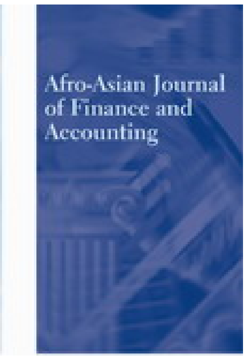


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# Rational speculative bubbles in the stock market - the case of Amman Stock Exchange

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# Rational speculative bubbles in the stock market – the case of Amman Stock Exchange

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**Abstract:** This paper aims at inspecting the existence of rational speculative bubbles in the Amman Stock Exchange market (ASE) along two sample periods, the first from 2004 to 2009, and the second from 2010 to 2018. The paper uses three different quantitative approaches to analyse the returns for ASE index over the selected sample periods. The first approach is the descriptive statistics, the second one is the explosiveness test approach, and the third one is the duration dependence test approach. The paper found evidence for the existence of a rational speculative bubble in ASE returns for the first sample period inspected and based on the three different approaches. This paper represents a contribution toward establishing an effective early warning system for predicting and mitigating financial crises. The paper represents a good contribution to improve the investment environment in Jordan.

**Keywords:** rational speculative bubble; duration dependence test; Amman Stock Exchange; ASE; explosiveness test.

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## 1 Introduction

Since its establishment in 1978, Amman Stock Exchange (ASE) market showed many stages of instability and fluctuations, some stages showed prosperity and some other showed recessions. Part of these fluctuations was healthy and normal fluctuations, and other part was abnormal appreciations in value, sometimes called bubbles, followed by tragic down turn. The presence of the bubbles in financial markets represent a threat for all players, particularly when these bubbles burst, the collapse of shock index can generate a tsunami of loss that can expand across the whole economy (Rjoub, 2011; Summers, 1986). All the time, the same story repeated, the abnormal appreciation in index value will develop to an irrational bubble, supported by what so called the herd behaviour, then this bubble must burst and the story of domino effect will start (Chen, 2013; Blasco et al., 2012; Montier, 2007; Ang et al., 2004; Chowdhry and Goyal, 2000). Although Jordanian market is relatively a small market, and the exposure for international crises is lower than what happen in the more developed markets, but the effect of any bubble burst will extend all over the world, and the consequences of the crises will reach even to the less developed emerging markets (Tawfiq and Tahtamouni, 2018).

The excessive importance of stock markets, in keeping the stability of the economy as a whole, lays in the transferability of its problems across the markets easily and quickly through what so called the contagion effect. Contagion effect is a real shock multiplier in the economy if not dealt with properly and in a timely manner by the regulatory authority (Singh and Singh, 2017; Paas and Kuusk, 2012). The problem might be triggered in certain company, certain sector, or even certain country, then this problem can easily expand to the healthy and solvent ones throughout the contagion effect, and that can be more obvious in stock markets, because of the instantaneous effect of information on demand and supply, and then on the price.

The main contributor to the existence of contagion effect in stock markets is the herd behaviour. Herd behaviour is an irrational investment behaviour from the side of investor, it implies that the investors will increasingly liquidate their investments depending on rumours in the markets, and without any fundamental background for their decisions (Litimi, 2017; Litimi et al., 2016). The non-healthy environment with a lot of panic and uncertainty will lead the investors to be over conservative in their investment decisions, and that will lead them to liquidate their investments and keep cash or gold as a safe resort for the value in these circumstances (Brown et al., 2014; Allen and Gale, 2000; Aharony and Swary, 1996).

The bubble inflates slowly and quietly, and when it bursts, it happens quickly and loudly. That is why such a burst creates a lot of panic, the investor will tend to behave in irrational way like herd, and that will contribute to the acceleration of contagion effect and problems dispersion (BenSaïda, 2017; BenSaïda et al., 2015).

This study will contribute to provide a quantitative assessment for the existence of rational speculative bubbles in ASE and will help in highlighting the irrational movements, in order to give more time and chance for investors to react properly. It will enhance the healthy investment environment and will represent a good milestone in evaluating the actual prosperity of financial markets and the speculative bubbles. This will help different investors and fund managers in ASE with different risk appetite, and different investment planning to allocate their capital and to select their investment properly. In general, this study will significantly update the current literature review with solid quantitative analysis for the market movement.

## 2 Literature review

The definition of bubbles might be different among different literatures; some of it defines the bubble as the stock price changes that cannot be explained by the fundamental analysis of the underlying company (Yanik and Aytürk, 2011). Some others define it as long run appreciation in asset price, followed by sudden collapse and deterioration (Nartea and Cheema, 2014). These definitions argued that the bubble can be examined through simple statistical approaches like autoregression and cointegration test, but unfortunately, there were many of criticisms for these approaches. McQueen and Thorley (1994) tried to overcome some of the drawbacks of the traditional bubbles inspection approaches. They defined the sources of unexpected price changes in a rational speculative bubble to be from two sources; fundamental sources and bubble sources.

Fendi et al. (2019) inspected the existence of rational speculative bubble in the bitcoin behaviour, they used two main approaches to do that, the first was the deceptive statistics approach and the second one was the duration dependence test approach, the two approaches are well known techniques to assess the existence of speculative bubble.

Some of the literatures used the descriptive statistics to detect the existence of the speculative bubbles in the stock markets (Nartea and Cheema, 2014; Yanik and Aytürk, 2011; Yu and Hassan, 2010). This approach detects the existence of the bubble from time series data of value and returns of the stock index, it uses some of the statistical measures that indicate for the existence of the speculative bubble like coefficients of skewness, kurtosis and autocorrelation. The existence of negative significant skewness may indicate to the existence of speculative bubble; on the other hand, the existence of positive significant skewness will support the absence of the bubble. The existence of positive significant kurtosis will support the existence of the rational speculative bubble, while the negative significant kurtosis will indicate for the absence of the bubble. With respect to the autocorrelation; the existence of autocorrelation will support the existence of the bubble (Nartea and Cheema, 2014).

Some other literatures used unit root cointegration test to detect the existence of the bubbles (Gurkaynak, 2008; Chang et al., 2007; Brooks and Katsaris, 2003; Herrera and Perry, 2003). Other econometrical approaches like the variance bound test and West's two step method, these methods are less applied in bubble detection mechanism for stock markets (Yanik and Aytürk, 2011; Gurkaynak, 2008).

Another econometrical approach was generalised supremum augmented Dickey-Fuller test, which was proposed initially by Phillips et al. (2011) in the work that inspected the existence of the bubble in NASDAQ. This approach enables the researcher to detect the existence of only one bubble episode. This approach was developed later by Phillips et al. (2015) to enable the researchers to detect more than one bubble episode and to overcome many disadvantages of the old approach, for example, this approach can help in detecting the nonlinear relationships in the bubble episodes (Yu and Hassan, 2010).

Fractional integration test is a dynamic fractional process that overcomes many technical problems. This approach is suitable in low frequency cases of the indices, and considers the dividends variable, and it is more relaxed in the short-term fluctuation of the index. This approach stands mainly on the autoregressive fractionally integrated moving average (ARFIMA) Models (Yu and Hassan, 2010; Cuñado et al., 2005; Koustas and Serletis, 2005).

Explosiveness test is another important measurement for the existence of the rational speculative bubble. This approach requires determining the probable episodes for the existence of the bubbles, then applies a regression model of the returns of these episodes on the time or number of periods within these episodes. If the coefficient of the time variable, as a regressor, was positive and significant, this represents an indication to the existence of rational speculative bubble (Yu and Hassan, 2010; Chan et al., 1998).

The last and most reliable approach is duration dependence test, which is the one that overcomes most of the drawbacks appeared in the previous approaches. It can give more solid, valid, and reliable results for the bubble detection process. This approach was initially developed by McQueen and Thorley (1994) and later has been applied by many researchers in inspecting the existence of rational speculative bubble in stock markets or even in real estate and agricultural sectors (Chang et al., 2016; Nartea and Cheema, 2014; Yanik and Aytürk, 2011; Yu and Hassan, 2010; Mohktar et al., 2006; Chan et al., 1998).

McQueen and Thorley (1994) adopted two approaches of measurements to investigate the existence of rational speculative bubble, the first approach included a group of descriptive statistics like skewness, kurtosis, autocorrelation, and the second was the duration dependence test. Their research was applied on the data of New York Stock Exchange (NYSE) over the period 1927 to 1991. The first approach's results showed indicators for the existence of rational speculative bubble, the second approach was more balanced and reliable one and shows the same conclusion and result.

Yu and Hassan (2010) examined the existence of rational speculative bubble in the stock markets of MENA region countries. The sample consists of eight countries of Bahrain, Egypt, Morocco, Jordan, Israel, Oman, Saudi Arabia and Turkey. The paper applied the fractional integration test and duration dependence test as a new more elaborated statistical approaches, in order to overcome the problems of the traditional bubble examination approaches like cointegration test and unit root test. The two adopted approaches supported the argument of the absence of any rational speculative bubble in the stock markets although we can notice some fluctuations in performance in the recent years.

Nartea and Cheema (2014) explored the existence of rational speculative bubbles in Malaysian stock market. They used three different statistical approaches for that, the descriptive statistics, explosiveness test, and duration dependence test. The selected sample was extended to episodes that include alleged bubbles. The paper concluded the absence of any rational speculative bubble, despite the probable existence of some bubbles, but they were not rational.

Gan et al. (2012) examined the existence of rational speculative bubble in Hong Kong stock market. They applied the duration dependence test for that on the data of Hong Kong stock market, for the period from 1993 to 2008, which include the 1997 year of Asian tiger crisis. The results showed no empirical evidence for the existence of rational speculative bubble, neither before 1997 nor after it.

Yanik and Aytürk (2011) tested the existence of any rational speculative bubble in Istanbul stock market for the period of 2002 to 2010. The duration dependence test has been applied as a relatively new approach for this situation. The results said that there is no evidence for the existence of rational speculative bubble in Istanbul Stock Exchange market during the period of 2002–2010.

Zhang (2008) investigated the existence of rational speculative bubble in the Chinese stock market using the duration dependence test. The results show the evidence for a bubble in the stock values. This result is consistent with many researches applied on the Chinese stock market (Haque et al., 2008).

Chang et al. (2016) investigated the existence of bubbles in a group of high growth countries, Brazil, Russia, India, China and South Africa. They used the new approach of generalised sup augmented Dickey-Fuller test of a series of monthly data of stock markets. They found a footprint for multiple bubbles in the time series of monthly returns of stock market in these countries.

## 3 Methodology

This paper is going to adopt three different approaches in order to detect the existence of rational speculative bubble in ASE index. The first approach is the descriptive statistics approach, which relies mainly on the analysis of the historical values and returns for ASE index, and tracking the long-term up ward trending that followed by sharp drop in value. Descriptive statistics has supportive statistical indicators that can advise about the existence of bubble or not, the coefficient of skewness, kurtosis and autocorrelation. The existence of negative and significant skewness, for example, can support the alleged statement of the existence of speculative bubble in ASE index, while, on the other hand, the existence of significant positive skewness coefficient will indicate to the absence of the bubble. The kurtosis coefficient has similar interpretation, where the existence of positive significant kurtosis coefficient in the ASE index returns will support the alleged statement of the existence of speculative bubble. Autocorrelation as well, will be used and can help in concluding the results. The existence of any order autocorrelation among the ASE index returns will support the existence of the bubble.

The second approach is the explosiveness test approach that adopts the simple linear regression model as the explanatory model for the level of ASE returns. The dependent variable will be the level of returns under measurement, whether it was daily, weekly, or monthly returns and the independent variable will be the number of periods from the start of the probable bubble.

$$Rt = \alpha + \beta Tt + \varepsilon t \quad (1)$$

where $Rt$ is the level of return from any measurement, $\alpha$ is the constant, $Tt$ is the number of period from the start of the probable bubble, and $\varepsilon t$ is the error term.

The third and the most advanced approach, that can overcome many of the drawbacks in the earlier approaches, is the duration dependence test approach. This approach was developed by McQueen and Thorley (1994), and applied later on by variety of researcher in trying to explore the existence of rational speculative bubbles in stock markets (Chang et al., 2016; Nartea and Cheema, 2014; Yanik and Aytürk, 2011; Yu and Hassan, 2010; Mohktar et al., 2006; Chan et al., 1998).

Duration dependence test applies its analysis on the abnormal returns for any stock index time series, and in order to extract the abnormal returns the autoregression model will be applied and the residuals from this regression will represent the abnormal returns. The positive and negative run counts must be discriminated and classified separately, total summation for positive run counts will be equal to the negative ones. The sample hazard rate will be then calculated, and the trend of this hazard rate can tell about the existence of rational speculative bubble or not, see equation (2).

$$HRt = \frac{Ct}{Ct + Tt} \quad (2)$$

where $HRt$ represents the hazard rate at count of run of length $t$, $Ct$ is the count of runs of length $t$, $Tt$ is the summation of count of runs of length $t$ and above.

The decreasing hazard rate with the increase in run length for positive runs will indicate to the existence of the bubble. Log logistic hazard model will estimate this relationship accurately and determine whether there is a rational speculative bubble or not, significant negative beta coefficient for this model will support the alleged opinion for the existence of rational speculative bubble, see equation (3).

$$hi = \frac{1}{1 + e^{-(\alpha + \beta \ln i)}} \quad (3)$$

This research will apply the three statistical approaches on the sample data of ASE returns for the two sample periods from August 2004 to March 2009, and from April 2009 to July 2018, the reason why we have this time line separation is that the first sample period contains probable speculative bubbles out of the 2008 financial crisis. The paper will use daily, weekly, and monthly returns as a variable represents the ASE index returns to catch any rational speculative bubble. The use of these different return measurements is mainly to detect any short-term changes that might not be traceable through monthly returns alone.

The data for all daily, weekly and monthly returns for ASE index is available on the website of ASE (http://www.ase.com.jo). The website is user friendly one that enables the users to tailor and customise the data as needed and based on the sample adopted. The selected sample includes many probable alleged bubbles in the history of ASE index.

## 4 Outcomes

### 4.1 Descriptive statistics

In the descriptive statistics section, we are trying to trace and detect the probable bubbles from the line graph of the ASE index over the sample period selected. Figure 1 shows the historical values of ASE index.

**Figure 1** The level of ASE over the extended period (2000–2018) (see online version for colours)

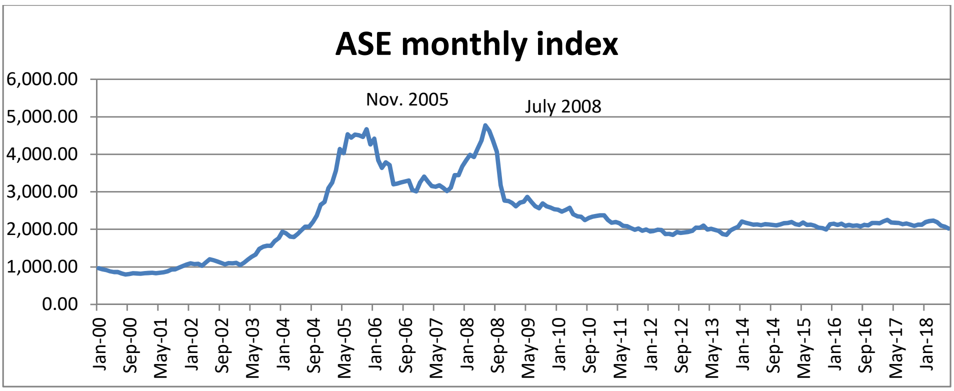


Figure 1 shows that there are two summits within the first sample period that might represent probable bubbles for ASE. The first one starts with a continuous increase in the index level since April 2004 with index value equals to 2,070 points, and continues to increase until it reaches the maximum level in July 2005 with a value equals to 4,668 points, and with a change rate equals to 126%. After that date the index started to drop sharply until it reached the level of 3,013 points in December 2006, with a decrease rate equals to –35%.

The second probable bubble started from August 2007 with an index value equal to 3,022 points, the index continued to increase until it reached the level of 4,772 points in June 2008, with a rate of 58% in less than one year. Immediately after that date, the index dropped sharply from these levels to the level of 2,552 points in March 2009, with a rate equals to –47% within only eight months. These extreme, or at least abnormal, rates of positive returns occurred in relatively short period of time, and immediately followed by negative change and sharp drop in value, can really indicate to foot prints for the existence of speculative bubble. Based on the definitions of the bubble mentioned earlier, these episodes represent actual speculative bubbles.

Comparing this analysis with the second sample period, we find no summits worth mentioning along the period from mid of 2009 and mid of 2018. The index along this period was stable and consistent without any noticeable increase or decrease. The index started from 2,500 points in July 2009 and continued to decrease and increase frequently, but it never increased above that 2,500 or decreased under 1,850 points.

The next step in descriptive statistics is to calculate the required statistical measures that can help in judging the existence of speculative bubble or not. Tables 1 and 2 present the required statistical measurements for these two stages.

**Table 1** The statistical indicators for ASE returns for the first sample period

| *Summery statistic* | *Daily returns* | *Weekly returns* | *Monthly returns* | *Lag* | *Autocorrelation* | | |
|---|---|---|---|---|---|---|---|
| Mean return | –0.01% | –0.06% | –0.22% | 1 | 0.247 | 0.091 | 0.345 |
| Standard deviation | 1.34% | 3.29% | 7.57% | 2 | –0.037 | 0.052 | 0.267 |
| Maximum return | 4.63% | 14.36% | 28.42% | 3 | 0.013 | 0.092 | 0.218 |
| Minimum return | –4.58% | –7.74% | –13.91% | 4 | 0.054 | 0.018 | 0.144 |
| Gap | 9.21% | 22.10% | 42.34% | 5 | –0.003 | 0.203 | 0.115 |
| Skewness | 0.400 | 1.158 | 1.186 | 6 | –0.042 | 0.067 | –0.028 |
| Kurtosis | 4.413 | 5.894 | 5.530 | 7 | –0.005 | –0.046 | –0.007 |
| Jarque-Bera | 120.720 | 133.845 | 25.830 | 8 | 0.028 | 0.042 | –0.098 |
| Prob. | 0.000 | 0.000 | 0.000 | 9 | –0.019 | 0.157 | –0.001 |
| | | | | 10 | –0.034 | 0.123 | –0.164 |
| | | | | 11 | 0.035 | 0.063 | –0.186 |
| | | | | 12 | 0.084 | 0.058 | –0.167 |
| | | | | Q(12) | 86.297 | 28.5 | 22.783 |
| | | | | Prob. | 0.00000 | 0.005 | 0.030 |

Table 1 shows that the average return for the daily ASE returns was –0.01% and the maximum return were 4.63% and minimum return of –4.58%, and the standard deviation equals 1.34%. For weekly and monthly returns, the average has changed, but the overall image remains the same and the standard deviation has increased. Large Jarque-Bera value for daily, weekly, and monthly returns indicates to the absence of the normality in these returns. There was positive kurtosis with values equal to 4.4, 5.9, and 5.5 for the daily, weekly and monthly returns, respectively. There was positive skewness as well, with values equal to 0.4, 1.15, and 1.18 for daily, weekly, or monthly returns, respectively. With respect to the autocorrelation, Box-Ljung test show that there was autocorrelation between returns either on the daily, weekly, or monthly returns, with different lags, Q(12) value were positive and significant.

Table 2 shows that the average returns for the second sample period were 0.01%, 0.06%, and 0.29% for the daily weekly and monthly returns, respectively. The standard deviations were 0.53%, 1.26% and 2.5%, respectively, which is less than the standard deviation in the first sample. Gap between maximum and minimum amounts were quite lower than the first sample. Jarque-Bera test show the absence of normality in the daily and weekly returns but the monthly returns show normality.

Statistics say that the existence of the speculative bubble will be supported with the non-normal return distribution, negative skewness, excess kurtosis, and significant serial correlation. The results presented in Tables 1 and 2 support the existence of speculative bubble in ASE returns for the first sample period, with an exception for the skewness statistics, and with more tendency to support the absence of speculative bubble in the second sample period.

**Table 2** The statistical indicators for ASE returns for the second sample period

| *Summery statistic* | *Daily returns* | *Weekly returns* | *Monthly returns* | *Lag* | | *Autocorrelation* | |
|---|---|---|---|---|---|---|---|
| Mean return | 0.01% | 0.06% | 0.29% | 1 | 0.129285 | −0.054592 | −0.088523 |
| Standard deviation | 0.53% | 1.26% | 2.50% | 2 | −0.005415 | 0.055383 | 0.003932 |
| Maximum return | 2.68% | 6.23% | 7.24% | 3 | −0.00241 | 0.068722 | −0.015696 |
| Minimum return | −2.33% | −5.46% | −6.68% | 4 | −0.03606 | 0.036994 | −0.079912 |
| Gap | 5.01% | 11.69% | 13.92% | 5 | 0.021528 | −0.086701 | −0.069995 |
| Skewness | 0.011814069 | −0.016262406 | −0.1497728 | 6 | 0.000868 | −0.034309 | 0.038431 |
| Kurtosis | 2.807325228 | 2.507566519 | 0.5968699 | 7 | −0.026068 | −0.035644 | 0.055779 |
| Jarque-Bera | 763.453 | 123.7787 | 1.657104 | 8 | 0.004838 | 0.03444 | −0.124122 |
| Prob. | 0 | 0 | 0.436681 | 9 | −0.016531 | 0.058818 | −0.047822 |
| | | | | 10 | 0.040692 | −0.020859 | 0.166563 |
| | | | | 11 | 0.013838 | −0.045409 | 0.177948 |
| | | | | 12 | 0.003816 | −0.113652 | 0.108305 |
| | | | | Q(12) | 4.11722 | 1.327463 | 0.704159 |
| | | | | Prob. | 0 | 0.199162 | 0.743 |

## *4.2 Explosiveness test*

In this approach, we need to apply simple regression analysis model on the return data for ASE for the selected period. This period implies upward trending levels of the index, which started from some point in time and continues to increase up to certain maximum point. This period will represent the regression period for the explosiveness test. The dependent variable will be the returns on ASE index during this period and the independent variable will be the number of period from the start of the upward trend until the local maximum point (Nartea and Cheema, 2014; Chan et al., 1998).

We will use Figure 1 to identify the local maximum points that might represent the probable bubbles. Two peaks have been identified: the first one that ends up on November 2005, and the second one that ends up in June 2008, if we are talking about monthly returns, and in weekly returns; the first peak will be on November 13th 2005, and the second peak will be on June 15th 2008. With respect to daily returns, the first peak will be on November 17th 2005, and the second peak will be on June 19th 2008. The regression will be applied on number of periods prior to each local peak and since the starting point of the sample, given that the sample was customised to start from the beginning of the upward trending of the index.

From Table 3, we can see that the coefficient of beta for the first peak was positive and significant at 10% significance level, for the daily and weekly returns, and positive and significant at 1% significant level for monthly returns. While for the second peak, the coefficients were negative and significant at almost at 1% significance level for all return levels. This implies that based on the explosiveness test, and on the sample selected, the first peak includes an increasing return pattern over time during the bubbling period (explosiveness returns), which supports the argument of the existence of rational speculative bubble in the first probable defined bubble, either on the daily returns base or on the weekly and monthly, while the second peak does not represent a rational speculative bubble and based on the three return measurement levels used.

**Table 3** The explosiveness test results for the first sample period

| | *Daily returns* | | *Weekly returns* | | *Monthly Returns* | |
|---|---|---|---|---|---|---|
| | *First peak* | *Second peak* | *First peak* | *Second peak* | *First peak* | *Second peak* |
| Beta coefficient | 1.05 | –9.2706 | 0.000298 | –0.000184 | 0.007913 | –0.002933 |
| Prob. | 0.0762 | 0.0003 | 0.0862 | 0.0018 | 0.0165 | 0.0113 |

With respect to the second sample period, there are no clear summits appears from the graph, so, we are going to apply this approach on the whole sample period from 2009 to 2018. Table 4 shows the results of the explosiveness test for the second sample period. The results show that there are negative coefficients for the daily, weekly, and monthly returns for the second sample period, and these coefficients were insignificant, which support the absence of speculative bubbles in the second sample period.

**Table 4** The explosiveness test results for the second sample period

| | *Daily returns* | *Weekly returns* | *Monthly returns* |
|---|---|---|---|
| Beta coefficient | –1.33E–07 | –3.47E–06 | –7.99E–05 |
| Prob. | 0.4106 | 0.395 | 0.2768 |

### 4.3 Duration dependence test

This approach, as mentioned earlier, overcomes most of the drawbacks present in the other approaches, it is widely used in bubble detection processes since developed by McQueen and Thorley (1994). The first step in applying duration dependence test is to generate the abnormal return series for ASE index. The abnormal return can be generated through applying autoregressive model and extracting the residuals for that model, these residuals represent the unexplained part of the return time series, and these unexplained patterns are simply the abnormal returns. The next step is to divide the abnormal returns to positive and negative deviations, and to recognise the length of each positive or negative deviation and to count them. Then, the run counts for each positive and negative run length will be founded. The hazard rate can be calculated based on the equation mentioned earlier. This hazard rate represents the probability for any positive/negative abnormal return that lasts for *x* periods to revert to negative/positive abnormal returns in the next period. The results for this approach can be noticed from the relationship between the positive run length and the direction of hazard rate. The last step is to verify the results acquired through the notice, by apply the log logistic model to find the relationship between the length of run and the hazard rate in the positive run side. The negative significant beta for this relationship supports the argument of the existence of rational speculative bubble. We do not discuss the results for the negative abnormal returns because it never generates a rational speculative bubble (Nartea and Cheema, 2014; McQueen and Thorley, 1994).

Results for duration dependence test are presented in Tables 5, 6 and 7 for the daily, weekly and monthly returns, respectively for the first sample period, and Tables 8, 9 and 10 for the daily, weekly and monthly returns, respectively for the second sample period.

From Table 5, we can see that we have 536 abnormal returns, 268 positive run and 268 negative run. The longest positive run lasts for six periods, while the longest negative run lasts for 13 periods. It is clearly noticed that the inverse relationship between the length of positive run and hazard rate. When the run length for positive abnormal returns was one period, the probability for these abnormal returns to reverse to negative abnormal returns in the next period is 50%, and when the run length is two periods, the probability for these positive returns to inverse in direction will increase to 54%. Although this increase is opposite to the evidence of the existence of rational speculative bubble, but it is the only increase along the rest of positive run lengths. The positive run length of 3 has a probability of 52% to revert in sign in the next period, and for positive run length of 4 the probability is 51.7%, and for run length of 5 it is 50%, and for run length of 6 it is 42.9%. This negative relationship means that as the positive abnormal returns last for longer period; the probability for these abnormal returns to change into negative sign abnormal returns will decrease. This inverse relationship between the positive run length and the hazard rate is an evidence for the existence of rational speculative bubble in ASE daily returns. To verify these results, we applied log logistic regression model on the data to measure the accurate relationship between the run length and the hazard rate. The results are listed in Table 5 as well, it shows that the coefficient for the equation is negative and significant, which means that there is an empirical evidence for the existence of rational speculative bubble in ASE daily returns.

**Table 5** Duration dependence test results for daily returns for the first sample period

| *Run length* | *Positive runs* | | *Negative runs* | |
|---|---|---|---|---|
| | *Actual run counts* | *Sample hazard rate* | *Actual run counts* | *Sample hazard rate* |
| 1 | 134 | 0.5 | 137 | 0.5148 |
| 2 | 73 | 0.5448 | 63 | 0.4809 |
| 3 | 32 | 0.5246 | 29 | 0.4265 |
| 4 | 15 | 0.5172 | 18 | 0.4615 |
| 5 | 7 | 0.5 | 8 | 0.381 |
| 6 | 3 | 0.4286 | 6 | 0.4615 |
| 7 | 4 | 1 | 3 | 0.4286 |
| 8 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 2 | 0.5 |
| 10 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 2 | 1 |
| Total | 268 | 0 | 268 | |
| *Log-logistic test* | | | | |
| α | 1.248115 | | 0.111635 | |
| β | –0.682249 | | –1.17284 | |
| LRT statistic | 2.12546 | | 1.337324 | |
| p-value | 0.0431 | | 0.2642 | |

**Table 6** Duration dependence test results for weekly returns for the first sample period

| *Run length* | *Positive runs* | | *Negative runs* | |
|---|---|---|---|---|
| | *Actual run counts* | *Sample hazard rate* | *Actual run counts* | *Sample hazard rate* |
| 1 | 29 | 0.5088 | 30 | 0.5263 |
| 2 | 17 | 0.6071 | 11 | 0.4074 |
| 3 | 7 | 0.6364 | 4 | 0.25 |
| 4 | 3 | 0.75 | 2 | 0.1667 |
| 5 | 0 | 0 | 5 | 0.5 |
| 6 | 1 | 1 | 3 | 0.6 |
| 7 | 0 | 0 | 1 | 0.5 |
| 8 | 0 | 0 | 1 | 1 |
| Total | 57 | | 57 | |
| *Log-logistic test* | | | | |
| α | 6.725932 | | –0.55678 | |
| β | –3.65979 | | 0.700667 | |
| LRT statistic | 1.277549 | | 0.329429 | |
| p-value | 0.4407 | | 0.5741 | |

**Table 7** Duration dependence test results for monthly returns for the first sample period

| *Run length* | *Positive runs* | | *Negative runs* | |
|---|---|---|---|---|
| | *Actual run counts* | *Sample hazard rate* | *Actual run counts* | *Sample hazard rate* |
| 1 | 7 | 0.5385 | 7 | 0.5385 |
| 2 | 3 | 0.5 | 2 | 0.3333 |
| 3 | 2 | 0.6667 | 2 | 0.5 |
| 4 | 1 | 1 | 1 | 0.5 |
| 5 | 0 | 0 | 1 | 1 |
| Total | 13 | | 13 | |
| *Log-logistic test* | | | | |
| A | 0.725932 | | 0.725932 | |
| B | 0.489198 | | 0.489198 | |
| LRT statistic | 0.049812 | | 0.049812 | |
| p-value | 0.8231 | | 0.8231 | |

**Table 8** Duration dependence test results for daily returns for the second sample period

| *Run length* | *Positive runs* | | *Negative runs* | |
|---|---|---|---|---|
| | *Actual run counts* | *Sample hazard rate* | *Actual run counts* | *Sample hazard rate* |
| 1 | 239 | 0.4434 | 249 | 0.462 |
| 2 | 134 | 0.4467 | 137 | 0.4724 |
| 3 | 76 | 0.4578 | 73 | 0.4771 |
| 4 | 46 | 0.5111 | 40 | 0.5 |
| 5 | 17 | 0.3864 | 14 | 0.35 |
| 6 | 15 | 0.5556 | 11 | 0.4231 |
| 7 | 6 | 0.5 | 8 | 0.5333 |
| 8 | 3 | 0.5 | 2 | 0.2857 |
| 9 | 3 | 1 | 2 | 0.4 |
| 10 | | | 2 | 0.6667 |
| 11 | | | 1 | 1 |
| Total | 539 | 0 | 539 | |
| *Log-logistic test* | | | | |
| A | –5.811289 | | –3.003798 | |
| B | 1.292257 | | 0.377162 | |
| LRT statistic | 7.353132 | | 2.741575 | |
| p-value | 0.006695 | | 0.097768 | |

Table 6 presents the results for duration dependence test for ASE weekly returns, we have 114 abnormal returns, 57 positive one and 57 negative one. The largest positive run length was six periods while the largest positive run length was eight periods. The hazard rate shows an increasing level as the positive run length increase. The hazard rate was

50.9% for the positive run length of one period, and then increase to 60.7%, 63.6%, 75%, and 0% for the rest of run lengths. This positive relationship is inconsistent with the evidence for the existence of rational speculative bubble in ASE weekly returns.

**Table 9** Duration dependence test results for weekly returns for the second sample period

| *Run length* | *Positive runs* | | *Negative runs* | |
|---|---|---|---|---|
| | *Actual run counts* | *Sample hazard rate* | *Actual run counts* | *Sample hazard rate* |
| 1 | 64 | 0.512 | 71 | 0.568 |
| 2 | 31 | 0.5082 | 28 | 0.5185 |
| 3 | 10 | 0.3333 | 15 | 0.5769 |
| 4 | 4 | 0.2 | 5 | 0.4545 |
| 5 | 7 | 0.4375 | 5 | 0.8333 |
| 6 | 5 | 0.5556 | 1 | 1 |
| 7 | 4 | 1 | | 0 |
| Total | 125 | | 125 | |
| *Log-logistic test* | | | | |
| α | 0.287682 | | 2.388082 | |
| β | –6.70E–11 | | –0.210292 | |
| LRT statistic | 0 | | 0.103988 | |
| p-value | 1 | | 0.747095 | |

**Table 10** Duration dependence test results for monthly returns for the second sample period

| *Run length* | *Positive runs* | | *Negative runs* | |
|---|---|---|---|---|
| | *Actual run counts* | *Sample hazard rate* | *Actual run counts* | *Sample hazard rate* |
| 1 | 13 | 0.4643 | 18 | 0.6429 |
| 2 | 5 | 0.3333 | 5 | 0.5 |
| 3 | 3 | 0.3 | 0 | 0 |
| 4 | 5 | 0.7143 | 3 | 0.6 |
| 5 | 2 | 1 | 2 | 1 |
| Total | 28 | | 28 | |
| *Log-logistic test* | | | | |
| α | –0.87495 | | 1.386294 | |
| β | 0.439499 | | 5.51E–09 | |
| LRT statistic | 0.42775 | | 8.88E–16 | |
| p-value | 0.513095 | | 1 | |

Table 7 presents the results for duration dependence test for ASE monthly returns, we have 36 abnormal returns, 13 positive and 13 negative. The largest positive run length was five periods while the largest positive run length was six periods. The hazard rate shows a fluctuating hazard rate with the run length, sometimes it increases and some other times it decreases. The hazard rate was 53.9% for the positive run length of one period, and then decreased to 50%, and then increased to 66.7%. This unstable relationship along with positive beta for the log logistic regression is consistent with the evidence for the existence of rational speculative bubble in ASE weekly returns.

Tables 5, 6 and 7 present the duration dependence test for the second sample period for the daily, weekly, and monthly returns of ASE. The analysis for daily returns appear in Table 8, the level of hazard rate increase sometimes with the increase of run length, and decrease some other times, the coefficient of log logistic model was positive and significant at 1% confidence level, which support the absence of rational speculative bubble. With respect to the weekly and monthly returns, in Tables 9 and 10, the same results holds true, and the coefficients for log logistic regressions were negative and insignificant and positive and insignificant for the weekly and monthly returns, respectively.

## 5 Conclusions

This paper is trying to trace the probable bubbles in ASE market return on certain period of time that is most likely to include a probable bubble. The paper discriminates the total sample period into two subsamples, the first one from 2004 to mid of 2009, and the second one from mid of 2009 to mid of 2018, the reason for this time line is to contain probable speculative bubble and compare it with the current period post applying corporate governance regulation by Security Exchange Commission (SEC). The paper uses some well-known statistical techniques for this purpose. The first one was the descriptive statistics approach, and the second was the explosiveness test approach, and the third was duration dependence test approach.

Empirical results for the process of inspecting the existence of rational speculative bubble in ASE returns were consistent with each other. The descriptive statistics for ASE index show two probable bubbles within the first sample period, and the key statistical indicators for daily, weekly, and monthly returns show that there was positive skewness, positive kurtosis, non-normal returns, and serial correlation. Except for the skewness; the rest of key statistical indicator support the argument of the existence of rational speculative bubble in the first sample period, and on the daily, weekly, and monthly return bases. The same analysis was applied on the second sample period, and the results show the absence of rational speculative bubble in daily, weekly, and monthly returns. The second approach was the explosiveness test, and it show that on the first probable bubble within the first sample period represents a rational speculative bubble on the daily, weekly, and monthly bases, While the second probable bubble within the first sample period does not represent a rational speculative bubble. With respect to the second sample period, the second approach shows no evidence for the existence of rational speculative bubble. On the third approach, duration dependence test show evidence for the existence of rational speculative bubble in the first sample of ASE daily returns, but this evidence does not exist in weekly and monthly returns. Duration dependence test show no evidence for the existence of rational speculative bubble in the second sample period and for daily, weekly and monthly returns.

This paper, with the above mentioned results, will help decision makers in public sector, represented by the regulatory authorities to improve the regulatory environment for ASE, some speculative bubbles can result in financial crises, and can create a recessionary stage that will cost the economy a lot. The early intervention and timely imposed resolution techniques will save the economy from unwanted consequences.

The correct evaluation for stock market indices will help different investors and fund managers to act properly based on their own attitudes, good assessment for the existence of speculative bubble will represent a guidance for those investors to adjust their positions before it is too late.

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