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Suggested Statistical Model for Evaluating the Performance and Designing a Strategic Plan to Maximize the Benefits of Egypt from the Egyptian Aviation Sector

(Case Study: Egyptair Airlines)

by

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under

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First Introduction:

This chapter is describing the general frame work of the research and discussing the characteristics of the aviation sector, the environment effecting the aviation and the different variables that compose this environment displaying its natures. Also in this chapter the researcher will discuss the target and importance of the research, then the research plan, data sources and collection techniques and finally the hypotheses and variables of the research.

(1-1) Aviation sector nature:

Despite the huge leap in the Egyptian Aviation sector, there are a lot of unanswered questions about the results and expectation from that sector as a result of the accumulation of boundaries and obstacles that face the Aviation in Egypt which could be summarized in the following points:

Undependable Demand: the demand on the aviation is composed from different drivers that mostly are not controllable by the aviation sector, for example the tourism passengers could be affected by the internal (political, environmental, social. . .) situation in Egypt. Another example of this demand type is the seasonal passengers.

Variables Dynamic & Variance of significance: the performance indicators (variables) are unknown, undefined and in most cases varies from one Route to another, in which the route connecting Cairo with London has performance indicators that differ from those for the route connecting Cairo with Jeddah or Bangkok or New York.

New Market Characteristics (Africa): the African market wetness high level of improvement and development, resulting from the cooperation between the African **legacy Carriers** [1]with the big European and Middle East carriers, as well as the founding of new African-European Low Cost Carriers **LCC**[2] that make very serious problem to Egyptair as the LCC offer very low standard of services with very low prices that meets the African passengers needs with low operating cost.

Unprofitable operation: the operating results are not as hoped, specially the Long Haul Routes, as the cost volume profit management composing big question mark, also the profitable operation is depending on two major factors (1) the **Load Factor** [3]of the route, (2) the **prices** of the Route.

Unfeasible Market Share: the market share of Egyptair in many of Egyptair's routes is not meeting the minimum requirements (Break Even) of the profitable operation, as well as in some cases the Market share of the competitors in a single route is more than the Market share of Egyptair.

High Competition Intensity: the recent focusing of the Middle East and African governments on the Aviation sector especially in Emirates, Qatar, Kenya and Ethiopia, more over the rapidly developing of the Turkish airline in Europe and the Middle East, made it so hard to sustain Egyptair's position in the middle of this aggressive competition.

[1] **Legacy Carriers:** the Carriers that Operates with the Services Standard approved by the ***IATA***

[2] **LCC:** the Carriers that applied low budget system, in which they offer low standard of services with low prices.

[3] **Load Factor**: is the Number of the passengers on an airplane divided by the number of the seats of the Airplane.

High Risk & Unstable Markets (African Governments): the very unstable political situation in the African governments makes it so risky to invest in those countries which reduce the opportunities of Egyptair in the markets against the competitors.

Negative Projections: considering the large growing rates of the surrounding countries including their Airline, airports… the future of the Egyptian Aviation is not attractive, unless some corrective and development actions took place.

(1-2) Target of Research:

This research in general is aiming to use the Statistical methods, science and techniques in designing a **Statistical Model** that's (1)Organizing large data base of aviation sector ,(2) Analyzing the data base, (3)Estimates the Sales volume and,(4)Display the weight of each variable in deferent markets.

(1-3)Research plan:

In order to assess the performance in the aviation sector specially the national airline Egyptair we should overcome some obstacles which are, (a) huge data size, (b) variation in the market characteristics, (c) the variation in distance (or flight time), thus we could classify Egyptair routes in two major categories that share the same benchmark which are (1) Distance of the route (Flying hours), and (2) the market geographic location.

Each of the two main categories has its internal classification as well, thus the distance category is classified in three sub groups which are long haul routes[4], Medium haul routes[5], Short haul routes.[6] Also the area category is consists of three sub groups; Africa, Europe and Middle East.

One destination will be selected that well be samples for the entire 63 destination (population), and among the 63, moreover it will be taken in account that the routes will be selected upon the availability of some basic characteristics which are;

[4] **Long Haul Routes:** the routes that take more than 5 flying hours per direction**.**

[5] **Medium Haul Routes**: the routes that take between 3 and 5 hours per direction.

[6] **Short Haul Routes:** The routes that take less than 3 hours per direction.

1) Stability: the route had to be operated for not less than 5 years unless there is a force major.
2) Competitiveness: the market must contain not less than 10 legacy airline operating in it.
3) Generality (Publicity): The market must not be a special case, such as the political routes like “Tel Aviv”.
4) Ability to improve: the selected market should possess with the required element to apply any development plans.
5) Market size: the traffic in the Market should exceed the Million passengers annually.

The previous factors are available in London route therefore the research will be study London route.

(1-4) Data Sources:

The input data will be gathered from a lot of software programs, statistical reports and press releases from different organizations and authorities which could be summarized in the following sources and systems:

1. IATA Passengers information systems.
2. IATA flights information systems.
3. IATA World Air Transport Statistics.
4. Reservation systems.
5. Annual reports of the Egyptian ministry of aviation.
6. Annual reports of Egyptair.
7. Reports from the “Central Agency of Public Mobility & Statistics”.
8. Internet official websites.
9. IATA direct data service System

(1-5)Variables of the Research:

The data required in the research is mostly numerical (Quantitative) data, the following table will show the variables that research will consider in evaluating the degree and the relation between the explanatory and response variables,

Name of Variable	Code	Unit	Description
First: Dependent Variable			
Sales Volume	Y_1	Tickets	Number of air tickets sold on London routes
Second: Independent Variables			
Demand (Market Size)	X_1	Passenger	Number of passengers traveled on all airlines
Average fare	X_2	EGP	Average price of air ticket
Egyptair Market Share	X_3	Passenger	Number of passengers traveled on Egyptair
Supply (Seats offered)	X_4	Seats	Number of seats offered for sale by all airlines
Egyptair Seats Offered	X_5	Seats	Number of seats offered for sale by Egyptair

Figure 1: The variables that the research studies

(1-6)Hypothesis of the research:

1. There is no relationship between geographic area and sales volume.
2. There is no relationship between route distance and sales volume.

(1-7)Data collection:

The data will be collected in cross functional method on monthly basis for the last 6 calendar years (January- December) which will give us 72 observations that covers the period of 2011, 2012, 2013, 2014, 2015 and 2016.

Second: Glance on the Aviation sector in Egypt:

(2-1) History of global aviation:

The story of the Aviation industry starts from more than two thousand years ago, thus the first artificial flying objects was kites and gliders that after continues working and development, it achieved its current shape in the now days from supersonic and hypersonic Aircrafts.

The history of the Aviation could be divided into five significant eras,

(A) The Exploration era.
(B) Modern era.
(C) Pioneer era.
(D) Golden era,
(E) Fine Tuning era.

(2-2) Egyptian Aviation Now:

From that day the Egyptian aviation sector has seen many changes and developments during the years, and we could summarize the modern era of Egyptian aviation as in the following major steps;

The modern era in aviation is considered to starts when **"Kamal Alwy"** with the assist of his colleges success to persuade **"Talaat Harb"** the director of **"Bank Misr"** to establish the first Egyptian company for air transportation as the relative importance of the aviation to Egypt, and they agreed to establish a national carrier (air transport company) with the finance of **"Bank Misr"** in which the terms stated to make the majority of the companies' capital is for the Egyptian people, as well as the board of directors is formed from Egyptian personals. So that the year 1932 is announced to be a historical year for the Modern Egyptian aviation, as the first Egyptian national carrier is born and named Egyptair (Misr Lltayaran).

Also the year 1932 had seen some followed action in the aviation sector, thus a royal decree is issued to establish the first Egyptian Aviation School to train and educate the Egyptian pilots to fly the Egyptian planes, and as a result for the large scramble on that career, a second school is also established in Alexandria.

In 1932 was the issuance of the first decree for organizing and regulating the air transport sector in Egypt to state that the Egyptian air space is owned by the Egyptian and it was what the Chicago agreement approved posterior in 1944.

The Egyptian civil aviation department has developed from being only a small department in the Ministry of defense, to be an independent authority, although the major real shift, was in 1968 after the issuance of the precedential decree, to collect all the Civil Aviation Activities and Organizations under one umbrella in order to accomplish a tangible progress in the Aviations activities in the terms of accuracy, efficiency, and

safety for the purposes of better serving the domestic community as well as the international community.
In the year 1971 **"Ahmed Nouh"** was the assigned as the first Civil Aviation Minster in the history of Egypt, to outrun 16 other Egyptian civil aviation ministers.
In 2007 Egyptair joined Star Alliance the world largest airlines alliance

(2-3) Egyptian Aviation Importance:

In general, like many economic component, that are intensive in infrastructure, the transportation sector is considered as one of the most economically important sector in all the world countries, which has a strong impact on development and welfare of a country's population. Thus an effective transportation sector provides economic and social opportunities as well as benefit of additional investments, and on the opposite side if the transportation sector is deficit, it can have an economic and costs as, reduction or missed opportunities.
From a general standpoint the economic impact of transportation could be direct and indirect impacts the economy;

- **Direct impacts** related to the accessibility change that the transportation enables larger markets and save time and costs.
- **Indirect impacts** related to the economic multiplier effects where the price of commodities, services drop or increase its variability.

Aviation as a key part of the transportation activities one of economic features which is **Mobility** as it satisfies the basic need of going from one location to others, and this need is shared by passengers, freight and information. That factor that makes the Air Transportation sector more important that the others (railways, roads, water,…ect), is that Air Transportation Is characterized by the fast, limitless, comfort, and insured **Mobility.** Thus the variety of level of the Mobility in the different economies, regions and countries, distinguish between the developing and the recessed economies. Thus we could say **"Mobility is a reliable indicator of economic development"**.
The national economic important of the Aviation industry could be assessed from **Microeconomic** and **Macroeconomic.**

- **Macroeconomic Level:** (the importance of Aviation in for the overall economy) in which the level of mobility confers is linked to a level of output, GDP, employment rate, and national income.
- **Microeconomic Level:** (importance of Aviation to a specific part of the economy) in which it is linked to the producer or consumers and production costs.

Also the Aviation sector gain an enormous importance from of the importance of the Tourism Sector in Egypt considering the Tourism massive contribution in the Egyptian GDP, conducting large portion of the foreign currencies, and absorb a large percent of the Egyptian employment. hereby the reports of the **CAPMS**[7] that shows the number of tourists that visited Egypt and the way of arrival they use.

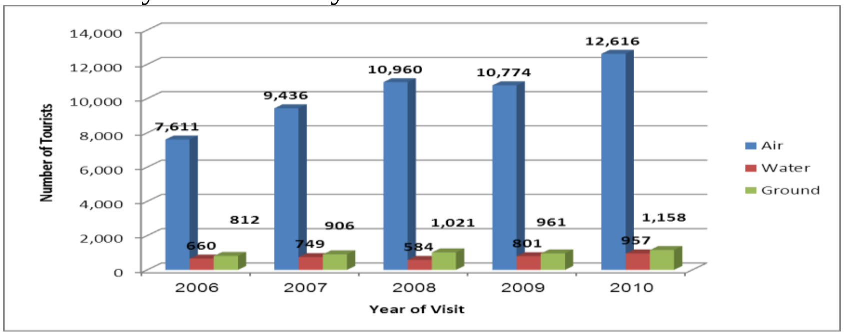

Chart 1: The number of tourists visits Egypt according to Transportation.

Third: Theoretical Framework of Statistical Model:

(3-1) VAR model:

In many research fields especially those with economical manner, the forecasting of a dependent variable's future values depending on its past values may depends on many independent variables related to each other, which made it so difficult to use a univariate model of a time series. **Christopher Sims 1980** had advocated and recommended a VAR model as a theory-free method to estimate the economic relationships, also VAR model is considered as a generalization of the univariate time series analysis which helps in analyzing the dynamic effects of the economic shocks.

[7] www.capms.gov.eg

The VAR model consider if a univariate time series y_t with one forecasted period h=1 depending on m lags in the past of $y_t$values, then we have;

$$\hat{y}_{T+1} = \alpha + \Phi_1 y_t + \Phi_1 y_{t-1} + \ldots + \Phi_m y_{t-m+1}$$

But the exact value of y_{T+1}will be equal the value of $\hat{y}_{T+1}$after denoting the shocks values that happened in the same period ε_{T+1}.

$$\hat{y}_{T+1} = y_{T+1} + \varepsilon_{T+1}$$

$$\therefore\ y_{T+1} = \alpha + \Phi_1 y_t + \Phi_1 y_{t-1} + \ldots + \Phi_m y_{t-m+1} + \varepsilon_{T+1}$$

Now the assumption is that the time series has AR model and the shocks is also are random variables thus $\varepsilon_{T+1}, \ldots, \varepsilon_s$ are not correlated which means that all the useful data from the past y_T are included in the forecast. If the multivariate consideration is taken as an extension based on his equations, the following will take place;

$$\hat{y}_{k,T+1} = y_{T+1} + \Phi_{k1,1} y_{1,T} + \Phi_{k2,1} y_{2,T} + \ldots + \Phi_{k\mathbf{K},1} y_{\mathbf{K},T}$$
$$+ \ldots + \Phi_{k1,p}\, y_{T-p+1} + \ldots + \Phi_{k\mathbf{K},p} y_{\mathbf{K},T-p+1}$$

(k=1,…,**K**)

Or it could be simplified in the following notation;

Let; $y_T \coloneqq (y_{1t}, \ldots, y_{Kt})'$, $\hat{y}_t \coloneqq (\hat{y}_{1t}, \ldots, \hat{y}_{KT})'$, $\alpha \coloneqq (\alpha_1, \ldots, \alpha_K)$, and

$$\Phi_i = \begin{bmatrix} \emptyset_{11,i} & \cdots & \emptyset_{1K,i} \\ \vdots & \ddots & \vdots \\ \emptyset_{K1,i} & \cdots & \emptyset_{KK,i} \end{bmatrix}$$

$$\therefore\ \hat{y}_{k,T+1} = \alpha + \Phi_1 y_T + \cdots + \Phi_p y_{T-p+1}$$

Then if all the y_T are regarded as random variables then the optimum forecasting will generated using;

$$y_t = \alpha + \Phi_1 y_{t-1} + \cdots + \Phi_p y_{t-p} + \varepsilon_t$$

Where; $\varepsilon_t = (\varepsilon_{1t}, \ldots, \varepsilon_{kt})'$ form a sequence of IID **K-Vector** that randomly distributed and has zero mean vectors.

The steps of VAR model is quite similar to those in the univariate models, in which the first step is to estimate the appropriate VAR model then this estimated model should be tested whether it is good to use or not, if the test rejects the model the estimated process should be restarted, but if the model checking accepts the VAR model, then it could pass to the next level to forecast and analysis. The following diagram shows the steps of VAR model.

Building and estimating VAR model requires three conditions;

A- **Stationary time series**; this condition could be achieved when the time series doesn't contains unit root, or when the expected value of mean $E(y_t)$ is constant among all (t)s in which $E(y_t)=E(y_{t+h})$, and the expected variance is constant between any two points in the time series $Var(y_t)=Var(y_{t+h})$, for all integer (h).moreover the covariance of $(y_t)\&(y_{t+h})$is independent from the time,

thus;

$$\frac{d(Cov(y_t, y_{t+h})}{dt} = 0$$

In order to test the stationary condition of a time series we could use the test suggested by **Dickey & fuller,** which assumed that in many cases the unstationary state is caused by the presence of unit root, and they develop a test that could discover the presence of unit root which states the following; assume that we have a random variables (X_t),

$$X_t = \rho x_{t-1} + \sum_{i=1}^{\rho} a_i(x_{t-1} - x_{t-i-1}) + \varepsilon_t$$

The DF tests the hypothesis if $\rho = 1$,or not, in which

H0 : $\rho = 1$ there is a unit root (time series is not Stationary)

H1 : $\rho < 1$ there is no unit root (time series is Stationary)

B- Assessment of the optimum lag length (Consistent VAR Model); Sims in his model didn't suggest any systematic method to assess the length of the lags but it was left for the personal judgments, however there are more than one criterion was developed after that to assess the optimum lag length, such as, **Akaike information criterion (AIC)**; which could be calculated by the following relationship

$$AIC(p) = log\big(det\Omega(p)\big) + 2\left(\frac{n^2p}{N}\right)$$

Where; p=lags

Ω =Variance-covariance matrix for runs

n = number of variables, N= total number of observations.

Another criterion to calculate the lag length is **Bayesian information criterion (BIC);** which is also known by **Bayesian**

arguments Schwarz (BS) and it could be calculated using the following relationship;

$$BIC(p) = log\big(det\Omega(p)\big) + 2\left(\frac{n^2 p\ logN}{N}\right)$$

Where all the symbols as expressed in AIC.

Hannan & Quinn Information criterion (HQ): is also a well-known criterion to choose the correct order for the model HQ assumed the following criterion;

$$HQ(p) = log\big(det\Omega(p)\big) + 2n^2pc\left(\frac{log\ logN}{N}\right)$$

Where, it is all same symbols in AIC & BIC however "**c**" is equals 2, and it considered as an indicator for the criterion power.

Perhaps the **Final Predictor Error criterion (FPE)** is one of the oldest criterions that help in choosing the correct order and test the consistency of VAR model, FPE assumes the following criterion;

$$FPE = \left(\frac{N+P-n}{N-pn}\right)^n .\, det\Omega(p)$$

This criterion choose the consistent order by calculating All **(P**) values till $k = \frac{N}{10}$, then the least value of FPE is used to select the order of the VAR model as the following ;

$$FPE\ (P_0) = \ min_{p=1}^{k} FPE\ (p)$$

C- **Causality testing (Granger-causality);** in 1976 Granger introduced the concept of causality to the econometrics, he defined the causality as if there are two random variables X and Z, and if X had effect on Z in the past, then it should have to effect it also in the future, in which the general idea is that "**a cause cannot come after the effect**." Also it is fairly easy to deal Granger causality in the context of VAR models, that’s why it has become quite popular in recent years.

Granger depends on the Mean square error (MSE) in the study of causality in which the minimum MSE is tends to be the optimum forecast. In other words, X has Granger-causality for Z if;

$$E_z = (h \,|\, \Omega_t) < E_z = (h \,|\, \Omega_t\{x_s \,|\, s \le t\})$$

For at least one h =1,2,3,…

In which;

$E_z(h \mid \Omega_t)$= the future forecast of MSE

Ω_t=all the information related to the variable till period t

This should mean that the Z_t could be estimated more accurately by using the data from X_t. (X_t is Granger-Causality for Z_t).

Testing the Granger Causality could take place by estimating the following parameters,

$$x_t = C_1 + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \cdots + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \varepsilon_t$$

Or

$$y_t = \Phi_1(B) y_t + \Phi_2(B) x_t + \varepsilon_t$$

Where; $\Phi_1(B) = \sum_{i=1}^{p} B^i$ & $\Phi_2(B) = \sum_{i=1}^{q} B^i$

Then we calculate the values of;

- Unrestricted sum of squared residuals **RSS_1**
- Restricted sum of squared residuals **RSS_2**

This test assumes the following hypothesis;

H_0: X_t doesn't Granger cause Y_t

H_1: X_t Granger cause Y_t

In order to accept or reject the H_0 the test's statistic F_c must be calculated using the following relationship;

$$f_c = \frac{(RSS_2 - RSS_1)/p}{RSS_1/(M-N)}$$

Where; M= T-Max (P,q) ,

N=P+q+2

T= Number of observations.

P=Number of Lags for exogenous variable.

q=number of Lags for the endogens variable.

The null hypothesis will be accepted when; **$F_c < F_\alpha$ (p, M-N),** and in that situation "X_t is said to be Granger-Cause of Y_t ".

In general the VAR model as a generalization function it must be applied on a stationary time series, however the stationarity of the data is not often easily achieved, in that case the first differences had to be calculated then test the stationarity of the new data again and these processes should be carried on until the stationarity achieved. (Usually the non-stationary time series contains stationarity in it's differences), stationarity could be tested by Dickey-Fuller test and the Augmented Dickey Fuller Test (ADF). Also it is an important notation that if more than one non-stationary time series and their differences are stationary then it is said to have **Co-integration**. The co-integration of two time series could be tested by getting the regression for the first differences of one on the other, and then the results will be tested by ADF test to find out if the unit root exist or not, and if not the null hypothesis that assumes that the residuals are not stationary will be rejected. This chain of steps and tests is used to be called **Engel-Granger Test**.

Fourth: Practical Application of the Statistical Model:

During this chapter, the VAR Model will be applied on several Phases which are;

1. Stationarity and Unit root testing
2. Cointegration testing
3. VAR Lag order testing
4. VAR Model Developing
5. Serial relations (Autocorrelation) testing
6. Normality testing
7. Forecasting
8. VAR Forecast stability checking
9. Granger Causality Testing
10. Impulse Response of Variables.
11. Forecast-Error Variance Decomposition

(4-1) Applying ADF on London Airport:

The results from testing the stationary for the sales volume (Y1) of London airport using ADF test in Stata software it appears that it has unit root so the first differences for Y_1 had taken and By running ADF test on Stata software to the rest of the variables under study of London airport X1, X2, X3, X4 and X5 the results were as The following table shows the final results of Augmented Dickey Fuller test of unit root for all six variables of London model;

Variable	Test Results	Critical Value	P-value	Significance level	Stationarity Level
Y_1	-6.177	-3.481	0.0000	5%	First Difference
X_1	-3.560	-3.481	0.0334	5%	Original Level
X_2	-6.709	-3.481	0.0000	5%	First Difference
X_3	-9.305	-3.481	0 0000	5%	First Difference
X_4	-7.012	-3.481	0.0000	5%	First Difference
X_5	-7.812	-3.481	0.0000	5%	First Difference

Table 1: Sammary of ADF results in London

(4-2) Applying Johansen Test for London Variables:

After running Johansen test on the variables (Y1) and (X1, X2, X3, X4 and X5) to test the Cointegration between in which test assumes the following hypotheses;
Null hypotheses: there are two Cointegration between variables
Alt hypotheses: there is no Cointegration between variables
The results shows that the trace statistics of Johansen Cointegration test less than the critical value at 5% level of significance at the rank of 3 in which the trace statistics is (24.63) while the critical value is (29.68) given that the number of lags used in the test is (k=2). So the variables used in London airport (Y1, X1, X2, X3, X4, X5) are cointegrated on the long run however there ADF test shows that there are different integration degrees for the variables, however the short term Cointegration could be measured using VAR only.

(4-3) Selecting the lag order for London Airport:

The following figure shows the results for testing the first 5 lags (K=0, 1, 2, 3, 4, 5) with the above mentioned criterions for the variables (Y1,X1 ,X2 ,X3 ,X4 ,X5):

```
varsoc y1, maxlag(5) exog(x1 x2 x3 x4 x5 x5)

 Selection-order criteria
 Sample:  1960m7 - 1966m1                      Number of obs      =        67
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-497.288				196049	15.0235	15.1016*	15.2209*
1	-497.182	.21053	1	0.646	201413	15.0502	15.1414	15.2806
2	-494.783	4.7997*	1	0.028	193243*	15.0084*	15.1126	15.2717
3	-494.777	.01097	1	0.917	199163	15.0381	15.1553	15.3343
4	-494.77	.01441	1	0.904	205280	15.0678	15.198	15.3968
5	-494.744	.05192	1	0.820	211495	15.0968	15.2401	15.4588

```
 Endogenous:  y1
  Exogenous:  x1 x2 x3 x4 x5 x5  _cons
```

Figure 2: Lags order test results for different criterion for London

Each criterion has different results based on the information criteria used but the research tries to apply the results that will help in developing the best possible VAR model, hence the AIC and the FPE well-known criterions and widely used is the researches that have economical aspect due to their strong power of minimizing the variation of errors for all sample size, then the research will assume that the optimal lag length is (2) as both AIC and FPE minimum values appears when the lag length is (2).

(4-4) Estimating London Model (Y1, X1, X2, X3, X4, X5):

A. Estimated Model for Sales Volume (Y_1):

$$Y_1 = 0.2745Y_{t-1} + 0.1914\,Y_{t-2} - 0.5842\,X_{1_{t-1}} + 0.4180X_{1_{t-2}} + 15.521X_{2_{t-1}} + 15.877\,X_{2_{t-2}} - 24370\,X_{3_{t-1}} - 17567\,X_{3_{t-2}} + 0.0744X_{4_{t-1}} - 0.2012X_{4_{t-2}} + 0.4413\,X_{5_{t-1}} - 0.6746\,X_{5_{t-2}} + 4258.95$$

Where,

Chi squared = 62.81 R Squared = 0.4729 P- Value =0.000

B. Estimated Model for Demand for travel (X_1):

$$X_1 = 1.300Y_{t-1} + 0.229\,Y_{t-2} - 0.474\,X_{1_{t-1}} + 1.196\,X_{1_{t-2}} + 21.030\,X_{2_{t-1}} + 21.823\,X_{2_{t-2}} - 38221\,X_{3_{t-1}} + 3431\,X_{3_{t-2}} + 0.668X_{4_{t-1}} + 0.170X_{4_{t-2}} + 0.322\,X_{5_{t-1}} - 1.661\,X_{5_{t-2}} + 7061.2$$

Where,

Chi squared = 80.65 R Squared = 0.5353 P- Value =0.000

C. Estimated Model for Ticket Price (X_2):

$$X_2 = -0.0321Y_{t-1} + 0.001\,Y_{t-2} + 0.024\,X_{1_{t-1}} - 0.024\,X_{1_{t-2}} - 0.422\,X_{2_{t-1}} - 0.297\,X_{2_{t-2}} + 782.5\,X_{3_{t-1}} - 290.83\,X_{3_{t-2}} + 0.00023X_{4_{t-1}} - 0.0010X_{4_{t-2}} - 0.0175\,X_{5_{t-1}} + 0.0045 + 3.592$$

Where,

Chi squared = 43.19 R Squared = 0.3816 P- Value =0.000

D. Estimated Model for Egyptair Market Share (X_3):

$$X_3 = -0.000008Y_{t-1} + 0.0000007\,Y_{t-2} + 0.000005\,X_{1_{t-1}} - 0.000006\,X_{1_{t-2}} + 0.00002\,X_{2_{t-1}} + 0.00005\,X_{2_{t-2}} - 0.3113\,X_{3_{t-1}} - 0.6306\,X_{3_{t-2}} - 0.00001X_{4_{t-1}} - 0.00001X_{4_{t-2}} + 0.000006\,X_{5_{t-1}} + 0.00001\,X_{5_{t-2}} - 0.0215$$

Where,

Chi squared = 56.54 R Squared = 0.4469 P- Value =0.000

E. Estimated Model for Offered Seats Supply (X_4):

$$X_4 = -0.0042Y_{t-1} + 0.041\,Y_{t-2} + 0.035\,X_{1_{t-1}} - 0.045\,X_{1_{t-2}} - 1.442\,X_{2_{t-1}} - 2.110\,X_{2_{t-2}} + 1063.5\,X_{3_{t-1}} + 18964\,X_{3_{t-2}} + 0.0069X_{4_{t-1}} + 0.3275X_{4_{t-2}} - 0.699\,X_{5_{t-1}} - 0.919\,X_{5_{t-2}} + 138.01$$

Where,

Chi squared = 66.26 R Squared = 0.4863 P- Value =0.000

F. Estimated Model for Egyptair Seats Supplied (X_5):

$$X_5 = 0.010Y_{t-1} + 0.021\,Y_{t-2} + 0.09\,X_{1_{t-1}} - 0.002\,X_{1_{t-2}} + 0.072\,X_{2_{t-1}} + 1.55\,\mathrm{X}_{2_{t-2}} - 3655\,\mathrm{X}_{3_{t-1}} + 7301\,\mathrm{X}_{3_{t-2}} + 0.069\mathrm{X}_{4_{t-1}} + 0.061\mathrm{X}_{4_{t-2}} - 0.6777\,\mathrm{X}_{5_{t-1}} - 0.488\,\mathrm{X}_{5_{t-2}} - 140.13$$

Where,

Chi squared = 79.43 R Squared = 0.5316 P- Value =0.000

The above results shows that the model contains equations that has statistical significance in which the P-values for all the formulas are less than the significance level of 5%. And to have a quick testing for the residual autocorrelation the research will apply the Lagrange-multiplier test of residuals in which this test assumes that there is no autocorrelation at the lag order used in the model (Null hypotheses), and by running Lagrange-multiplier test the following results

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	50.2969	36	0.05718
2	41.8312	36	0.23241

H0: no autocorrelation at lag order

Figure 3: Lagrange Multiplier Residual Autocorrelation Test for London

Results accepts the null hypotheses in which there is no autocorrelations among the residual values in the VAR model at 2 lags, where the (P value = 0.23241) which is greater than the significance level of 5%.

(4-5) Forecasting Sales on London:

Before going forward and start forecasting the sales volume of London routes for the future time period, the research will check the normality of the residual values in the previous suggested models by running the "Jarque – Bera Test of Normality" in which this test has the following hypotheses;

H_0: The residual Values follows the Normal distribution

H_1: The residual Values don't follows the Normal distribution

The following figure displays the normality test results for London suggested Models;

Equation	chi2	df	Prob > chi2
dy1	173.645	2	0.00000
x1	0.411	2	0.81444
dx2	1.997	2	0.36850
dx3	0.871	2	0.64685
dx4	5.182	2	0.07493
dx5	57.998	2	0.00000
ALL	240.104	12	0.00000

Figure 4: Results for Jarque-Bera Test of Normality on London Equations

The results shows that out of 6 equation models there are four equations (X_1, X_2, X_3, X_4) have P Values more than 5% , (81%, 37%, 65%, 8%) which means to accept null hypotheses and the residual values follow the normal distribution, however there two equations (Y_1 , X_5) have too little P value that rejects the null hypotheses and accepts the alternative hypotheses hence their residual values don't follow the normal distribution.

Before going forward with the model forecasting the short-term causality between variables in each equation should be tested, Granger causality test will be used in this aspect, in which Ganger-Wald causality test assumes the following hypotheses;

H_0: There is no short-run causality between variables.

H_1: There is short-run causality between variables.

Each equation will be tested by the Granger causality test to know the causality between variables in the short-run, and the results as follows;

Results for Granger Causality Test:

From	To	P-Value	Causality Direction
Y_1	X_2	0.028	There is a short-run causality from sales volume and selling price in London.
X_1	X_2	0.035	There is a short-run causality from Demand on travel and selling price in London.
X_2	Y_1	0.024	There is a short-run causality from selling price to Sales volume in London.
X_2	X_1	0.036	There is a short-run causality from selling price to demand on travel in London.
X_2	X_3	0.051	There is a short-run causality from selling price to Egyptair Market Share in London.
X_4	X_5	0.003	There is a short-run causality from Seats supplied to Egyptair Seats Supplied in London.
X_5	X_3	0.031	There is a short-run causality from Egyptair Seats supplied to Egyptair Market Share in London.

Table 2: Results for Ganger Causality Test for Variables

The above tables shows the Ganger Wald test for short run causality between variables in which the forecast process of the sales volume of London route variable Y_1 could be begins as follows;

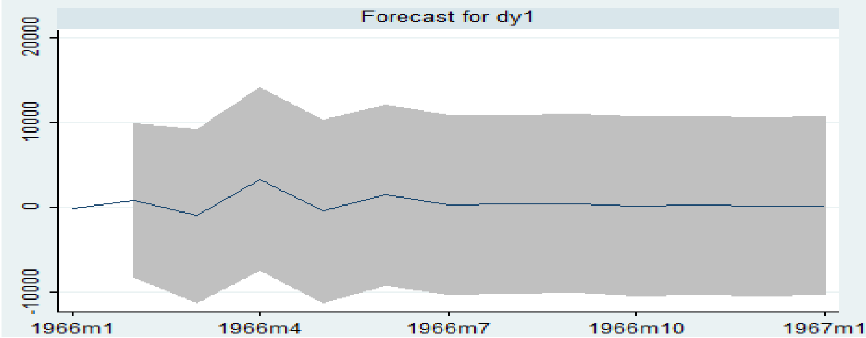

Figure 5: Forecasting the Result of Sales volume for London in 12 Month after 2016

The above figure displays the forecast of the sales volume of London route in the next 12 months during 2017 which shows that sales will not change much however in the first three months the sales will increase. The figure shows also that all the forecasted sales each months is within the upper and lower levels of confidence area.

(4-6) Stability checking for Forecasting Sales on London:

The results of the VAR model should be stable in order to get correct results of the impulse response function and component of variance, therefore the root of companion matrix test will be used to check if all the results of the VAR model lies inside the unit circle or not.

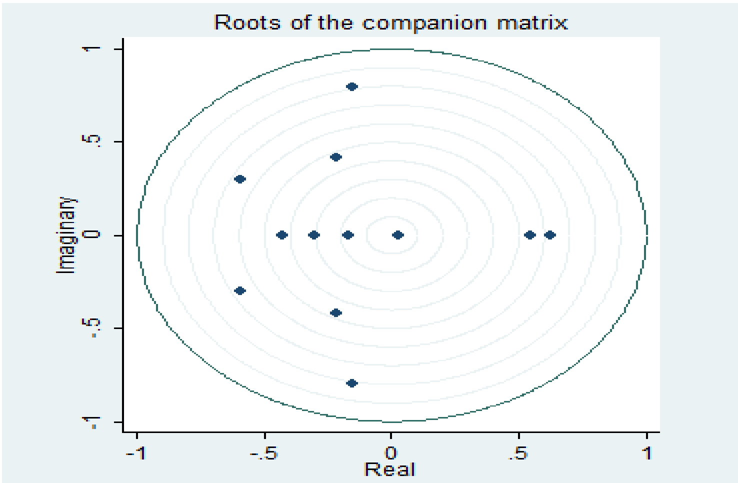

Figure 6: Roots of comoanion matrix results for London

The above figure shows that all the results of the model lie inside the unit circle therefor the VAR model results satisfies all the stability conditions

(4-7) Impulse Response Function for London:

The results of the IRF for the sales volume in London variable Y_1 to shocks from the other variables (X_1, X_2, X_3, X_4, X_5) at one standard deviation and the Cholesky forecast-error variance decomposition FEVD was as follows;

A. Response of Y_1 to a shock from X_1

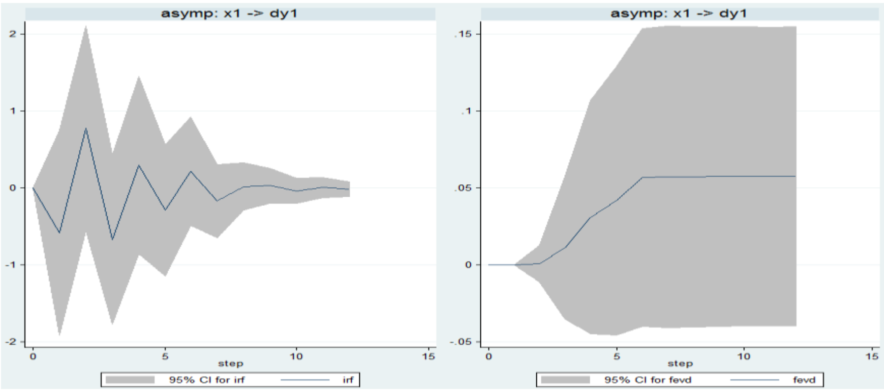

Figure 7: IRF and FEVD of Y1 to X1

The previous figure shows on the left hand side the response of the sales volume on London Y_1 to one standard deviation shock from the demand on travel to London X_1 along the forecasted 12 months in which the Y_1 after 1 month decreases to negative to be (-0.584) then increase to the maximum values after 2 months (0.774) and then the IFR decreases again in month 3 to be (0.668) after that the fluctuation decreases and the reaction became stable by time.

On the right hand side the figure shows the variance decomposition of Y_1 to a shock of X_1 in which the following table displays the values of FEVD.

B. Response of Y_1 to a shock from X_2

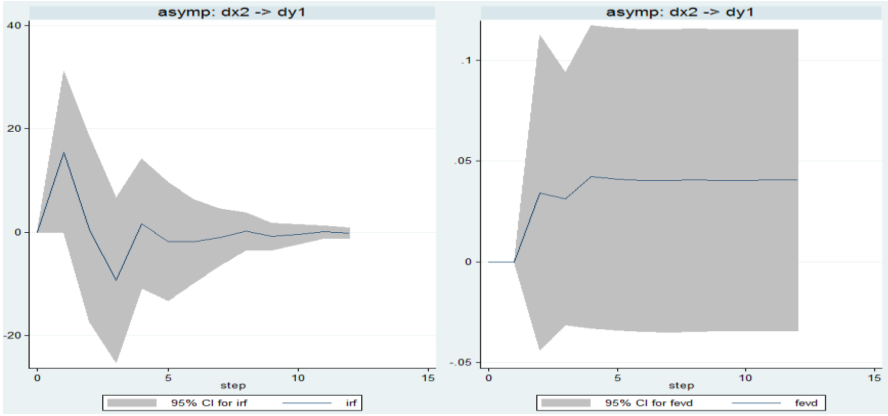

Figure 8: IRF and FEVD of Y1 to X2

The previous figure shows on the left hand side the response of the sales volume on London Y_1 to one standard deviation shock from the tickets prices to London X_2 along the forecasted 12 months in which the Y_1 after 1 month increases to the maximum value to be (15.52) then decreases after 2 months (0.531) and then the IFR decreases again in month 3 to be negative (-9.334) after that the fluctuation decreases and the reaction became stable by time.

C. Response of Y_1 to a shock from X_3

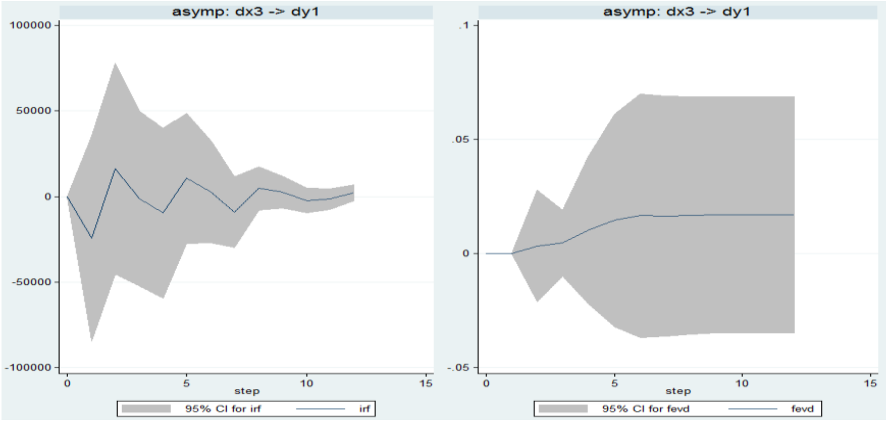

Figure 9: IFR of Y1 from Shocks X3

The previous figure shows on the left hand side the response of the sales volume on London Y_1 to one standard deviation shock from the market share of Egyptair to London X_3 along the forecasted 12 months in which the Y_1 after 1 month Decreases to be (-24370) then increases after 2 months (16272) and then the IFR decreases again in month 3 and 4 to be negative (-1169) and (-9598) then the fluctuation decreases and the reaction became stable by time.

D. Response of Y_1 to a shock from X_4

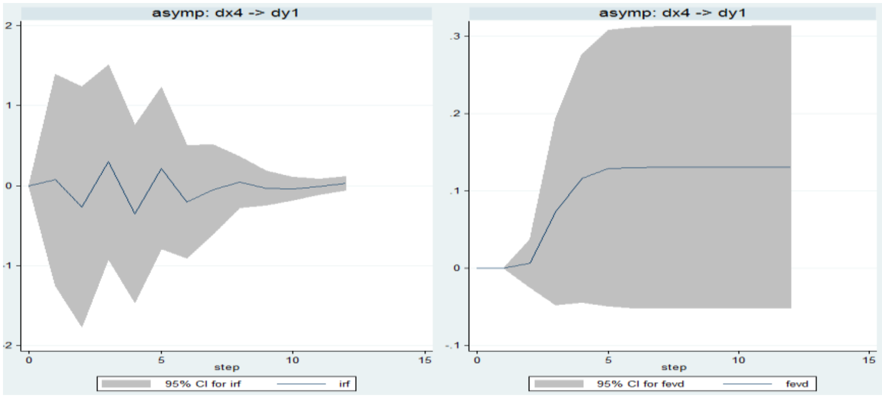

Figure 10: IRF of Y1 to shocks of X4

The previous figure shows on the left hand side the response of the sales volume on London Y_1 to one standard deviation shock from the seats supplied X_4 along the forecasted 12 months in which the Y_1 after 1 month increases to be (0.0744) then decreases after 2 months (-0.263) and then the IFR increases again in month 3 to be (0 .300) then the fluctuation decreases and the reaction became stable by time.

The FEVD of the change of the Seats Supplied in London market X4 and the response of the sales volume on London route Y1 on the long and short time is displayed in the previous table.

E. Response of Y_1 to a shock from X_5

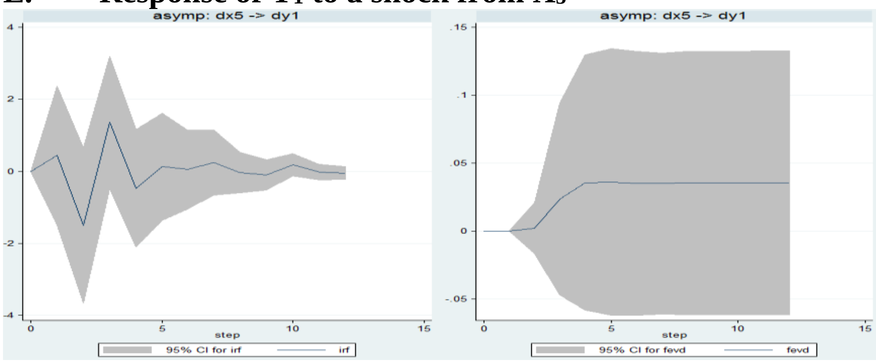

Figure 11: IFR and FEVD for Y1 to shock from X5

The previous figure shows on the left hand side the response of the sales volume on London Y_1 to one standard deviation shock from Egyptair seats supplied X_5 along the forecasted 12 months in which the Y_1 after 1 month increases to be (0.441) then decreases after 2 months (-1.493) and then the IFR increases again in month 3 to be (1.361) then the fluctuation decreases and the reaction became stable by time.

The FEVD of the change of Egyptair Seats Supplied in London market X5 and the response of the sales volume on London route Y1 on the long and short time is displayed in the previous table.

Fifth: Results and Recommendations:

(5-1) Results:

1- Variables are not stationary and contains unit root but after the first difference it became stationary.

2- The variables have different integration degrees in which there are no Cointegration between variables on the long run.

3- The optimum lag length for VAR model is 2.

4- There are no autocorrelation for the residuals and they are normally distributed.

5- VAR model forecasted results are stable and good for use in which they are all included inside the circle of root.

6- Sales volume in London and price have bidirectional causality, price and demand also have bidirectional causality, price cause the market share, total supply is affected by Egyptair supply and finally Egyptair supply causes the market share.

7- The sales volume response to the demand changes is the strongest followed by the price, however on the short run the price increase the sales volume on the short run but on the long run it decreases.

(5-2) Recommendations:

1. Stabilizing the prices of London route to increase the sales volume on the long run.
2. Link the ticket prices to London with demand.
3. Match Egyptair supply with the demand on travel to London.
4. Avoid depending on the Market share in Egyptair planning as it is caused by the supply not the demand.
5. Monitor and study closely the changes in demand on travel for London because of its immediate impact on the sales volume
6. Evaluate the Egyptair pricing strategies on the long term not the short term because the response of the sales to the change in prices in London appears after 2-3 months.

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