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Herding behavior and government policy responses: Evidence from COVID-19 effect

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ABSTRACT

The purpose of this study is to investigate the impact of a sudden shock from the COVID-19 epidemic on the behavioral bias of investors in the stock market of Iran as a developing country. The study also examines whether the government response to the COVID-19 pandemic can reduce investor herding behavior. We have used the Cross-sectional absolute deviation (CSAD) to measure securities dispersion from market returns. The studied period includes the cross-sectional data of the top 50 companies listed on the stock exchange during 2381 working days of the market (from March 1, 2012, to March 1, 2022). Furthermore, we use the semi-parametric estimator of the quantile regression for the data on the Iranian government response during the COVID-19 epidemic taken from the Oxford COVID-19 Government Response Tracker (OxCGRT). The main findings are in order. First, results show that the COVID-19 pandemic caused the formation of herding behavior aggravated by market volatility. Second, we document that the government response stringency index is unsuccessful in reducing investor herding behavior in the Iranian stock market. Finally, given the evidence that herding behavior, as a form of behavioral distortion, can drive security prices away from equilibrium values supported by fundamentals and cause price bubbles, our findings have important implications for policymakers and investors to mitigate herding effects and mis valuations.

1. Introduction

The outbreak of COVID-19 caused a public health emergency in most countries of the world [1]. The unprecedented disease was first identified in December 2019 in Wuhan City (China) and has rapidly spread across the world to become a global pandemic [2]. The fast spread of COVID-19 (Coronavirus) has had significant effects on financial markets around the world, while it is still difficult to estimate and predict the scale of its social and economic consequences [3].

The financial market plays a vital role in any economy and facilitates the production sector [4]. There are studies of the financial markets of some countries that discuss the economic risks of the COVID-19 epidemic citing managerial and policy implications. For instance, in two separate studies, Ref. [5] have investigated the impact of the COVID-19 pandemic on the efficiency of European stock markets [5] and exchange rate markets [6]. In both studies, indicators and data indicate a decrease in market efficiency during the COVID-19 outbreak. In a recent study, Ref. [7] show that the increasing number of deaths and reported cases of COVID-19 creates fear among investors due to its risk to health and global economic activities. This fear of death and infection could lead to behavioral abnormalities such as increased trading and unreasonable herding behavior among stock market investors [7]. Christie and Huang

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(1995) define herding as 'an environment in which investors follow the decision of the group, even if it conflicts with their own private signals'.

Empirical studies provide evidence that government responses to the COVID-19 pandemic can affect market volatility and improve market quality. For example, there is a negative relationship between volatility and the intensity of government actions in developed markets and it decreases volatility [8]. In the study of [2], Vietnamese government policies have a positive effect on market quality, except for school closure policy (negative effect) and international travel (no effect). However, in some countries, the implementation of restrictions and government responses to the COVID-19 pandemic appear to have increased herding behavior and worsened the liquidity of stock markets [9,10]. For example [11], examined the stringency of policy responses to the novel coronavirus pandemic in 67 countries around the world and showed that non-pharmaceutical interventions significantly increased stock market volatility. Therefore, it is necessary to investigate the effect of each government's policy interventions and responses on the liquidity and stability of that country's market during the crisis period.

Although a large number of studies have been conducted to identify herding behavior in the past two decades, there are several gaps. First, the existing literature on the impact of exogenous shocks and rare events on stock market behavior is limited. For example, past studies observe the impact of local epidemics such as SARS and HIV/AIDS on financial markets [12,13], but there is limited research on how unprecedented global shocks such as COVID-19 affect market stock values. Second, most academic studies have focused on investigating behavioral bias in developed stock markets or rapidly expanding financial markets, while only a few studies have investigated behavioral bias in emerging markets. Third, rather than investigating a specific behavioral bias in the stock market, the existing research concentrates on the trading data using surveys and primary datasets that show the existence of irrational investment patterns. Furthermore, their results are not conclusive.

Specifically, the purpose of this paper is to investigate how the COVID-19 pandemic affects the herding behavior of investors in the Iranian stock market as a developing country. We have chosen the Iranian stock market as our target for two reasons.

First, Iran's stock market plays a key role for both companies and private individuals. Iran Stock Exchange is the main source of setting prices for the most important commodities such as cement and other goods as well as capital allocation for companies. Since 2020, Iran's economy has been significantly impacted by three major crises, COVID-19, severe economic sanctions, and high inflation [14]. As a result, financial markets, especially the stock market, do not have a logical connection with the other sectors of the economy and other financial markets of the world. Therefore, examining the impact of the COVID-19 epidemic on the economy of such a country is important and different. Because this market experiences different conditions compared to the major financial markets of the world, and to manage the epidemic and lessen its detrimental effects on the economy, this country must rely only on domestic resources.

Second, we have also studied the effect of the government policy responses in curbing COVID-19 on the behavior of investors in the Iranian stock market. The Iranian government, in the same way as other many countries, intervened and took many measures to contain the spread of COVID-19. In addition, following the increasing and unprecedented decline in the value of the national currency of Iran and the lack of a coherent policy to maintain the value of people's assets, people have been directed towards unproductive activities such as buying and selling currency, gold, and land [4]. Iran's economic policymakers have encouraged people to invest in the stock market in an effort to discourage people from doing such activities and compensate for the government's budget deficit through the stock market [14]. This has caused the majority of people to herd to invest in the financial markets, particularly the stock market, to preserve the value of their property, and if stock prices fall abnormally, a lot of individuals lose their properties.

Considering the background and motivation, our study is based on two main research questions.

First, is there any evidence of investor herding behavior in the Iran stock market during the Coronavirus crisis?

Second, is the severity of the government response effective in reducing herding behavior?

Following the questions, there is a novelty in this study because it is a pioneering empirical analysis that tries to evaluate the impact of the epidemic and health crisis on market-wide herding behavior with a new and comparative approach. This study helps the literature by providing a developmental basis for the academic body in perceiving how exogenous shocks and rare historical events affect stock market behavior. Second, investigating the herding bias in Iran's emerging market is of interest due to its closed economy, as investors share common fears and experience panic following each other into and out of securities. Our research provides a formative context for understanding the degree of inefficiency caused by behavioral bias during exogenous shock. Third, to the best of our knowledge, no other study has investigated the effect of stock market fluctuations on herd behavior during the outbreak of COVID-19 and the impact of strict government measures on herding behavior in Iran. Our study also fills this gap.

In the next step, to answer these questions, the movements of the Iran stock market have been analyzed separately for different subperiods (time scale). Our methodology is based on Christie and Huang (1995) and Chang et al. (2000), who proposed cross-sectional absolute deviation (*CSAD*) and cross-sectional standard deviation (*CSSD*) as measures of investor herd behavior. *CSAD* and *CSSD* measure the average distance between an individual stock return and the market return and help to ascertain whether an investor's decisions feature herding [15].

Given that Christie and Huang (1995) point out that herding behavior should occur during severe times and crises, we expect an increase in herding behavior during COVID-19 in the Iran stock market. The results of the current research showing a remarkable relationship between herding behavior and cross-sectional dispersion of stock returns, contribute to investors and policymakers to observe at what point the herd behavior occurred. The occurrence of herding behavior increases market volatility, which in turn plays an important role in the decision-making process of policymakers and portfolio allocation with the lowest possible risk for investors [16]. This study offers solutions to investors so that they can avoid big losses. In addition, the main question is how policymakers can help investors in Iran's financial markets in this exceptional situation. This study also helps policymakers in evaluating the consequences of their decisions, informing about how to manage the epidemic and improving the country's economic situation.

The remainder of this article is organized as follows. In Section 2, the relevant theoretical background is briefly discussed. The data and method used in our empirical estimations are explained in Section 3. Section 4 presents the empirical results. In Section 5, the empirical findings are discussed. Finally, the conclusions and their practical implications for participants in the stock market are presented in Section 6. Additionally, suggestions for future research are made.

2. Literature review

In the last decade, the study of the impact of COVID-19 on financial markets and investor behavior has been the main topic of economic research. The COVID-19 pandemic is one of the foremost unexpected crises that has affected the achievement of economic goals since late 2019 [17]. Also, limited studies have been done in this field. In addition, investigating herd behavior of investors in the stock market has recently attracted much attention. Without government intervention, no country can certainly overcome such a crisis [17]. Here, we first point out the effects of the epidemic on the financial markets and the behavior of investors, and then we examine the role of the government in controlling the effects of the epidemic on the financial market and herd behavior.

2.1. The impact of COVID-19 on financial markets and investor behavior

One aspect of the COVID-19 pandemic is that it is not equally distributed throughout the world, so a homogeneous effect on financial markets all over the world cannot be expected [4]. For instance, the majority of nations have felt the negative impact of the COVID-19 epidemic after its widespread spread in Wuhan Province in the Republic of China [18]. The majority of COVID-19 victims have been in South and North American nations, and European countries have also been significantly impacted [4]. India has had the highest incidence of COVID-19 among Asian countries. India reported 4,56,183 confirmed positive cases of COVID-19 on June 24, 2020. These cases included 14,476 deaths [18]. Also, Iran is the most affected country in the Middle East. Since the beginning of 2020, Iran's economy has been affected by the spread of the coronavirus. From February 27, 2020, to June 12, 2021, it has experienced four waves of COVID-19 with more than 3 million confirmed cases and approximately 85000 dead, which has had a significant effect on the country's economic and social situation. This occurred after two challenging years for the country, 2018 and 2019, when sanctions imposed by the United States caused the economy to grow only −5 and −7%, respectively [4].

Therefore, according to the economic structure of each country, some countries are more affected by the COVID-19 epidemic than others, and in others, its effects have been more transient. For example, countries with more service-oriented economies are more affected and more jobs are at risk [19]. Furthermore [20], have investigated the reaction of the stock market to the COVID-19 pandemic by examining the performance of 77 countries' stock markets. The results of the research show that the announcement of the COVID-19 pandemic creates a significant negative shock in the global stock market, and a country with a different income gives a different response to this announcement. For instance, stock markets in higher-income countries tend to overreact initially and recover faster than those in lower-income countries [20].

The COVID-19 epidemic crisis, like other past epidemics, terrorist attacks, and natural disasters caused shock and fear among international investors, which led to severe fluctuations in the stock market globally [21]. According to Ref. [22], people would have enough time to gather enough information, think logically, examine the market, and make an informed decision in normal circumstances. However, in times of market distress, such as the COVID-19 outbreak, investors are more likely to follow the crowd's decision by suppressing their private data [22]. Ref. [23] have identified three common reasons for the herding behavior: imperfect information, concern for reputation, and compensation structure. In particular, in crisis situations, informationally inefficient herding behavior may occur and can lead to price bubbles and mispricing as uncertainty about the accuracy of private information increases [5, 21]. In fact, the intensity of herding increases during market stress moments due to uncertainty because investors deviate from reasonable cognitive assessment especially when the markets are inundated with negative news that causes changes in asset prices [24]. Finally, the collective social anxiety causes investors to follow the crowd and look for safer havens [25].

Therefore, researchers who have focused on herding behavior tend to agree that it is one of the common irrational investment behaviors that may cause abnormal losses and returns in the financial market, the deviation of asset prices from the fundamental value, the instability of financial markets, the exacerbation of crises and eventually the increase of the fragility of the financial system [26, 27].

In Iran, only a few studies examine the effects of the COVID-19 pandemic on the Iran stock market. From February 19, 2020, to May 22, 2020, Ref. [28] observed the fluctuations of the Tehran Stock Exchange Price Index (TEPIX) and the trading volume of the Iranian stock market. Nearly 50 million Iranians, or more than 60% of the population, are currently involved in the Tehran Stock Exchange. The effects of COVID-19 were studied using an emotion-focused therapy approach by Ref. [29]. Ref. [14] utilized Wavelet Coherence Analysis to examine the co-movement between markets in a period from September 2014 to June 2020 as a period of extreme uncertainty in Iran. Based on our research, no study has been conducted to survey the impact of COVID-19 on the behavioral bias of investors in the Iranian stock market. Hence, it is necessary to study how the COVID-19 pandemic affects the behavior of investors and the stock market of each country.

2.2. The impact of government policy response to the COVID-19 pandemic on financial markets and investor behavior

In an effort to contain the spread of the COVID-19 pandemic, government policy responses around the world have had a significant impact on limiting the negative effects of the virus on different aspects of the economy, including the financial market [2]. In this regard, Ref. [28], using a linear regression model in the financial markets of the USA, Germany, Brazil, Australia, China, Russia, South Korea, Spain, Iran, and Sweden, have concluded that the reaction of the financial markets to COVID-19 depends on the speed of government control and intervention to prevent its further spread. In fact, the faster the government's response is, the more limited the spread of the virus will be and the financial market will be less vulnerable to the impact of the pandemic.

In another study, Ref. [10] show that the pandemic has had a negative impact on the financial market of ten countries with confirmed COVID-19 cases. These researchers stated that government intervention is effective and useful only in the short term because it reduces investor panic. However, it may cause long-term problems and increase uncertainty. Ref. [30] found that indicators of G7 government intervention, including economic stimulus packages, travel bans, and quarantines, had a positive effect on stock markets' response to COVID-19. Ref. [11] used the regression method to investigate the effect of the government stringency index on stock market volatility in 67 countries. They found that the stringency index has a positive effect on stock market volatility.

In a more detailed study [4], using threshold regression, show that government intervention indicators have different effects on the stock market return in Iran so that when the growth rate of confirmed cases of Coronavirus is under 0.06%, government intervention cannot influence the securities exchange return. However, when there is a higher growth rate of confirmed COVID-19 cases, the economic support index increases the return, but the stringency index, the government response index, and the containment and health index decrease the return. Similarly, Ref. [1] investigated whether investor herding behavior was reduced in the stock markets of 72 nations during the first quarter of 2020 by government responses to the pandemic. Overall, they found evidence of investor herding behavior during the pandemic. Furthermore, they showed that government policy responses mitigated this behavior by reducing the pandemic's multidimensional uncertainty.

In general, according to the extent of the literature, in models that examine the effect of government interventions on the stock markets, herding behavior was found, especially during the outbreak of the COVID-19 pandemic. Without the government's effective intervention, this behavior could be more serious. So, not only is it important to examine government responses to control the epidemic, but economic support policies can increment liquidity in the stock market and decrease investors' fear [1].

Therefore, this article basically focuses on two points: first, the effect of the COVID-19 pandemic on the behavior of investors in the stock market, and second, the impact of the government policy responses on the stock market and the behavior of investors.

3. Data and methodology

3.1. Data

The herd level is more visible when daily data are used [31]. Therefore, we calculated daily stock returns as $R_{i,t} = (P_{i,t} - P_{i,t-1})/(P_{i,t-1})$. The cross-sectional average stock of N returns ($R_{m,t}$) is calculated by taking an average of all individual stock returns on day t as per the following equation [18]:

$$R_{m,t} = \frac{\sum R_{i,t}}{N} \tag{1}$$

where $R_{i,t}$ is the observed stock return of firm i at time t, and N is the number of companies in the market portfolio.

The observations are the result of combining the data of the top 50 companies[1] listed on the stock market as cross-sectional data during 2381 working days of the market (from March 1, 2012, to March 1, 2022), as the study period. Also, data on the Iranian government's response during the COVID-19 epidemic is taken from the Oxford COVID-19 Government Response Tracker (OxCGRT), which provides stringency index (SGI) values that help track and compare government policy responses to contain the spread of the virus.

3.2. Methodology

3.2.1. Investigating herding behavior in the market

Empirical literature uses the dispersion measure of market returns to investigate herding behavior in financial markets. The measure of dispersion is calculated in two ways. The first measure is the cross-sectional standard deviation of returns (CSSD), which was first proposed by Christie and Huang (1995) to examine investor herding behavior in the US stock market. CSSD is measured as follows [15]:

$$CSSD_t = \sqrt{\frac{\sum_{i=1}^{N} \left(R_{i,t} - R_{m,t}\right)^2}{N-1}} \tag{2}$$

where $R_{i,t}$ is the observed stock return on i at time t and $R_{m,t}$ is the cross-sectional average return of N on the total market portfolio at time t.

This measure of dispersion quantifies the average closeness of individual returns to the realized mean. Christie and Huang (1995) argue that in traditional asset pricing models, individual stock returns differ from market returns due to distinct sensitivities.

[1] Identification of more active companies in the Iranian Stock Market is based on a combination of stock liquidity and stock trading volume in transactions, stock trading frequency, and the company's impact on the market (average number of shares issued and average current stock value in the period under review).

Consequently, dispersion (CSSD) should be increased. However, under conditions of uncommon market volatility and stress, investors are anticipated to disregard their individual information and converge on a general market consensus and herd. Consequently, private asset returns will not differ significantly from the overall market return, thus resulting in a smaller than normal CSSD.

Hence, using the relationship between market returns (R_m) and dispersion (CSSD), Christie and Huang empirically examine whether the dispersion of stock returns is notably lower than the average during periods of extreme market volatility or not. They classified asymmetric market movements as up (U) or down (L). The regression equation with dummy variable (D) is given below [15]:

$$CSSD_t = \alpha + \beta^L D_t^L + \beta^U D_t^U + \varepsilon_t \tag{3}$$

The dummy variable (D) is designed to show the differences in investor behavior during extreme market movements. D_t^U takes the value one if the market return on day t lies in the extreme upper tail of the distribution; and zero otherwise. D_t^L takes the value one if the market return on day t lies in the extreme lower tail of the distribution; and zero otherwise. The herd behavior is implied by negative and significant values of β^U and β^L coefficients. The CSSD criterion has three following limitations:

First, the outliers in the return distribution have an impact on the model results Christie and Huang (1995). Second, equation (3) is invalid during periods of herding because this model is linear and the linear relationship between market returns and dispersion does not hold true during herding periods. Third, the Christie and Huang model overlooks the fact that in addition to abnormal periods and market stress, herding behavior can also occur during normal periods. As a result, under typical market conditions, equation (3) cannot be utilized.

Following these limitations, in this study, we use the second and most common measure of return dispersion, namely the cross-sectional absolute deviation (CSAD), which was proposed by Chang et al. (2000). As a starting point in the analysis, they describe the relationship between CSAD and market returns with the conditional version of the Black (1972) CAPM. $ECSAD_t$ denotes the expected cross-sectional absolute deviation of stock returns in period t. $R_{m,t}$ is the return of the market portfolio and E_t represents the expectation in period t [15].

$$ECSAD_t = \frac{1}{N}\sum_{i=1}^{n} |\beta_i - \beta_m| E_t(R_{m,t} - \gamma_0) \tag{4}$$

where γ_0 is the zero-beta portfolio return, β_i is the time-constant systematic risk measure of the security. Also, β_m is the systematic risk of a market portfolio with equal weight [15].

$$\beta_m = \frac{1}{N}\sum_{i=1}^{n} \beta_i \tag{5}$$

It should be noted that Chang et al. used the conditional version of CAPM only to establish a linear relationship between $ECSAD_t$ and $E_t(R_{m,t})$. Next, they proposed an alternative and more powerful test to detect herding based on the behavior of the stock returns. They used post-post data to test for the presence of herding behavior in their sample through the average relationship between $CSAD_t$ and $R_{m,t}$.

It should be noted that Chang et al. used the conditional version of the CAPM only to establish a linear relationship between $ECSAD_t$ and $E_t(R_{m,t})$. Next, they proposed an alternative and more powerful test to detect herding based on the behavior of stock returns. Through the average relationship between $CSAD_t$ and $R_{m,t}$, they tested for the presence of the herding behavior in their sample using ex-post data. This method is statistically expressed as follows [15]:

$$CSAD_{m,t} = \frac{1}{N}\sum_{i=1}^{n} |R_{i,t} - R_{m,t}| \tag{6}$$

This empirical test is comparable in spirit to the market timing model proposed by Treynor and Mazu (1966). Actually, in this test, $CSAD_t$ is not a measurement of herding, instead the relationship between $CSAD_t$ and $R_{m,t}$ is used to identify the herding behavior. Return dispersions are expected to decrease (or increase at a decreasing rate), in the presence of severe (moderate) herding. In order to capture any potential non-linear relationship between market return and security return dispersions, this new approach requires an additional regression parameter. Finally, Chang et al. proposed the relationship between CSAD and $R_{m,t}$ as follows [15]:

$$CSAD_t = \alpha + \beta_1 |R_{m,t}| + \beta_2 |R_{m,t}^2| + \varepsilon_t \tag{7}$$

where $R_{i,t}$ is the daily return on stock of individual firm i at time t, $|R_{m,t}|$ is the market return (equal-weighted average stock return which has been taken as an indicator of market return in the capital asset pricing model (CAPM)), $\boldsymbol{\beta}1$ is the coefficient of $R_{m,t}$ and $\boldsymbol{\beta}2$ is the coefficient of $R_{m,t}^2$ obtained after applying OLS regression. When herding is present in financial markets, the coefficient of $\boldsymbol{\beta}2$ is significantly negative.

In order to assess the effect of COVID-19 on herding, the following model is formulated [32]:

$$CSAD_t = \alpha + \beta_1 D^{covid} |R_{m,t}| + \beta_2 \left(1 - D^{covid}\right) |R_{m,t}| + \beta_3 D^{covid} |R_{m,t}^2| + \beta_4 \left(1 - D^{covid}\right) |R_{m,t}^2| + \varepsilon_t \tag{8}$$

where the COVID-dummy (D^{covid}) equals one from February 27, 2020, and zero before that. Significantly negative values of (β_3) and

(β_4) would indicate the presence of herding following (before) of COVID-19. We have also investigated three factors that can affect the formation of the herding behavior from March 1, 2012, to March 1, 2022 to evaluate the results:

1. Asymmetric effects of market return: In this case, we survey whether there is an asymmetry in herding behavior during the rise or fall of the market [31,33].
2. High and low volatility: In this case, if the observed volatility is higher than the moving average of volatility in the last 30 days, we consider high volatility, and when it does not exceed the moving average over the same period, we consider low volatility [15].
3. Domestic market trading volume: The volatility is calculated as the standard deviation of the market return times the square root of 2381 trading days. In this case, we calculate for each market as the total daily volumes of all listed stocks in that market [32].

3.2.2. The criteria used to develop the prediction model

In order to investigate the presence of herd in equations (7) and (8), we have used the most common approach of empirical evaluation of herding behavior in the stock market, that is, ordinary least squares (OLS) estimation. Furthermore, to ensure the efficiency and reliability of the model, we have set up two tests of R-square values and F-test statistics as a tool to evaluate the predictive power of regression models.

R^2-type measures provide information about a regression model. The R^2 measure, called the coefficient of determination or explained variation, measures the percentage of the total variation in the dependent variable that is explained by the regression model [34]. Adjusted R^2 is a useful tool to assess the goodness-of-fit (accuracy of the model) of linear regression models. In addition, adjusted R^2 specifies the proportion of the target field's variance that is explained by the input or inputs [35]. R or correlation coefficient is a measure of correlation between two variables. In the context of regression measurement, R^2 is a more meaningful measure than R, because it provides a wider practical measure of explaining changes in the dependent variable by explanatory variables and it is more sensitive to small samples, while R lacks such a feature [36].

The F-test statistic tests the significance of the estimated coefficients, and naturally, the higher value of this statistic indicates the more explanatory power of the model. With this test, the statistical validity of the regression model is checked. This test is mainly used in models fitted with ordinary least squares regression [37]. However, OLS estimation's description of the explained variables is not comprehensive because it only focuses on the expected mean of a dependent variable [38]. On the other hand, the characteristics of financial data and financial markets (known as stylized facts) differ from other economic variables. Therefore, the results of an OLS regression analysis may be biased and not always the best method for estimating a financial model [39].

Quantile regression (QR) is a natural extension of OLS estimation that makes up for its shortcomings. In this regard, Ref. [40] have used the QR method to compensate for the flaws of traditional models to analyze the relationship between explanatory variables and explained variables at various quantiles. In fact, quantile regression is a semi-parametric technique of estimation that evaluates the entire distribution of the dependent variable (not only the mean). Furthermore, QR is more resistant than OLS to outliers in data, asymmetry as well as non-normality, and it is better able to deal with the inherent heterogeneity of data, which frequently occurs under market volatility conditions [41,42]. Hence, in the next section, in order to more accurately answer the second question of the study, we will use quantile regression to analyze herding behavior and the effect of the government's response on it.

3.2.3. Impact of government intervention on herding behavior using quantile regression

The quantile regression estimator is used in this section to examine the extreme tails of the distribution. The model is a more powerful and appropriate one comparing other available regression methods for analyzing periods of crisis [43]. In this regard, Ref. [44] have used regression to investigate the effect of independent variables on CSAD. This technique has been broadly utilized within the past to study herd behavior [1,16,38]. During the study period, we assume that the relationship between dispersion (CSAD) and market return is non-linear. We consider the quantile(τ) regression equation as follows [16]:

$$CSAD(\tau / x_t) = \beta_{0\tau} + \beta_{1\tau,t}\left|R_{m,t}\right| + \beta_{2\tau,t}\left|R^2_{m,t}\right| + \epsilon_{i\tau,t} \tag{9}$$

in the next step, we use the difference of stringency index (DSGI) as a regressor in equation (9) to comprehend how government control measures affect herd behavior. SGI which can be used for the analysis is measured as the primary DSGI to stabilize the data. Research shows that herding behavior can be influenced by government policy responses [45,46].

The Iranian government, in the same way as other many countries, intervened and took many measures to contain the spread of COVID-19. According to the Oxford University report, Iran has performed moderately most of the time. However, it has had an inadequate performance in areas such as financial support and vaccination. First, the rapid spread of the epidemic and the increase in the number of deaths, the low vaccination, and the imposed lockdowns led to an increase in unemployment and fear among investors [4]. Second, the government faced a significant budget deficit as spending increased due to the recession caused by the sanctions and the limited access to post-sanctions oil revenues [14]. Therefore, the government, in order to compensate for the budget deficit, strongly encouraged people to invest in the stock market and influenced the herd behavior of investors. We assume that the reaction of the government and its control measures can play a big role in the market movement and the presence of herd behavior in the stock market.

Following the [25] study, we examine the difference of stringency index (DSGI) using the modified regression model as per the following equation [25]:

$$CSAD_t = \beta_0 + \beta_{1,t}\left|R_{m,t}\right| + \beta_{2,t}\left|R^2_{m,t}\right| + \beta_3(DSGI) + \varepsilon_{i,t} \quad (10)$$

The DSGI coefficient (β3) presents the effect of the government's response on herd behavior. A significant and negative value of β2 indicates a herd pattern. The quantile values (τ) of 5%, 10%, 25%, 50%, 75%, 90%, and 95% have been considered for the analysis. The range of quantiles chosen is important because it covers the entire set of the distribution to better estimate the bias [25].

4. Empirical analysis

4.1. Descriptive statistics of herding behavior in the market

Table 1 reports the descriptive statistics of the variables for the sample period. To investigate the presence of herding behavior in the stock market, the sample period is divided into three parts to investigate the presence of herding behavior in the stock market. The first part is the entire period from March 1, 2012, to March 1, 2022. The second period is from March 1, 2012, to February 27, 2000, as the period before COVID-19. The third period is from February 27, 2020 to March 1, 2022, as the COVID-19 period.

In this table, we have calculated the CSAD term and the average market return using both equal weights for each of the periods. These results indicate that the mean and standard deviation values of CSAD are higher during the COVID-19 period, which means that the mean values and standard deviations of CSAD are higher during the period of COVID-19, which means that the market has experienced unusual cross-sectional changes due to unexpected events. The SGI value is between 0 and 100, with higher values indicating responses that are more stringent.

The skewness and kurtosis values of the variables show that the skewness is to the right and stretched upwards. In addition, this indicates that, firstly, the changes and returns at the end of the distribution have increased since the beginning of March 2020, secondly, the outlier data and extreme values are at the end of the distribution (i.e., higher returns than the average have been observed in the second half of the data distribution). This confirms the use of quantile regression as a better estimator [43].

4.2. Testing effect of COVID-19 on herding behavior

Table 2 provides the regression results as per equation Eq. (8) over the period from March 1, 2012, to March 1, 2022. Column 1 shows the results of the overall model. We have also investigated three factors that can influence the formation of herding behavior. Columns 2 to 6 show, in turn, the results considering asymmetric effects:

Columns 2 and 3 indicate the asymmetric effects of market returns ($R_{m,t} > 0$ and $R_{m,t} < 0$, respectively). Also, the β_3 coefficient was found to be a negative and significant value for both cases, which shows that there is an asymmetry in herding behavior during the rise or fall of the market.

Column 4 indicates the high volatility state ($\sigma^{HIGH} > \sigma^{MA}_{t-30}$). In this case, the observed volatility is higher than the moving average of volatility in the last 30 days. With the increase of fluctuations, the value of CSAD decreases and herding behavior increases [15], which is a negative and statistically significant coefficient β_3 indicating this fact.

Finally, columns 5 and 6 indicate the asymmetric effects of domestic market trading volume ($Vol^{HIGH} > Vol^{MA}_{t-30}$ and $Vol^{LOW} > Vol^{MA}_{t-30}$, respectively). β_3 coefficient was obtained to be a negative and significant value for both cases, which shows that in this market, in uncertain conditions, investors with limited information choose to imitate the trading strategies of other investors, which highlights the importance of the effect of trading volume on the tendency to herd behavior.

Hence, β_3 is significantly negative in all cases, which shows that the COVID-19 crisis has been a driver of herd behavior in the stock market because it has put the financial market in a chaotic situation and strengthened the herd behavior.

The results are robust in all tests. Based on the results presented in Table 2 for probability, the F-test statistic gives significant results in each case, indicating that the regression model for all cases has a good overall fit because the probability value for the F-test statistic is less than the significance level of 0.01. In addition, the coefficient of determination, which expresses the prediction value of the dependent variable by the independent variables, is also accurate. Also, the coefficient of determination (adjusted R^2) for the overall model is 0.466, which shows that the independent variable and the control variables explain 46.6% of the changes in the dependent variable.

Table 1
Descriptive statistics.

	variable	No. Obs.	Mean	Std. Dev.	Min	Max	Kurtosis	Skewness
Total	CSAD	2381	0.0173	0.0069	0.0013	0.0855	3.715	1.912
	$R_{m,t}$	2381	0.0003	0.0169	−0.0869	0.1169	4.366	2.093
Before COVID-19	CSAD	2126	0.0169	0.0066	0.0013	0.0729	0.812	1.049
	$R_{m,t}$	2126	0.0005	0.0085	−0.0785	0.1085	0.976	1.528
After COVID- 19	CSAD	255	0.0211	0.0098	0.0029	0.0855	1.201	1.823
	$R_{m,t}$	255	−0.0007	0.0956	−0.0869	0.1169	1.344	3.509
	DSGI	255	51.0201	37.9721	0	100	−1.819	−0.092

Table 2
COVID-19 effect on herding behavior.

	Model	$R_{m,t} > 0$	$R_{m,t} < 0$	$\sigma^{HIGH} > \sigma^{MA}_{t-30}$	$Vol^{HIGH} > Vol^{MA}_{t-30}$	$Vol^{LOW} > Vol^{MA}_{t-30}$
β_1	0.477*** (0.028)	0.566*** (0.038)	0.428*** (0.054)	0.634*** (0.030)	0.482*** (0.033)	0.651*** (0.035)
β_2	0.214*** (0.011)	0.260*** (0.015)	0.182*** (0.016)	0.169*** (0.017)	0.110*** (0.016)	0.355*** (0.019)
$\boldsymbol{\beta_3}$	**−2.128*** (0.314)**	**−2.756*** (0.818)**	**−1.230*** (0.726)**	**−1.740*** (0.544)**	**−0.162*** (0.581)**	**−2.955*** (0.817)**
β_4	1.668*** (0.198)	1.719*** (0.247)	1.528*** (0.316)	2.296*** (0.498)	2.907*** (0.451)	1.345*** (0.545)
α	0.007*** (0.000)	0.007*** (0.000)	0.008*** (0.000)	0.008*** (0.000)	0.008*** (0.000)	0.009*** (0.000)
Obs.	2381	1169	1212	1345	1190	1429
R-squared	0.469	0.401	0.396	0.313	0.323	0.369
Adjusted R^2	0.466	0.399	0.394	0.311	0.319	0.366
F-Statistic	102.982	121.044	85.252	119.724	109.877	79.608
Prob. (F-Statistic) t-stat1	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
$(H_0 : \beta_1 = \beta_2)$ t-stat1	220.8***	198.4***	99.12***	178.3***	57.96***	298.1***
$(H_0 : \beta_3 = \beta_4)$	46.11***	30.29***	8.252***	34.77***	42.38***	285.1***

Notes: standard errors in parentheses. ***p < 0.01.

4.3. *Impact of government intervention on herding behavior using quantile regression*

Table 3 presents the results of quantitative regression to investigate herd behavior and the effect of the government's response using Eq. (10). The results reported in this table show significant herding at the market level. The coefficient of the nonlinear term (R_m^2) is negative for all quantile levels; however significant only for higher quantile values of 25%, 50%, 75%, 90%, and 95% indicating the evidence of herd behavior during the period of study.

This finding is not surprising because due to the uncertainty surrounding the spread of COVID-19, the stock market of most countries suffered a sharp drop in price. However, unlike other countries, in the first and second waves of the outbreak of COVID-19, the stock market index in Iran increased sharply from the time the first case of COVID-19 was registered, then decreased in the following months [47].

In this regard, we have considered another factor to investigate the irrational expansion of the herd during the outbreak of COVID-19. This table shows the results of the government's response to herding at the market level. The reported results show that the government's intervention has not been successful in reducing herd behavior, but it has also been a stimulus and encourager to the herd behavior of investors.

The negative and significant relationship between SGI and CSAD at 25%, mean values, and higher quantiles of 75% and 90% indicate that increased government control measures reduce dispersal and lead to widespread herd behavior. Therefore, our hypothesis that government response magnifies herding behavior is valid.

5. Discussion

The results of our study indicate that the COVID-19 pandemic has had a strong impact on the Iranian stock market. In particular, in the critical situation of the COVID-19 epidemic, significant herding has been observed in the Iranian stock market. As the results show, the intensity of herding increases during market stress moments due to uncertainty because investors diverge from reasonable cognitive evaluation, especially when the market is undated with negative news that causes changes in asset prices [24]. The panic caused by the epidemic of COVID-19 and the increase in the number of deaths, lockdowns, and greater uncertainty are some of the various factors that have increased the vulnerability and fragility of emerging financial markets [48].

Based on the results of our study, the three factors of asymmetric effects of market returns, fluctuations, and the volume of market transactions indicate that the market has experienced a lot of uncertainties and fluctuations, which causes panic among market participants. We argue that these factors have the potential to create negative emotions, fear, and social anxiety during such critical

Table 3
Quantile regression results for the impact of stringency index on herding.

Quantiles							
Coeff.	0.05	0.1	0.25	0.5	0.75	0.9	0.95
C	0.712*** (3.805)	0.746*** (4.990)	0.914*** (7.021)	1.056*** (8.963)	1.811*** (10.241)	2.175*** (12.601)	2.230*** (13.422)
$\|R_m\|$	0.426** (2.291)	0.447*** (3.495)	0.509*** (5.561)	0.582*** (4.124)	0.491*** (6.113)	0.520*** (5.083)	0.468*** (5.241)
R_m^2	−0.014 (−0.805)	−0.019 (−0.962)	−0.023** (−1.950)	−0.015* −1.907)	−0.014** (−2.203)	−0.029** (−2.998)	−0.032** (−3.549)
DSGI	0.003 (0.341)	−0.011 (−0.915)	−0.019** (−2.112)	−0.026** (−2.990)	−0.013* (−1.809)	−0.016** (−1.997)	−0.008 (−0.044)

Notes: t-statistics in parentheses. ***, ** and * mean significant at 1%, 5% and 10% respectively.

periods, which cause behavioral traps and intensify herd behavior [24]. Our results are consistent with the studies by researchers who have focused on herding behavior, [5,21,25].

In this research, we also document that the government's stringency response to the Corona crisis increases the herding behavior of investors. The results of our research with the studies of some researchers [9,10] are consistent. However, our findings with [2,8,25] who report a reduction in herding behavior in the stock market due to government interventions and responses are in contrast. As Oxford University researchers have reported, Iran's government has performed moderately in response to the COVID-19 pandemic, but it has performed poorly in measures such as financial support and vaccination.

The logic of our findings, which are different from the effect of the intervention of some governments on their stock market, is threefold. In recent years, the stock market in Iran was affected by several special features. First, the government plays a significant role in Iran's economy, especially financial institutions. Second, the Iranian government is financed through the sale of shares and the tax on the transfer of shares from the stock exchange. Third, since 2018, Iran's economy was subjected to the most severe international sanctions and high inflation and instability, which affected the government budget and stock returns [4].

Therefore, the government encouraged people and increased their confidence to invest in the stock market in order to compensate for its budget deficit by supporting the stock market and ensuring its upward trend [14]. So, nearly 50 million Iranians, or more than 60% of the Iranian population registered in the Tehran Stock Exchange. Although the stock market index was almost constant at the beginning of the Coronavirus. However, its sharp increase started in early April and grew by almost 300% until mid-August, and then decreased sharply in the following months [28]. This growth of the stock index in Iran was unlike other countries in the world, which faced a decrease in economic growth and a decrease in stock market indices during the COVID-19 epidemic.

6. Conclusion

This research investigates the herd behavior of investors in the Iranian stock market. In addition, we study the impact of asymmetric market effects and government stringency measures on herd behavior during the COVID-19 pandemic. Since this article is the first study that examines herding behavior during the COVID-19 pandemic in Iran, in order to be more cautious and ensure the robustness of the results, we have used two common and powerful regression estimators, QR, and OLS for estimation. The strong evidence of this study shows that under the COVID-19 epidemic crisis, the tendency to herding behavior has increased. The two issues of asymmetric market effects and government stringency measures can be one of the main reasons that explain herding behavior.

First, the sample period findings reveal that uncertainty about the effects of the COVID-19 pandemic and an increase in market volatility exacerbated the herding market. We argued that pandemic effects cause extreme market conditions and induce fear and behavioral traps among the market participants.

Second, we document that less stringent government responses to the COVID-19 crisis increase herd behavior. As we discussed, the government is trying to compensate for the budget deficit through the stock market and encourage people towards this market, given the severe revenue restrictions and the increase in its current expenses due to the sanctions and the COVID-19 pandemic. Overall, we can clearly outline four specific policy and practical implications for investors and policymakers based on these results and our findings:

1. Investment in Iran's stock market is strongly influenced by negative shocks, such as shocks caused by oil sanctions, the COVID-19 pandemic, the government budget deficit, and political events. The government has encouraged people to buy government Exchange-Traded Funds (ETFs) and invest in the stock market in order to finance the budget deficit.
2. There is the risk of falling indices due to the creation of behavioral distortions in the stock market and the creation of price bubbles. This point is important for the small shareholders, that with the fall of the stock market, market makers and monopolists, etc., will be taken out of the field, and it is the common people who will lose. Hence, herding shows the need for better portfolio management. Individuals can create a basket of shares from various fields, such as chemical, pharmaceutical, banks, etc. because the shares of all companies do not go negative at the same rate and at the same time.
3. The specific suggestion is that people enter the stock market with knowledge and get help from expert opinions. Because the market has high risk and is affected by internal and external shocks and can endanger the capital of these people. The knowledge of the presence of herding will help in making informed decisions, especially during such exogenous occasions.
4. Finally, the selected method provides accurate and real information about the impact of the COVID-19 epidemic on the behavior of investors in the Iranian stock market, which can help policymakers adopt more efficient policies. Empirical findings show that government intervention should be reduced for the stability of the Iranian stock market. It is absolutely necessary that the market movements follow fundamentals rather than the herd. In such circumstances, policymakers and regulators should publish real, correct, and transparent information for investors instead of selective and biased news. Also, volatility management tools should be properly calibrated to manage sudden spurts in volatility wisely.

We would like to acknowledge that this study is the first paper that highlights the role of the COVID-19 pandemic as a potential driver of herd behavior in the Iranian stock market. Therefore, it is suggested that the presented results be interpreted with caution and future research can examine whether herding behavior in international stock markets or other markets is more responsive to government intervention during pandemic crises. Nevertheless, the paper provides a solid foundation for further research in this area, which will be of great helpful to investors and policymakers as new events unfold in the COVID-19 crisis.

Author contribution statement

Mohadese nouri, M.Sc.: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

S. Navid Hojaji, M.Sc.: Contributed reagents, materials, analysis tools or data.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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