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Price Bubbles Spillover among Asset Markets: Evidence from Iran[1]

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Abstract

This paper investigates the existence of possible spillover effects among four main asset markets namely foreign exchange, stock, gold, and housing markets in Iran from 2002:03 to 2015:06. For this purpose, we have exploited Sigma-Point Kalman Filter (SPKF) to extract the bubble component of assets prices in the aforementioned Markets. Then, in order to analyze the price bubbles spillover amongst asset markets, we have taken several measures. First, we performed a pairwise Granger test. Afterwards, for the sake of studying the shock effects of the bubbles, a multivariate time series model in the form of a vector autoregressive (VAR) system has been implemented. Based on the results of Pairwise Granger Causality test, the assets bubbles have a causality relation amongst each other. Furthermore, the outcomes of impulse response function and variance decomposition analysis derived from the estimation of VAR model implies on the existence of bubbles spillover among asset markets.

Keywords: Bubbles Spillover, Asset Markets, Sigma-Point Kalman Filter, VAR.

JEL Classification: C32, E44, G12.

1. Introduction

In the last decades, the asset markets have been a major topic of discussion due to the subsequent Ups and Downs (fluctuations) in assets prices. In this regard, considerable researches have been

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performed about relationship among actual prices across various asset markets. For instance, Bahmani-Oskooee & Sohrabian (1992) found bidirectional causality between exchange rate and stock price in UK. Alexander & Barrow (1994) and Slade (2006) suggested that pairs of regional housing markets have a Granger causality relationship. Smith (2001) found evidence of unidirectional Granger causality from US stock market to the gold market. Alagidede et al. (2011) have investigated the nature of the causal linkage between stock markets and foreign exchange markets in Australia, Canada, Japan, Switzerland and UK. Riddel (2011) find out that Los Angeles housing prices, as an urban core, do have a causal link with the housing prices in Las Vegas, which he called a peripheral market. Costello et al. (2011) employed a vector error correction model (VECM) to test whether the housing prices of states can be contagious among each other. Shahzadi & Chohan (2012) examined the impact of gold prices on Karachi Stock Market index and found a negative correlation between the two prices. Zubair (2013) used Johansen’s co-integration and Granger-causality to test the relationship between stock market index, exchange rate and M_2 before and during the era of global financial crisis in Nigeria. Srinivasan & Karthigai (2014) by applying ARDL model and Granger causality test indicated that gold and stock prices in India tend to long-run relationship with foreign exchange rate. Arouri et al. (2015) using VAR-GARCH model investigated the effect of gold price volatility on the stock market returns in China. Their results demonstrated evidence of significant impact of gold price volatility on China’s stock market return. Sui & Sun (2016) explored the dynamic relationships across stock returns and exchange rates in U.S and BRICS. They found significant spillover effects from exchange rates to stock prices in the short-run, but not vice versa.

However, some of the evidences suggest that high relationship between assets prices might be due to factors that can't be explained exclusively through the fundamental factors. There are widespread evidences that the assets price bubbles happen through time. At this point, question that may come to mind is that whether bubbles have the potential to spillover from one market to another? This mentality separates the current paper from earlier studies, since they have tried to explore the relationship between markets, in a situation that presume those markets to be restricted to actual prices. While, on many occasions in the respective literature, Bubbles has been considered as a probable key element for explaining the asset price movements.

Understanding the patterns of speculative transmission in the markets, in order to implement certain monetary policies which are aimed at preventing another bubble spillover, should be an important object for policymakers. In addition, there is a considerable possibility that such bubbles may lead to deviations such as financial crises and instability in economy (Roubini, 2006).

In this study, an empirical examination on the effects of price bubbles spillover among some asset markets has been implemented. To this end, we have extended the domain of respective tests to include bubbles in the exchange rate, stock price index, gold price and housing price index in Iran from 2002:03 to 2015:06. Then, we explore the reciprocal effects of bubbles among those markets. In other words, we investigate the contagiousness of assets price bubbles. For this purpose, we begin by extracting the bubble components of assets prices using Sigma-Point Kalman Filter. Then we perform two complementary processes to obtain not only the casual relationship amid bubbles in different markets, but also the effects of their variations on each other. Therefore, we have exploited a Granger causality test – to investigate the casual relations- and have developed a multivariate bubble spillover model by applying a reduced form VAR system– to study the interactional effect amongst the market bubbles, through derived IRF and VD analysis from the respective VAR model- to gather our conclusions.

The structure of this paper is as follows. Section 2 presents a literature review on relationship of prices and then bubbles. Section 3 describes the applied methodology in this study. In Section 4, we provide our empirical results and eventually, in Section 5, we summarize and draw conclusions.

2. Literature Review

In this section, we first explore theoretical relationship among assets price and then express reasons that indicate the assets price bubbles can spillover amid markets.

Perhaps the simplest way of the effectiveness of a change in an asset price on the other assets is to rely on the portfolio approach. Base on the portfolio models, the individuals allocate their wealth among alternative assets. Therefore, any change in the demand and supply of an asset can change the prices of the other assets. For instance, consider an increase in domestic stock prices. This will result in an increase in domestic wealth. According to portfolio approach, the increased wealth will result in an increase in demand for money and other assets. Actually, an increase in domestic stock prices may result in an increase in speculative demand on assets (Bahmani-Oskooee & Sohrabian, 1992).

The change in exchange rate can either raise or lower a firm's stock prices depending on whether that firm is an exporter or importer (Aggarwal, 1981). The domestic exporting firms face trade volatilities which derive the exchange rate changes (Arezki et al., 2012). A change in exchange rate will change the value of that domestic firm's revenues and costs directly or indirectly which will be affected firm’s profit or loss. After the announcement of a profit or the loss, that firm’s stock prices will change (Fama, 1981). On the other hand, if the firm be the user of the imported inputs, the change in exchange rate will change its costs and profits and as a result firm’s stock price. If the firm involved in the export and import, its stock prices can move in either direction (Aggarwal, 1981).

Furthermore, the change of exchange rate has a major role in gold and housing prices instability. Generally, for assets that are traded continuously, the change in exchange rate results in adjustment in the prices of assets. For instance, when the dollar appreciates against the Rial, dollar prices of assets tend to fall and Rial prices rise (Sjaastad, 2008). Since the abolition of the Bretton Woods system, floating exchange rates have been a main source of prices instability in the gold market (Sjaastad & Scacciavillani, 1996).

Also, we can consider assets as substitute for each other. Thus, there can be a negative relationship between them. For example, the gold is one of the major substitutes that investors and ordinary people hold in their portfolios. So, any changes in the gold prices effect on investors decision for holding various assets in their portfolio. Therefore, increase in the gold prices motivates the people to sell other assets and buy the gold for gaining more profits. Just as the gold, housing is a major substitute asset for others. So, when home prices increase, for gaining more revenue, investors prefers to carry their savings to housing sector, thus investment in this section arises (Hasanzadeh & Kianvand, 2012).

In general, high interest rates in assets market lead to attract capital and growth of bubbles (Bahmani-Oskooee & Sohrabian, 1992). The price bubbles usually have common features. On one hand, sufficient amount of credit expansion alongside with continuous raise in demand and asset prices, causes an inflation in price bubbles. On the other hand, the bubbles burst and result in collapse of asset price, due to abundant sales. In the last decades, many financial crises have followed by an enlargement of price bubbles in assets[1] (Gomez-Gonzalez et al., 2013). Although a vast amount of studies has targeted the issues raised upon the rise of bubbles in a single market and its effect on economy as a whole, however, there has been little attention toward this phenomenon in markets and bubble spillover from one market to another.

On the theoretical aspect, the possibility of price bubbles spillover from one asset market to another can be demonstrated throw various channels. For instance, Bikhchandani et al. (1992) affirmed that the spillover of Speculative bubbles can occur due to the Harding effects. Whenever we have uncertainty and asymmetric information in a market, individuals probably get influenced by the others decision making processes; this happens due to the fact that these individuals own a particular mentality that force them to believe that the rest of the agents in market are better informed than them and therefore moving along with this group shall be more secure. Hence, any new information makes rational investors more reliant on the other agents' judgements and eventually more group dependent.

Moreover, the media coverages with regard to assets price interactions, may have caused those investors who are already own bubbly assets to go in search of assets that are not overestimate value. For instance, that is a possibility that house owners have invested in these unstable assets, due to the fact that media reports have led them to believe that house prices would continue their uprising path. In this

1. For example, Japan in the late 1980s and early 1990s, several Latin American economies in the 1980s, South East Asian Economies in the late 1990s, Russia in the late 1990s, and an important group of industrialized economies in the recent international financial crisis.

case, demand and afterwards the prices for real estates shall grow and might cause an exceed in fundamental values, which in turn, could lead to speculative attempts to purchase in housing market. Therefore, the speculative bubbles in housing market have the potential to affect speculative bubbles in the other markets (Pollakowski & Ray, 1997).

Brounen & Eichholtz (2003) have addressed that during the period of tech-bubble in the stock market, real estate prices were depressed as investors preferred to buy the bubbly assets. However, when the bubble reached to its end, investors in an attempt to avoid the risk, switched to indirect real estate. Therefore, the price bubble in stock market grew, then collapsed and afterwards combined with asset rotation caused the reverse effects in real estate prices.

Nneji et al. (2013) found that there is interrelation trajectory between stock market bubble and real estate market bubble. They have indicated that when the stock market is booming and there is a growing positive speculative bubble, investors become less interested in the performance of the housing market, and therefore they might reduce their real estate holdings to fund investment in the stock market. On the other hand, whenever there is a growing bubble in the stock market, the aggregate wealth of investors rises. As a result, these investors might choose to diversify their portfolios through buying buildings, which in turn, leads to an upward demand for real estate; subsequently this will result in an inception of a speculative bubble in the property market.

Hatipoglu & Uyar (2012) based on the existence of various assets in investors' portfolios, pointed at positive and negative transitional effects of sentiments among different markets through portfolio chains channels. Accordingly, Bubbles might get established and eventually collapse on more than one market or in another way and any bubble emanating from one market might spillover to another either simultaneously or with a time lag.

It can be easily concluded, that if for whatever reason the prices have risen in an asset market, there is a considerable possibility that it leads to creating an attractive situation for investors and then entry of new capitals and creation of bubbles in that market. As a result, the sentimental transfer of capitals from other parallel markets to this market causes a depreciation of asset prices in other markets, which will end up to the collapse of price bubbles. On the other hand, if for any reason, an asset price bubble bursts, it will result to an inflow of capital to other parallel markets. Therefore, the price of other assets has increased. In the next stage, this will add to the attractiveness and desirability of these markets, and then will cause a sharp rising in demand and prices and at the end forms speculative bubbles. Thus, the bursting of the bubble in one of the markets eventually will arrive to the formation of bubbles in other markets and vice versa.

A number of studies have concentrated on the empirical aspect of prices bubble's behavior and its spillover effects. Hatipoglu & Uyar (2012) applied directionality tests for the bubbles that have been formed in USA and Turkey. They found out that bubbles which were generated in USA shall lead to the creation of bubbles in Turkey, but bubbles originating in Turkey does not cause bubbles in USA. Nneji et al. (2013) developed a multivariate bubble model to evaluate whether the stock and real estate bubbles spillover into Real Estate Investment Trusts (REITs). Nneji et al. (2015) examined bubbles spillover between neighboring and more distant regions and discovered that the transmission of bubbles between regions is multidirectional and has no dependency on contiguity or distance. Shih et al. (2014) addressed two major questions: whether there are housing price bubbles in the provinces of china and whether the bubbles are spatially contagious. They found that most of the provinces have bubbles and affordability problems. Also, housing prices in provinces that were in the same potentially region was co-integrated together.

Results from previous studies show that there is no certain evidence regarding a global rule about the size of the impact of price bubbles spillovers or even the sign of their effects. Therefore, it is better to deal with empirical tests for price bubbles spillover and to concentrate our efforts to make them more conservative.

3. Data and Methodology

3.1 Data

In this study, we use monthly data in the period of 2002:03 to 2015:06 for foreign exchange, stock, gold and housing markets in Iran. The stock market data were obtained from Tehran Stock Exchange webpage and the exchange and gold markets data were gathered from Central Bank of

Iran. Also, the housing market data are taken from the Statistical Center of Iran. After collecting these data, we extract the bubble components of the assets prices using sigma- point kalman filter (SPKF).

3.2 Methodology

According to Wu (1997), the price of an asset (P_t^a) could be expressed by present value of its expected price in the next period plus the expected income obtained from holding that asset. So, this equation can be written as:

$$e^{-r_t} = \frac{E_t[P_{t+1}^a + D_t]}{P_t^a} \tag{1}$$

Where r_t is the discount rate and E_t is the conditional expectation operator on information at time t. Also D_t shows the income derived from asset at time t, but it can take, depending on the asset, pecuniary or non-pecuniary structure (Blanchard and Watson, 1982). After solving the above equation, the asset price is separated in two components, the fundamental value and the non-fundamental value or the speculative bubble:

$$P_t^a = \lim_{s\to\infty} \exp(-\sum_{j=0}^{s} r_{t+j})E_t P_s + E_t \sum_{s=0}^{\infty} \exp(-\sum_{j=0}^{s} r_{t+j})D_{t+s} \tag{2}$$

By applying the transversality condition (equation (3)), we obtain no bubble solution (equation (4)), so that P_t^f denote the fundamental component. The fundamental value is affected by market fundamentals and is expressed as the sum of the asset's expected future dividends discounted to the present time.

$$\lim_{s\to\infty} \exp(-\sum_{j=0}^{s} r_{t+j})E_t P_s = 0 \tag{3}$$

$$P_t^f = E_t \sum_{s=0}^{\infty} \exp(-\sum_{j=0}^{s} r_{t+j})D_{t+s} \tag{4}$$

But if the transversality condition be violated, the equation (4) is only one solution for equation (2). The general solution takes following form, so that B_t is non-fundamental or bubble term.

$$P_t^a = P_t^f + B_t \tag{5}$$

Where B_t satisfies:

$$E_t(B_{t+1}) = e^{t(r-g)} B_t \tag{6}$$

That g indexes the constant growth rate of dividend.

Empirically speaking, the assets price often deviates from the fundamental price. These deviations can appear as a result of speculation in the assets market, where excessive demand by market Participants causes jumps in the prices that may exceed the fundamental price of the asset. So, the difference between the actual price and the fundamental value in period t is the non-fundamental component or bubble.

Based on Wu [31], if prices and fundamentals have unit root, the general solution can be written in differences as follows:

$$\Delta P_t^a = \Delta P_t^f + \Delta B_t \tag{7}$$

In this paper, we separate the bubble component of assets price from their fundamental component. For this purpose, we shall apply the Sigma-Point Kalman filter (SPKF). The SPKF is an algorithm for sequential updating a non-linear projection for the state space model. Because the bubble is unobservable component, we regard it as a state vector and estimate it in a state space model. Also, because fundamentals and price are observable, we consider them as observation vectors in signal equation. The state-space model setup is given as follows:

$$\Delta P_t = \Delta D_t + F_t \Delta Y_t + \Delta B_t \tag{8}$$

$$\Delta Y_t = A_t + (C_t - I) Y_{t-1} + \varepsilon_t \tag{9}$$

$$\Delta B_t = (\rho_t - 1) B_{t-1} + \theta_t \tag{10}$$

Where F_t, A_t and C_t are time-varying coefficients which follow a random walk process. Also, ρ_t illustrates the growth rate of the bubble. Moreover, we assume the fundamentals follow an ARIMA (h, 1, 0) process, where h is determined empirically. Therefore:

$$Y_t = (D_t, D_{t-1}, D_{t-2}, \ldots, D_{t-h+1})' \tag{11}$$

Is a $h \times 1$ vector. Also:

$$C_t = \begin{bmatrix} \varphi_t^1 & \varphi_t^2 & \varphi_t^3 & \ldots & \varphi_t^{h-1} & \varphi_t^h \\ 1 & 0 & 0 & \ldots & 0 & 0 \\ 0 & 1 & 0 & \ldots & 0 & 0 \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \tag{12}$$

is a $h \times h$ matrix. Furthermore, ε_t and θ_t are supposed to be white noise and F_t is a h-row vector, where I is an $h \times h$ identity matrix and m = (1, 0, 0, …, 0).

$$F_t = mC_t(I - C_t)^{-1}[I - (1-\rho_t)(I - \rho_t C_t)^{-1}] \tag{13}$$

In this paper, we apply SPKF for four main asset markets including foreign exchange, stock, gold, and housing markets in Iran. In this regard, we have taken consumer price index and real interest rate as fundamentals in exchange market; world gold price and exchange rate as fundamentals variables in gold market; also, the ratio of housing price to rent and stock returns are considered for playing the role of fundamentals in housing and stock markets.

After extracting the bubble components, to examine stationary of bubbles time series, we have applied Phillips-Perron (PP) unit root test for each market. Then, for the purpose of testing the spillover of bubbles among asset markets, we have exploited the pairwise Granger causality and VAR model.

The pairwise Granger causality test is adopted to determine the bubbles in which market can have a casual relation to growth or collapse pattern of the bubbles in another parallel market. Granger (1969) presents the concept of causality, which is based on the predictability of some series. If a series y contains information in past terms that helps in the predication of a series x and if this information is contained in no other series used in the predictor, then y is said to cause x. For testing the null hypothesis of no Granger causality, F test is employed. Also, multivariate Granger causality analysis is performed by fitting a vector autoregressive model (VAR) to the time series. In general, if we deal with stationary variables, VAR models are usually assumed to carry out the Granger causality test between multi variables. The number of lags used in these models is selected by an information criterion, such as the Akaike information criterion (AIC), the Schwarz information criterion (SIC) or Hannan-Quinn information criterion (HQIC), which mostly depends on the number of observations.

Next, we have adopted the Impulse Response Function (IRF) analysis to predict the long-term effects of shocks to the bubbles equilibrium system, meanwhile detecting how can one market's price bubbles impulses other markets' price bubbles, as a shock to an equilibrium system. In the other words, an IRF shows the effect of a standard shock to one of the variables on current and future values of the other variables in a vector autoregressive model. A shock to the i^{th} variable directly affects the i^{th} variable itself and is also transmitted to all of the variables through the structure of the vector autoregressive model.

Furthermore, to comprehend the amount of the forecast error variance for each of the assets bubbles that can be explained by exogenous shocks to the other bubbles, we have used the Variance Decomposition (VD) from the VAR model. In the context of multivariate time series analysis, variance decomposition is used to aid the process of interpretation for a vector autoregression model.

4. Empirical Results

In this paper, we have investigated the possibility of intra-market transfer of assets price bubbles. In this regard, we have turned our focus to four main asset markets, namely foreign exchange, stock, gold and housing markets in Iran. This section provides empirical findings from study of bubbles spillover procedure across these markets. In general, spillovers can occur when market participants use information about the performance of one market to find out the future behavior of prices in other markets, although there won't be any new information that can directly relevant to the latter. Thus, bubbles in one market can spread to others, and similarly bubbles collapses may occur concurrently.

In order to identify the series of bubbles, first we have followed the SPKF methodology to detach the bubble component from the fundamental component in each of the markets. Since the assets price variables are non-stationary in level, but stationary in first difference (Table 1), and then we are capable of separating the bubble component of a change in the price, from its fundamental components. The results of SPKF are obtained by the MATLAB algorithm.[1]

Table 1: Results of Phillips-Perron Unit Root Test for Assets Price

Variable	Level		First Difference		Results
	Statistic	Prob.	Statistic	Prob.	
Exchange Rate	0.0772	0.9631	-9.6570	0.0000	I(1)
Gold Price	-0.6922	0.8445	-9.7404	0.0000	I(1)
Housing Price Index	4.9396	1.0000	-10.861	0.0000	I(1)
Stock Price index	-0.1331	0.9428	-7.2836	0.0000	I(1)

1. The MATLAB code is available from the Hatipoglu & Uyar (2012).

Figures 1 to 4 show the actual price indexes alongside with the estimated bubbles which created from price changes in each of the foreign exchange, stock, gold and housing markets, respectively, for the period of 2002:04 to 2015:06. In foreign exchange and gold markets, most of the bubbles in price changes have been compressed at the 2012m09, that's because about 61% of the exchange rate change and about 52% of the gold price change can be attributed to the bubble component. Also, in housing market and stock market, most share of the bubbles in actual prices change have been at 2013m06 (almost 17%) and 2013m11 (almost 27%), respectively.

Figure 1: Exchange Rate and Bubbles

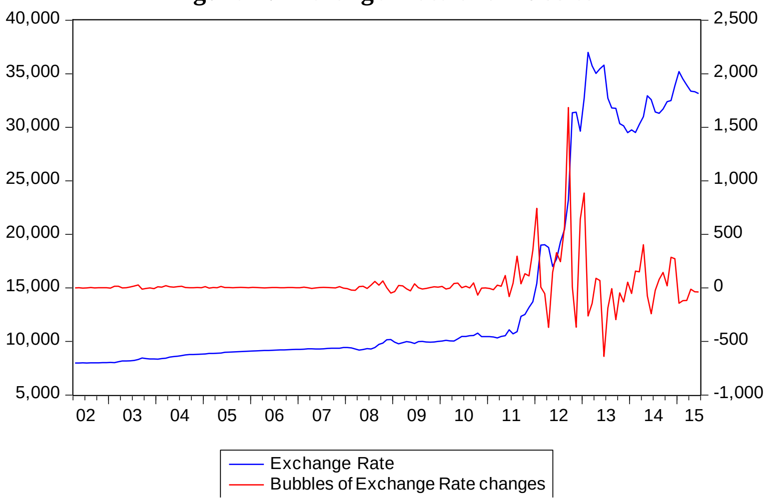


Figure 2: Gold Price and Bubbles

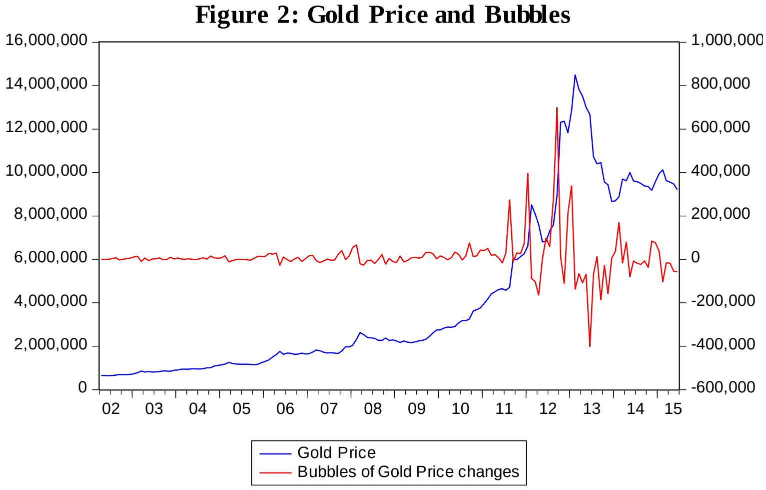


Figure 3: Housing Price Index and Bubbles

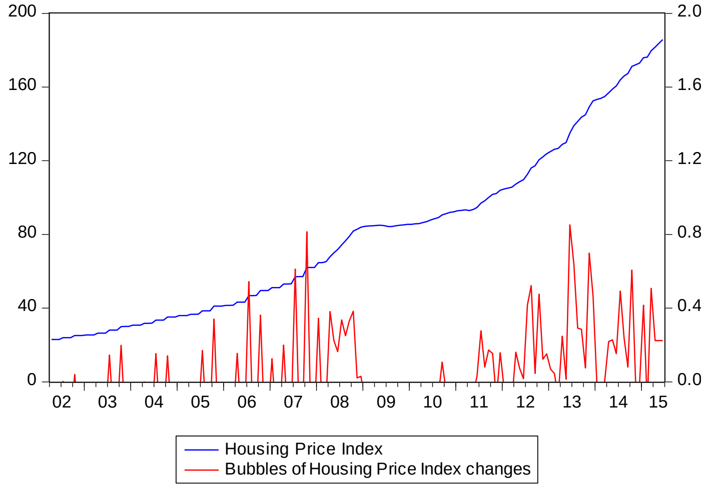
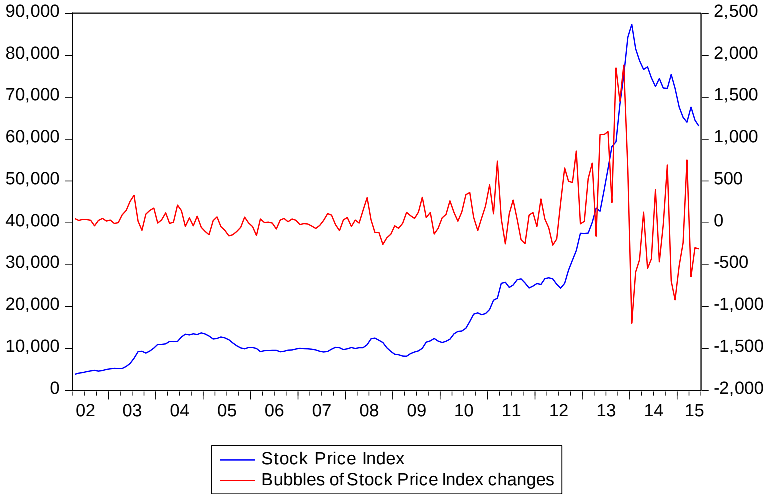


Figure 4: Stock Price Index and Bubbles



After extracting the bubbles from fundamentals, we have followed econometrics and mainly time series methods to evaluate the bubbles spillover among assets markets.

At first to explore stationarity condition for bubbles, we had run a unit root test on the aforementioned acquired price bubble series for each market. In order to carry out this task, we have applied Phillips-Perron (PP) unit root test. The results of this test are shown in table 2. In this table, BEX, BG, BH and BS are representative for price bubbles in a case of change in foreign exchange rate, gold price, housing price index and stock price index, respectively.

Table 2: Results of PP Unit Root Test for Bubbles Change

Variable	Level		Results
	Statistic	Variable	
BEX	-9.6849	0.0000	I(0)
BG	-9.7499	0.0000	I(0)
BH	-11.061	0.0000	I(0)
BS	-7.2737	0.0000	I(0)

The results of the PP test indicate that all of the variables are stationary at level. Thus, the Bubble of foreign exchange, stock, housing and gold markets are co-integrated.

Followed by these results, to determine whether time series of price bubble in a market is useful in forecasting another, we have employed a Pairwise Granger Causality test. The results of this test summarize in table 3.

Table 3: Results of Pairwise Granger Causality Test

Null Hypothesis	Lags	Prob.
BEX does not Granger Cause BG	3	0.0017
BG does not Granger Cause BEX	3	0.0608
BEX does not Granger Cause BH	12	0.0060
BH does not Granger Cause BER	12	0.0496
BEX does not Granger Cause BS	8	0.0000
BS does not Granger Cause BEX	8	0.0103
BG does not Granger Cause BH	10	0.0611
BH does not Granger Cause BG	10	0.0406
BG does not Granger Cause BS	9	0.0000
BS does not Granger Cause BG	9	0.0456
BH does not Granger Cause BS	6	0.0543
BS does not Granger Cause BH	6	0.0004

The outcomes illustrate that for the period studied, the size of the bubble in exchange rate is Granger Causality to the bubbles in the gold, stock and housing markets after 3, 8 and 12 lag, respectively. It means that bubbles in the gold, stock and housing price indexes are somehow caused by the exchange rate bubble. Also, stock price bubble contains a causal relation with housing price, exchange rate and gold price bubbles with lags of 6, 8 and 9, respectively. On another hand, Gold price bubble also has a causal connection with bubbles in the stock market with a lag of 10. Similarly, the bubble originated in the housing market does Granger cause bubbles in the gold and foreign exchange markets after 10 and 12 lag respectively. Generally, price bubbles in foreign exchange and housing markets, foreign exchange and stock markets, and gold and stock markets have bidirectional causality toward each other.

In the next step, in order to analyses bubbles spillover among the asset markets, we have developed a multivariate time series model for bubbles and therefore exploited a vector autoregressive (VAR) system as follows:

$$\begin{pmatrix} BEX_t \\ BS_t \\ BG_t \\ BH_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{pmatrix} + \sum_{i=1}^{k} \begin{pmatrix} \alpha_{11i} & \alpha_{12i} & \alpha_{13i} & \alpha_{14i} \\ \alpha_{21i} & \alpha_{22i} & \alpha_{23i} & \alpha_{24i} \\ \alpha_{31i} & \alpha_{32i} & \alpha_{33i} & \alpha_{34i} \\ \alpha_{41i} & \alpha_{42i} & \alpha_{43i} & \alpha_{44i} \end{pmatrix} \times \begin{pmatrix} BEX_{t-i} \\ BS_{t-i} \\ BG_{t-i} \\ BH_{t-i} \end{pmatrix} + \begin{pmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \end{pmatrix} \quad (14)$$

Where, k denotes an optimal lag length in the VAR model. As mentioned before, to determine the optimal lag, we have used Akaike Information Criterion (AIC). The results show that containing 6 lags for our multivariate system is an optimal lag length.

Afterwards, we have estimated the bubble spillover model stated above. The results of VAR model estimates are reported in table 4.

Table 4: Results of VAR Model Estimates

		BEX	**BG**	**BH**	**BS**
BEX(-1)	Coefficient	0.3670	82.588	0.0004	0.2152
	t-statistic	[1.7945]**	[0.8493]	[2.1677]**	[0.6152]
BEX(-2)	Coefficient	-0.4580	-182.34	0.0002	0.2682
	t-statistic	[-2.1702]**	[-1.8171]**	[1.1404]	[0.7428]
BEX(-3)	Coefficient	0.3990	189.18	0.0003	0.1837
	t-statistic	[1.9567]**	[1.9512]**	[1.6877]**	[0.5266]
BEX(-4)	Coefficient	0.0561	-44.992	-0.0005	0.0918
	t-statistic	[0.2682]	[-0.4522]	[-2.1957]**	[0.2564]
BEX(-5)	Coefficient	-0.5415	-323.70	0.0004	0.7733
	t-statistic	[-2.5836]***	[-3.2483]***	[2.0176]**	[2.1568]**
BEX(-6)	Coefficient	0.4443	209.64	0.0001	0.7203
	t-statistic	[1.9764]**	[1.9614]**	[-0.1894]	[1.8733]**
BG(-1)	Coefficient	0.0002	0.2346	-0.0001	-0.0005
	t-statistic	[0.4991]	[1.1299]	[-1.7700]**	[-0.6579]
BG(-2)	Coefficient	0.0005	0.2909	-0.0001	-0.0001
	t-statistic	[1.2749]*	[1.4110]*	[-2.6295]***	[-0.0528]
BG(-3)	Coefficient	-0.0005	-0.2678	-0.0001	-0.0013
	t-statistic	[-1.2667]	[-1.3415]*	[-0.8192]	[-1.8346]**
BG(-4)	Coefficient	0.0003	0.2026	0.0001	-0.0001
	t-statistic	[0.7505]	[0.9790]	[1.7235]**	[-0.0421]

		BEX	BG	BH	BS
BG(-5)	Coefficient	0.0009	0.6148	-0.0001	-00015
	t-statistic	[2.1513]**	[2.9360]***	[-1.7702]**	[-1.9579]**
BG(-6)	Coefficient	-0.0010	-0.5403	0.0001	-0.0010
	t-statistic	[-2.2487]**	[-2.4463]***	[0.3486]	[-1.2673]
BH(-1)	Coefficient	217.89	113812.7	0.1228	-353.11
	t-statistic	[2.3842]***	[2.6194]***	[1.3179]*	[-2.2589]**
BH(-2)	Coefficient	-2.8781	-464.96	0.0586	-124.80
	t-statistic	[-0.0295]	[-0.0100]	[0.5890]	[-0.7477]
BH(-3)	Coefficient	94.9318	55823.9	0.6586	391.82
	t-statistic	[1.0026]	[1.2400]*	[6.8199]***	[2.4191]***
BH(-4)	Coefficient	-113.97	-88452.7	-0.18166	116.08
	t-statistic	[-1.2165]	[-1.9859]**	[-1.9012]**	[0.7243]
BH(-5)	Coefficient	30.013	-17624.7	-0.0520	97.684
	t-statistic	[0.3130]	[-0.3866]	[-0.5314]	[0.5956]
BH(-6)	Coefficient	-101.67	-46941.6	-0.0127	-662.08
	t-statistic	[-1.0850]	[-1.0537]	[-0.1326]	[-4.1306]***
BS(-1)	Coefficient	-0.0008	-24.297	0.0001	0.5124
	t-statistic	[-0.0175]	[-1.0556]	[1.8853]**	[6.1878]***
BS(-2)	Coefficient	-0.0090	15.5533	-0.0001	0.0698
	t-statistic	[-0.1660]	[0.6015]	[-0.7091]	[0.7499]
BS(-3)	Coefficient	-0.1127	-39.9526	-0.0001	-0.118
	t-statistic	[-2.0429]**	[-1.5232]*	[-1.3325]*	[-0.1247]
BS(-4)	Coefficient	0.0525	7.9884	0.0001	-0.0886
	t-statistic	[0.9266]	[0.2697]	[-0.7273]	[-0.9149]
BS(-5)	Coefficient	0.1158	63.798	0.0001	0.1087
	t-statistic	[2.0967]**	[2.4294]***	[0.5629]	[1.1505]
BS(-6)	Coefficient	-0.0617	-27.698	0.0001	0.0149
	t-statistic	[-1.1833]	[-1.1168]	[0.5179]	[0.1671]
C	Coefficient	16.778	5971.9	0.0043	7.6501
	t-statistic	[1.0405]	[0.7790]	[0.2668]	[0.2774]
R^2		0.4115	0.3660	0.5577	0.5080
Adj. R^2		0.3012	0.2472	0.4748	0.4157
F-statistic		3.7299	3.0792	6.7248	5.5068

* Significance at the 90% confidence interval

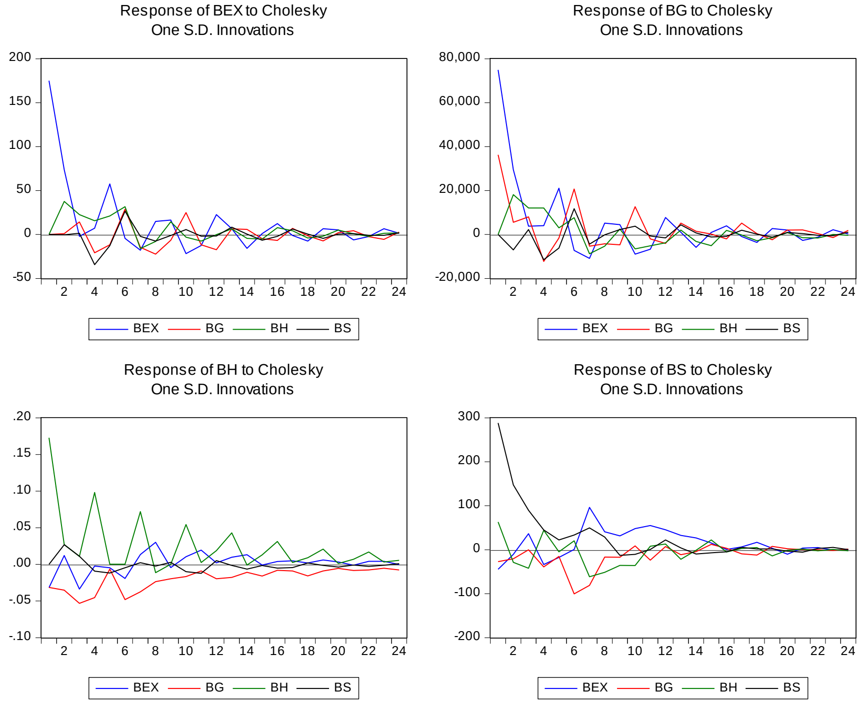
** Significance at the 95% confidence interval

*** Significance at the 99% confidence interval

As table 4 demonstrates, there are considerable evidences on the existence of bubble spillover amongst assets markets. In particular, it can be noticed that the influence of the housing price bubble is faster than other assets bubbles. From the aforementioned table, it could be followed that after 1 lag, the bubble of housing market contains a positive effect on exchange and gold markets, and negative effect on stock market. This can be explained by capital transmission to exchange and gold markets, while the housing price bubble is growing. On the other hand, the bubbles in the housing market were faster affected by bubbles among any of the above markets. The positive coefficient for the first lag of exchange and stock market bubbles in the housing bubble equation indicates that the size of the bubbles in housing market is increasing, while the exchange rate and stock price index bubbles are rising. Probably, followed by the growing exchange and stock price bubble and subsequently the wealth of investors, they shall diversify their portfolios by purchasing from real estate market. But, it can be noticed that the gold price bubble is negatively influenced on the housing market bubble after 1 lag. Thus, we can state that when the price bubble in gold market is rising, then the price bubble in housing market will going to burst and vice versa. Also, it can be notified that compared to other markets, the bubbles in the stock market have weaker effectiveness among other assets.

After estimating the VAR model, we have adopted an impulse response function analysis to detect how one market's bubbles impulses toward other market's bubbles. The following IRFs are reported in figure 5.

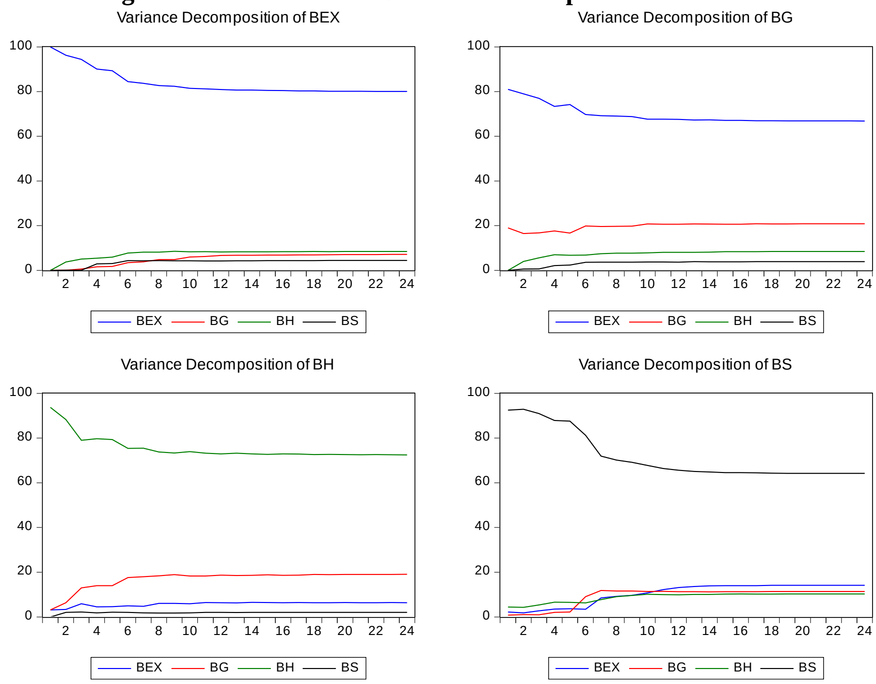
Figure 5: The Results of Impulse Response Functions



Based on the results of this figure, the standard shocks to the bubbles in price changes of each asset would lead to oscillations in future bubbles size, until these fluctuations would be diminish gradually. In particular, the response of exchange rate bubble to housing price bubble is faster, by comparison to gold and stock bubbles. Furthermore, the response of gold price bubble to the standard deviation of the exchange rate bubble at the first and second lags is larger than housing, stock and gold markets. Also, the shock to the gold price bubble has a negative effect on housing prices index through the entire supposed time spectrum. It can be mentioned that housing price bubble is not increasing in parallel with shocks on gold price bubbles. Moreover, figure 5 displays negative effects of response from stock bubble to gold markets impulses until 9 lags. Also, response of gold bubble to the shocks on stock market cannot be considered a large and considerable reaction.

At the next stage, to explain that what portion of the variance from each of the bubbles can be explained by shocks to the others, we have exploited a variance decomposition analysis, which obtained from the estimated VAR model. Figure 6 reports the VDs.

Figure 6: The Results of Variance Decomposition of Bubbles



The findings from this analysis suggest that the bubbles of foreign exchange and housing markets have the most effects in explaining the fluctuations in exchange rate bubble. Since after 24 months, the explanatory effect of BEX, BH, BG and BS are 80%, 8.43%, 7.11% and 4.40%, respectively. According to figure 6, in gold market, exchange rate bubble has a significant role in explaining the variance of gold price bubble. After 24 months, BEX, BG, BH and BS have explained almost 66.83%, 20.85%, 8.43% and 3.88% from the fluctuations in gold bubble. Also, the results of variance decomposition from housing bubble shows that bubble of housing and gold have the most participation in explaining the fluctuations of housing price bubble, in a way that after 24 months, the extent of involvement of BH, BG, BEX and BS in explaining the variance in this market, is accordingly 72.49%, 19.08%, 6.39% and 2.04%. In stock market, bubbles of stock price and exchange rate include the most effect in explaining its fluctuations. We found that after 24 months, the explaining capacity BS, BEX, BG and BH have increased to 64.17%, 14.15%, 11.35% and 10.32%, respectively.

4. Summary and Conclusions

This paper investigates the price bubbles spillover among asset markets. We have employed several tests on particular bubbles which has been generated in four main asset markets namely foreign exchange, stock, gold and housing markets in Iran, according to the monthly data from 2002:03 to 2015:06. In this regard, at first we have applied a Sigma-Point Kalman filter (SPKF) to extract the bubble term from assets price changes. Then, we performed a pairwise Granger causality test to determine whether the price bubbles in a market can have a causal connection toward growth or collapse of the bubbles in another parallel markets. Also, by developing a multivariate time series model for bubbles and exploiting a VAR system, we followed IRF and VD analysis, to evaluate the influence of price bubbles spillover across asset markets.

The findings of Granger Causality test suggest that, for the considered period, the size of the bubble in foreign exchange rate is Granger Causality to the bubbles in the stock, gold and housing markets. Also, stock price bubble has a casual relation with foreign exchange rate, housing price and gold price bubbles. Gold price bubble contains a Granger causal connection toward bubbles in the stock market. Similarly, price bubbles raised from the housing market is connected to bubbles in the exchange and gold markets, through a Granger causal link.

The results from VAR Model estimates show that there are considerable evidences for bubbles spillover amongst some of the markets. In particular, effect of the housing price bubble is more rapid than other bubbles. On the other hand, the bubbles in the housing market are affected more quickly by bubbles from other markets. Also, it can be notified that compared to other markets, the bubbles in the stock market have weaker effects on the bubbles from other assets.

Also, the findings of IRFs indicate that the standard shocks to bubbles in price changes of each asset would lead to fluctuation in future bubbles size, in a way that these fluctuations would be diminishing gradually. In particular, the response of exchange rate bubble to housing price bubble is faster than its impulses toward gold and stock bubbles. Furthermore, the response of gold price bubble to the standard deviation of the exchange rate bubble at the first and second lags is larger than housing, stock and gold markets. In addition, extend of the response from gold market bubble to shocks on the stock market is not significant.

Finally, our findings from VAR analysis illustrate that bubbles of foreign exchange and housing markets have the most effects in explaining the fluctuations in exchange rate bubble. In gold market, exchange rate bubble has a remarkable role in describing the variance of gold price bubble. Moreover, bubble of housing and gold prices have a considerable explanatory effect about the oscillation of housing price bubble. Also, in stock market, bubbles of stock price and exchange rate have an enormous effect in explicating the fluctuations in stock bubble.

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