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Applied-Research Paper

# Investigating the effects of time variables of gold, crude oil and foreign exchange markets on herding behavior in Tehran Stock Foreign exchange

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## ABSTRACT

Due to overlap between stock markets and financial markets, this study was an attempt to examine the herding behavior in the Iranian stock market and the crude oil, foreign exchange and gold markets. For this purpose, in this research, monthly data between 2011 and 2020 for Tehran Stock Foreign exchange were used. The results of the study based on two criteria explaining herding behavior indicate the existence of herding behavior of the stock market and crude oil, gold and foreign exchange markets. The results also show that it has had different effects on herding behavior in different periods. This issue has also been different in increasing and decreasing market periods. Therefore, gold is introduced as an important asset that influences herding behavior. Also, during the decreasing period of the stock market, herding behavior is not affected by the exchange and crude oil market, and in this period, the behavior of investors and investment risks in the stock market can be predicted without considering the exchange and crude oil market.

## 1 Introduction

Most economic and financial theories are based on the assumption that investors behave rationally when making decisions, which is consistent with the theory of economic man. In this case, it is assumed that investors consider all aspects when making an investment decision and make the most rational decision. However, it should be noted that sometimes factors cause irrational behavior and affect the way of making decisions. In the behavioral finance issues, the phenomenon of herding behavior is one of the most popular objective phenomena in financial markets reflecting an extreme tendency towards the performance of winners [1]. Regardless of whether a herding behavior is rational or irrational, many researchers believe that herding behavior is a by-product of information asymmetry in the market. Behavioral finance as an alternative to classical finance is based on hypotheses such as market efficiency and the rational expectations of investors. Researchers have stated that irrational behaviors affect the stock market [2]. Among these behaviors, herding behavior has been most welcomed by academics and market actors [3].

In experimental research on herding behavior, the stock market index has always been examined

with one of the other indices of the stock market. However, the research literature has well stated that the basic goods market and foreign exchange rates have been highly integrated and coordinated with traditional financial markets [4]. Despite the growth of research literature on the interaction of these two markets, neither of them examined the existence of herding behavior between these markets and even a few studies conducted on the herding behavior of basic goods have yielded conflicting results. The economic integration has increased significantly in recent decades due to greater dependence between stock markets and international markets [5]. It is now widely accepted that financial variables spread over time between assets and markets, so it is important to examine the effect of changes in other markets on stock market herding behavior. The question here is whether herding behavior occurs in the stock market in general. What factors are effective in shaping this behavior in the stock market in Iran? How has herding behavior changed over time?

As regards the commodities market, oil is a vital and strategic product for the world economy. The oil market has witnessed high instability and severe shocks during the past decade (e.g., the spectacular increase in oil prices during the summer of 2008 and the significant price decrease in mid-2014). Crude oil plays an important role in the world economy. Hamilton found that oil price increases cause US economic recessions [35]. Since then, many scholars have studied the impacts of crude oil on the economy. As an economic barometer, the relationship between stock market behavior and crude oil has attracted wide attention [41, 37]. Gold is also a strategic commodity. Energy traders use gold to hedge their position against a sudden fall in oil prices [45]. It is usually used during periods of turmoil as a safe-haven asset for equity markets [21, 22] and foreign exchange markets [45, 46]. Also policymakers, academics and journalists have frequently discussed the link between stock market and exchange rates in recent years. The link between stock market and exchange, crude oil and gold market has long been the subject of research and policy debates and it has received considerable attention in the financial economics literature [32, 47, 44, 39]. But, so far, the impact of these variables on stock market herding behavior has not been investigated in internal researches.

Humans are prone to herding mentality, conforming to the activities and orientations of others in many ways, from how they buy to how they invest. The fear of missing out on a profitable investment idea is often the driving force behind herding behavior, especially following good news or after an analyst releases a research note. Due to the large volatilities in the prices of gold, exchange and crude oil, these variables can affect herding behavior in the stock market [43]. Therefore, by the results of this study, the causes of herding behavior of investors and their adherence to each other's investment can be investigated by economic variables.

Accordingly, the aim of this study is to investigate the herding behavior in the Iranian stock market and the crude oil, foreign exchange and gold markets. Therefore, after reviewing the theoretical and experimental foundations of the study, the research methodology will be presented and the experimental findings obtained from the present study will be presented and finally, conclusion and discussion will be presented.

## 2 Literature Review

Gold and crude oil are considered the world's most strategic commodities and, therefore, their prices are strategically more important than those of other commodities. The technology revolution that has

occurred since 2000, accompanied by the boom in international trade, leads to the characterization of oil as a global commodity with high volatility. Similarly, gold is known as the most strategic metal, as a movement in gold price generates a parallel movement in other metal prices. In the last decade, these commodity prices were not determined by basic market supply and demand. Indeed, the US crisis in 2002<sup>1</sup> generated a simultaneous expansion in both the oil and gold indices [34]. On the other hand, the exchange rate has been very important for the investment behavior in the stock market due to the many fluctuations it has had in recent years.

We note that research on commodity markets, especially the oil and gold markets, has evolved. The literature related to the gold market started by studying market efficiency, in line with neoclassical finance [19, 31, 25]. At the same time, researchers have been interested in the price of oil and its impact on economic activity [35]. Moreover, in line with the emergence of behavior finance, the literature has focused on the relationship of these markets (oil, gold and exchange rate) with the stock market. Further, gold and exchange rate are considered an asset for portfolio diversification [38, 40], while oil price is shown as counter-cyclical, with respect to the stock market [29, 33, 30, 42]. Research in this area has evolved in order to explore the main fundamental drivers of each market. Therefore, oil and gold prices and exchange rate, and their relationship with some macroeconomic factors and financial behavior, are analyzed. Some researchers consider gold a dollar hedge [48, 26], others consider it an inflation hedge [20, 27, 24], and others consider it a safe haven during periods of crisis [21, 22]. Further, oil price fundamental drivers consist basically on oil supply, demand factors, price shocks, world economic growth, exchange rate [28, 36]. According to the mentioned literature, the relationship between gold, crude oil and exchange market with financial behavior was also investigated [49, 23].

Chiang Thomas et al., used the VAR model, which includes short-term interest rates and industrial production to study the relationship between stock prices and oil prices. He found an important relationship between oil prices and other variables. In a study conducted found a negative relationship between the return on the basic goods index and stocks and bonds [6]. Choi & Hammoudeh, investigated the relationship between the WTI daily price and the S&P 500 stock index They found that oil price movements affected stock market returns. In this regard, Choi & Hammoudeh, examined the relationship between several goods prices (Brent oil, WTI oil, copper, gold and silver) and the S&P 500 index and found that goods prices affected stock market returns. In short, goods prices play a major role in explaining stock markets. He stated that the basic goods market and the stock market could move like a market in times of instability and high volatility [7]. It is likely that herding behavior in the stock market to transfer under the influence of global market shocks, either directly through prices or what triggers behavior in the stock market and the crude oil market. In fact, new empirical evidence has examined the dynamic relationship between shocks in crude oil prices and shocks in financial market indices.

Büyüksahin et al., found evidence of herding behavior in the stock market during the 1997 financial crisis. Given what was stated above, the importance of the effect of investors' tendencies on herding behavior as an indicator of investors' tendencies and examining the herding behavior in each market and the herding behavior between the stock market and the crude oil market has a great importance [8].

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<sup>1</sup> The 2002 US crisis involved a high inflation rate, the depreciation of the US dollar, and a manipulation of the oil supply by OPEC.

The present study investigates the herding behavior between the two markets, namely the stock market and the crude oil market for the first time. However, studies such as Chang et al., have stated that herding behavior in the basic goods markets or financial markets leads to market irregularities by causing the price of assets to fluctuate too much from their equilibrium value [9]. In fact, Avramov as has stated, irrational investor behaviors destabilize prices, leading to market instability. Froot et al. also state that the tendency to imitate each other's behavior may be the source of fluctuations. Accordingly, Avramov examined the relationship between individual fluctuations and herding behavior and found that herding behavior increases market fluctuations [10]. Moreover, studies of herding behavior have well shown that herding behavior is common during market turmoil and financial crises. In a case study by Balcilar, in Taiwan, they found evidence of herding behavior, especially during a market recession [11].

In Iran, some studies have been conducted in the area of herding behavior. For example, Veysi, examined the effect of herding behavior on fluctuations in the returns of the Tehran Stock Foreign exchange from April 2006 to September 2015 and the results showed that herding behavior has a positive and significant effect on stock return fluctuations in the study period [12]. Shayestehmand, [13] examined the effect of intangible information on the herding behavior of institutional investors using the Christie & Huang, [17] models for a period between 2010 and 2014 in the Tehran Stock Foreign exchange. Results of his research confirmed the existence of intangible information on the herding behavior of institutional investors.

In a study entitled “Herd Behavioral in Tehran Stock Exchange Based on Market Microstructure (case study: Mokhaberat Company)”, Kobari et al., examined herding behavior in buying and selling of companies’ stock. The results showed that there is a herding behavior in buying and selling in the stocks of the telecommunication company during the study period, and the herding behavior of selling is more than the herding behavior of buying [14].

Vares et al., examined the “Herd Behavior Analysis in Tehran Stock Exchange with Chiang and Zheng Model”, The results showed that the LSV model confirms the existence of herding behavior, and in buying stocks, they show higher herding behavior than in selling and trading large stocks [14].

Jamshidi et al., examined the Studying the Overconfidence and Representativeness Biases of Individual Investors in Tehran Stock Exchange. He investigated the difference between herding behavior in large and small funds. The result indicated that the herding behavior between large and small funds during the recession is significantly different [15].

Saedi et al., examined the Effect of the Manager’s Excessive Self-Confidence on Stock Returns and Unsystematic Stock Risk Given the Dual Role of Managing Director: Evidence from Tehran Stock Exchange. The results showed that there is no herding behavior during the boom of the stock market, but using daily data, they observed herding behavior during the recession [16].

### 3 Methodology

In the study of herding behavior, financial literature is divided into two main branches. The first branch is measures of herding behavior based on return dispersion Christie & Huang, [17] and Chang et al., [2]. The second is a statistical criterion based on analysts' transactions Lakonishok et al., [18]. In this study, based on the approach of Chang et al., [2]. who expanded the studies of Christie & Huang,

[17] is as follows:

$$CSAD = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{m,t}| \quad (1)$$

Where, N represents the number of companies in the market, R is the return of securities i in period t,  $R_{m,t}$  is average return of securities N from the market portfolio for day t based on CAPM Chang et al., [2], hypothesized that the absolute deviation of returns increase and is a linear function of market returns. Therefore, in herding behavior, the positive and linear relationship between dispersion and market returns will no longer continue.

To test the existence of herding behavior, Chang et al., [2] suggested the following regression:

$$CSAD_t = \alpha + \lambda_1 |R_{m,t}| + \lambda_2 (R_{m,t})^2 + \varepsilon_t \quad (2)$$

Where, the negative coefficient  $\lambda_2$  indicates the existence of herding behavior.

Thus, the herding behavior in each of the foreign exchange, gold and oil markets can be calculated according to the study conducted by Bandopadhyaya. Accordingly, instead of deviating from the returns of the entire stock market, deviations from the returns of each of the foreign exchange, gold and oil markets are also considered, which is called herding behavior on each of these markets [4].

For the foreign exchange market, the sectional standard deviation of each i share in the stock foreign exchange from the foreign exchange market will be as follows.

$$CSAD_{EX,t} = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{EX,t}| \quad (3)$$

$$CSAD_{EX,t} = \alpha + \lambda_1 |R_{EX,t}| + \lambda_2 (R_{EX,t})^2 + \varepsilon_t \quad (4)$$

For the gold market, the sectional deviation of each i<sup>th</sup> share in the stock market from the gold market will be as follows.

$$CSAD_{Gold,t} = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{Gold,t}| \quad (5)$$

$$CSAD_{Gold,t} = \alpha + \lambda_1 |R_{Gold,t}| + \lambda_2 (R_{Gold,t})^2 + \varepsilon_t \quad (6)$$

For the crude oil market, the sectional standard deviation of each  $i^{\text{th}}$  stock on the stock foreign exchange from the oil market will be as follows.

$$CSAD_{oil,t} = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{oil,t}| \quad (7)$$

$$CSAD_{oil,t} = \alpha + \lambda_1 |R_{oil,t}| + \lambda_2 (R_{oil,t})^2 + \varepsilon_t \quad (8)$$

Accordingly, the negative coefficient  $\lambda_2$  in equations (4), (6) and (8), respectively, indicates the existence of herding behavior on foreign exchange, gold and crude oil markets.

Investigating the existence of herding behavior in the capital market affected by each of the markets can be expressed as follows.

$$CSAD_t = \alpha + \lambda_1 |R_{m,t}| + \lambda_2 (R_{m,t})^2 + \lambda_3 |R_{EX,t}| + \lambda_4 (R_{EX,t})^2 + \varepsilon_t \quad (9)$$

$$CSAD_t = \alpha + \lambda_1 |R_{m,t}| + \lambda_2 (R_{m,t})^2 + \lambda_3 |R_{Gold,t}| + \lambda_4 (R_{Gold,t})^2 + \varepsilon_t \quad (10)$$

$$CSAD_t = \alpha + \lambda_1 |R_{m,t}| + \lambda_2 (R_{m,t})^2 + \lambda_3 |R_{Oil,t}| + \lambda_4 (R_{Oil,t})^2 + \varepsilon_t \quad (11)$$

In this study, in recent equations, the negative coefficient  $\lambda_2$  indicates the herding behavior of investors in the stock market and the negative coefficient  $\lambda_4$  indicates the herding behavior at the stock market level influenced by other markets.

This issue in increasing and decreasing markets for other markets can also be rewritten as follows.

$$CSAD_{Ex,t}^u = \alpha + \gamma_1^u |R_{Ex,t}^u| + \gamma_2^u (R_{Ex,t}^u)^2 + \varepsilon_t, \quad R_{Ex,t} > 0 \quad (12)$$

$$CSAD_{Ex,t}^D = \alpha + \gamma_1^D |R_{Ex,t}^D| + \gamma_2^D (R_{Ex,t}^D)^2 + \varepsilon_t, \quad R_{Ex,t} < 0$$

$$CSAD_{Oil,t}^u = \alpha + \gamma_1^u |R_{Oil,t}^u| + \gamma_2^u (R_{Oil,t}^u)^2 + \varepsilon_t, \quad R_{Oil,t} > 0 \quad (13)$$

$$CSAD_{Oil,t}^D = \alpha + \gamma_1^D |R_{Oil,t}^D| + \gamma_2^D (R_{Oil,t}^D)^2 + \varepsilon_t, \quad R_{Oil,t} < 0$$

$$CSAD_{Gold,t}^u = \alpha + \gamma_1^u |R_{Gold,t}^u| + \gamma_2^u (R_{Gold,t}^u)^2 + \varepsilon_t, \quad R_{Gold,t} > 0 \quad (14)$$

$$CSAD_{Gold,t}^D = \alpha + \gamma_1^D |R_{Gold,t}^D| + \gamma_2^D (R_{Gold,t}^D)^2 + \varepsilon_t, \quad R_{Gold,t} < 0$$

Accordingly, the models of herding behavior in the stock market in increasing and decreasing periods in each of the gold, foreign exchange and oil markets can be expressed as follows.

$$\begin{aligned}
CSAD_t^u &= \alpha + \gamma^u_1 |R^u_{m,t}| + \gamma^u_2 (R^u_{m,t})^2 + \gamma^u_3 |R^u_{EX,t}| + \gamma^u_4 (R^u_{EX,t})^2 \\
&\quad + \gamma^u_5 |R^u_{Gold,t}| + \gamma^u_6 (R^u_{Gold,t})^2 + \gamma^u_7 |R^u_{Oil,t}| + \gamma^u_8 (R^u_{Oil,t})^2 \\
&\quad + \varepsilon_t, \quad R_{m,t} > 0 \\
CSAD_t^D &= \alpha + \gamma^D_1 |R^D_{m,t}| + \gamma^D_2 (R^D_{m,t})^2 + \gamma^D_3 |R^D_{EX,t}| + \gamma^D_4 (R^D_{EX,t})^2 \\
&\quad + \gamma^D_5 |R^D_{Gold,t}| + \gamma^D_6 (R^D_{Gold,t})^2 + \gamma^D_7 |R^D_{Oil,t}| + \gamma^D_8 (R^D_{Oil,t})^2 \\
&\quad + \varepsilon_t, \quad R_{m,t} < 0
\end{aligned}
\tag{15}$$

The herding behavior in the stock market regarding the change in the returns of each of the foreign exchange, gold and oil markets will be examined in this study, which is considered as an innovation. Another innovation of this study is that unlike previous approaches in regression study where the estimation coefficients are constant, the approach of time variable parameters were used in the present study. In this approach, estimation coefficients can change over time. Accordingly, conventional models fail to calculate the parameters in these conditions, and it is better to develop a model that can calculate these facts and represent how herding behavior occurs over time and how different variables will affect it.

## 4 Findings

### 4.1 Statistical Population and Research Variables

The statistical population of this research is the total stock foreign exchange index and oil, gold and foreign exchange markets from the beginning of 2011 to the end of December 2020. (Table 1) summarizes the preliminary statistics on the studied variables for companies listed in stock foreign exchange.

**Table 1.** Statistical Characteristics of Research Variables

variable	mean	median	max	min	SD	skewness	kurtosis
Total index return	2.393	1.693	23.446	-7.893	5.778	0.762	3.574
Oil return	0.533	1.156	23.719	-28.127	8.627	-0.179	4.277
Gold return	-0.281	0.445	13.026	-15.690	5.042	-0.126	3.589
Foreign exchange logarithm	10.086	10.367	11.775	9.188	0.616	-0.150	2.306

In the first step of this study, the existence of herding behavior of the stock foreign exchange between the study years on a monthly basis was investigated statically. Given what was stated in the third chapter, only the existence of herding behavior in each of the markets throughout the period is examined and it does not examine the existence of this behavior in a particular period.

(Table 2) presents the regression estimation of existence of herding behavior in the whole market without increasing and decreasing conditions. This table shows that the coefficient  $\gamma_2$  in the studied markets have a negative and significant effect. The existence of a negative coefficient for the squared variable market return indicates the reduction of companies' open deviations from the returns of the studied markets. Decreasing the open deviations of companies from market returns means that there is herding behavior in the market.

**Table 2.** Test of Static Herding Behavior at the Market Level

Market	parameter	Coefficient t	SD	Statistic t	probability	Coefficient of de-termination	Statistic F
Stock market	$\alpha$	8.327	0.367	22.662	0.000	55%	69.14 (0.00)
	$\lambda_1$	0.190	0.114	1.675	0.097		
	$\lambda_2$	-0.020	0.007	-2.999	0.003		
Oil market	$\alpha$	9.474	0.622	15.224	0.000	51%	52.07 (0.00)
	$\lambda_1$	0.285	0.157	1.819	0.072		
	$\lambda_2$	0.012	0.007	1.812	0.073		
Gold market	$\alpha$	8.604	0.569	15.117	0.000	45%	47.29 (0.00)
	$\lambda_1$	0.316	0.236	1.339	0.183		
	$\lambda_2$	-0.040	0.019	2.162	-0.033		
foreign exchange market	$\alpha$	9.266	0.424	21.864	0.000	62%	92.01 (0.00)
	$\lambda_1$	0.359	0.121	2.951	0.004		
	$\lambda_2$	-0.011	0.004	2.880	-0.005		

(Table 3) presents the results of examining the existence of herding behavior in each of the markets in their increasing and decreasing conditions based on Equations (12) to (14). As the results show, the coefficient  $\gamma^D_2$  in the decreasing markets for the stock market and the gold market have a negative and significant effect at the significance level. The existence of a negative coefficient for the variable of squared market return indicates the reduction of deviations of companies' returns from market returns, when the market is in recession and decreasing condition. Decreasing the open deviations of companies from market returns means the existence of herding behavior in these two markets.

**Table 3.** Test of Static Herding Behavior in Increasing and Decreasing Conditions of Each Market

Market	parameter	Coefficient t	SD	Statistic t	probability	Coefficient of de-termination	Statistic F
Stock market	$\alpha^D$	6.943	0.761	9.122	0.000	52%	22.3 (0.00)
	$\gamma^D_1$	1.181	0.498	2.373	0.019		
	$\gamma^D_2$	-0.116	0.066	-1.754	0.082		
	$\alpha^U$	8.694	0.509	17.081	0.000		
	$\gamma^U_1$	0.119	0.136	0.877	0.382		
	$\gamma^U_2$	0.023	0.007	3.115	0.002		
Crude oil market	$\alpha^D$	8.490	0.571	14.869	0.000	54%	29.5 (0.00)
	$\gamma^D_1$	0.564	0.148	3.817	0.000		
	$\gamma^D_2$	-0.002	0.005	-0.365	0.716		
	$\alpha^U$	10.503	1.798	5.840	0.000		
	$\gamma^U_1$	-0.041	0.331	-0.123	0.902		
Gold market	$\gamma^U_2$	0.030	0.012	2.439	0.016	42%	23.4 (0.00)
	$\alpha^D$	8.487	0.809	10.495	0.000		
	$\gamma^D_1$	0.286	0.311	0.922	0.359		
	$\gamma^D_2$	-0.057	0.023	-2.502	0.014		
	$\alpha^U$	8.246	0.753	10.945	0.000		

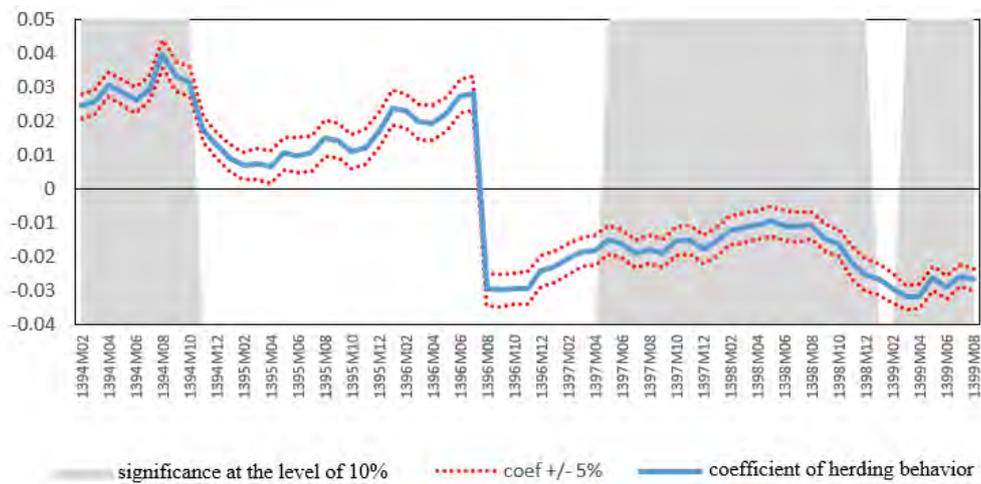
	$\gamma^U_1$	0.656	0.345	1.897	0.060		
	$\gamma^U_2$	-0.005	0.030	-0.163	0.871		
foreign ex- change mar- ket	$\alpha^D$	9.168	0.678	13.514	0.000	63%	29.7 (0.00)
	$\gamma^D_1$	0.538	0.576	0.934	0.352		
	$\gamma^D_2$	0.008	0.044	0.181	0.857		
	$\alpha^U$	9.232	0.669	13.790	0.000		
	$\gamma^U_1$	0.317	0.107	2.961	0.004		
	$\gamma^U_2$	0.013	0.003	4.007	0.000		

Source: Research calculations

Investigating the herding behavior in a long term does not seem to reflect the reality of the market, because the coefficient presented for the whole period and in static conditions has been estimated. However, the stock market is a dynamic market and during the fluctuations of this market and the conditions of other markets, the information set of people has undergone many changes and in many cases, by overlooking their information, they follow others and cause herding behavior. Thus, estimating the time variable of the regression parameters mentioned in the previous section makes it possible to estimate a series of these parameters over time instead of a specific value of the parameter explaining the herding behavior, which makes it possible to explain the herding behavior during the period. For this purpose, in the present study, the rolling window approach is used to estimate the parameter of herding behavior as a time variable. In this approach, it is necessary to consider a fixed estimation period used to estimate the model parameters.

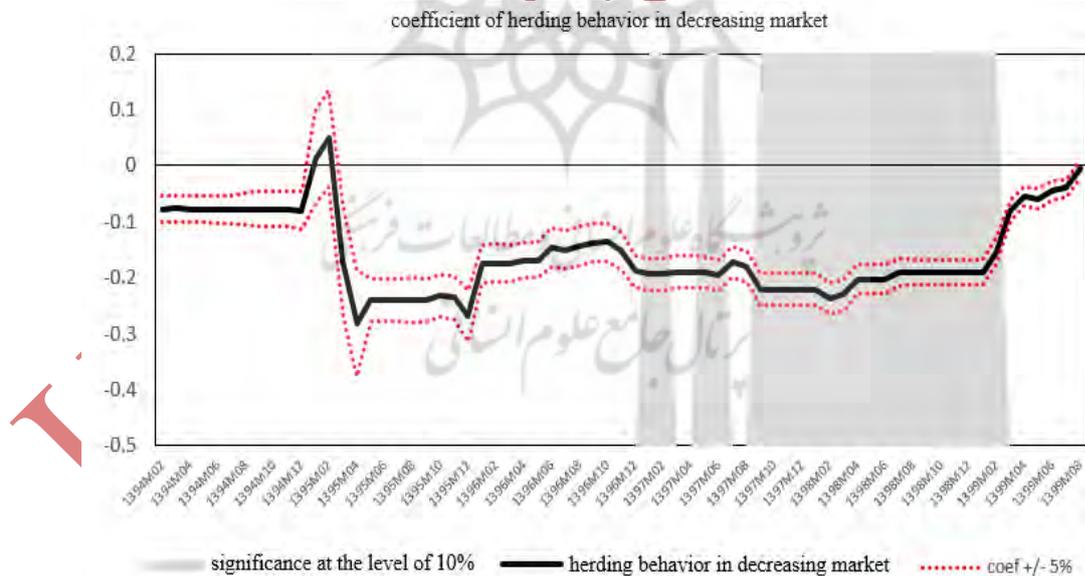
This estimation sample is rolled over the entire data period, and then the parameter values for each period will be estimated. In this study, estimation period is considered at four years equal to 48 months and the herding parameter values for different models are estimated from the 49th month to the end of the period. The results of estimating the values of the  $\gamma_2$  coefficient parameter in the stock market for the out of sample period are shown in (Figure 1). In this chart, highlighted values shows the significance of the estimated parameter at the 90% confidence level, and the 95% confidence return for the estimated parameter has been specified as a dotted line. It should be noted that other parameters of the model have been estimated in this study and only the desired parameter ( $\gamma_2$ ) is presented to explain the herding behavior in this chart.

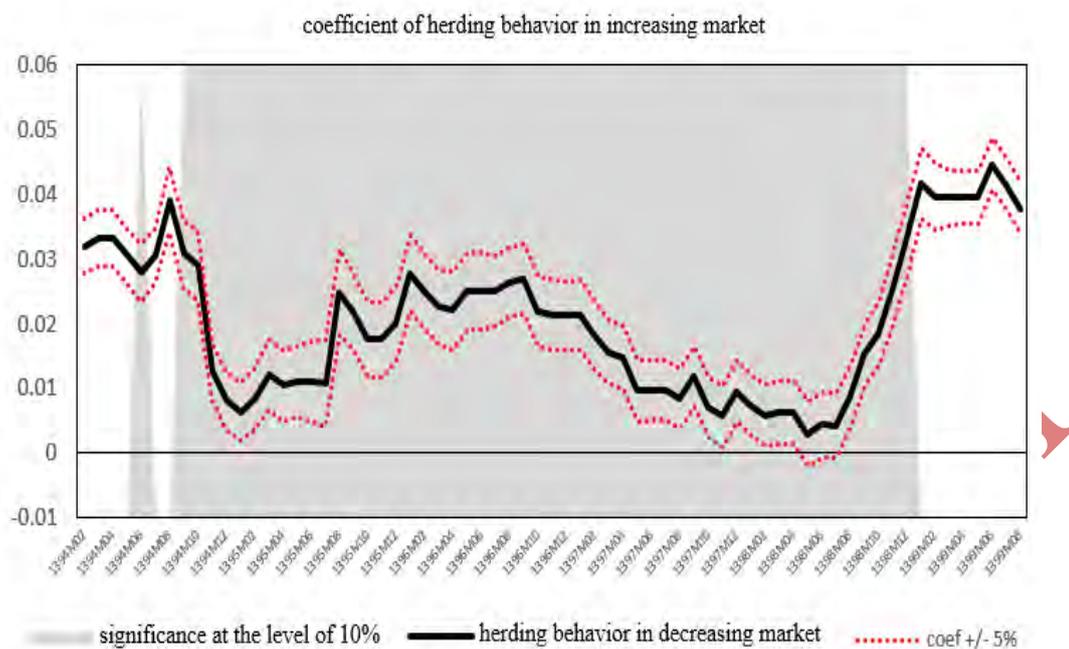
As shown, during the study period, the periods that have a negative and significant impact at the level of 90% significance indicate the existence of herding behavior in the stock market. This (Figure 1) that there was a herding behavior in the stock market in the periods between August 2018 to April 2020 and from June 2020 to the end of the period (December 2020), since the estimated parameter is negative and significant and the existence of a negative coefficient for the variable of squared market return indicates the reduction of companies' open deviations from the returns of the studied markets. Decreasing the open deviations of companies from market returns means that there is herding behavior in the market.



**Fig. 1:** Estimation of the Time Variable of Herding Parameter in the Stock Market

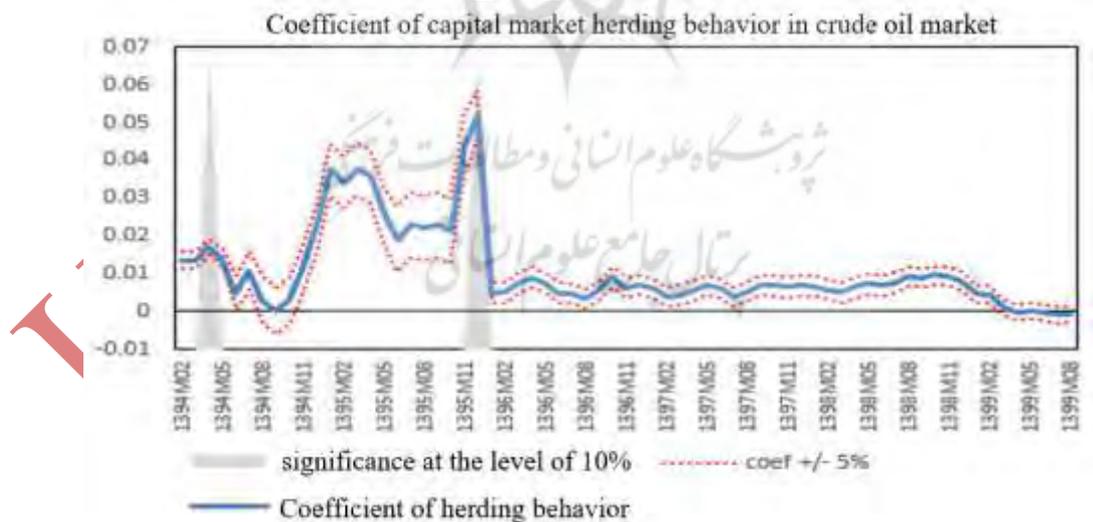
(Figure 2) shows the herding behavior in the stock market in the increasing and decreasing conditions (2). As shown in this chart, in the increasing period, while the estimated coefficient is significant, it has positive values, indicating the absence of herding behavior in the stock market in the increasing period. In other words, in increasing period, investors make trades based on their own information and analysis and the existence of herding behavior is not confirmed. However, during the decreasing period between 2018 and early 2020, this coefficient is negative and significant, indicating the existence of herding behavior in the stock market and when this market experience negative returns.



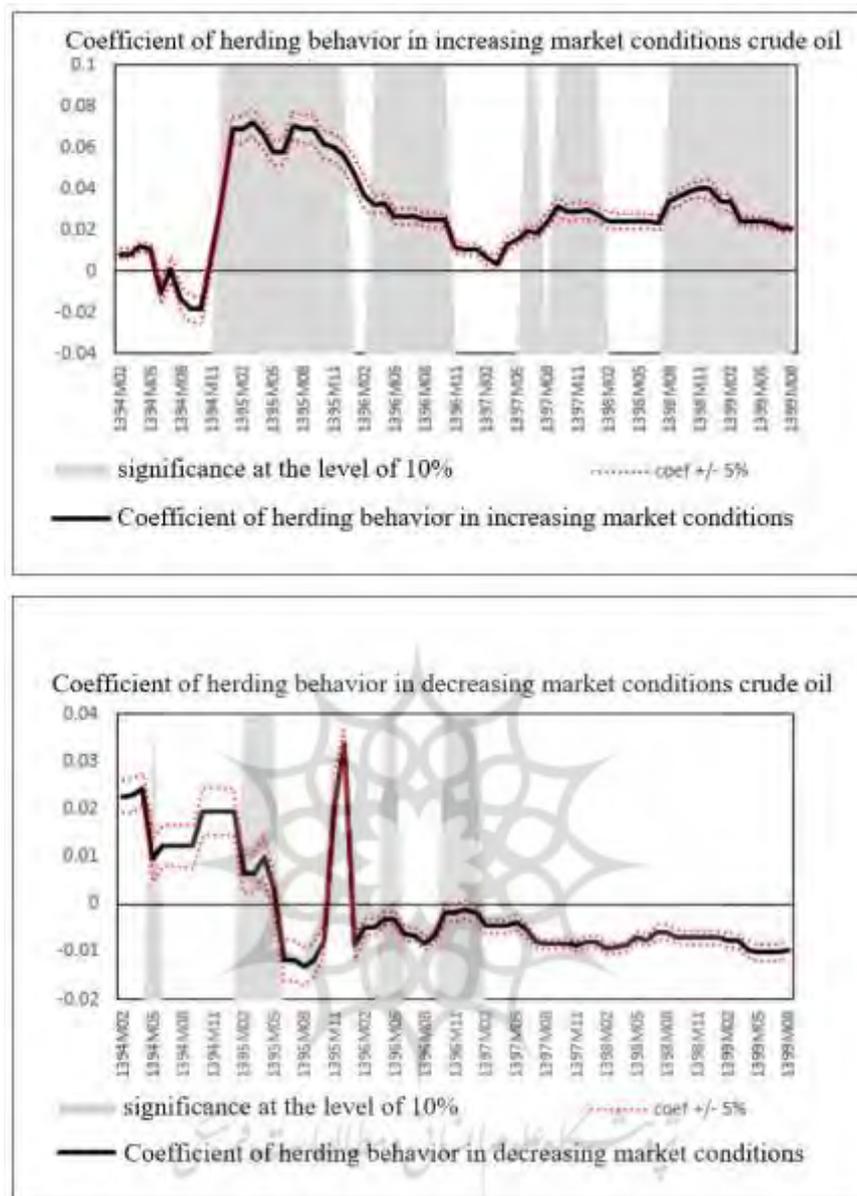


**Fig. 2:** Estimation of Time Variable of Herding Parameter in Increasing and Decreasing Stock Market Conditions

(Figure 3) shows the results of estimating the values of the  $\gamma_2$  coefficient parameter to explain the herding behavior on the crude oil market for the out of sample period. As shown, during the study period, the periods did not have a significant effect on the sectional deviation of stock returns from the oil market, indicating the absence of herding behavior on the crude oil market (Figure 4).



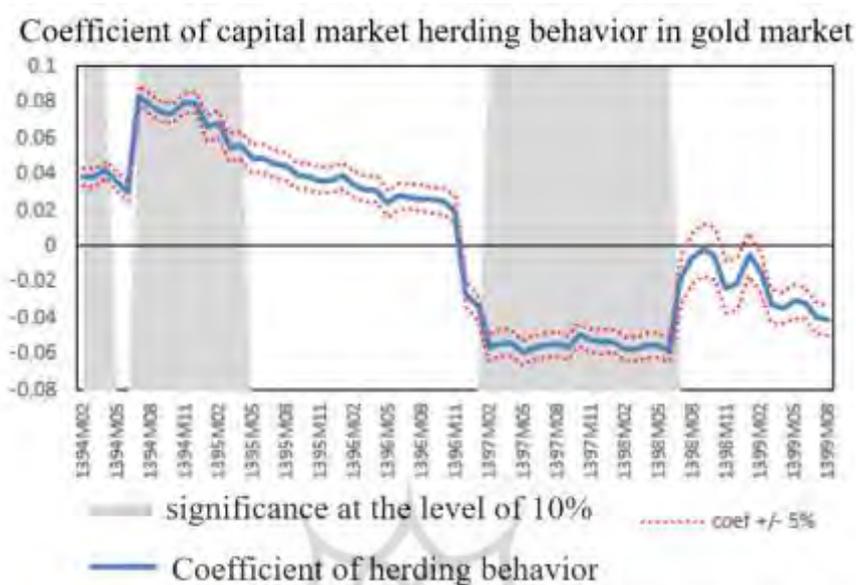
**Fig. 3:** Estimation of Time Variable of Herding Parameter on Crude oil Market



**Fig. 4:** Estimation of Time Variable of Herding Parameter on Crude oil Market in Decreasing and Increasing Conditions

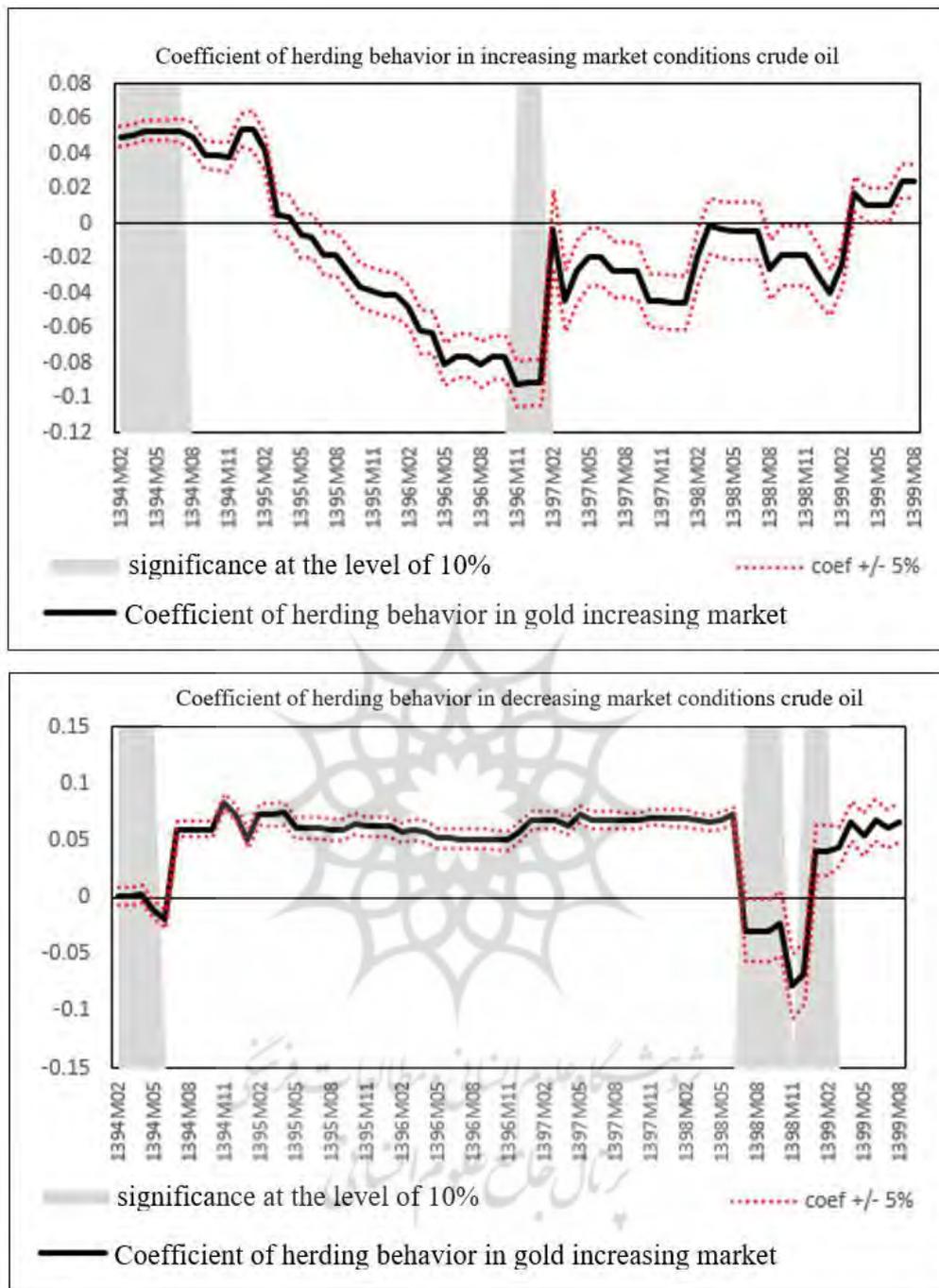
In examining the herding behavior on the crude oil market, the results show the fact that in the increasing period of the oil market, the coefficient of herding behavior has been positive in all periods, indicating that when the crude oil market is increasing, sectional standard deviation of the stock return from oil market return is increasing. Hence, there has been no herding behavior on the crude oil market. Also, during the decreasing period, only in two short periods in the second quarter of 2017 and the quarter ending in 2019, herding behavior in the stock market on the crude oil market has occurred among stock market actors in Iran.

(Figure 5) shows the results of estimating the parameter values of coefficient  $\gamma_2$  on the gold market in Iran to explain the relationship between squared market return and the values of the standard deviation of the stock return from gold market return.



**Fig. 5:** Estimation of the Time Variable of Herding Parameter on Gold Market

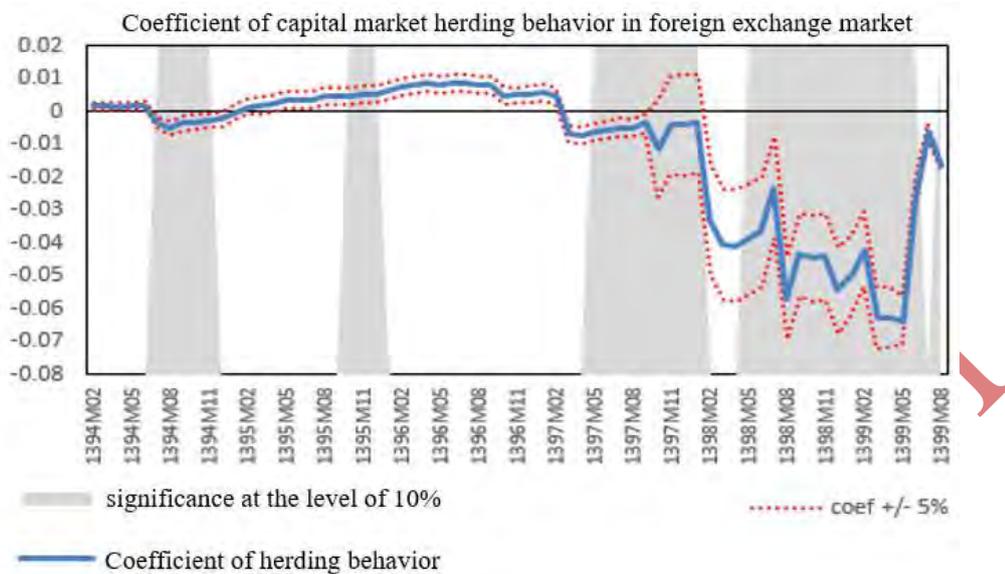
As shown, in the study period, the estimated coefficient of herding behavior from the beginning of 2018 to the end of summer 2019 is negative and significant. It indicates that there is an inverse relationship between the squared gold market returns and the sectional deviation of the stock market and the gold market returns. (Figure 6) shows the results show that in the increasing period, herding behavior on this market has occurred only in the period of February 2017 to May 2018. On the other hand, in the decreasing period from the beginning of autumn 2019 to June 2020, the herding behavior on this market is confirmed.



**Fig. 6:** Estimation of Time Variable of Herding Parameter of Gold Market in Decreasing and Increasing Conditions

(Figure 7) shows the results of estimating the values of the  $\gamma_2$  coefficient parameter to explain the herding behavior on foreign exchange market for the out of sample period. As shown, from the beginning of August 2018 to end of April 2019 and from the beginning of August 2019 to October 2020, herding behavior has occurred in this market, since the parameter values of coefficient  $\gamma_2$  in this period

were negative and statistically significant.

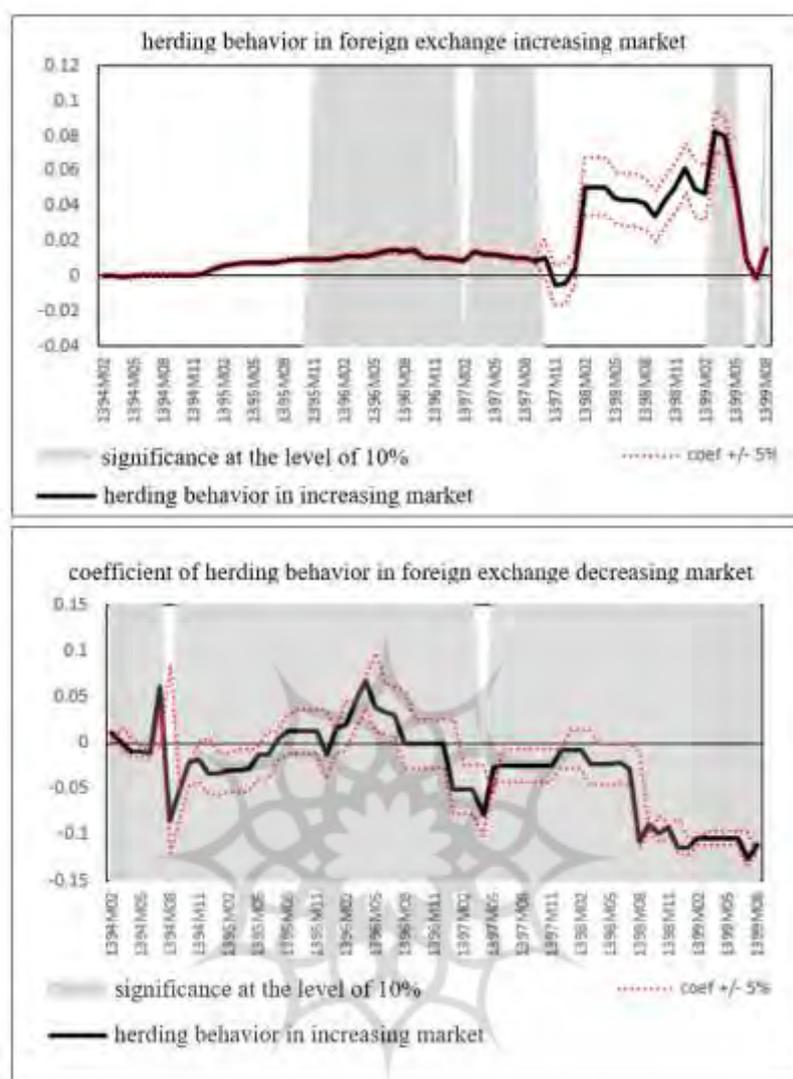


**Fig. 7:** Estimation of the Time Variable of Herding Parameter in the Foreign Exchange Market

In investigating herding behavior in the foreign exchange market, the results show the fact that during the decreasing period of foreign exchange market in Iran, the coefficient of herding behavior has been estimated significantly and negatively from the beginning of winter 2015 to the end of the period, except July 2018. It indicates that when the foreign exchange market is in decreasing period, the sectional deviation of the stock return from the foreign exchange market return is decreasing, thus a herding behavior in foreign exchange market occurred. Also, during the increasing period, there was no statistical evidence of herding behavior in this market (Figure 8).

Uncorrected

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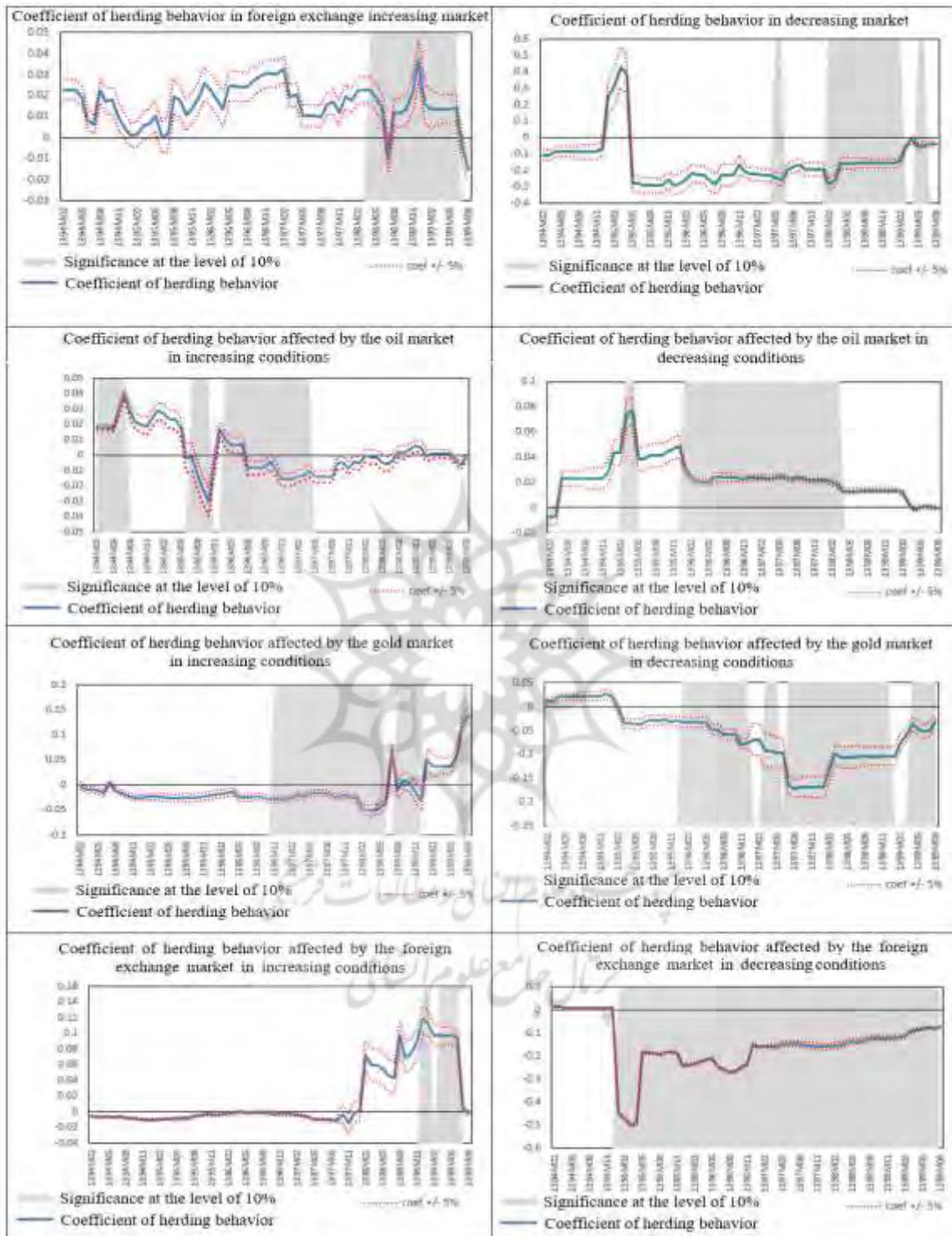


**Fig. 8:** Estimation of Time variable of Herding Parameter in Foreign Exchange Market in Decreasing and Increasing Conditions

In this section, the effect of other markets on the herding behavior in the stock market is estimated. According to the last equation in the third chapter, time variable approach is used to estimate equation parameters to explain the effect of oil, gold and foreign exchange markets on the herding behavior in the stock market (15). (Figure 9) presents the parameters measuring herding behavior in decreasing and increasing market conditions.

The results of investigating the herding behavior in the stock market in the presence of other markets show that there is a herding behavior in the stock market during the decreasing period of stock market from the beginning of May 2019 to the end of spring 2020 and from August 2020 to November 2020. However, in the stock market increasing period, the existence of herding behavior in the study period cannot be confirmed. Hence, it can be concluded that the existence of herding behavior in the stock market is confirmed. It indicates the inefficiency of the stock market, which should be considered by

investment companies as well as stock market actors in explaining the optimal investment portfolio during decreasing period.



**Fig. 9:** Estimation of the Time Variable of Stock Market Herding Behavior Affected by the Decreasing and Increasing Conditions of all Markets

## 5 Discussions and Conclusion

Investigating the effect of crude oil market on herding behavior in the stock market during the decreasing period of market suggests that its effect on herding behavior has been positive throughout this period, and in some periods, it has been significant. It indicates the absence of herding behavior. In other words, the return of the oil market did not cause herding behavior in the stock market in the study period. This evidence shows that changes in the crude oil market have not affected the trading process of capital market actors and have not led to herding behavior. The effect of oil market in the increasing period of stock market in one-year periods from August 2017 to August 2018 has had a significant effect on the occurrence of herding behavior in the stock market. Also, it is true for a period from October 2016 to February 2016. Therefore, it can be stated that the existence of herding behavior of investors in the oil market in the decreasing period of stock market is not confirmed. However, in the increasing period, this hypothesis is confirmed in two different periods, and it can be stated that the herding behavior in the stock market has been influenced by the crude oil market. This result can be very helpful for market actors and investment companies in explaining the risk coverage of financial transactions and optimal explanation of the stock portfolio during decreasing period. Because during the decreasing period of stock market, the herding behavior is not affected by the oil market, and therefore, in this period, investors' behavior can be investigated and investment risks can be predicted regardless of the oil market. In examining the effect of the gold market, it is clear that the price of gold has caused herding behavior in the stock market from the end of 2016 to the end of 2017 and from May 2018 to September of the same year and from November 2018 to the end of 2019.

It should be noted that the effect of gold on herding behavior in the stock market in 2020 has been significant among stock market actors. The results also show that the effect of the gold market on the herding behavior in long periods between February 2017 to September 2019 is confirmed in the increasing period of the stock market, since in this period, the estimator parameter is negative and significant, which confirms the effect of the gold market on the existence of herding behavior in increasing period. Therefore, based on the results obtained in this study, in the mentioned periods, increasing the return of gold market in decreasing and increasing period of the stock market in the specified periods causes herding behavior, which is based on the hypotheses of this research. Hence, it can be stated that the herding behavior in the market increases and decreases and it changes over time under the influence of gold market among investors of the Tehran Stock Foreign exchange. Therefore, gold is introduced as an important asset that influences herding behavior. Thus, managers and policy makers should consider this issue so that they can help increase market efficiency and prevent potential bubbles caused by herding behavior. Finally, in explaining the effect of foreign exchange market returns, it can be stated that from the beginning of winter 2015 to the end of the study period, foreign exchange market and increases in returns in this market causes herding behavior significantly. This result shows that the foreign exchange market has been influential in the herding behavior of investors in the stock market, so that it has been one of the main reasons for the increase in this behavior in the stock market. However, during the increasing period of the foreign exchange market, it did not have a significant effect on the occurrence of herding behavior in the stock market. Thus, it can be stated that the herding behavior in the decreasing market and over time among investors of the Tehran Stock Foreign exchange is affected by the foreign exchange market. Therefore, during the decreasing period of the stock market, herding behavior is not affected by the exchange market, and in this period, the behavior of investors and investment risks in the stock market can be predicted without considering the exchange market.

The present study was conducted to examine, identify and classify the time variable of herding behavior of shareholders in the Tehran Stock Foreign exchange and to examine the effect of foreign exchange, gold and crude oil markets on the herding behavior of shareholders in the Tehran Stock Foreign exchange. To achieve these goals, the time series data of Tehran Stock Foreign exchange market in the period 2011 to 2020 were used on a monthly basis and data were examined based on regression method. The results of the time variable of estimating herding behavior in the stock market in increasing period show that while the estimated coefficient is significant, it has positive values, indicating lack of herding behavior in the stock market in the increasing period. In other words, during increasing period, investors make trades based on their own information and analysis, and the existence of herding behavior is not confirmed. However, during the decreasing period from 2018 to early 2020, this coefficient is negative and significant, indicating the existence of herding behavior in the stock market when this market experience negative returns. According to these results, since the existence of herding behavior in the Iranian stock market was confirmed, improving the mechanism for disseminating information about market stocks can reduce this behavior among shareholders in the market. Also, since the existence of herding behavior in the Iranian stock market is affected by the crude oil, gold and foreign exchange markets, it is recommended to conduct further studies to reduce herding behavior by considering the conditions of parallel markets.

The results of this study, in terms of the influence of oil, gold and exchange markets on the behavior of investors, are consistent with the studies of Xu et al. [23], Omidi et al. [49], Sahebi Fard et al. [50], Zamani et al. [51] and Bildirici & Sonustun [52].

Our findings should be important for both policy-makers and investors. Based on these results, investors can optimize their strategies by understanding the nature of price of gold, exchange and crude oil. Similarly, policymakers and financial authorities can improve their expectations based on their knowledge of the sources of gold, exchange and crude oil. For future researchers, it is suggested to investigate the effects of volatilities in the price of gold, exchange and crude oil on herding behavior. Also, researchers can examine the effect of cryptocurrencies on herding behavior.

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