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The gold market bubble and its contagion to the stock market

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Abstract

Gold has always been considered as a strategic commodity in crises. When markets are down, gold acts as a safe haven. Because the price of gold usually does not move with the market prices. The purpose of this research is to investigate the gold market bubble and the possibility of its contagion to the stock exchange. For this purpose, in order to check the existence of a price bubble in the gold market, using (RADF), (SADF) and (GSADF) tests, the price bubble of the gold market was tested and the date of their creation and collapse was determined. To investigate the contagion of the gold market bubble to the stock exchange, a time variable regression model was used. The results indicate the existence of 4 periods of explosive behavior and the existence of multiple price bubbles in the price of gold. Based on this, the bubble periods in the Iranian gold market are related to the periods 2016:07:03-2016:10:4, 2018:01:7-2018:12:16,2018:12:30-2019:08:26 and 2019:12:10-2021:03:20 and the contagion of the price bubble from the gold market to the stock market has also occurred.

Keywords: price bubble, gold market, contagion, stock exchange
2020 MSC: 91G15

1 Introduction

Since gold is one of the most commonly traded commodities in the world and one of the leading economic variables in the economy, their price changes have important implications for the global economy and financial markets. Therefore, analyzing its common movement with other markets and their causality is of vital practical importance [14]. In recent decades, the increasing convergence and influence of financial markets on each other has intensified the contagion and transmission of events between them. So that any fluctuation in one market affects other markets as well. This issue has focused researchers on how the turbulence spreads between markets and how they affect each other. Researchers including Bedoui et al. [4], Ewing and Malik [11], Figurella Ferretti and McCrorie [12], and Narayan et al. [23], discussed the relationship between gold and other commodities and markets.

Gold is always known as a shield against inflation. Many articles have been written on the relationship between gold and financial markets because the ability to predict commodity prices plays an important role in financial markets. This clarifies the necessity of understanding price movements and transferring information between the actives of the disturbed markets [27]. The market is necessary because the occurrence of a bubble in this market can cause the bankruptcy of large financial organizations, panic of depositors, bank raids, credit collapse, etc. On the other hand, gold acts as both a hedge and a safe haven in times of market stress or turmoil [3]. As Su et al. [31], state,

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when investors anticipate a decline in the value of the US dollar, they tend to move away from the dollar and buy commodities.

Most of the researches that have been conducted in the financial market of Iran have mostly focused on estimating the price bubble, and the need to investigate the contagion of the price bubble from the gold market to other markets has been neglected. Therefore, in this research, we are looking for three basic questions. First, has there been a bubble in the gold market? From what date did the periods of the gold price bubble start and on what date did they end? If there is a gold bubble, has the bubble contagion happened between the gold market and the stock exchange?

The necessity of conducting this research stems from the fact that understanding the relationship between the gold market and other strategic markets can help investors and decision makers make correct decisions in critical situations. On the other hand, due to the importance of gold as a strategic asset of governments, the need to investigate the price bubble of this market doubles. The use of gold by managers of investment companies and investors as a tool for risk hedging and protection against crises is also one of the factors that add importance to this.

2 Background Research

The increase in asset prices in a continuous process leads to the formation of a bubble, in which the future expectations of price increases increase with the increase in current prices, and finally this issue leads to the stimulation of new buyers and fuels the formation of a bubble. According to the most common definition, the deviation of asset prices from their intrinsic value is called a bubble [20]. This deviation of market prices from fundamental values is not a new phenomenon, as it has been at the center of many financial crises [30]. The price explosion was more pronounced after the emergence of futures markets because it allowed investors to speculate on futures prices and hence bubbles lead to crises [13]. Basically, the effects of contagion increase during crises due to financial instabilities and economic uncertainties [1]. In general, before the cryptocurrency bubble in 2017-2018, there were three important quantitative bubble events that spread to other markets and caused international crises. These three events are the dot-com bubble of 2000, Housing prices in 2008 and the Chinese market bubble that occurred in 2015 [6].

The effect of contagion between financial markets was noticed after the collapse of the dot-com bubble in 2000. In this bubble, during the period of 1998-2000, the price of Internet stocks was much higher than the stock prices of other sectors, and the volume of technology stock transactions was 20% of the total. The stock market arrived [24]. Another crisis that not only had harmful and longer-lasting effects on the US macroeconomics but also spilled over into other countries leading to global economic disaster was the global financial crisis of 2008. When this bubble burst, the S&P 500 was almost It lost 50% of its value. Although the underlying causes of the dot-com and housing bubbles are quite different, the global impact of the destructuring of both events was similar in its scope of contagion. (Burks, Nathan Fadahunsi, Hibbert,2021). The spread of this bubble to the market of other European countries and other countries of the world was investigated by many researchers, such as [33, 9, 18, 10].

Communication between different markets, both commodity and financial, is one of the fundamental challenges for investors. This relationship is examined in two general ways, the effect of yield and transfer of volatility between these markets. Wang et al. [34], investigated the effects of fluctuations in crude oil prices, gold prices, and the exchange rate of the US dollar against various currencies on the stock price indices of the United States, Germany, Japan, Taiwan, and China. Their empirical results showed that there are co-accumulations between fluctuations in oil prices, gold prices and dollar rates against other currencies and stock markets in Germany, Japan, Taiwan and China. This result shows that there are stable long-term relationships between these variables. Hammoudeh et al. [16], showed that gold acts as a hedge of exchange rate risk and the past fluctuation of gold expands the fluctuation of exchange rate. Sari et al. [29], undeniably stated the role of gold as a hedge against inflation, especially when the value of the dollar against the euro declines. Kim and Dilts [19], confirmed the negative relationship between gold prices and the value of the dollar.

The research of Maghyereh and Abdoh [21], showed that the safe asset of gold and silver during financial market turbulence causes an excessive increase in prices that are beyond their fundamental values. Furthermore, the results show that bubbles in precious metals markets are contagious and mainly flow from gold to silver. These findings are related to the period after 2005, especially during the global financial crisis. During the 2020 corona virus pandemic, no contagious bubble effect was found between gold and silver.

Mensi et al. [22], studied the correlation and transmission of volatility between commodity markets such as gold and oil. The results showed that the S&P price index has an effect on the fluctuation of gold and oil prices. Bhunia [5], investigated the relationship between the internal price of gold and stock price returns using the Granger test and confirmed a two-way causality between stock price returns and gold prices. Badshah et al. [2], tested the effects of

simultaneous influence by explaining the fluctuations between stocks, gold and exchange rates. Their findings show that there is a strong one-way transfer effect from the stock market to the gold and currency markets; Where the volatility of the stock market increases the volatility of gold and exchange rates.

Choudhry et al. [8], in the investigation of nonlinear dynamic co-movements and fluctuation transitions between gold and stock returns for three countries, England, America and Japan, using the nonlinear Granger causality model, showed that in times of crisis, the said relationship is bilaterally dependent and, in the state, Normally, the use of gold can optimize the stock portfolio.

Raza et al. [28], investigated the asymmetric effects of gold and oil prices on volatility transmissions of emerging countries' stock markets using the nonlinear ARDK approach. They showed that there is convergence and positive effect of gold price in the market of BRICS countries and its negative effect in the countries of Mexico, Malaysia, Thailand, Chile and Indonesia.

Vardar et al. [32], in the study of the shock transmission and volatility spillover of ten countries with the cash price of crude oil, natural gas, platinum, silver and gold using the GARCH VAR-BRKK model showed that in addition to the significance of the gold volatility spillover on the stock market, Convergence between markets after the 2007 crisis period has become more than the pre-crisis period.

Gharib et al. [14], investigated the spread of the bubble between the gold and oil markets. They examined the causal relationship between the spot prices of crude oil and gold to assess how the economic impact of COVID-19 on gold and oil. They analyzed West Texas Light (WTI) and gold prices from January 4, 2010 to May 4, 2020 and found that there were periods of bubbles in the WTI and gold markets and, most importantly, a two-way bubble contagion effect in the markets. Oil and gold have been found during the recent covid-19 outbreak.

3 Research Method

The current research is based on the classification of research based on the method, nature and direction, respectively descriptive, applied and post-event, and in terms of type, it is correlational. Took the problem of bubbles in the markets can be multiple due to its variable nature, but the economic diagnosis of multiple bubbles with periodic collapse is much more difficult than the determination of a single bubble. The problem also stems from the fact that the structure of multiple bubbles is nonlinear and complex. In fact, multiplicity leads to a decrease in the detection power of existing mechanisms such as regression tests in models. This reduction in power complicates the attempt to date the bubble and increases the need for a new method (which does not have this problem). In this regard, Phillips et al. [25], have presented a new framework to solve this problem, which is used for the existence of multiple bubbles in the data.

The procedure of the PSY model is based on the soft burst measurement that occurs in the time series. This method was used by Phillips and Yu. [26], to measure the bubble.

The random step process under the PSY method is as follows:

$$y_t = dt^{-n} + y_{t-1} + \varepsilon_t \varepsilon_t{}^{\sim} NID(0, \sigma^2) \tag{3.1}$$

where y_t is the investigated variable (gold price in this research) d is a constant value, N is a coefficient that controls the amount of drift when the size of T tends to infinity and ε is the error term. The following equation is the generalization of the above model.

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum \gamma_i \Delta y_{t-1} + \varepsilon_t \tag{3.2}$$

The framework used in this study also follows the aforementioned structure. It should be stated that the method used by Phillips et al. is a supremum ADF (SADF) test and is based on a sequence of ADF forward-regressive right-sided unit root tests. This method is able to determine the start date, duration and burst date of the bubble. Homm and Breitung [17], showed that this model works well, unlike other regression methods, for structural failures, and it is especially considered as an efficient algorithm for bubble detection.

3.1 Standard ADF Test

r_1, r_2 in ADF unit root test is the fixed standard and the first and last observation of the sample respectively, so rw=r0=r1, this issue is shown in the diagram below.

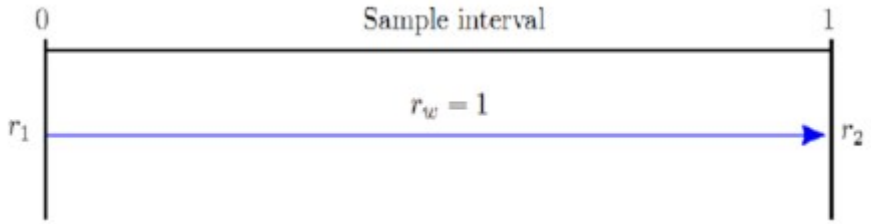

Figure 1: **Showing the ADF process (source Caspi [7])**

3.2 Rolling Augmented Dicky Fuller test

Rolling augmented dicky fuller test representative is a standard ADF with a window of fixed length and value rw=r0. In each step of the estimations of this method, the starting and ending points (r1 and r2, respectively) increase with the length of the window. At each stage of estimation, the standard ADF statistic of each window is calculated and symbolized by the start and end points of each window as ADFr1, r2. The Dickey Fuller statistics of the Goltan window is the supreme among all the statistics related to any window.

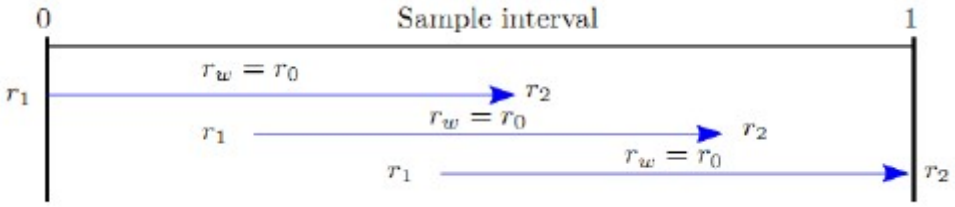

Figure 2: **Viewing the RADF Process (source Caspi [7])**

3.3 SADF test

This test is based on ADR calculation, so that in all windows, the starting point is fixed, but the length of the window increases in each neighborhood. In this process, the first observation is the starting point of the estimation window. That is, r1=0.

In this case, the length of the window in each step is equal to r1=r2 and rw=r2. At each step of the estimation, the window length increases by a certain ratio, but the starting point is fixed. Based on this, the ADR statistic related to each estimate is calculated, which displays it with the symbol ADRr2. Finally, among all the ADRr2 statistics related to each window, the SADF statistic is the supreme one, in other words:

$$SADF(r_0) = \sup\{ADF_{r2}\} \quad r_2 \in [r_0, 1] \tag{3.3}$$

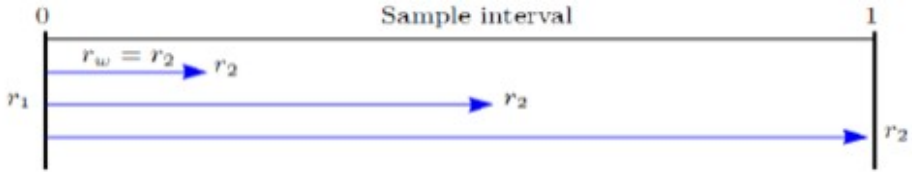

Figure 3: **Showing the SADF process (source Caspi [7])**

3.4 GSADF test

The GSADF strategy is based on the generalization of the SADF test. This test is also based on the calculation of ADF statistics, but the starting point can be both fixed and variable. The GSADF statistic is the supreme among all ADFr^2 statistics associated with each window; Or in other words

$$GSADF(r_0) = \sup\{ADF_{r_1}^{r_2}\} \quad r_1 \in [0, r_2 - r_0] \quad r_2 \in [r_0, 1] \tag{3.4}$$

where

$$ADF_{r_0}^{r_2} = \frac{\int_0^{r_2} w^{\sim} dw}{\left(\int_0^{r_2} w^{\sim} dw\right)^f rac12}$$

where W ~ and W are the standard Brownian process

$$\mathrm{w}^{\sim}(\mathrm{r}_2) = \mathrm{w}(\mathrm{r}_2) - \frac{1}{\mathrm{r}_2}\int_0^{\mathrm{r}_2} \mathrm{WdW} \tag{3.5}$$

$$ADF_{r_1}^{r_2} = \frac{\frac{1}{2}\mathrm{r_w}\left[\mathrm{w}(\mathrm{r}_2)^2 - \mathrm{w}(\mathrm{r}_1)^2 - \mathrm{r_w}\right] - \int_{\mathrm{r}_1}^{\mathrm{r}_2} \mathrm{w}(\mathrm{r})\,\mathrm{dr}[\mathrm{w}_{(\mathrm{r}2)} - \mathrm{w}_{(\mathrm{r}1)}]}{\mathrm{r}_{\mathrm{w}}^{\frac{1}{2}}\left(\mathrm{r_w}\int_{\mathrm{r}_1}^{\mathrm{r}_2} \mathrm{w}(\mathrm{r}^2)\,\mathrm{dr} - \left[\int_{\mathrm{r}_1}^{\mathrm{r}_2} \mathrm{w}(\mathrm{r}^2)\,\mathrm{dr}\right]^2\right)^{\frac{1}{2}}} \tag{3.6}$$

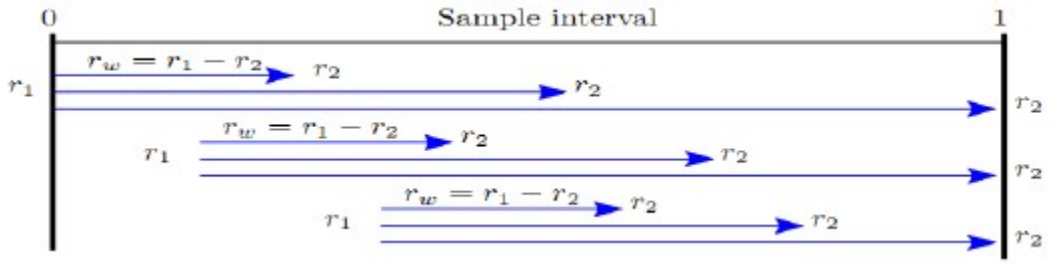

Figure 4: **Showing the GSADF process (source Caspi [7])**

The purpose of these tests is to discover the explosive behavior of the entire GSADF sample. Covering more sub-duhs than SADF and having higher window flexibility, it is expected to perform better in detecting multiple bubbles.

3.5 Time Variable Regression Test

Greenaway-McGrevy and Phillips [15], used a time-varying regression to investigate the contagion of the price bubble, which could measure the contagion of the bubble. In this regression, based on the betas calculated in equation (3.1), the potential contagion rate is calculated based on the following regression.

$$\beta_{j,s} = \sigma_{1i} + \sigma_{2j}\left(\frac{S}{T - S + 1}\right)\beta_{core,S-d} + error_{S,S} = S, ...T, \tag{3.7}$$

In this equation, the index s specifies the samples ($s = S, \cdots, T$), $\beta_{j,s}$ will be the beta coefficient obtained in equation number 1 above, β_{core} represents the potential market from which the bubble spreads, which is the beta coefficient of the currency market for this research, d is a delay parameter for the delayed contagion effect from *core* to j and σ_{2j} is the time variable contagion coefficient.

4 Research Findings

In this study, to discover multiple price bubbles in the Iranian gold market during the time period of 2016-2021, the price of 18 karat gold was used.

Descriptive statistics are presented in Table 1. Based on this, the average price of gold in the period of 2015-2021 was equal to 350,997 Tomans. Also, the minimum and maximum price of 18 carat gold in this period was 88455 and 1462917 Tomans corresponding to 2015:08:03 and 2020:10:13 respectively. In addition, the skewness and kurtosis values show that this variable does not have a normal distribution.

Table 1: descriptive statistics of gold price

Indicator	Average	maximum	minimum	crookedness	Elongation	Jarek-bra
18 karat gold prices	350997	1462917	88455	1.4607	4.0993	0.0000

In Table 2, the results of using ADF, RADF, SADF and GSADF unit root tests to test the presence of bubbles in the price series of 18 carat gold are reported. The findings show that if RADF and SADF tests are used, the null hypothesis of unit root is rejected. Therefore, the evidence points to an explosive behavior in gold prices. In addition, the results of the GSADF test indicate the existence of multiple bubbles in the Iranian gold market during the period under review.

Table 2: The Results of the Unit Root Tests to the Right for the Gold Market

Indicator	Test	probability value	The value of the statistic	Critical value 1 percent	Critical value 5 percent	Critical value 10 percent
18 karat gold prices	ADF test	0.0020	1.1501	0.5546	-0.976	-0.4130
	RADF test	0.0000	4.1140	0.7083	-0.0164	-0.03840
	SADF test	0.0000	10.8218	2.0830	1.4667	1.1800
	GSADF test	0.0000	10.8218	2.8841	2.1383	1.9381

Chart 5 shows the periods of explosive behavior and price bubbles in Iran's gold market based on the results of the GSADF test. This chart shows evidence of 4 periods of explosive behavior and the existence of multiple price bubbles in gold prices. Based on this, the bubble periods in the Iranian gold market are related to the periods 2016:07:03-2016:10:4, 2018:01:7-2018:12:16,2018:12:30-2019:08:26 and 2019:12:10-2021:03:20. As can be seen, except for a short period, Iran's gold market was a bubble from the middle of January 2016 to the end of 2021.

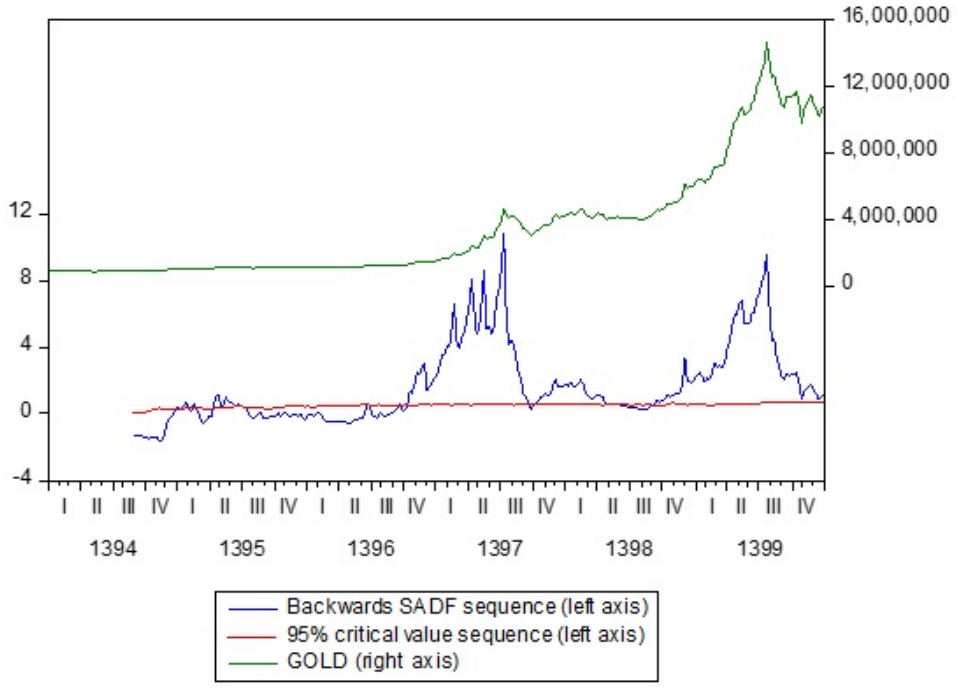

Figure 5: **GSADF Test for 18 Karat Gold Rate**

The results obtained from the SADF and RDF tests for the 18-karat gold rate are presented in charts 6 and 7.

All three methods show that there is a bubble in the gold market and this bubble has been multiple in different periods.

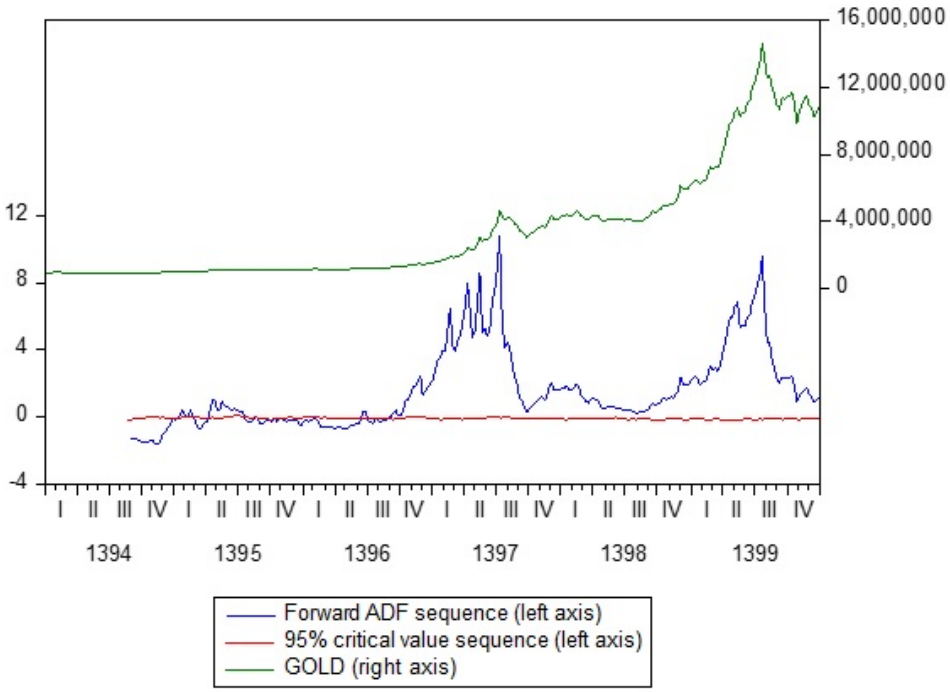

Figure 6: **SADF Test for 18 Karat Gold Rate**

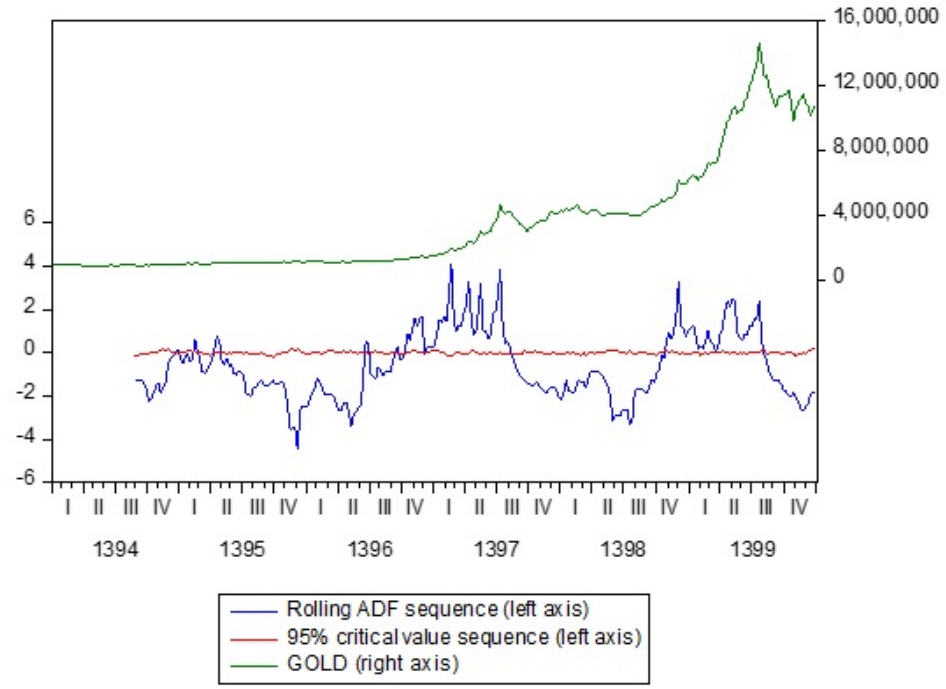

Figure 7: **RADF test for 18 karat gold prices**

4.1 Bubble contagion

In this section, the possibility of the spread of price bubbles from the gold market to the stock market has been examined and tested. Before estimating the model, in order to prevent the occurrence of false regressions, the significance test of the variables was used using the statistical estimation method (ADF), which is presented in Table No. 3.

Considering that the statistical value for all variables in the estimate without width from the origin and trend at

Table 3: Results of ADF unit root test for currency and stock bubble components

Variable		with width from the origin	With the width of the origin and trend	No width from origin and trend	Result
stock bubble	The value of the statistic	-2.8474 0.0531	-23134 0.0662	-2.3884 0.0166	Positive
currency bubble	Possibility	-2.5863 0.0970	-2.7274 0.2264	-2.2323 0.0249	Positive

the level of variables is less than -1.96, the variables are significant. In the next step, using estimated regression, the spread of bubbles between the gold market and The stock is evaluated. The findings are presented in Table 4.

Table 4: The Results of Bubble Propagation Test

hypothesis	The value of the statistic	Result
Contagion of the bubble from the gold market to the stock market	8.9447	Failure to reject the hypothesis

The results indicate that there is considerable evidence of the contagion of bubbles created in the gold market to the stock market. Based on this, the contagion of the bubble from the currency market to the stock market is confirmed.

5 Discussion and Conclusion

In this research, to investigate the existence of a price bubble in the gold market using (RADF), (SADF) and (GSADF) tests, the price bubble of the gold market was tested in a 6-year period (2015-2021) and the date of their creation and collapse It was found. To investigate the contagion of the gold market bubble to the stock exchange, a time variable regression model was used. The results indicate the existence of 4 periods of explosive behavior and the existence of multiple price bubbles in the price of gold. Based on this, the bubble periods in the Iranian gold market are related to the periods 2016:07:03-2016:10:4, 2018:01:7-2018:12:16,2018:12:30-2019:08:26 and 2019:12:10-2021:03:20 and the contagion of the price bubble from the gold market to the stock market has also occurred. Gold is welcomed by investors as an asset to be immune to price inflation and considering the significant changes in liquidity and exchange rate in Iran, these economic effects are expected to converge and affect the two markets. On the other hand, with the creation of crises, investors and company managers turn to the gold market to avoid inflation and extreme fluctuations, because the created crises cause fluctuations in the stock market. Therefore, both markets suffer from fluctuations according to the level of risk aversion and risk tolerance of investors and risk hedging companies.

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