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Evaluation of Multiple Bubbles in the Stock Market of Tehran

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Abstract:
Inability to identify asset price bubbles and their types (single and multiple) causes adverse effects on economy. New economic instruments make, not only the analysis of mild explosive behavior but also the determination of origination and termination of bubbles possible, of bubbles possible. The present study aims to detect price bubbles of Tehran stock exchange and OTC, and determine date of origination, burst, and complete deletion of bubbles in the period of 2010.03 to 2016.03. To this end, the study uses total index, industry index, index of 50 firms and total OTC index. The results show that the stock market and OTC have experienced 2 and 5 bubble periods, respectively. The results also show that stock and OTC markets were bubbling in 59% and 57% of sample period, respectively. Therefore, these markets have had bubbles in more than half of the study period indicating the great instability in the stock prices.

JEL classification**:** C22, G10

Keywords: *Explosive Bubble, Dicky Fuller, Rolling Window, Stock, OTC*

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1. Introduction

Undesirable phenomena such as uncertainty in the financial market (due to the bankruptcy of large financial institutions), fear of depositors, bank run, and credit crunch all stem from factors such as bubbles in financial markets. Price bubble stems from deviation of price from the basic price[4]. However, increasing asset price is not always the reason for bubble; there are several reasons for this phenomenon. The first reason is that an increase in the risk leads to changes in the basic price of a guaranteed asset within the limits of rational expectations (Bansal and Yaron, 2004). The other reason is factors that may cause permanent deviation from equilibrium path. Fama (2013) states that the great movements of asset price can be explained by Premium[5] risk of variable time; while Shiller (2000) believes that psychological effects that are often irrational (such as herd behaviour) cause changes in asset prices and creation of bubbles. In this context, there are various theories that investigate the formation of the bubble (Escobari & Jafarinejad, 2016; Balcilar *et al*., 2016;Chen *et al.*, 2016; Chang *et al.*, 2016; Narayan *et al.*, 2016; Miao *et al.*, 2014; Werner, 2014).

Now the question that comes to mind is what the remedy is. It is obvious that a healthy and dynamic economy needs a financial system that can transfer funds from the savers to the people who want to take advantage of investment opportunities. Achieving this healthy economy requires great remedial care and adoption of remedial care also requires a lot of studies. Hence, researchers are required to carry out this important task in order to provide appropriate economic arrangement[6]. Analysis on

[4] Price of the intrinsic value of the product is called basic price.

[5] Equity premium is a key concept in financial economics and means revenue derived from a particular asset.

[6] Despite researchers' attempt, arrangement of economic condition may be processed in a way that not only steps are not taken toward a healthy economy, but also there is a reverse process toward uncertainty, lack of transparency, crises and etc. Historical events such as the Wall Street Crash of 1929, the housing bubble in Japan in the 1980s, bubbles in Internet companies like Amazon bubble in the years 2000-2001, America's housing market bubble in 2006, the bank run on the "Northern Rock" bank

bubble detection helps better understanding of reasons and ways to overcome the financial crisis and reduce systemic risk[7] (Lee and Phillips, 2016).

However, domestic studies have not comprehensively investigated this issue and more importantly, different types of bubbles have not been classified so as to let us separately investigate the effect of each type on economic and financial system. Due to these shortcomings, this paper aims to investigate dating of a bubble in the market and determine its multiplicity and singularity in the period of 3/2010 to 3/2016. In fact, what distinguishes this study from previous studies is determining the date of origination and explosion of the bubble and investigation of multiple bubbles.

Then the paper is continued as follows: the second part is literature review, third part is the theoretical foundations, fourth part is the research method, fifth part is results, and at the end the paper is summarized and concluded.

2. Literature review

The reason for the recent international financial crisis is America's housing bubble burst. This highlights the fact that the failure to detect asset price bubbles causes devastating effects on the economy. In the real world, detection of future bubbles is very difficult (even detection of occurred bubbles is difficult). Financial theories suggest that if there is a bubble, the price should inherit its explosive properties (Caspi, 2014). This property makes an attempt to make statistical tests for the analysis of the bubble.

of Britain in 2007, bankruptcy of "Bear Sterns" Bank in 2008 and other crises can show moving in that direction.

[7] Variability in the returns of the securities that are directly associated with general changes in market or economy is called systematic risk (of market). Almost all securities such as stocks or bonds are subject to some degree of systemic risk because systematic risk directly involves the risk of interest rate fluctuations, market fluctuations, and inflation. This risk is unavoidable because it is not related to the performance of investors and diversification of stock (Foroughi and Dehaghi, 2010).

Numerous time series methods such as co-integration test (Diba and Grossman, 1988a and 1988b), restricted variance test (LeRoy and Porter, 1981; Shiller, 1981), specification test (West, 1988) and Chow and CUSUM tests (Homm and Breitung, 2012) are used to explore speculation in asset prices. The study of Diba and Grossman (1988) on the stock market of America has used modified stationary tests related to stock prices. The problem of their model was that the previous bubble is ignored if it is not more explosive than the next bubble. Evans (1991) questioned the ability of such models. He used simulation method and indicated that in the presence of bubble, unit root and co-integration tests cannot reject the hypothesis of the absence of bubbles. He proposed better diagnostic strategy as an "open problem". Finally, “Recursive window right-tailed ADF” test was first introduced by Phillips et al (2011) that was developed by Philips et al. (2016). In fact, bubble discovering strategies have been developed in studies of Phillips et al. (2011) and Phillips et al (2013); the first study is known as PWY and the latter is known as PSY. These strategies are based on generalized rolling and recursive Dicky Fuller unit root test and eventually lead to the discovery of the bubble and its occurrence time. These tests use changes in generalized right-tailed Dickey Fuller test, where the null hypothesis, the alternative hypothesis and unit root are mild explosive processes[8]. PWY and PSY studies showed that rolling and recursive tests are more able to detect bubbles compared with standard tests. Homm and Breitung (2012) used Monte Carlo simulation method to compare several time series tests to explore the bubbles and concluded that PWY strategy works fairly well. Phillips et al (2013) also used the Monte Carlo method and showed that in the presence of multiple bubbles, PSY strategy works better than PWY strategy.

A group of studies also used the above-mentioned strategies to explore bubble and its history. For example, Philips and Yu (2011) used SADF test to determine the date of the bubble in

[8] Note that traditional generalized Dickey Fuller test uses left-tailed changes, where the null hypothesis, the alternative hypothesis, and unit root tests are stationary.

housing markets, companies' securities and oil prices during the global financial crises. Lee and Phillips (2016) used SADF and GSADF tests for pricing assets according to the bubble.

In the present study, generalized Standard Dickey Fuller, rolling window Dickey Fuller, supremum[9] ADF, and generalized supremum ADF tests are applied to study the presence of speculation bubbles and their occurrence and collapse date in the total index, industry index, index of 50 firms, and total index of OTC. Escobari and Jafarinejad (2016) used the SADF and GSADF tests to detect the presence of single and multiple bubbles in four REIT (real estate investment trust) indices. Their results indicated the presence of speculative bubbles in REIT index and its three components (REIT of assets, mortgages and their combinations).

Balkilar et al (2016) assessed the existence and dating of bubbles in South Africa's stock market. This study used an experimental model of the formation of bubbles in asset prices and entered nonlinearity into the model using the entrance of multiple bubbles into the model. The results indicated the presence of multiple bubbles in the market.

Domestic studies done on the bubble can be Saeedi and Shabzendedar (2011), Abbasian et al. (2011), Fallah et al (2012), Salehabadi and Dalirian (2010) and Yahyazadeh et al (2009).

Saeedi and Shabzendedar (2011) used system dynamics approach to model the price bubble in Tehran Stock Exchange's auto industry. In this study, two factors affecting the incidence of bubbles were identified: 1) speed of change in people's perception of the share, and 2) mass purchases. They concluded that the faster the investors thought about changes in a share, the more price instability there will be. Also, mass purchases cause a particular psychological atmosphere because of their high inertia[10].

[9] Supremum is a mathematical term that means the smallest upper bound of any set.

[10] Inertia here means great impact of a factor on the investment environment, whereby investment in a particular stock increases dramatically.

Abbasian and Farzanegan (2011) investigated the presence of rational bubbles taking into account one of the arbitrage limitations, noise trader risk[11], and assumption of rational expectations at Tehran Stock Exchange. Their results showed that even with rational arbitragers, noise traders have had a significant impact on price deviation from fundamental factors.

Fallah et al (2012) examined and explored factors determining and predicting the formation of artificial price bubbles. They divided the selected companies into two groups of with bubbles and without bubbles through sequential test, kurtosis test, and duration dependence test. The next step was investigating the cumulative efficiency and turnover of companies that intentionally experienced share price bubble.

Salehabadi and Dalirian (2010) investigated the price bubble in Tehran stock exchange. They used stationary test of price to earnings ratio and approved the presence of bubbles in the stocks of 280 companies out of 324 companies.

Yahyazadeh et al (2009) studied the presence of rational price bubbles in Tehran Stock Exchange. They used three unit root, co-integration, and fractional integration tests and concluded that Tehran stock exchange has bubbles.

According to the surveys, it is indicated that domestic studies related to bubbles have either simply investigated the presence or absence of bubbles in a specific time period (in other words, studies have not attempted to determine the starting date of the bubble, the explosion, and the complete abolition time), or even if a limited number of studies have attempted to date the bubbles, they have ignored multiple bubbles. The difference between this study and previous studies is that in addition to the discovery of the bubble, it is trying to do so for exchange and OTC markets. In other words, innovation of this study is dating bubbles and determining their singularity and multiplicity because failure to

[11] Noise trader usually refers to irrational investors who have an irrational and incorrect idea of the revenues of risky assets' future market and react to noise information unrelated to future cash flows. Unlike arbitragers, noise traders follow a rule of thumb or trends and waves of emotion as a group.

detect multiple bubbles and assuming them to be single has consequences such as false detection of bubble, adoption of wrong policies for the market and so on.

3. Theoretical foundation

The equilibrium price of assets at time t (under the condition of no arbitrage[12] and the assumption of risk neutrality[13]) is equal to the discounted expected outcome at time t + 1.

$$P_t = \frac{1}{R_{t+1}} E_t (P_{t+1} + D_{t+1}), \quad (1)$$

In which, P_t is the actual price of stock at time t, D_{t+1} is dividends received for stock maintenance since t-1 to time t, R_{t+1} is the discount (gross) rate, and E_t represents the expectations at time t. By following the procedures introduced by Campbell and Shiller (1988) and Cochrane (2001), Log-linear approximation of equation (1) is obtained:

$$p_t = \kappa + \rho p_{t+1} + (1-\rho) d_{t+1} - r_{t+1} \quad (2)$$

In which, $p_t \equiv \log(P_t)$, $d_t \equiv \log(D_t)$, $r_t \equiv \log(R_t)$, $\rho = 1/\left[1+\exp(\overline{p-r})\right]$, and $\overline{p-r}$ that is log price-to-dividend ratio is:

$$\kappa = -\log \rho - (1-\rho)\log(\frac{1}{1-\rho}).$$

Equation (2) is a first-order difference equation that can be rewritten as follows:

$$p_t = p_t^f + b_t \quad (3)$$

In which,

$$p_t^f = \frac{k-\gamma}{1-\rho} + (1-\rho) \sum_{i=0}^{\infty} \rho^i E_t d_{t+1+i}$$

[12] Arbitrage pricing theory was first developed by Ross and it is a one-period model in which the investor believes in random properties of capital assets' income. Ross says that if equilibrium prices lead to the lack of arbitrage opportunities in asset portfolios, then the expected income of assets is approximately equal to the actual revenue (Huberman & Wang, 2005).

[13] Risk neutrality is a situation in which investors effectively eliminate risk through adopting certain investment decisions.

$$b_t = \lim_{i\to\infty} \rho^i E_t p_{t+1}$$

$$E_t(b_{t+1}) = \frac{1}{\rho} b_t = (1 + \exp(\overline{d-p}))$$

Solving equation (2) through forward iteration, expectations and log-linear approximation leads to equation (4):

$$p_t - d_t = \frac{\kappa}{1-\rho} + \sum_{i=0}^{\infty} \rho^i E_t(\Delta d_{t+1+i} - r_{t+1+i}) + \lim_{i\to\infty} \rho^i E_t(p_{t+i} - d_{t+i}), \quad (4)$$

The right side of the equation (4) can be decomposed into two components:

$$p_t - r_t = f_t + b_t \quad (5)$$

$$f_t = \frac{\kappa}{1-\rho} + \sum_{i=0}^{\infty} \rho^i E_t(\Delta d_{t+1+i} - r_{t+1+i}), \quad (6)$$

Equation (5) is the main component expressed in terms of growth rate of expected profit and expected revenues. In addition,

$$b_t = \lim_{i\to\infty} \rho^i E_t(p_{t+i} - d_{t+i}), \quad (7)$$

This is known as the component of rational bubble[14]. Rational bubble component is impossible[15] in transversality condition (i.e. $\lim_{i\to\infty} \rho^i E_t(p_{t+i}) = 0$) and the price is equal to the actual price. Existence of strictly positive bubble component (i.e. a condition in which the price exceeds the actual price) requires investors who think that in exchange for this additional payment, their expectations will be compensated through increased future expected prices. In other words, investors are willing to pay a premium, over- the- base price just because they believe that this

[14] It is a situation in which the stock price takes distance from fundamental values without calling investors' behaviour irrational. In rational bubble, although investors are aware of the fact that the stock price is higher than the fundamental value, they still remain in the market because they believe that the market bubble will probably grow.

[15] Transversality condition is optimization condition that is often accompanied by Euler equations to determine optimum paths of dynamic economic models. For more information see Kamihigashi (2006).

premium will increase in the next period. As the above behaviour is perfectly compatible with the hypothesis of rational expectations, it is called rational bubble (Caspi, 2014). Equation (7) is of Submartingale feature for b_t:

$$E_t(b_{t+1}) = \frac{1}{\rho} b_t = [1 + \exp(\bar{p} - \bar{d})] b_t , \quad (8)$$

In which, $[1 + \exp(\bar{p} - \bar{d})] > 0$. Therefore, when $b_t \neq 0$, the logarithmic component of bubble grows with a rate of g, in which $g = [1 + \exp(\bar{p} - \bar{d})] > 0$. The proposed model represents an important observation on random features of $p_t - d_t$, based on which an economic test can be designed to study the effect of rational bubble on asset price. To this end, it should be noted that random features of $p_t - d_t$ in equation 4 are determined through f_t and b_t. F_t dynamics are also determined through future expectations of Δd_t and r_t. If d_t and r_t are the maximum co-integration of the first order, explosive evidence of $p_t - d_t$ confirms the existence of bubble (i.e. $b_t = 0$).

Mild explosive behaviour occurs when the mechanism applied to the data has a root greater than the unit. It should be noted that in accordance with the process, it will have a random behaviour like unit root process (as opposed to explosive behaviour).

$$\kappa_n \frac{1-\rho_n^{I_n}}{1-\rho_n} \approx \kappa_n I_n \rho_n^{I_n - 1} = -I_n \rho_n^{I_n - 1} \log \rho_n - I_n \rho_n^{I_n - 1}$$

$$(1 - \rho_n) \log(\frac{1}{\rho_n} - 1) \to 0$$

In which, ρ_n is the discount factor; I_n is the investment horizon that depends on the duration of the period (n). Mild explosive process is useful in financial boom modelling and has been introduced by Philips and Magdalinos (2007). They proposed its different features and showed how they can be used to direct implications (Lee and Philips, 2016).

4. Methodology

Phillips, Wu and Yu (2011) developed a retrospective method that can determine the boom of asset price series during inflation periods. This method is efficient when the sample data has just one bubble, such as the Nasdaq Episode in the 1990s and housing price bubble of the USA in the 2000s. When the sample period is long enough, there will often be the possibility of multiple asset price bubbles in data (just as several financial crises[16] in successive historical experiences). However, economic detection of multiple bubbles with a collapse period is more difficult than determining a single bubble. The problem also arises from the fact that the structure of multiple bubbles is non-linear and complex. In fact, multiplicity leads to a decrease in the ability of defining existing mechanisms such as retrospective tests in PWY. This reduction in power makes the attempt to date bubbles complicated and increases the need for a new method (that lacks this problem). In this regard, Phillips et al (2013) developed a new framework to solve the problem that is used for multiple bubbles in data.

The framework used in this study also follows the above-mentioned structure. It should be stated that the method used in PWY is a Sup ADF test (SADF) and is based on the sequence of recursive right-tailed unit root ADF test. This method is able to determine the starting date, duration and date the bubble bursts[17]. There are other tests such as Chow test (model selection) and cumulative SUM test for dating. Homm and Breitung (2012) showed that PWY model, unlike other iterative methods, works well for structural failure and is especially considered as an efficient algorithm for discovering bubbles.

When the sample period includes multiple events of boom and collapse, SADF test is not of enough power to identify bubbles and cause compatibility. To fix the problem and work with multiple boom and collapse failures, generalized Sup ADF

[16] Ahamed (2009) reported 60 different types of financial crises up until17th century.

[17] It is known that when there is a bubble in data, dating strategy is possible (Philips and Yu, 2011).

(GSADF) test is used. GSADF test is based on right-tailed retrospective ADF tests, but it has great flexibility in using windows on the run. In other words, instead of considering starting point of retrospection fixed on the first observation, the sample is expanded by changing start and end points of retrospection around the possible period of flexible windows.
The process of random step under PSY method is as follows:

$$y_t = dT^{-\eta} + \theta y_{t-1} + e_t, \quad e_t \sim N(0, \sigma^2), \theta = 1 \tag{9}$$

In which, d is the constant value, η is a coefficient that controls the thrust amount and is error term when the sample size of (T) approaches infinity. Equation (8) is the generalized form of the following standard equation:

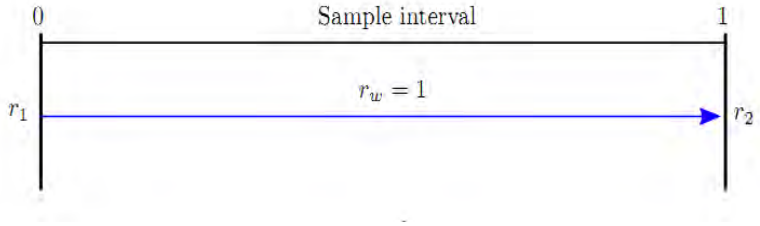
$$y_t = \mu + \delta y_{t-1} + \sum_{i=1}^{p} \phi_i y_{t-i} + \varepsilon_t \tag{10}$$

In which y_t is the variable under study, μ is the intercept, and p is the maximum number of intervals. Bubble test is based on the fluctuations in right-tail of standard ADF test in which the null hypothesis is based on unit root and the alternative hypothesis is based on mild autoregressive coefficient. Now, it is necessary to state the signs used in RTADF test. The sample range is normalized at [0, 1] to simplify interpretations. The sign δ_{r_1,r_2} is representative of approximation coefficient in the normalized sample of $[r_1,r_2]$ related to equation (9) that shows the peer-to-peer ADF statistics with ADF_{r_1,r_2}. The size of the window in the regression is shown with r_w that is defined as $r_w = r_2 - r_1$. The initial size of window is shown with r_0 (Caspi, 2014).

The difference of RTADF tests is related to the way of replacing r_1 and r_2. Accordingly, standard ADF unit root test, rolling ADF, SADF, and GSADF test are studied below.

In the standard ADF unit root test, r_1 and r_2 are fixed and are the first and last observations of sample, respectively; accordingly, $r_w = r_0 = 1$. This has been shown in figure (1).

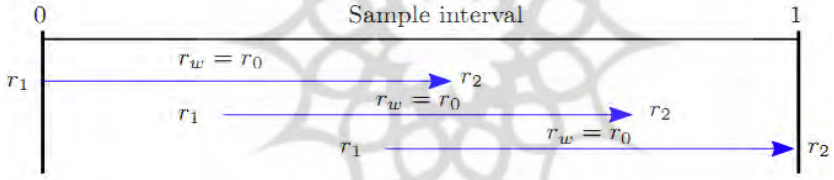
Figure 1: the process of ADF



Resource: Caspi, 2014

However, the structure of rolling window Dicky Fuller is different. Its structure is based on a rolling level of standard ADF with a window of fixed length and $r_w = r_0$. At each stage of the estimation of this method, the start and end points (r_1 and r_2) increase with the length of the window (see figure 2). As explained before, at each stage of estimation, standard ADF statistics of each window is calculated and is signed as ADF_{r_1,r_2} with the start and end points of each window. Rolling window Dickey Fuller statistics (RADF) is the supremum among all ADF_{r_1,r_2} statistics related to each window.

Figure 2: the process of rolling ADF



Resource: Caspi, 2014

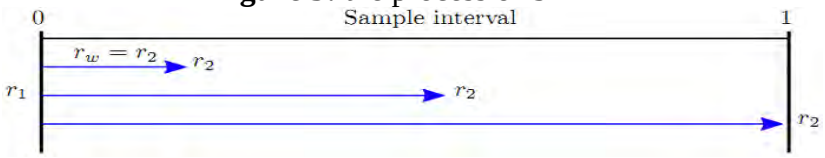
SADF test is based on the calculation of ADF statistics such that the starting point is fixed in all windows, but the length of the window increases at each stage[18] (Figure 3). In this process, the first observation is the start point of the estimation window; i.e. $r_1 = 0$. In this case, the length of the window at each stage is equal to $r_W = r_2 - r_1 = r_2$. At each stage of estimation, the length of the

[18] Supremum Augmented Dicky Fuller

window increases at a specific rate, but the start point is constant. Accordingly, ADF statistics related to each estimation is calculated and shown as ADF_{r2}. Finally, among all the ADF_{r2} statistics related to each window, SADF statistics is the supremum or in other words:

$$SADF(r_0) = \sup_{r_2 \in [r_0, 1]} \{ADF_{r_2}\} \quad (11)$$

Figure 3: the process of SADF

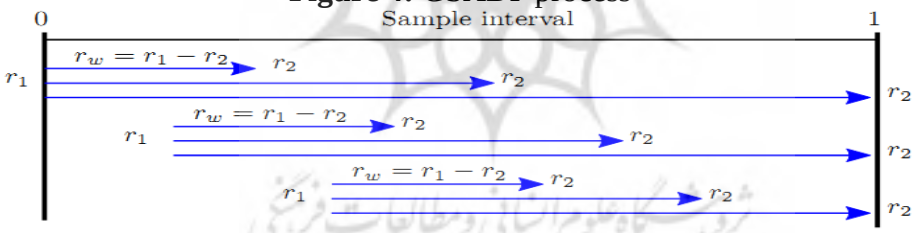


Source: Caspi, 2014

GSADF strategy is based on the generalization of SADF test. This test is also based on the calculation of ADF statistics, but the start point can be both fixed and variable (figure 4). GSADF statistics is the supremum among all ADF_{r2} statistics related to each window or in other words:

$$GSADF(r_0) = \sup_{\substack{r_2 \in [r_0, 1] \\ r_1 \in [0, r_2 - r_1]}} \left\{ ADF_{r_1}^{r_2} \right\} \quad (12)$$

Figure 4: GSADF process



Resource: Caspi, 2014

5. Data and findings

This study has used four indices[19] to analyse the bubble. The four indices are: total index, industry index, 50-firms index and OTC index. The above data include the period from 3/2010 to 3/2016 that are extracted daily from Tehran Stock Exchange website and then averaged to be changed into monthly data. Now, the indices are introduced[20].

The total price index: Tehran Stock Exchange has calculated and published price index under the name of TEPIX since April 1990. The index represents price changes in the market.

The industry Index: In a general breakdown, companies listed in Tehran Stock Exchange are divided into two industry and financial groups. The industry group includes all stock companies except financial intermediaries. Tehran Stock Exchange calculates index of price for the two groups that are calculated and published as financial index and industry index[21].

The index of 50 active firms: This index reflects the general level of prices of 50 firms active in Tehran Stock Exchange that is calculated by two different methods. In the first method, simple average method is used and the second method[22] is the same as calculating TEPIX that leads to the calculation of the index of 50 active firms- weighted average[23].

OTC index: total OTC index (price and cash return) includes all companies listed in the first and second markets of this company[24].

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[19] In the process of discovery and dating of a bubble, indices play a key role. To explore a bubble in the market, indices in that market are used. So the discovery and dating of bubbles in a market is in fact the discovery and dating of bubbles of market indices.

[20] http://www.tse.ir/cms/Default.aspx?tabid=222

[21] http://tse.ir/cms/Default.aspx?tabid=192

[22] What is of great importance in the selected of 50 firms is the number of trade days. Tehran Stock Exchange considers liquidity or firms' activities as the main criterion for selecting 50 firms and that is why this index is called 50 active firms index.

[23] http://tse.ir/cms/Default.aspx?tabid=192

[24] http://tse.ir/cms/Default.aspx?tabid=192

5.1. The discovery of bubble in Tehran stock market and OTC of Iran

In domestic studies, several tests such as sequential, skewness, kurtosis, co-integration and fractional integration are usually used to evaluate the bubble in the stock market. The sequential test shows random process of variables. If the sequences are not random and do not follow a specific pattern, it is indicating growth and fall of prices and there is the possibility of a bubble. In the skewness test, if skewness is negative, there is the risk of price bubble because after the growth of prices, its reduction will be more than its increase due to the psychological atmosphere that is created. Therefore, if a share is left-tailed and is not normal, there is the possibility of bubble and if the skewness is less than normal, variance distribution would be more and this factor along with skewness shows the occurrence of bubbles (Shourvarzi et al., 2012; Fallah et al., 2012, Ebrahimi et al., 2012). Co-integration method tests long-run relationship between stock prices and cash returns on shares. In this context, presence and establishment of long-term relationship between the stock price and cash returns means there is no bubble in the market. In addition, lack of the relationship between the stock price and cash returns means there is a bubble in the market (Abbasi et al., 2010).

However, these tests are not able to determine the date of the occurrence of bubbles. The tests can only check the presence or absence of bubbles. Tests based on right-tailed augmented Dicky Fuller (RTADF) should be used to determine the date of the bubbles. In the first step, this study uses four tests based on Dickey Fuller including generalized standard Dickey Fuller, rolling window Dickey Fuller, supremum Dickey Fuller (Phillips, Wu and Yu, 2011), and generalized supremum Dickey Fuller (Phillips, Shi and Yu, 2013) to discover the bubbles. Rejection of the null hypothesis in each of these tests is the evidence of the existence of a bubble in assets' prices. Then in the second stage, the starting date of the bubble will be determined using the SADF and GSADF tests. In this respect, the results of the discovery of bubble have been shown in Table 1 below.

In Table 1, the bubble discovery tests are based on the volatility of right-tailed standard test in which the null hypothesis is based on the unit root and the alternative hypothesis is based on the existence of bubbles[25]. If the ADF statistics is ignored for OTC index[26], in general, results in four indices represent the rejection of unit root hypothesis. In other words, the results do not reject the presence of bubble for the period from 3/2010 to 3/2016 in the stock market. With the discovery of bubble in the stock market, start date of bubble can be identified using SADF and GSADF tests.

Table 1: Bubble Discovery Tests

Statistics / Index	ADF	RADF	SADF	GSADF
Total	.02 (.04)	4.40 (.00)	8.00 (.00)	8.00 (.00)
Industry	.04 (.04)	3.93 (.00)	8.27 (.00)	8.27 (.00)
50-firm	.33 (.02)	7.66 (.00)	11.33 (.00)	11.33 (.00)
OTC	-.62 (.15)	2.82 (.00)	5.02 (.00)	5.02 (.00)

Source: findings of research

5.2. Date of the occurrence of bubbles

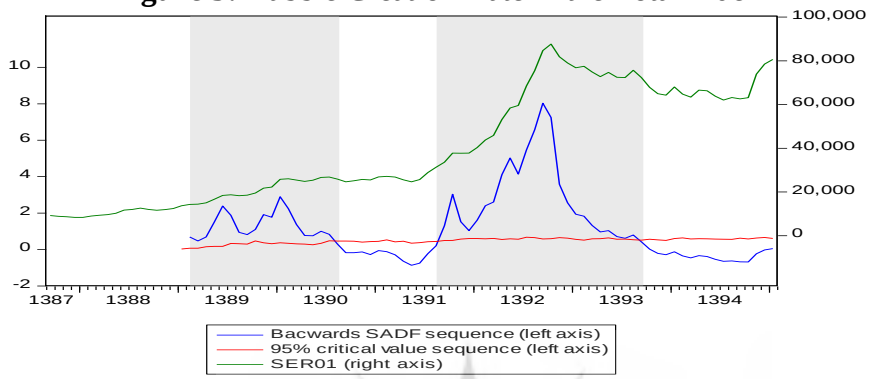
After the formation of bubbles, the process continues to grow so that it finally reaches its peak and bursts. After the bubble bursts, it does not die suddenly, but begins to adjust itself. This adjustment may lead to the complete collapse of the bubble (which is then called single bubble) or otherwise, another bubble may form before the complete collapse of the bubble (Phillips and Lee, 2016; Escobari & Jafarinejad, 2016; Balcilar *et al*., 2016). This bubble may be even larger than the previous one (in this case the period is called multiple bubble period). This section determines time of bubble creation, burst, and complete collapse based on the proposed methodologies. It should be noted that in a

[25] Tests are carried out using a software installed on Eviews 9.

[26] Note that this index is less able to detect bubbles compared with other statistics used.

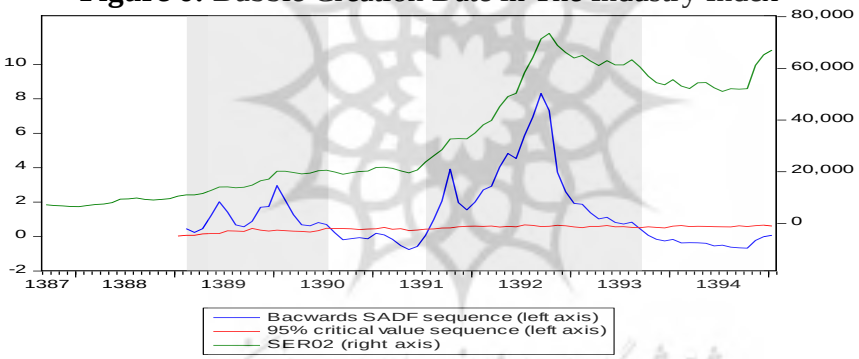
period of multiple bubbles, the bubble burst corresponds to the largest bubble among the bubbles of that period. The results showed that the SADF and GSADF tests fully acknowledge each other, so that dates of the formation and collapse of bubbles will correspond exactly. In this context, figures related to GSADF test are presented because of the allegorical figures of SADF and GSADF.

Figure 5: Bubble Creation Date in the Total Index



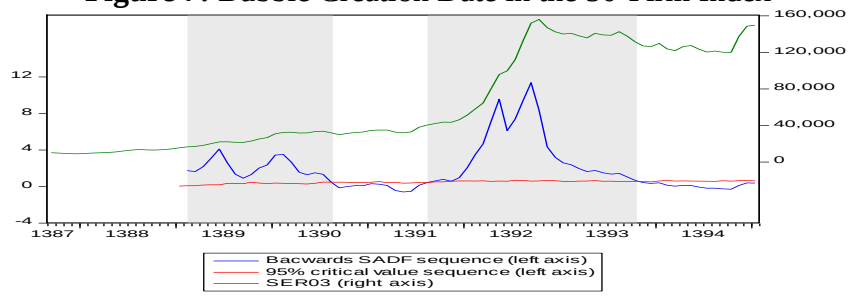
Resource: research findings

Figure 6: Bubble Creation Date in The Industry Index



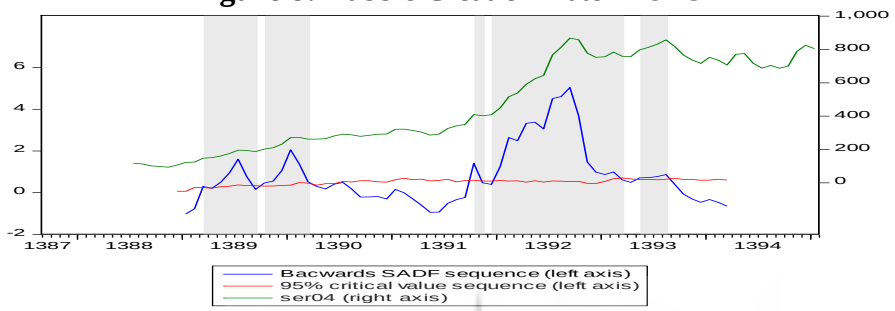
Resource: research findings

Figure 7: Bubble Creation Date in the 50-Firm Index



Resource: research findings

Figure 8: Bubble Creation Date in **OTC**



Resource: research findings

Table 2: Bubble Dating In Stock and OTC Markets Based On Different Indices

Index		Type of the bubble	Start time	Burst time	Complete collapse time
Total index	First bubble period	Multiple	There already	2011.03	2011.10
	Second bubble period	Multiple	2012.10	2013.11	2014.11
Industry index	First bubble period	Multiple	There already	2011.03	2011.09
	Second bubble period	Multiple	2012.09	2013.11	2014.11
50-firms index	First bubble period	Multiple	There already	2010.08	2011.10
	Second bubble period	Multiple	2012.10	2013.11	2014.12
OTC index	First bubble period	Single	2010.05	2010.09	2010.11
	Second bubble period	Single	2010.12	2011.03	2011.05
	Third bubble period	Single	2012.12	2012.12	2013.01
	Fourth bubble period	Multiple	2013.02	2013.11	2014.05
	Fifth bubble period	Single	2014.07	2014.10	2014.10

Resource: research findings

The most important results are given below. It should be noted that the results are valid for the period of 2010.03 to 2016.03.

• Stock market has experienced two bubble periods. The first bubble is approximately 19 months and the second bubble almost lasted 26 months.

• Stock market has experienced a period without bubbles from 2011.09 to 2012.10 (approximately 14 months) and from 2014.11 to 2016.03 (approximately 17 months).

• Bubble periods of stock are multiple bubbles.

• The stock market has experienced bubbles in the 59 percent of the study period and has been bubble-free in 41 percent of the study period.

• OTC market has 5 bubble periods, one of which is multiple bubbles and the other four are single -bubble periods.

• The longest bubble-free period is from 2011.06 to 2012.11 in the OTC market, which is approximately 18 months.

• OTC market has experienced bubble in 57% of the study period and has been bubble-free in 43 percent of study period.

Capital market experts have different opinions on 85 percent growth increase of Tehran Stock Exchange in 2010[27]. Some believe that increasing global prices of products, profitability and suitable prospects of companies are the main factors of growth index increase. Others believe that stagnation in alternative markets and the flow of liquidity of saving holders toward stock has led to the creation of bubble in stock prices. The results of this study indicate that there are two bubbles in the OTC market and one bubble in the stock exchange in this period, which can be derived from the second factor. In describing the first bubble in the stock (and first and second bubbles in OTC) it suffices to say that from the beginning of 2010 coincided with an increase in global prices of raw materials and partial withdrawal of European and American countries from the global financial crises, the index added to the pace of its ascending trend. In this year, all Tehran stock indexes such as the value of transactions, trade

[27] http://www.isna.ir/news

volume, stock index, turnover, the number of transactions, the rate of return on investment, and stock value have consecutively registered new records that were historically unprecedented in the stock market. In fact, the growth of Tehran Stock Exchange index in 2011 was limited to 11%, while the index faced an 85% growth in 2010.

As was mentioned in the second factor of the growth in the stock index in 2010, the existence of alternative markets significantly affects the growth and fall of stock market prices. It means that with the start of boom period in markets such as gold and currency markets, attraction of stock market reduces. Also, the more the boom, the more investors will be attracted. Since the change in the currency and gold markets' price coincided with the lack of growth in the stock market of 2011, it can be considered the main factor for the lack of growth of this market[28].

The bubble which occurred in 2012 can be considered as a kind of contagious crisis. Contagious crises refer to a condition based on which the crisis goes from one financial institution to another. In fact, currency crisis of 2012 may be the origination of the second bubble in stock market and third and fourth bubbles in OTC. It can be said that currency shock is the origin of the contagious crisis created, such that currency shock causes an increase in the inflation rate[29]. Increasing inflation rate also leads to increasing the prices of consumer goods and raw material of companies and as a result, the cost shock of companies would increase. Cost shocks were the start of gradual fall and finally, creation of significant sale lines and increase of fear in the market as well as the influx of previous buyers for immediate withdrawal from the market. The presidential election of 2013 could have contributed to the explosion of the bubble because the time of the second bubble burst of the stock market and forth bubble burst of the OTC was roughly coinciding with the relocation of the government.

[28] http://didban.ir/fa/news-details/5104/

[29] It does so by surplus entrance of currency and changing it to domestic money and supplying the money in the monetary system of the country.

However, since the root of the bubble is a social, psychological, and anthropological process rather than an economic one (Samadi et al., 2009), caution should be observed in the above analyses.

6. Summary and conclusion

The financial crisis refers to a situation in which a significant percentage of the value of some assets is unexpectedly lost. There are different types of crises (a banking crisis, a currency crisis, recession and economic downturn and the crisis of the speculative bubble (Mishkin, 2013) and bubble crisis is one of them. In fact, if most traders have an incentive to purchase a specific asset so as to sell it when it becomes more expensive and do not focus on the income of that asset over time, bubbles will be formed on that asset. However, in this case, there is always the risk of falling prices and as soon as a large number of dealers decide to sell, this fall occurs (Wall Street Crash of 1929 and the housing bubble in Japan (Mishkin, 2013)).

Discovery and dating of bubble is very difficult; but financial theories have provided statistical tests to analyze the bubbles with regard to the explosive property of prices. Various tests such as sequential test, skewness, kurtosis, co-integration, fractional integration, and unit root tests have been provided, but these tests are not able to determine the date of bubbles occurrence. These tests can only check the presence or absence of the bubble and are unable to determine the occurrence and burst time of the bubble. For example, studies such as Saeedi and Shabzendedar (2011), Abbasian et al. (2011), Fallah et al (2012), Salehabadi and Dalirian (2010) and Yahyazadeh et al (2009) confirmed the presence of bubbles in financial markets, but the problem of these studies is just confirming the existence of the bubble and not determining the date of bubble occurrence. In this regard, recent studies have proposed new methods for this problem and have used tests based on "generalized right-tailed Dicky Fuller (RTADF)". Among these studies is the study of Biabani Khamaneh et al. (2016). Based on this study, the period from 2008.12 to 2014.08 is a bubble period. But despite the detection

of bubbles, their decomposition into singularity and multiplicity has not been carried out.

This study has used standard generalized Dickey Fuller, rolling window Dickey Fuller, Supremum Dicky Fuller, and Supremum generalized Dickey Fuller tests to detect bubbles. In the next stage, date of the bubble occurrence has been identified using the SADF and GSADF tests. The results confirm the presence of two bubbles in the stock and five bubbles in OTC. Stock market has experienced two bubble periods. The first bubble is approximately 19 months and the second bubble almost lasted 26 months. OTC market has 5 bubble periods, one of which is multiple bubble and the other four periods are single bubble. The roots of the above bubbles can be searched in the recession of alternative markets, global market booms, and contagious crises.

One of the causes of the bubble in this year is the recession of alternative markets. Over a 2-year period from the beginning of 2009 up to the end of 2010, housing yield was an average of -1.2 percent, an average of 22.4 percent in the gold market, 3.9 percent in the foreign exchange market, and bank's profit was 14.2 percent, while stock yield was an average of 77 percent. Finally, by examining the causes of the currency crisis in 2012 and the subsequent creation of bubbles in the stock and OTC, it was found that it has a pattern similar to contagious crises. In fact, the currency crisis of 2012 was the source of the second bubble in the stock market and the third and fourth bubbles in the OTC market.

To prevent the creation of bubbles and mitigate their negative consequences on economy, the following can be cited as a policy recommendation:

• The method used in this study can be applied to detect the occurrence of bubbles at the time of the occurrence and date it; therefore, it is advisable to check the bubble of the market and inform the public market participants so as to create transparency of information and avoid the consequences of the bubble.

At the end, the following points are recommended for future studies in this field:

• This study attempted to date bubbles. Based on the method of Lee and Philips (2016), market puzzles (like stock market volatility and equity premium puzzles) can be answered according to bubble dating. It is suggested that future studies investigate major stock market puzzles considering bubble risk factor.

• It is suggested to study causal relationship between stock market bubbles and bubbles of other markets such as gold, coin, and currency markets.

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