International Journal of Management, Accounting and Economics
Vol. 3, No. 12, December, 2016
ISSN 2383-2126 (Online)

www.ijmae.com

Intervention Analysis of Daily GBP-USD Exchange Rates Occasioned by BREXIT

Ette Harrison Etuk[1]
Department of Mathematics, Rivers State University of Science and Technology, Port Harcourt, Nigeria

Eberechi Humphrey Amadi
Department of Mathematics, Rivers State University of Science and Technology, Port Harcourt, Nigeria

Abstract

This work concerns itself with the intervention analysis of the British pound, GBP, and the United States dollar, USD.It has been observed that the GBP has fallen sharply after June 23, 2016 relative to the USD. It is being speculated that this is due to the recent exit of Great Britain from the European Union EU. A realization of the daily exchange rate series from 17th March to 12th September. 2016 is analyzed by ARIMA methods. The intervention point is June 23, 2016, after which there is a sharp fall in the relative value of the GBP. This fall is shown to be statistically significant. The pre-intervention series is observed to follow an ARIMA(1,1,0) model. Following the nature of this fall, an adequate intervention model has been proposed and fitted.

Keywords: GBP, USD, exchange rates, ARIMA modeling, intervention analysis.

Cite this article: Etuk, E. H., & Amadi, E. H. (2016). Intervention Analysis of Daily GBP-USD Exchange Rates Occasioned by BREXIT. *International Journal of Management, Accounting and Economics, 3*(12), 797-805.

[1] *Corresponding author's email:ettetuk@yahoo.com, ettehetuk@gmail.com, etuk.ette@ust.edu.ng*

Introduction

It has been observed in this study that the Great British pound (GBP) has depreciated markedly since June 2016. In particular the daily exchange rates which form the focus of this work indicate that since 23 June, 2016, GBP has fallen sharply relative to the United States Dollar (USD). This calls for intervention on the part of Great Britain. It is herein speculated that this situation has been occasioned by the recent Brexit incident.

It is to be noted that 23 June, 2016 is exactly the date when British citizens voted 52%:48% to opt out of the European Union EU. This appears to have affected the British economy adversely and drastically reduced the relative value of the pound. Interest in this work is in the putting up of an intervention model for the daily GBP/USD exchange rates which could helpful in the management of this situation.

The methodology to adopt is the Box-Jenkins or ARIMA methodology. $(Box \,\&\, Tiao, 1975)$ introduced intervention modeling. Ever since, authors have taken interest in the application of such models. For instance, $(Tagaris\ et\ al.\ 1997)$ conducted an intervention analysis of functional magnetic resonance imaging data. $(Chung, et\ a., 2009)$ designed an ARIMA intervention model for the financial crisi in Chinese manufacturing industry. Such a model was built for Chinese stock prices too by $(Jarrette \,\&\, Kyper, 2011)$. Intervention study of crime data in the Eastern region of Ghana has been done by $(Tarkwah\ et\ al., 2012)$, to mention but a few.

Materials and Methods

Data

The data for this study are daily GBP/USD exchange rates from 17th March, 2016 to 12th September, 2016 obtained from the website www.exchangerates.org.uk/GBP-USD-exchange-rate-history.html accessed on 13th September 2016. It is read as the amount of USD per GBP.

Arima Modelling

$(Box \,\&\, Jenkins, 1976)$ defined an *autoregressive moving average model of order p and q* denoted by ARMA(p, q) as

$$X_t - \alpha_1 X_{t-1} - \alpha_2 X_{t-2} - \cdots - \alpha_p X_{t-p} = \varepsilon_t - \beta_1 \varepsilon_{t-1} - \beta_2 \varepsilon_{t-2} - \cdots - \beta_q \varepsilon_{t-q} \qquad (1)$$

where $\{X_t\}$ is a stationary time series and $\{\varepsilon_t\}$ is a white noise process and the α's and β's are constants.

Suppose model (1) is put as

$$A(L)X_t = B(L)\varepsilon_t$$

ISSN 2383-2126 (Online)

where $A(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \ldots - \alpha_p L^p$ and $B(L) = 1 + \beta_1 L + \beta_2 L^2 + \ldots + \beta_q$ and $L^k \varepsilon_t = \varepsilon_{t-k}$. Besides for stationarity and invertibility the roots of A(L) = 0 and B(L) = 0 are outside of the unit circle respectively.

If $\{X_t\}$ is not stationary, $(Box\ \&\ Jenkins, 1976)$ also proposed that sufficient differencing of the series could make it stationary. Let d be the minimum positive integer for which the d^th^ difference of the series denoted by $\{\nabla^d X_t\}$ is stationary. Then a replacement of the series with its d^th^ difference in (1) yields an *autoregressive integrated moving average model of order p, d and q* denoted by ARIMA(p, d, q) which could be given by

$$A(L)(1-L)^d X_t = B(L)\varepsilon_t \tag{2}$$

since ∇ = 1 – L.

the model (1) is fitted by first of all determining the orders p, d and q. the orders p and q are estimated by the cut-off points of the autocorrelation function, ACF, and the partial autocorrelation function, PACF respectively. Progressive increase of the value of d and each time testing for the series stationarity until stationarity is attained determines the minimum value of d. To test for stationarity the Augmented Dickey Fuller (ADF) Test may be used. Then the α's and β's may be estimated by the least squares method or the maximum likelihood procedure. Contending models may be compared for adequacy by the use of Akaike's Information Criterion (AIC).

Intervention Analysis

A drastic change in the mean level of a time series at a known point in time t = T is known as intervention. Analyzing to know how and why the change has taken place is usually of interest. The pre-intervention series might be modeled using model (2) as

$$X_t = \frac{B(L)}{A(L)(1-L)^d}\varepsilon_t \tag{3}$$

An overall intervention model is given by

$$Y_t = Z_t I_t + \frac{B(L)}{A(L)(1-L)^d}\varepsilon_t$$

where Z_t represents the amount of change in the mean level of the time series attributable to the intervention and I_t is the indicator variable such that it takes the value of zero over the pre-intervention period and the value of one after intervention. If after intervention at t = T the series changes in level gradually before reaching a more or less constant level an appropriate intervention model is given by

$$Z_t = \frac{C(1)(1-C(2)^{t-T+1})}{(1-C(2))} \tag{4}$$

$(Box\ \&\ Tiao, 1975)$, $(The\ Pennsylvania\ State\ University, 2016)$.

Computer Software

The statistical and econometric package Eviews7 was used for all data analysis. It uses the least square criterion for model estimation.

Results and Discussion

The time plot of the series herein called GBUS in Figure 1 shows an intervention point after 99 values, precisely on 23rd June, 2016, after which there is a sharp fall in the exchange rates in favour of the USD. It is believed that this fall is due to Brexit. The pre-intervention data are 99 in number and have a mean of 1.4399 and a standard deviation of 0.0179. on the other hand, the post-intervention data are 81 in number and have a mean of 1.3179 and a standard deviation of 0.01161. A comparison between the two parts of the series shows that their means are statistically significantly different. This makes the intervention worthwhile.

The pre-intervention series is not stationary given that the ADF test statistic value of -1.0723 and the 1%, 5% and 10% critical values of -3.4984, -2.8912 and -2.5827 respectively. However its first differences DGBUS are stationary with an ADF test statistic of -7.8837. the correlogram of these first differences in Figure 2 suggests an AR(1) model for DGBUS which is which is estimated as summarized in Table 1 as

$$DGBUS_t = 0.2024DGBUS_{t-1} + \varepsilon_t \tag{5}$$

which is equivalent to

$$GBUS_t = \frac{\varepsilon_t}{(1-0.2024L)(1-L)} \tag{6}$$

The adequacy of the intervention model is not in doubt. The residuals have a zero mean and are normally distributed as evident from the Jarque-Bera test of Figure 3and the goodness-of-fit of the pre-intervention observations and forecasts of Figure 4 and Figure 5. Figure 5 is a plot of the difference of the observed data and the pre-intervention ARIMA(1,1,0) forecasts.

From table 2 estimation summary

$$Z_t = -0.1770(1 - 0.6412^{t+1}) \tag{7}$$

Hence, by combining (6) and (7), the intervention model is given by

$$GBUS_t = \frac{\varepsilon_t}{(1-0.2024L)(1-L)} - 0.1770(1 - 0.6412^{t+1}), t > 99 \tag{8}$$

On the adequacy of the intervention model, Figure 6 compares the post-intervention observed data with intervention model forecasts. The chi-square goodness-of-fit test statistic has a value of 0.0104 and is not significant. Hence the model is adequate.

Conclusion

It may be concluded that model (8) is an intervention model for daily GBP/USD exchange rates given its goodness-of-fit to the observations. The application of this model is therefore appropriate to explain the dynamics of the interruption of the pre-intervention trend by the Brexit incident in the presence of a noise structure. It is hoped that this analysis shall be of help in the management of the situation.

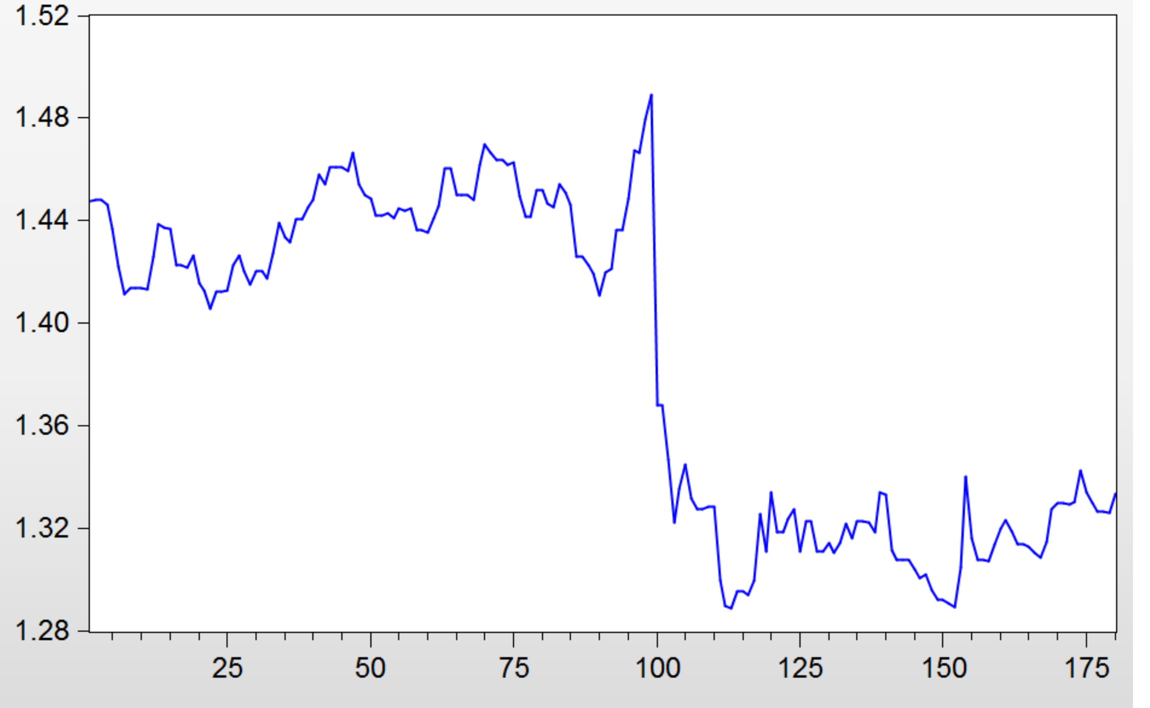


FIGURE 1: GBUS

Table 1: Estimation of the pre-intervention ARIMA(1,1,0) model

Dependent Variable: DGBUS				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	0.202449	0.1000955	2.005348	0.0477
AIC	-7.047375			
Inverted AR Roots	0.20			

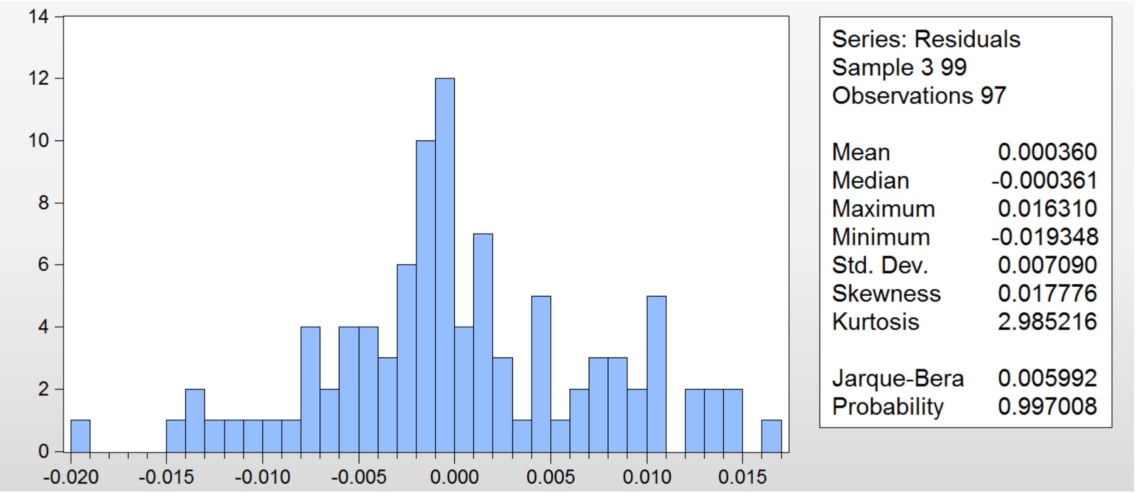
Table 2: Estimation of the intervention model

Dependent Variable: DIFF DIFF = C(1)*(1-C(2)^(T+1)/(1-C(2))				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.063522	0.005475	-11.60258	0.0000
C(2)	0.641187	0.031586	20.29975	0.0000

International Journal of Management, Accounting and Economics
Vol. 3, No. 12, December, 2016
ISSN 2383-2126 (Online)

www.ijmae.com

Lag	AC	PAC	Q-Stat	Prob
1	0.197	0.197	3.9043	0.048
2	0.072	0.035	4.4388	0.109
3	0.007	-0.014	4.4439	0.217
4	0.119	0.122	5.9082	0.206
5	-0.099	-0.152	6.9419	0.225
6	-0.027	0.011	7.0186	0.319
7	-0.151	-0.141	9.4657	0.221
8	-0.043	-0.004	9.6697	0.289
9	-0.042	0.011	9.8670	0.361
10	0.027	0.019	9.9457	0.445
11	-0.057	-0.031	10.306	0.503
12	-0.096	-0.120	11.367	0.498
13	0.017	0.070	11.399	0.577
14	0.043	0.001	11.617	0.637
15	-0.081	-0.091	12.383	0.650
16	0.042	0.102	12.595	0.702
17	-0.108	-0.183	14.000	0.667
18	-0.089	-0.045	14.972	0.664
19	-0.118	-0.092	16.685	0.611
20	-0.001	0.008	16.686	0.673
21	-0.085	-0.022	17.597	0.674
22	0.016	0.000	17.631	0.728
23	-0.052	-0.037	17.990	0.758
24	0.002	-0.074	17.990	0.803
25	-0.084	-0.068	18.929	0.801
26	0.098	0.088	20.234	0.780
27	-0.054	-0.116	20.636	0.803
28	0.064	0.117	21.205	0.817
29	0.134	0.101	23.751	0.741
30	0.117	-0.033	25.719	0.689
31	-0.109	-0.113	27.456	0.649
32	0.082	0.066	28.443	0.647
33	-0.001	-0.026	28.443	0.694
34	-0.057	-0.095	28.939	0.714
35	-0.026	0.086	29.043	0.750
36	0.102	0.053	30.692	0.719



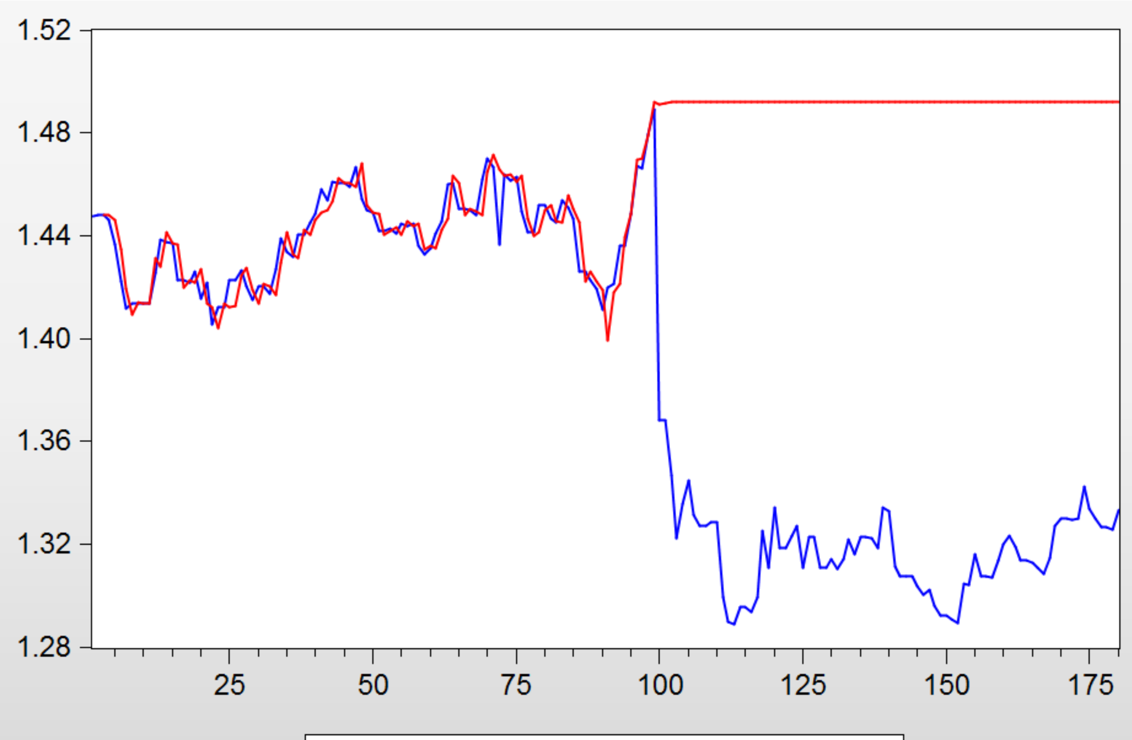


FIG. 4: FORECAST

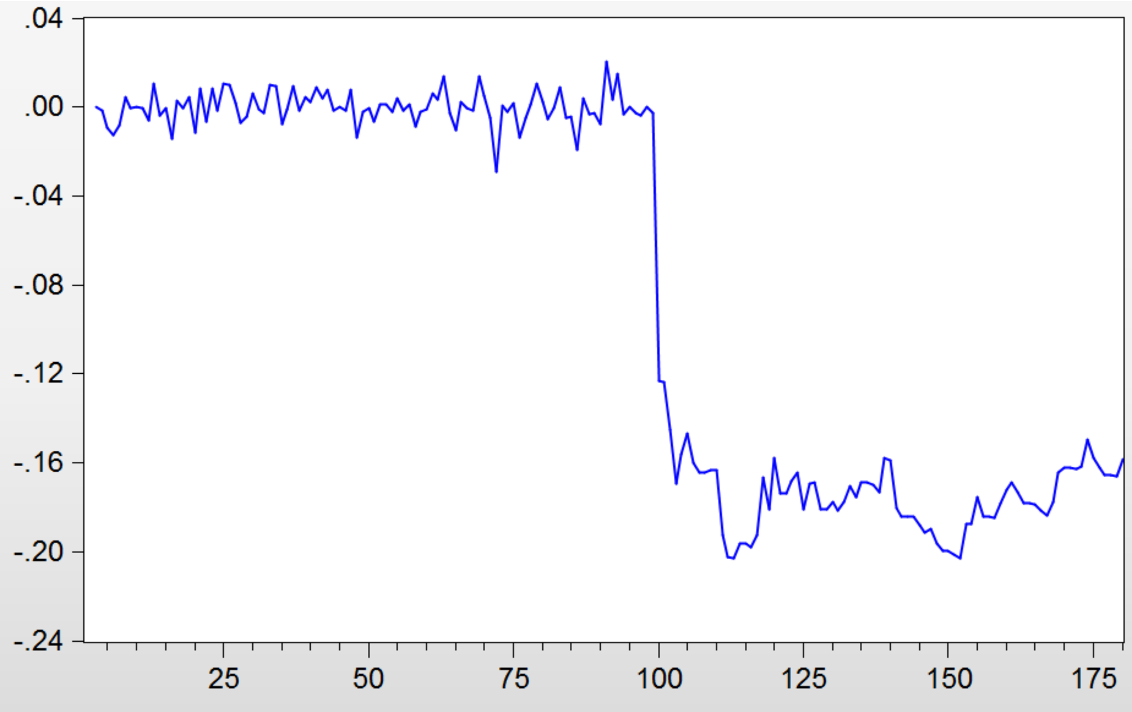
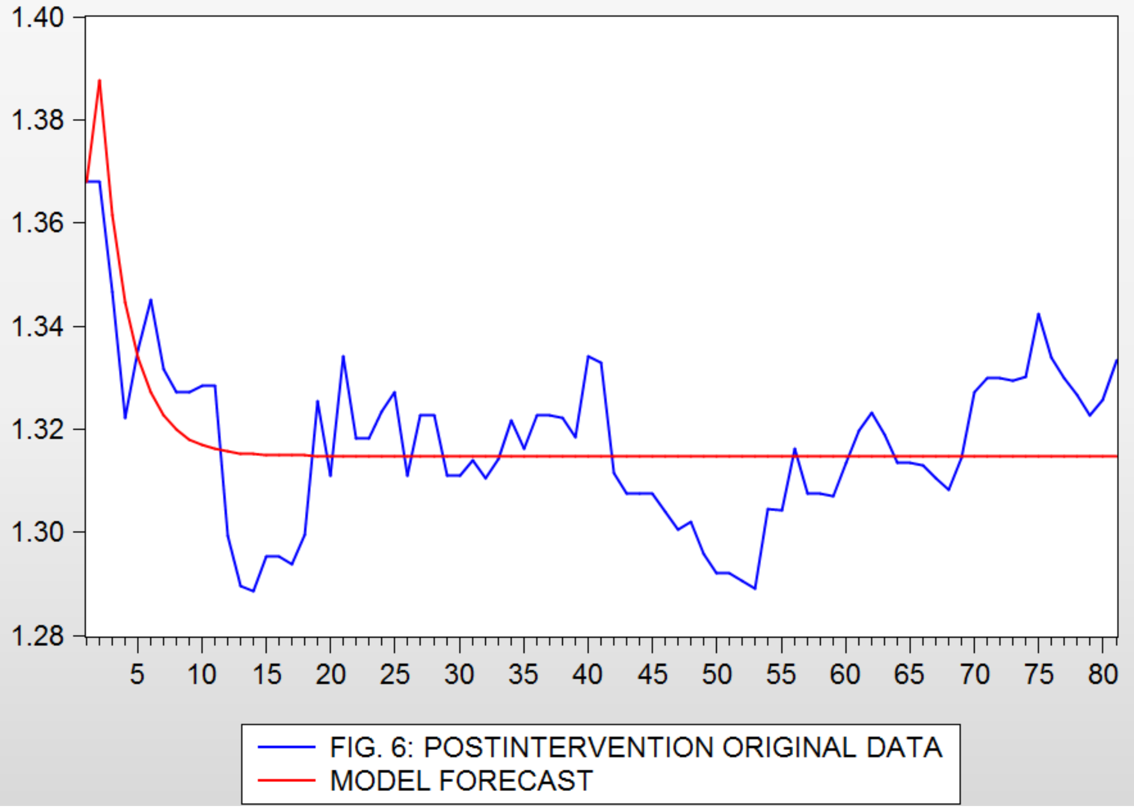


FIGURE 5: DIFF



References

Box, G. E. P., & Jenkins, G. M. (1976). *Time Series Analysis, Forecasting and Control.* San Francisco: Holden-Day.

Box, G. E. P. & Tiao, G. C. (1975). Intervention Analysis with Applications to Economic and Environmental Problems. *Journal of American Statistical Association.* 70(349): 70-79.

Chung, R. C. P., Ip, W. H. & Chan, S. L., (2009). An ARIMA-Intervention Analysis Model for the Financial Crisis in China's Manufacturing Industry. *International Journal of Engineering Business Management*, 1(1): 15-18.

Darkwah, K. F., Okyere, G. A. & Boakye, A. (2012). Intervention analysis of serious crimes in the eastern region of Ghana. *International Journal of Business and Social Research (IJBSR)*, 2(7): 132 - 138.

Jarrette, J. E. & Kyper, E. (2011). ARIMA Modelling With Intervention to Forecast and Analyze Chinese Stock Prices. *International Journal of Engineering Business Management*, 3(3): 53 - 58.

Tagaris, Ritcher, W., Kim, S. G. & Georgopoulos, A. P. (1997). Box-Jenkins intervention analysis of functional magnetic resonance imaging data. *Neuroscience Research* 27, 289 - 294.

International Journal of Management, Accounting and Economics
Vol. 3, No. 12, December, 2016
ISSN 2383-2126 (Online)

www.ijmae.com

The Pennsylvania State University (2016) Welcome to STAT 510! Applied Time Series Analysis Lecture Notes. Lesson 10: Intervention Analysis. Department of Statistics Online Program. www.onlinecourses.science.psu.edu/stat510/ accessed 9th November 2016.