality analysis had developed to check the causality in the evolving geographies of air passenger transport and trade connections in Asia-Pacific. Jayathilake.P.B(2013) observed causality and long run relationship between tourism and economic growth in Sri Lanka. It found that unidirectional causality running from tourist arrivals to economic growth and did not exist from economic growth to tourist arrivals. Massidia.C(2012) conducted a research on SVECM Analysis of the Relationship between International Tourism Arrivals, GDP and Trade in Italy. Ishutkina.M.A(2009) analyzed on interaction between air transportation and economic activity in worldwide perspective. Ozturk.I(2009) investigated on causality between tourism growth and economic growth in Turkey. The results found that there was no co-integrating relationship between the real GDP and international tourism. Guney.S(2010) was studied on relationship between tourism and trade in Turkey. It was found that one-way causality was running from tourist arrivals and tourist expenditures to exports; two-way causality was running between trade and no of tourist arrivals. Suleiman.N.N(2013) studied on dynamic relationship between tourism, trade, infrastructure and economic growth in Malaysia. The results showed that, causal relationship between trade, tourism, infrastructure and economic growth.

B. Research Objective
The research objectives are
- To build up a models to forecast air passenger arrivals and air passenger departures in Sri Lanka

- To find Granger causality between air passenger air passenger arrivals, air passenger departures, exchange rate USD and GDP in Sri Lanka.
- To investigate air passenger movements in Sri Lanka

C. Significance of the Research
This research is useful for policy makers and stake holders in Sri Lankan air transportation industry. Civil aviation authority is the policy maker of air transportation in Sri Lanka. This research gives guideline for new policies and upgrades the old policies. Also relevant authorities can formulate strategies to achieve their targets.

This research paper gives the one way casual effects and two way casual effects. It means uni-directional causality and bi-directional causality. With the help of results in causality can predict effects to the Sri Lankan economy. The findings will provide guideline to build up the environment associated with the aviation sector to increase the passenger arrivals and departures. It will give positive effects to the economy.

II. METHODOLOGY
In the methodology, the systematic and theoretical analysis methods and techniques used to accomplish the study.

A. Sample Selection
The data set consists of Sri Lanka's time series observations on air passenger traffic and economic growth. The objective is to examine the causal relationship between air passenger arrivals, departures, exchange rate (USD) and GDP in Sri Lanka. The time series data on Sri Lanka's annual air passenger arrivals and departures and GDP for the period 1976 to 2012.It is obtained the figure of GDP in million USD. Air passenger traffic and GDP have seasonal changes. Annual time series data on air passenger arrivals and departures were obtained from various issues of annual reports of Airport and Aviation Services Limited in Sri Lanka. The data on real GDP and average exchange rate were obtained from annual report of Central Bank in Sri Lanka.

This research is converted each original time series data into log form before analysis. Logarithms are used for statistical modeling as a mathematical tool. Small changes in the natural log of variables are equal to percentage changes in original series. In order to check the stationarity of time series data which is tested for unit root using the Augmented Dickey Fuller Test. Co-integration test is used to identify the long term relationship between variables. Vector Error Correlation model and Granger causality test is applied to examine

the short term relationship among air passenger arrivals, departures and real GDP in Sri Lanka.

B. Description of the Data

Data is obtained from annual reports of Central Bank and Airports and Aviation Services Limited in Sri Lanka. Based on the secondary data, this research has used statistical package E views 5.0 software for data analysis. It is used for econometric analysis such as panel data analysis, cross section data analysis and time series analysis.
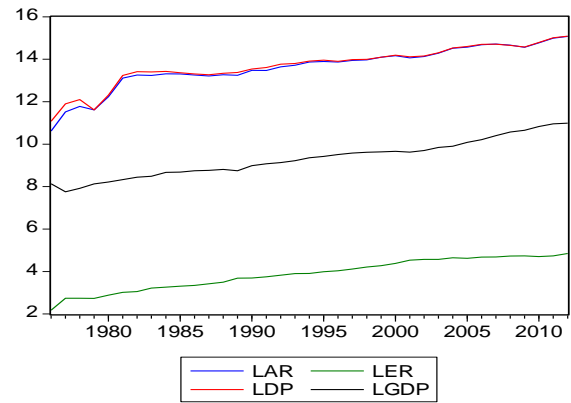
III. RESULTS

A. Descriptive Statistics

Descriptive statistics describe simple functions of the data. Log form of arrivals, departures, exchange rate and GDP are varied with the time period.

This is time series graph that shows relationship between time and other variables.There is a positive relationship between variables. It means variables move together in same direction as illustrated in figure 1 log form of air passenger arrivals (LAR) and log form of air passenger departures (LDP) are increased dramatically at the same level of difference approximately. Also log form of GDP (LGDP) and log form of exchange rate (LER) are rised stteply year by year.

Figure 3 : Natural log forms for AR,DP,ER,GDP

B .Inferential Analysis

Inferential statistics is used to make conclusions from the data. Inferential statistics are in general linear model.

1) Stationary Test: Augmanted dickey fuller test and Phillips Perron test will be applied in order to check the stationarity of the variables. Stationarity of the data is important for forecasting. Also checking for stationarity, unit root testing has been carried out prior to modeling. In order to make accurate predictions, unit root testing will provide guide to build the models. Unit root testing was popular by David Dickey and Wayne Fuller (1979), Pierre Perron and Peter Phillips(1988). Augmented Dickey Fuller test and Phillips Perron test have used for testing unit root.

Table 1: Individual unit root testing by using ADF test and PP test

Using constant	Stationarity	Variables	t- statistic	Prob. Value
	At level	Arrivals	-3.872319***	0.0053
		Departures	-2.973596**	0.0471
		exchange rate	-3.025552**	0.0419
		GDP	1.000318	0.9957
Augmented Dickey Fuller Test	1 st difference	Δarrivals	-5.588200***	0.0000
		Δdepartures	-5.655182***	0.0000
		Δexchange rate	-11.802680***	0.0000
		ΔGDP	-9.131933***	0.0460
	At level	Arrivals	-3.851116***	0.0056
		Departures	-3.196280***	0.0284
		exchange rate	-3.461168**	0.9965
		GDP	1.070749	0.0001
	1 st difference	Δarrivals	-6.10380***	0.0000
		Δdepartures	-6.724777***	0.0000
		Δexchange rate	-10.962250***	0.0000
PP Test		ΔGDP	-8.238777**	0.0000

Note: Significance level: * 10% ,** 5% ,*** 1%

Augmanted dickey fuller test

$$\Delta Y_t = \alpha + \beta T + \gamma Y_{t-1} + \sum_{i=0}^{p} \varphi_i \, \Delta Y_{t-1} + \varepsilon_t$$

Y_t is level and ΔY_t is first difference time series. T is time in year. α is the intercept constant. β is the coefficient on the time period. γ is the coefficient presenting root. p is the lag order of first difference autoregressive process. α , β, γ are parameters which are estimated.

2) Lag Order Selection: The rejecting of null hypothesis test depends on optimum number of lag differences in the model. Different methods are used to determine the lag period. However, most of literatures were used SC as selection criterion. In this analysis optimum lag length is selected with resulting from Schwarz Information Criterion.

3) Johansan Co-integration test: In order to check long run relationship among air passenger arrivals, air passenger departures, average exchange rate and GDP, use co-integration test. Trace test showed that there are two co-integrated relations at the 5% level of significance. The null hypothesis (There is no co-integrating relationship) can be clearly rejected. The calculated test values lie outside interval 0 and critical values. The maximum Elign test confirmed further the rejection of null hypothesis (There is no co-integrating relationship). Both tests provides same conclusion that shows two co-integrating relationships at the 5% significant level.

Table 2: Co-integration test

Null hypothesis	Eigen Value	Trace Statisic	0.05 Critical Value	Max-Eigen Statisics	0.05 Critical Value
None r=0	0.758694	86.85171	47.85613 (0.0000)	49.75912	27.58434 (0.0000)
At most 1 r=1	0.569121	37.09259	29.79707 (0.0060)	29.46746	21.13162 (0.0027)
At most 2 r=2	0.194077	7.625127	15.49471 (0.5063)	7.551847	14.26460 (0.4261)

4) Vector Error Correlation(VEC): Vector Auto Regressive (VAR) model is not applicable for this multiple time series, since all variables are not stationary at level. Therefore, VEC model can be applicable to estimate the models for forecasting air passenger arrivals and departures.

The error correction model shows two causations, long run causality and short run causality. Long run causality was identified with the error correction term. C(1) is the error term. If the C(1) is negative and significant(P value <0.05) , there is a long run causality between variables. Short run causality was identified with the lagged differences.

D(LAR) = C(1)*(LAR(-1) - 0.3646723775*LER(-1) - 0.4188951415*LGDP(-1) -   8.35056303) + C(2)*(LDP(-1) - 0.3037403119*LER(-1) - 0.4321595657*LGDP(-1) - 8.537751565) + C(3)*D(LAR(-1)) + C(4)*D(LDP(-1)) + C(5)*D(LER(-1)) + C(6)*D(LGDP(-1)) + C(7)

D(LDP) = C(8)*(LAR(-1) - 0.3646723775*LER(-1) - 0.4188951415*LGDP(-1) -   8.35056303) + C(9)*(LDP(-1) - 0.3037403119*LER(-1) - 0.4321595657*LGDP(-1) - 8.537751565) + C(10)*D(LAR(-1)) + C(11)*D(LDP(-1)) + C(12)*D(LER(-1)) + C(13)*D(LGDP(-1)) + C(14)

(Error term of the co-integrating equation 1,C(1))
(Error term of the co-integrating equation 2, C(2))
(Coefficient of the first difference of arrivals in previous value, C(3))
(Coefficient of the first difference of departure in previous value, C(4))
(Coefficient of the first difference of exchange rate in previous value, C(5))
(Coefficient of the fist difference of GDP in previous value, C(6))
(Constant ,C(7))
(Error term of the co-integrating equation 1, C(8))
(Error term of the co-integrating equation 2, C(9))
(Coefficient of the fist difference of arrivals in previous value C(10))
(Coefficient of the fist difference of departures in previous value ,C(11))
(Coefficient of the fist difference of exchange rate in previous value ,C(12))
(Coefficient of the fist difference of GDP in previous value C(13))
(Constant, C(14))

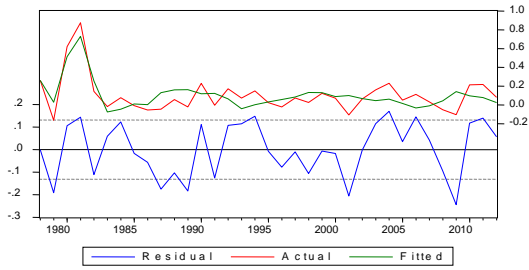*5) Fit Validation using Residual Diagnostic Test:*

Figure 4 : Variation of Residual, Actual and Fitted Line for Air Passenger Arrivals
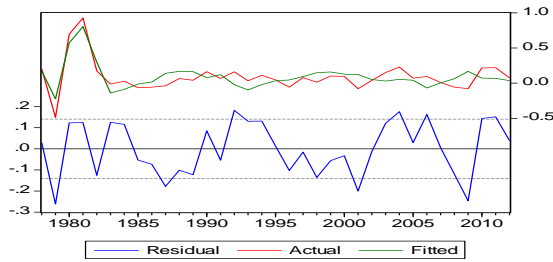

Figure 3: Variation of Residual, Actual and Fitted Line for Air Passenger Departures

Residuals are difference between pragmatic and forecasted responses. It is independently distributed with 0' mean and constant variance. Forecasted response is calculated by the model. Parameters of the model are estimated from pragmatic responses. According to the model, in figure 2 and 3 experimental (actual) and predicted (fitted) responses are varied in a same line.
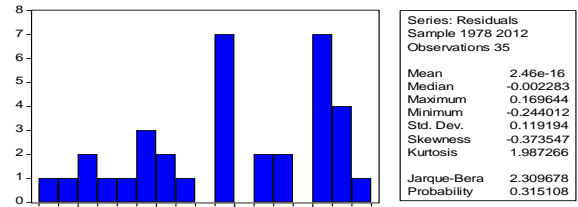Jarque Bera Test

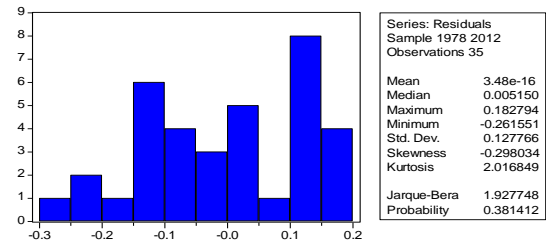Figure 4 : Output of Normality Test for Residuals in Air Passenger Arrivals Model

Figure 5 : Output of Normality Test for Residuals in Air Passenger Departure Model

Residuals are normally distributed as the probability of Jarque Bera test is greater than 0.05. Therefore, models for air passenger arrivals and air passenger departures are desirable.

There is no evidence of auto regressive conditional heteroskedasticity (ARCH) in the residuals since probability is greater than 0.05.(0.39638) ,Therefore model for air passenger arrivals is desirable.

There is no evidence of auto regressive conditional heteroskedasticity (ARCH) in the residuals since probability is greater than 0.05.(0.10054). Therefore model for air passenger departures is desirable.

6) Granger Causality test:

Table 3 : Granger Causality Output

Null Hypothesis:	F-Statistic	Probability	Significant
LDP does not Granger Cause LAR	1.56197	0.22017	In significant
LAR does not Granger Cause LDP	3.74634	0.06153	In significant
LER does not Granger Cause LAR	6.15619	0.01836	Significant
LAR does not Granger Cause LER	2.41546	0.12968	In significant
LGDP does not Granger Cause LAR	13.6169	0.00080	Significant
LAR does not Granger Cause LGDP	8.22332	0.00715	Significant
LER does not Granger Cause LDP	5.24655	0.02851	Significant
LDP does not Granger Cause LER	2.06271	0.16035	In significant
LGDP does not Granger Cause LDP	11.6361	0.00173	Significant
LDP does not Granger Cause LGDP	7.87594	0.00834	Significant
LGDP does not Granger Cause LER	10.9259	0.00229	Significant
LER does not Granger Cause LGDP	10.7415	0.00247	Significant

The granger causality test is used to forecast the information of another series. Uni-directional causalities are running from air passenger arrivals to departures, from exchange rate to air passenger arrivals and from exchange rate to air passenger departures. Bi-directional causalities are running between air passenger arrivals and GDP, between GDP and air passenger departures and between GDP and exchange rate. However, there is no other causality at 5% significant level.

IV. DISCUSSION AND CONCLUSION

This reach paper examines the co-integration and causality relationships among air passenger arrivals, air passenger departures, exchange rate and GDP in Sri Lanka from years 1976 to 2012. Most of literatures constrained in to two variables. This is four-variate framework which is lined up this study to assuring the literature. Since lack of literatures, an econometric approach is proposed .The demand forecasting model is used for aviation field.

Air passenger arrivals and departures are normally distributed. Therefore, data set is well modeled. All the variables are rose dramatically year by year. However, air passenger arrivals and departures are increased in a sameline with same difference approximately. Null hypothesis series are rejected at their first difference. It is stationary at the 1%, 5% and 10% significant level in their first difference. Though the series of air passenger arrivals, air passenger departures and exchange rate are stationary at their level individually. Therefore, all variables are integrated in the same order.

The analysis is used lowest SC value as reported in lag order selection statistics. It shows lag order at one. Therefore, analysis is preceded further.

In order to test long run relationship among air passenger arrivals, departures, exchange rate and GDP, Johansan co-integration test was applied as mentioned earlier. The results shows that two co-integrating relationships in variables. Therefore, long run relationships exist among variables.

Through the VEC model, there is statistically significant short run causality from air passenger departures to arrivals. Also long run causality is running between variables with respect to co-integrating equation 2.

It is recommended to extend the scope of this research to a cross country analysis. Air passenger arrivals can be recorded in country wise. It is recommended to use panel data which provide more information covering longer duration. It is recommended to gather secondary data from both BIA and Mattala International Airport. Concern more macro economic variables such as population, interest rate, capital stock, exports and imports

It is suggested to focus on factors affecting to air passenger arrivals and development in air transportation. This research is built up a model based on annual economic data and air passenger traffic. However, it can be built up a model for forecast the air passenger arrivals and departures only based on actual data.

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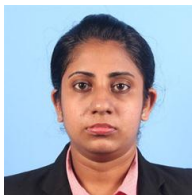
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