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The use of unit root and Box-Jenkins in Amman Stock Exchange

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This paper aims at examining the level of the efficiency of Amman Stock Exchange (ASE) on weak form, semi-strong form and strong form levels over the period of January 2008 - December 2014. The paper concludes that there is a significant prediction performance of all ASE indices of the Jordanian market by using Box-Jenkins estimation. This result was confirmed by unit-root test since the return series for the five Jordanian indices failed to prove unit root.

keywords: unit root; box-Jenkins; market efficiency; ASE.

1 Introduction

The efficient market hypothesis has gained significant importance in the finance literature over the last three decades. A handful of theoretical and empirical studies have discussed this central research paradigm in the financial economics and therefore documented diverse stages of the development of efficient market hypothesis. The early findings are however based the data of developed markets that provide foundation to the notion that assets price in the stock market instantaneously reacts to all publically available information. These finding thus shaped the basis for the definition of capital market efficiency (Malkiel and Fama, 1970; Fama et al., 1969).

Later findings generated by the empirical studies were not consistent that much with the findings of earlier studies. The evidence of over- and under-reaction by the stock prices to different events such as earning announcement inferred that there is a systematic

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deviation from what efficiency was defined in the earlier researches (Ball, 1978; Bondt and Thaler, 1985; De Bondt and Thaler, 1987), thus lead to the debate on the market efficiency in later studies. Further, theoretical models were developed refuting the possibility of securities prices perfectly reflecting all information (Grossman and Stiglitz, 1980). In this vein, several studies have examined the phenomenon of market efficiency both in the developed and emerging markets, during different nature of data, techniques and thus documented different findings. In this paper, we examine the level of efficiency of the Amman Stock Exchange using Box-Jenkins and Unit Root methodologies.

2 Literature Review

Stock market analysis has been a center for quite a long span of time. The developed stock markets usually earn more attention thus setting standards for stock market regulation. Several studies have been conducted on the emerging markets. This section briefly presents empirical findings on the emerging markets particularly in the GCC equity market. For instance, Dahel et al. (1999) examined the behaviour of four GCC markets namely, KSA, Bahrain, Kuwait and Oman over the period of September 1994 - April 1998. Their study noted that during this span, KSA was the largest as well as the strongest market. A progressive method of testing was applied. First two tests, variance ratio and unit root tests showed that these markets follow random walk but the third test of regression for autocorrelation proved Kuwaiti market as weak-form efficient. For the other markets only the regression test rejects their weak-form efficiency. Butler and Malaikah (1992) focused on the stock returns of KSA and Kuwait stock markets over the period of 1985-1989. Various run tests and correlation methods were applied to evaluate the weak form of efficiency in these stock markets. They noted that, KSA stock market was inefficient as compared to Kuwait stock market and that institutional factors affect the efficiency of Saudi market. In Kuwait Stock Market this factor is less pronounced but autocorrelation is the Kuwaiti stock market is more prominent. Abraham et al. (2002) examined the Random Walk Hypothesis (RWH) of Saudi, Kuwaiti and Bahraini stock markets. Their results showed that KSA and Bahrain markets follow RWH while a Kuwaiti market fails to do so proving its inefficiency. Squalli (2005) examined the efficiency of Dubai Financial Market (DFM) and Abu Dhabi Exchange (ADX) over the period 2000-2005. Statistical tests such as Variance Ratio tests rejected the random walk model of UAE financial market except its banking sector. Run Test resulted in proving that insurance sector in ADX is the only weak form efficient sector. Lagoarde-Segot and Lucey (2008) investigated seven emerging Middle-Eastern North African (MENA) stock markets of Egypt, Morocco, Tunisia, Jordan, Lebanon, Israel and Turkey. The efficiency of the markets was assessed against their supposed sustainability. It was found out that all markets were efficient at weak-form level. The weak-form efficiency of MENA markets is primarily due to the variation in stock market sizes. The governance trends significantly differ among all the mentioned states which highly effect the markets depending on their respective restrictions. El-Barghouthi (2004) examined the ASE between the periods of 1992 2000 using run test, autocorrelation test and filter technique and reported that ASE is weak-form efficient as its historical data predominantly reflected on the market behaviour. Hassan et al. (2003) examined the Kuwaiti Stock Market. They focussed on the effect the market faces in case of non-linearity, delayed or halted trading and frequent changes in rules and regulations. The results seemed non-supportive to market efficiency in the initial phase. However the Kuwaiti market has observed improvement in the later stage. Elbarghouthi et al. (2012) conducted an analysis on Amman Stock Market during the span from 2001-2008 using Box Jenkins Estimation and Stationary and Random Walk Test. The Box-Jenkins estimation, irrespective of the index examined, produced models with high prediction validity; this implies the existence of deviations from market efficiency in the pricing of equities in the ASE. Sekreter and Gursoy (2014) used daily data of ISE 100 over the period of January 2006 -November 2012. Using ARIMA, GARCH and exponential GARCH, they noted that ARIMA models are most suitable for forecasting the market trends. Jreisat and Al Barghouthi (2015) conducted the Run Test on ASE. This test considers the data points up and down, above and below as well as distributions of runs by length. This was used to examine whether ASE was weak form efficient. Their findings suggest that ASE is not weak-form efficient and reflects a high degree of positive temporal dependency patterns, violating the assumption of random walk model.

3 Data and sample

For all tests, the daily prices for the Jordanian indices (Bank Index, Service Index, Insurance Index, Industry Index and General Index) in Amman Stock Exchange were employed for the period of January 2008 to December 2014.

4 Box Jenkins Estimation

Box Jenkins method is used to estimate market efficiency by using an iterative method. The five following steps are used to estimate a variety of competing models in order to select the best performing model with the least number of parameters.

Step 1: The aim of this step is to attain price sustainability which is achieved by calculating the price differences of the price series. If the price levels are auto-correlated, this indicates non-stationary prices.

Step 2: The second step involves examination of the Autocorrelation (AC) and the Partial Autocorrelation (PAC) of the data to identify the appropriate orders of the Autoregressive (AR) and Moving Average (MA) components. The first order autoregressive model will be recommended if the AC became insignificant in a geometric way and the PAC, after one lag, was zero. On the other hand, the MA model will be recommended if the PAC became insignificant in a geometric way and the AC, after one lag, was zero. ((Maddala, 2001).

Step 3: Different ARMA models are used to examine the significance of the estimated parameters and t-Statistics are applied. If higher orders are insignificant for the estimated parameter then the significant lower order can describe the process and all insignificant parameters will be dropped from the model. Then, the randomness test will be applied for the remaining parameters. The Akraike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC) will be used to specify the model with the lowest AIC and SBC to decide the order of the model. The Ljung Box Q-statistics test was also applied to assess the disturbances by autocorrelation; these show that the residuals for the chosen models are uncorrelated. The ARCH LM test indicates heteroscedasticity in the disturbance and a strong ARCH effect in all models. Changes in variance also, referred to as conditional heteroscedasticity or stochastic volatility can be attributed to variations in the amount and importance of relevant price information.

4.1 Empirical Results

Table 1 shows that the auto-correlation of the price change is insignificant after 1 or 2 lags for all Jordanian indices and the results also show that the PAC is almost zero after 1 or 2 lags. These results indicate a first or second order AR model. The most suitable ARMA models which describe the price changes for each index of the Jordanian indices are listed in Table 2.

4.1.1 Theil's Inequality Coefficient

Theil's inequality coefficient (U) is used to evaluate the accuracy of the prediction of the model. The following equation has been devised to calculate the market performance and make predictions (Farnum and Stanton, 1989):

$$U = \left(\frac{\sum_{t=1}^{T}\left(\frac{\hat{y}_t - y_t}{y_{t-1}}\right)^2}{\sum_{t=1}^{T}\left(\frac{y_t - y_{t-1}}{y_{t-1}}\right)^2}\right)^{0.5}; 0 \leq U \leq 1 \tag{1}$$

where

$\hat{y}_t$ Forecast value of subject variable y at time t (observation t of $\hat{y}$)

y_t Actual value of subject variable y at time t (observation t of y)

T Amount of sample observations in the process

If $U = 0$, then $\hat{y}_t = y_t$ for all t, this shows a "perfect fit" between actual and predicted data. The prediction of the model gets weaker as the value of U raises to 1. Theil's inequality coefficient can further be distributed into U^M, U^S, and U^C as follows:

1. U^M - Bias proportion: this focuses on the systematic differences in actual and predicted values.

$$U^M = \frac{(\bar{\hat{y}} - \bar{y})}{\frac{1}{T}\sum_{t=1}^{T}(\hat{y}_t - y_t)^2} \tag{2}$$

where $\bar{\hat{y}}$ and $\bar{y}$ are the means of the series $\hat{y}_t$ and yt respectively

2. U^S - Variance proportion: highlights unequal variances of actual and predicted values.

$$U^s = \frac{(\hat{\sigma} - \sigma)^2}{\frac{1}{T}\sum_{t=1}^{T}(\hat{y}_t - y_t)^2} \tag{3}$$

where $\hat{\sigma}$ and σ are the standard deviations of the series $\hat{y}_t$ and yt respectively.

3. U^C - Covariance proportion: shows the correlation between the actual and predicted values. (zero=perfect correlation between actual and predicted values).

$$U^C = \frac{2(1-\rho)\hat{\sigma}\sigma}{\frac{1}{T}\sum_{t=1}^{T}(\hat{y}_t - y_t)^2} \tag{4}$$

where ρ is the correlation coefficient between $\hat{y}_t$ and yt , and

$$U^M + U^S + U^C = 1 \tag{5}$$

where U^M, U^S, and U^C are useful as a means of breaking the error (difference) down into these three characteristic sources.

The prediction validity of the modes is calculated in a systematic manner. First the models are estimated using the initial 1760 observations, then a period of 260 observations ahead is forecasted. The result in the forecast period is evaluated by using the Theil Inequality Coefficient. Theil Inequality Coefficient is 0 for a perfect forecast and 1 for a nave static forecast, so under the EMH the coefficient is 1.

Following observations decide market efficiency therefore supporting the results;

- The bias proportion indicates how far the mean of the forecast is from the mean of the actual series.

- The variance proportion indicates how far the variation of the forecast is from the variation of the actual series.

- If the forecast is good, the bias and variance proportions should be small so that most of the bias should be concentrated on the covariance proportions.

- Empirically, for all models, the bias and variance proportion should be small, indicating that bias is indeed concentrated in the covariance proportion.

These results are consistent with other studies carried out in other emerging markets such as Saudi Arabian Financial Market (Khababa, 1998), Johannesburg Stock exchange (Roux and Gilbertson, 1978) and the Indian market (Poshakwale, 1996) which indicates the non-randomness of stock prices. The results confirm that the market is inefficient at weak-form levels.

5 Stationary and Random Walk Tests

Greene (1997) stated that non-stationary could be the reason behind many econometric issues. It was concluded by Granger and Newbold in 1974 that the regression applied on integrated macroeconomic data could mislead standard significant test. For that reason, stock prices or returns should be adjusted before using regression analysis.

The random walk model is:

$$X_t = X_{t-1} + \epsilon_t \tag{6}$$

The random walk with drift is:

$$X_t = \alpha + X_{t-1} + \epsilon_t \tag{7}$$

The trend stationary process is:

$$X_t = \alpha + \beta t + \epsilon_t \tag{8}$$

A unit root characterizes each of these three series. Granger, Newbold and Phillip concluded that errors in inferences could occur when using data characterized by unit roots (Davidson et al., 1993). However, to test efficient market hypothesis at weak form level, an alternative test can be used which is based on the random walk hypothesis:

$$R_t = ln(P_t) - ln(P_{t-1}) \tag{9}$$

Where P is the price index of the weak EMH implies. The log of the price is generated by the following process:

$$ln(P_t) = \beta_0 + ln(P_{t-1}) + \epsilon_t \tag{10}$$

which is a random walk with drift in the process generating $ln(P_t)$. This implies that the $ln(P_t)$ process has a unit root, an implication which may be tested using standard tests for a unit root in $ln(P_t)$.

5.1 Tests for Unit Roots

The Augmented Dickey-Fuller (ADF) statistic which was developed by Dickey and Fuller (1979) is used to examine any significant existence of a unit root. Assuming an AR(1) process with an intercept α:

$$X_t = \alpha + \phi X_{t-1} + \epsilon_t \tag{11}$$

According to the above equation, the parameters α and ϕ, Also ϵ_t are assumed to be independent and distributed in an identically with a zero mean and an equal variance. If ϕ is more than -1 and less than 1, then the process AR (1) is stationary and if ϕ is equal to 1, then the process AR (1) is non-stationary which indicates that the series is a random walk with a drift. In order to obtain an estimate ϕ, the OLS will be applied and the null hypothesis will be tested by using a t-test against the alternative hypothesis $H_A : |\phi|< 1$. If the null hypothesis is rejected, that indicates stationary series. To avoid the weaknesses of OLS, the unit test will be rewritten as follows:

$$\Delta X_t = \alpha + \phi^* \Delta X_{t-1} + \epsilon_t \tag{12}$$

where

$$\phi^* = \phi - 1 \tag{13}$$

Moreover, the modified ADF test, which adjusts the actual testing procedure by generalizing equation (11) is used to test stationarity as follows:

$$X_t = \alpha + \phi_1 X_{t-1} + \phi_2 X_{t-1} + ... + \phi_r X_{t-r} + \epsilon_t \tag{14}$$

Reparameterize (14) to obtain:

$$\Delta X_t = \alpha + \phi^* \Delta X_{t-1} + \phi_1^* \Delta X_{t-1} + \phi_2^* \Delta X_{t-2} + ... + \phi_r^* \Delta X_{t-r+1} + \epsilon_t \tag{15}$$

where $\phi^* = \phi_1 + \phi_2 + ... + \phi_{r-1}$ and the other ϕ_j^* are also functions of the original ϕ_s in(14). As noticed, the regressor in the original equation (11) has been augmented by extra differenced terms in equation (14), and is written sometimes as ADF(k), where k is the number of differenced terms included on the right-hand side of (14). The question is what order of AR process best fits the time series under study to determine the differenced terms to be included on the right-hand side of (14). Usually, the differenced terms should be included up to the limit which produces non-autocorrelated OLS residuals. The LM tests for autocorrelation are usually used for this purpose.

Testing the r_{th} order process (14) for stationarity now is testing whether $\phi^* = 0$ or not in (15). To test $H_0 = \phi^* = 1$ the OLS is applied to (12) and the t ratio is examined using the critical t ratios table developed by Dickey-Fuller. If $\phi^* = 0$ is sufficiently negative, the H_0 is rejected in favour of stationarity.

5.2 Deterministic and Stochastic Trends

If the 3 models (16), (17) and (18) are combined in a single equation, deterministic or stochastic trends can appear in the process:

$$X_t = \alpha + \phi X_{t-1} + \beta t + \epsilon_t ; \alpha \neq 0 \tag{16}$$

where ϵ_t is a white noise and "t' a time trend. A stochastic trend appears if $\phi = 1$ and, $\beta = 0$. Then

$$\Delta X_t = \alpha + \epsilon_t \tag{17}$$

X_t trends upwards or downwards depending on the sign of α. This kind of trend can be removed by first-differencing. X_t is then referred to as a difference stationary. The deterministic trend appears if $\phi = 0$ and, $\beta = 0$. Then:

$$X_t = \alpha + \beta t + \epsilon_t \tag{18}$$

X_t trends upwards or downwards depending on the sign of β. This kind of trend cannot be removed by first-differencing, since t doesn't remove from the process. X_t is then referred to as a trend stationary process. Stochastic and deterministic trends are present if $\phi = 1$ and, $\beta \neq 0$. The previous ADF tests only for the non-stationarity of a stochastic trend. Since both types of trends cause spurious regression problems, Dickey and Fuller suggest an F test to detect a deterministic trend, by rewriting (16) as:

$$X_t = \alpha + \phi^* X_{t-1} + \beta t + \epsilon_t \tag{19}$$

where $\phi^* = \phi - 1$. F-test is used to test the joint hypothesis $\phi^* = \beta = 0$ (critical values of F obtained by Dickey Fuller simulation experience since F statistic has a non-standard distribution under the null hypothesis of stochastic trend). Failure to reject this hypothesis would imply that X_t is subject to a stochastic trend only, with the absence of a deterministic trend. To test for a deterministic trend alone, the t ratio on the time trend in (19) can be examined using critical values of the t ratio provided by Dickey Fuller simulation. The unit root test with the exploration of time trend and drift for the series was applied as follows:

$$\Delta X_t = \alpha + \phi^* \Delta X_{t-1} + \phi_1^* \Delta X_{t-1} + \phi_2^* \Delta X_{t-2} + ... + \phi_r^* \Delta X_{t-r+1} + \epsilon_t \tag{20}$$

To achieve the ADF Test the serial correlation LM test is applied to measure the order of differenced terms included in the equations. In equation (19), if LM suggests autocorrelated residuals then a higher AR process is tried until the LM statistics are satisfactory. The serial correlation LM test is an alternative test for general serial correlation. It uses the Breusch-Godfrey large sample test for autocorrelated disturbances. After determining the sufficient number of lagged differences, the ADF test is applied to the series.

5.3 Testing the null hypothesis

$H_0 : (\alpha, \beta, \phi^*) = (\alpha, 0, 0)$ against the alternative hypothesis $H_A : (\alpha, \beta, \phi^*) \neq (\alpha, 0, 0)$ is tested through the application of the Wald (coefficient restrictions) test by imposing zero coefficients onβ,ϕ^* . The computed value Φ_1 of the Wald test (F-statistic) was compared with the critical value taken from the Dickey and Fuller (1981) tables, which is 6.25 under 5% significance level. If the result accepts H_0 (computed value of Φ_0¡ 6.25), Path A is followed. If H_0 is rejected, then Path B is followed.

- **Path A** there is a unit root ($\phi^* = 0$) with no trend ($\beta = 0$), with possible drift. To reinforce the inference that the series contains a unit root, the reported value of the t-statistic of the coefficient ϕ^* must be smaller than the critical value obtained from the Dickey and Fuller (1981) tables. To investigate the presence of the drift component, Φ_2 is used to test $H_0 : (\alpha, \beta, \phi^*) = (\alpha, 0, 0)$against the alternative hypothesis $H_A : (\alpha, \beta, \phi^*) \neq (\alpha, 0, 0)$, the tabulated value for the F statistic of 4.68 from Dickey and Fuller (1981) tables was used. If H_0 is rejected, then the series is a random walk with drift, otherwise, it is a random walk without drift. Then the equation (21) is estimated

$$\Delta X_t = \alpha + \phi^* \Delta X_{t-1} + \phi_1^* \Delta X_{t-1} + \phi_2^* \Delta X_{t-2} + ... + \phi_r^* \Delta X_{t-r+1} + \epsilon_t \qquad (21)$$

The F-test Φ_3 is used to test against using the tabulated critical value for the F statistic of 4.59 from Dickey and Fuller (1981) tables. If H_0 is rejected then the series is random walk with drift, otherwise, it is random walk without drift.

- **Path B** : Either ($\beta \neq 0, \phi^* = 0$); ($\beta = 0, \phi^* \neq 0$) or ($\beta \neq 0, \phi^* \neq 0$). To test if $\phi^* = 0$, the reported t statistic of ϕ^* coefficient is compared with the critical value taken from the standard normal tables. If $\phi^* = 0$ is rejected, then the series does not have a unit root and is considered stationary, otherwise it has a unit root. To test if $\beta = 0$, the reported t statistic of the β coefficient is compared with the critical value taken from the standard normal tables. If $\beta = 0$ is rejected, then the series has linear trend, otherwise it has no linear trend. To test if the intercept is zero, the t statistic test for α is applied. If $\alpha = 0$ then the series is without intercept. Otherwise, it has a non-zero drift.

5.4 Empirical Results

The Amman Stock Exchange has been studied by conducting the unit root test for the initial five prices indices and then the series of five return series. The return as indicated in Table 3 implies that the value of ϕ_1 for general, bank and insurance price indices are below 6.25 confirming a unit root. This conclusion is aptly supported by the analysis of t-statistic of the coefficient and further comparing it with the values obtained from Dickey and Fuller (1981) tables. There is an absence of drift that is observed through the calculated values of ϕ_2 which accumulate to be less than 4.68. Therefore it can be inferred from ϕ_1 test that $\beta_t = 0$ and the estimated value will be 4.36. The values of ϕ_3 are critical because they lead to the conclusion that the series are random walk without drift. Our tests indicate that all these three series have a unit root but no deterministic trend or a drift term. Evaluating the industry and services price indices, the value of ϕ_1 is higher than 6.25. Comparison of the t-statistic of these coefficients (-3.334 and -4.09 respectively) shows that H_0 is rejected when critical value of 1.96 from the standard normal tables is taken. They also have reported a t statistic of coefficients t of -3.6 and -3.84 respectively. This implies a linear trend, possibly with an interruption. Using a conventional ttest in order to test whether the intercept is zero, the t- statistic for the two indices was found to be 3.48 and 4.18 respectively, thereby rejecting the null hypothesis and implying a drift. As a conclusion, the industry and service price indices are stationary with a linear trend and a non-zero drift.

The stock prices exhibit a unit root when different specifications for a unit root were used, such as different number of lags, with or without intercept, with or without trend, and the combinations of these alternatives. Although the price series of the indices show deterministic trend still the presence of a unit root in stock prices is a necessary condition for random walk process. This has been demonstrated by Campbell et al. (1997) that unit root tests only explore the permanent/temporary nature of shocks to the series and, as such, have no bearing on the random-walk hypothesis (or predictability). So the use of unit test to evaluate random walk model can be doubtful. Moreover, the random walk model needs to fit the model ARIMA (0, 1, 0) where the future value of share prices cannot be determined on the basis of past information. Specifically, future share prices will not depend on past (lag) values of share prices or on the disturbance terms as mentioned in Section 1.2. The significant coefficients different from zero suggest dependency of the series in variables other than simply $P\ t-1$, and this violates the assumption of a random walk model and weak-form efficiency. On the other hand, when the unit root test was performed using the return indices all the indices of stock returns are stationary, none of the readings exhibited a unit root. As the return is the log for first difference of the prices, the price series can be considered as I (1) series, whilst returns are I (0). However the market's performance rejects the random walk model because it portrays a very high level of confidence $> 99\%$. This leads us to conclude at this stage that ASE does not satisfy the random walk model. It must be noted that this conclusion does not imply stationarity. However these results coincide with the previous results reported by Neaime (2002) also proved that the MENA market is non-stationary, by running ADF tests. However the unit root in stock prices is rejected at the 1 per cent significance level, suggesting that price indices in the MENA regions are I (1).

6 Conclusion

This paper investigates the Amman Stock Exchange by analysing the vital aspects of price indices and return behaviour properties. We have assessed the Efficient Market Hypothesis using recent econometric procedures. The Box-Jenkins estimation, irrespective of the index examined produced models with high prediction validity. This implies the existence of deviations from market efficiency in the pricing of equities in the ASE. The unit-root test also confirmed these results, as the return series for all indices did not exhibit unit root and all processes were stationary. Although the prices series for the general, bank, and insurance indices, exhibited unit roots, it is not sufficient for a random walk process since the series did not fit the ARIMA (0, 1, 0) model. As Campbell et al. (1997) demonstrated, unit root tests only explore the permanent/temporary nature of shocks to the series and, as such, have no bearing on the random-walk hypothesis or predictability.

Table 1: AC and PAC of five indices of Jordanian market for price changes

Lags	General		Banks		Insurance		Industry		Service	
	AC	PAC	AC	PAC	AC	PAC	AC	PAC	AC	PAC
1	0.25802**	0.25802**	0.22019**	0.22019**	0.19012**	0.19012**	0.25123**	0.25123**	0.2134**	0.2134**
2	0.01261	-0.06111**	0.01746	-0.03395	0.02813	-0.0097	0.02134	-0.04656*	0.05238**	0.00679
3	-0.0194	-0.00776	-0.0097	-0.00582	0.05626**	0.05432*	-0.0388	-0.03395	0.02328	0.01067
4	-0.02716	-0.02037	-0.02231	-0.01843	0.04268*	0.02231	-0.0388	-0.01649	0.00388	-0.00388
5	-0.01843	-0.00679	-0.02425	-0.01552	-0.01455	-0.0291	0.00097	0.01552	-0.03007	-0.03201
6	0.0097	0.01649	0.01261	0.02231	-0.02231	-0.01746	0.02231	0.01746	-0.0097	0.00291
7	-0.01164	-0.02231	-0.02134	-0.03201	0.00388	0.00873	0.02425	0.01261	-0.02813	-0.02619
8	-0.01455	-0.00582	-0.02328	-0.01261	0.01552	0.01552	0.00194	-0.00873	-0.00194	0.01067
9	-0.00582	-0.00097	-0.01843	-0.01067	-0.00485	-0.00776	0.01358	0.01843	-0.02134	-0.02231
10	0.02328	0.02619	0.00194	0.00873	0.00485	0.00776	0.03686	0.03395	0.00291	0.01261
11	0.04753*	0.03589	0.03492	0.03395	-0.00873	-0.01455	0.04947*	0.03492	-0.00291	-0.00485
12	-0.01649	-0.04268*	-0.02231	-0.04268*	-0.0291	-0.02716	-0.0097	-0.03395	0.01746	0.01843
13	-0.0097	0.0097	-0.01746	-0.00194	-0.01746	-0.00582	0.02037	0.03686	-0.01067	-0.01843
14	0.05335**	0.05917*	0.04753*	0.05626*	0.01358	0.02037	0.04268*	0.03589	0.04365*	0.04947*
15	0.03104	0.00194	0.03104	0.00776	0.03201	0.03007	0.01455	-0.00582	0.03104	0.01358
16	0.01552	0.00776	0.02134	0.01261	0.03395	0.02619	0.00776	0.00388	0.00485	-0.00873
17	0.04365*	0.04171	0.05723**	0.04947	0.03395	0.02134	0.0291	0.03104	0.01358	0.01552
18	0.03201	0.01552	0.02716	0.00776	-0.00776	-0.02619	0.05044*	0.04074	0.00679	-0.00291
19	0.01455	0.00679	0.01649	0.01358	0.02134	0.02425	0.00776	-0.01746	-0.0485*	-0.0485
20	-0.01649	-0.02328	-0.00291	-0.01067	-0.00291	-0.01358	-0.0291	-0.02813	-0.02813	-0.00776

Table 2: Estimated ARMA models of five indices of Jordanian market for price changes

Panel (A)- Coefficients and Specification										
	General Index (GI)		Bank Index (BI)		Insurance Index (InsI)		Industry Index (IndI)		Service index (SI)	
Specifications	ARMA(2,0)		ARMA(2,0)		ARMA(1,0)		ARMA(2,0)		ARMA(1,0)	
Variables	Coefficients	T-Stat	Coefficients	T-Stat	Coefficients	T-Stat	Coefficients	T-Stat	Coefficients	T-Stat
AR(1)	0.2856	13.8534	0.2423	11.7309	0.1895	9.3261	0.2598	12.5969	0.2091	10.3614
AR(2)	-0.0754	0.0199	-0.0436	-2.1136	-	-	-0.0658	-3.1897	-	-
Panel (B) Forecast Evaluation Statistics										
Theil Inequality Coefficient	0.0028		0.0039		0.0032		0.0032		0.0023	
Bias Proportion	0.0036		0.001		0.003		0.0077		0.0029	
Variance Proportion	0.0133		0.0071		0.0018		0.0087		0.0091	
Covariance Proportion	0.953		0.9618		0.965		0.9534		0.9578	

Table 3: Unit Root Tests

Unit Root Tests (Price level of General Index (GI))			
1) To achieve ADF test the order of differenced terms included in the equations is determined.			
LS // Dependent Variable is D(GI)			
Variable	Coefficient	Std. Error	t-statistic
C	0.4385	0.1675	2.5389
GI(-1)	-0.0026	0.0011	-2.2069
Trend	-0.00001	0.00003	-0.4614
D(GI(-1))	0.2849	0.0199	13.8344
D(GI(-2))	-0.0750	0.0199	-3.6416
2)Serial Correlation LM Test (suggests no autocorrelated residuals)			
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.5649	Probability	0.5418
Obs*R-squared	1.1327	Probability	0.5409
3)Wald Test:			
Equation: D(GI)=c1+c2(GI(-1))+c3(trend)+ c4(D(GI(-1))+c5(D(GI(-2))			
Null Hypothesis:	C(2)=0		
	C(3)=0		
F-statistic (ϕ_1)	3.6747		
Chi-square	7.3495		
There is a unit root (With no trend, with possible drift.)			
Path A: Wald Test			
Equation: D(GI)=c1+c2(GI(-1))+c3(trend)+ c4(D(GI(-1))+c5(D(GI(-2))			
Null Hypothesis:	C(1)=0		
	C(2)=0		
	C(3)=0		
F-statistic (ϕ_2)	2.60846095	random walk without drift	
Chi-square	7.82538285		
LS // Dependent Variable is D(GI)			
Variable	Coefficient	Std. Error	t-statistic
C	0.4550	0.1638	2.6940
GI(-1)	-0.0029	0.0010	-2.630
D(GI(-1))	0.2852	0.0199	13.7581
D(GI(-2))	-0.0746	0.0199	-3.6265
Wald Test:			
Equation: D(GI)=c1+c2(GI(-1))+ c3(D(GI(-1))+c4(D(GI(-2))			
Null Hypothesis:	C(1)=0		
	C(2)=0		
F-statistic (ϕ_3)	3.80417316	Unit root and zero drift	
Chi-square	7.60834632		

Table 3 - continue

Unit Root Tests (Price level of the Insurance Index (InsI))			
1) To achieve ADF test the order of differenced terms included in the equations is determined.			
LS // Dependent Variable is D(InsI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.4348	0.1669	2.5264
InsI(-1)	-0.0029	0.0012	-2.4109
Trend	0.0000	0.0000	-1.4707
D(InsI(-1))	0.1878	0.0200	9.0915
D(InsI(-2))	-0.0310	0.0204	-1.4757
D(InsI (-3))	0.0341	0.0204	1.6208
D(InsI(-4))	0.0316	0.0201	1.5263
2)Serial Correlation LM Test (suggests no autocorrelated residuals)			
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.4422	Probability	0.2195
Obs*R-squared	2.8918	Probability	0.2185
3)Wald Test:			
Equation: D(InsI)=c1+c2(InsI(-1))+c3(trend) + c4(D(InsI(-1))+c5(D(InsI(-2))+ c6(D(InsI(-3)) +c7(D(InsI(-4))			
Null Hypothesis:	C(2)=0		
	C(3)=0		
F-statistic (ϕ_1)	3.1333		
Chi-square	6.2667		
There is a unit root (= 0) with no trend (t = 0), with possible drift.			
Path A			
Wald Test:			
Equation: D(InsI)=c1+c2(InsI (-1))+c3(trend)+ c4(D(InsI (-1))+c5(D(InsI (-2))+ c6(D(InsI (-3)) +c7(D(InsI (-4))			
Null Hypothesis:	C(1)=0		
	C(2)=0		
	C(3)=0		
F-statistic (ϕ_2)2.2859	random walk without drift		
Chi-square	6.8576		
LS // Dependent Variable is D(InsI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.2923	0.1380	2.0545
InsI (-1)	-0.0022	0.0011	-1.9783
D(InsI (-1))	0.1880	0.0200	9.0991
D(InsI (-2))	-0.0310	0.0204	-1.4723
D(InsI (-3))	0.0343	0.0204	1.6278
D(InsI (-4))	0.0317	0.0201	1.5344
Wald Test:			
Equation: D(InsI)=c1+c2(InsI (-1))+ c3(D(InsI (-1))+c4(D(InsI (-2))			
Null Hypothesis:	C(1)=0		
	C(2)=0		
F-statistic (ϕ_3)	2.3126	Unit root and zero drift	
Chi-square	4.6253		

Table 3 - continue

(Price level of the Insurance Index (InsI))			
1) To achieve ADF test the order of differenced terms included in the equations is determined.			
LS // Dependent Variable is D(InsI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.4348	0.1669	2.5264
InsI(-1)	-0.0029	0.0012	-2.4109
Trend	0.0000	0.0000	-1.4707
D(InsI(-1))	0.1878	0.0200	9.0915
D(InsI(-2))	-0.0310	0.0204	-1.4757
D(InsI (-3))	0.0341	0.0204	1.6208
D(InsI(-4))	0.0316	0.0201	1.5263
2)Serial Correlation LM Test (suggests no autocorrelated residuals)			
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.4422	Probability	0.2195
Obs*R-squared	2.8918	Probability	0.2185
3)Wald Test:			
Equation: D(InsI)=c1+c2(InsI(-1))+c3(trend) + c4(D(InsI(-1))+c5(D(InsI(-2))+ c6(D(InsI(-3))+c7(D(InsI(-4))			
Null Hypothesis:	C(2)=0		
	C(3)=0		
F-statistic (ϕ_1)	3.1333		
Chi-square	6.2667		
There is a unit root (= 0) with no trend (t = 0), with possible drift.			
Path A			
Wald Test:			
Equation: D(InsI)=c1+c2(InsI (-1)) +c3(trend)+ c4(D(InsI (-1))+c5(D(InsI (-2)) + c6(D(InsI (-3))+c7(D(InsI (-4))			
Null Hypothesis:	C(1)=0		
	C(2)=0		
	C(3)=0		
F-statistic (ϕ_2)	2.2859	random walk without drift	
Chi-square	6.8576		
LS // Dependent Variable is D(InsI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.2923	0.1380	2.0545
InsI (-1)	-0.0022	0.0011	-1.9783
D(InsI (-1))	0.1880	0.0200	9.0991
D(InsI (-2))	-0.0310	0.0204	-1.4723
D(InsI (-3))	0.0343	0.0204	1.6278
D(InsI (-4))	0.0317	0.0201	1.5344
Wald Test:			
Equation: D(InsI)=c1+c2(InsI (-1))+ c3(D(InsI (-1))+c4(D(InsI (-2))			
Null Hypothesis:	C(1)=0		
	C(2)=0		
F-statistic (ϕ_3)	2.3126	Unit root and zero drift Chi-square	4.6253

Table 4: Unit Root Tests (Returns of Indices)

Unit Root Tests (Price level of General Index (GI))			
1) To achieve ADF test the order of differenced terms included in the equations is determined			
LS // Dependent Variable is D(GI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.4385	0.1675	2.5389**
GI(-1)	-0.0026	0.0011	-2.2069**
Trend	0	0	-0.4614
D(GI(-1))	0.2849	0.0199	13.8344***
D(GI(-2))	-0.075	0.0199	-3.6416**
2)Serial Correlation LM Test (suggests no autocorrelated residuals)			
F-statistic	0.5649	Probability	0.5418
3)Wald Test:			
F-statistic (ϕ_1)	3.6747		
Chi-square	7.3495		
There is a unit root (= 0) with no trend (t = 0), with possible drift.			
Path A			
Wald Test:			
F-statistic (ϕ_2)	2.6084	Random walk without drift	
Chi-square	7.8253		
LS // Dependent Variable is D(GI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.455	0.1638	2.6940**
GI(-1)	-0.0029	0.001	-2.6302**
D(GI(-1))	0.2852	0.0199	13.8576***
D(GI(-2))	-0.0746	0.0199	-3.6265**
Wald Test:			
F-statistic (ϕ_3)	3.8041	Unit root and zero drift	
Chi-square	7.6083		

Table 4 - Continue

Unit Root Tests (Price level of the Bank Index (BI))			
1) To achieve ADF test the order of differenced terms included in the equations is determined			
LS // Dependent Variable is D(BI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.2935	0.1457	1.9539
BI(-1)	-0.0016	0.001	-1.4348
Trend	0.00005	0	0.6083
D(BI(-1))	0.2417	0.02	11.7047***
D(BI(-2))	-0.0436	0.02	-2.1101**
2)Serial Correlation LM Test (suggests no autocorrelated residuals)			
F-statistic	0.4657	Probability	0.6001
3)Wald Test:			
F-statistic (ϕ_1)	1.58727114		
Chi-square	3.17454325		
There is a unit root (= 0) with no trend (t = 0), with possible drift			
Path A			
Wald Test:			
F-statistic (ϕ_2)	1.5872	random walk without drift	
Chi-square	3.1745		
LS // Dependent Variable is D(BI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.455	0.1638	2.6940**
BI(-1)	-0.0029	0.001	-2.6302**
D(BI(-1))	0.2852	0.0199	13.8576***
D(BI(-2))	-0.0746	0.0199	-3.6265**
Wald Test:			
F-statistic (ϕ_3)	2.2725	Unit root and zero drift	
Chi-square	4.5451		
Unit Root Tests (Price level of the Insurance Index (InsI))			
1) To achieve ADF test the order of differenced terms included in the equations is determined			
LS // Dependent Variable is D(InsI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.4348	0.1669	2.5264**
InsI(-1)	-0.0028	0.0011	-2.4108**
Trend	0	0	-1.4706
D(InsI(-1))	0.1878	0.02	9.0914***
D(InsI(-2))	-0.031	0.0203	-1.4756
D(InsI (-3))	0.0341	0.0204	1.6207
D(InsI(-4))	0.0315	0.02	1.5263
2)Serial Correlation LM Test (suggests no autocorrelated residuals)			
F-statistic	1.4421	Probability	0.2195
3)Wald Test:			
F-statistic (ϕ_1)	3.1333		
Chi-square	6.2666		
There is a unit root (= 0) with no trend (t = 0), with possible drift.			
Path A			
Wald Test:			
F-statistic (ϕ_2)	2.2858	Random walk without drift	
Chi-square	6.8575		
LS // Dependent Variable is D(InsI)			
Variable	Coefficient	Std. Error	t-Statistic
C	0.2922	0.1379	2.0545**
InsI (-1)	-0.0021	0.001	-1.9783*
D(InsI (-1))	0.188	0.02	9.0999**
D(InsI (-2))	-0.0309	0.0204	-1.4723
D(InsI (-3))	0.0342	0.0204	1.6278
D(InsI (-4))	0.0317	0.02	1.5343
Wald Test:			
F-statistic (ϕ_3)	2.3126	Unit root and zero drift	
Chi-square	4.6252		

Table 4 - Continue

Unit Root Tests (Price level of the Industry Index (IndI))

1) To achieve ADF test the order of differenced terms included in the equations is determined

LS // Dependent Variable is D(IndI)

Variable	Coefficient	Std. Error	t-Statistic
C	0.7084	0.2034	3.3782**
IndI(-1)	-0.0044	0.0013	-3.2346**
Trend	-0.0001	0	-3.4918**
D(IndI (-1))	0.2588	0.0199	12.5744***
D(IndI (-2))	-0.0656	0.0199	-0.0656

2)Serial Correlation LM Test (suggests no autocorrelated residuals)

F-statistic	0.781	Probability	0.4336

3)Wald Test:

F-statistic (ϕ_1)	6.5125
Chi-square	13.0251

Path B

The series is stationary with time trend and intercept.

Unit Root Tests (Price level of the Service Index (SI))

1) To achieve ADF test the order of differenced terms included in the equations is determined

LS // Dependent Variable is D(SI)

Variable	Coefficient	Std. Error	t-Statistic
C	1.1097	0.2653	4.0571**
SI(-1)	-0.0072	0.0017	-3.9672**
Trend	-0.0001	0	-3.7316
D(SI(-1))	0.2093	0.0195	10.4073

2)Serial Correlation LM Test (suggests no autocorrelated residuals)

F-statistic	0.1667	Probability	0.8168

3)Wald Test:

F-statistic (ϕ_1)	8.6383
Chi-square	17.2766

The series is stationary with time trend and intercept.

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