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COVID-19 pandemic and herd behavior: Evidence from a frontier market

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ABSTRACT

This paper examines the presence of herd behavior in the Vietnamese stock market using the cross-sectional absolute deviation (CSAD) method and by applying quantile regression (QR). We detect herd behavior in the Vietnamese stock market from January 2016 to May 2022. Herd behavior is less pronounced for bullish markets, yet more prominent under other market conditions. Importantly, the paper provides insight into the herd phenomenon during COVID-19's fourth wave outbreak in Vietnam. We discover that during the fourth wave outbreak, investors on the Hanoi Stock Exchange (HNX) do not engage in herding. However, herd behavior does manifest on the Ho Chi Minh Stock Exchange (HOSE) with falling stock prices engendering pessimistic herd selling. Knowledge of this empirical evidence of herd behavior in the Vietnamese stock market should prove useful to investors in determining the intrinsic value of stocks, and to policymakers wishing to enhance the efficiency of the equity market.

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1. Introduction

An efficient financial market is one where investors make rational decisions, and stock prices reflect all available information, remaining unpredictable over time (Fama, 1970). However, herd behavior is a common phenomenon among investors, particularly during periods of uncertainty, leading to irrational transactions and the potential for asset bubbles (Bikhchandani and Sharma, 2000). Emerging financial markets are vulnerable to exogenous shocks (Do et al., 2020; Ishaq et al., 2022), with herd behavior most likely to be triggered in such markets, such as in Vietnam (Bui et al., 2018; Vo and Phan, 2017, 2019), especially during unexpected shocks (Chiang et al., 2010; Batmunkh et al., 2020).

The 2008 global financial crisis (GFC) was an unstable period for financial markets that arose from the collapse of the US banking system and had significant impacts on the global economy and the international stock market (Chang et al., 2020). The 2008 GFC was an enormous shock, born from gaps in the financial system. Herding behavior during times of turmoil can threaten financial stability, as initial negative shocks can be amplified and exacerbated (Mobarek et al., 2014). Thus, exploring the role of the

2008 GFC in triggering herd behavior across markets has been a hot issue in the pre-2020 period (Chiang and Zheng, 2010; Mobarek et al., 2014; Sharma et al., 2015; Vo and Phan, 2017).

Since 2020, the hugest exogenous shock to economies around the world has been the COVID-19 pandemic. The worldwide negative effects of the COVID-19 pandemic included a staggering number of deaths and concomitant economic and social instability (Ashraf, 2022). In Vietnam, the first case of COVID-19 caused by the SARS-CoV-2 virus was confirmed in Ho Chi Minh City (HCMC) on January 23, 2020. In the first six months of 2020, Vietnam was internationally praised as a “miracle” since no deaths were recorded.¹ This result was achieved by the timely intervention of the Vietnamese government and community coordination, such as the strict implementation of medical isolation, social distancing, and “5K” messages (VnExpress²). With drastic and effective solutions in realizing the dual goal of “both disease prevention and socio-economic development”, the Vietnamese economy was able to maintain positive economic growth. Despite the looming uncertainty posed by the COVID-19 pandemic, the gross domestic product (GDP) growth rate in 2020 reached 2.9% according to the Vietnamese General Statistics Office (GOS).

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¹ <https://vncdc.gov.vn>² Vietnamese online newspaper written in English and Vietnamese.

By the end of 2020, the Delta variant appeared in India with a rapid spread, appearing in more than 179 countries and territories.³ The Vietnamese center for disease control and prevention (CDC) has confirmed a huge number of cases due to both delta (India) and alpha (UK) variants in the fourth wave of the COVID-19 pandemic in Vietnam starting from April 27, 2021, to December 30, 2021. Within four months (April 27, 2021–August 27, 2021), Vietnam recorded more than 390,000 new infections and nearly 10,000 deaths due to COVID-19. According to an announcement by the Vietnamese Ministry of Health on December 29, 2021, HCMC had 502,632 COVID-19 cases, including 19,455 deaths, making it the hardest-hit city in Vietnam. In the first quarter of 2021, the gross regional domestic product (GRDP) growth rate of HCMC increased by 4.58%, and by 5.46% in the first six months of the year. However, in the third quarter of 2021, HCMC's GRDP growth fell by 24.39%, and the cumulative growth rate for the first three quarters was −4.98%. In the first six months of 2022, Vietnam's gross domestic product (GDP) growth rate reached 6.42%.⁴ Vietnam had to encounter difficulties in socioeconomic life in 2021.

In the equity market, the VN-Index first surpassed 1,500 points (November 26, 2021), marking a “historic peak” of the index. According to data from the Vietnam Securities Depository (VSD), the number of new accounts opened in 2021 is higher than 1.5 times the total number of new openings in the period 2017–2020. The quantity of securities trading accounts in 2021 reached roughly 4.2 million, an increase of 43.7% compared to the end of 2020. From January 1 to December 27, 2021, the average trading value of shares reached 26,526 billion Vietnamese Dong (VND)/session, an increase of 257.5% compared to the previous year's average, and set a record in the session on December 23, 2021, with nearly 53 trillion VND — equivalent to nearly 2.3 billion USD.⁵

The COVID-19 pandemic caused adverse shocks to the global financial markets (Vuong et al., 2022). The massive turbulence created by the COVID-19 pandemic ascends the likelihood of herding presence (Wen et al., 2022). COVID-19 can impact herd behavior in two ways. Firstly, investors face an economic slowdown and social and medical instability; hence, they tend to consider available information to make investment decisions in equity markets based on their own beliefs. Less-informed investors can also follow the agents, who are more informed. Secondly, the most informed dealers, capturing the behavior of the least informed, can execute market arbitration strategies to their own benefit and to the detriment of others. The influence of the COVID-19 pandemic on the herd behavior of investors has become a topic of intrigue among scholars (Kizys et al., 2021; Espinosa-Méndez and Arias, 2021a,b; Wen et al., 2022).

Experimental evidence on herd behavior in the Vietnamese market is still scant and characterized by drawbacks. Firstly, the existing studies mostly focus on the herd behavior of Vietnamese investors covering the period from 2005 to 2016. Rare research on Vietnamese herd behavior has been done post-2016. Secondly, according to Bui et al. (2018); Vo and Phan (2017), herd behavior in the Vietnamese equity market was significantly driven by events from various displacement thresholds and trading volumes. Still, the impact of the COVID-19 pandemic on

herd behavior in the Vietnamese market has been ignored. Additionally, herd behavior exhibits across downside and upside markets, and on markets with high or low trading volumes during the COVID-19 pandemic is unanswered. Lastly, quantile regression (QR) has not been applied to discover herd phenomenon at different tails of stock return dispersions and extreme conditions.

Our study attempts to fill these gaps by investigating the presence of herd behavior in the two largest Vietnamese stock exchanges covering the period from January 2016 to May 2022 and focusing on the impact of the fourth wave of the COVID-19 pandemic on the herd phenomenon in Vietnam. In particular, we examine its disproportionate effect on various scenarios of the equity market by using the cross-sectional absolute deviation (CSAD) measure proposed by (Chang et al., 2000). We apply the QR approach (Koenker and Bassett, 1978) to examine the herd behavior of investors in the Vietnamese market across various return dispersions. Our findings indicate the existence of herding in the Vietnamese stock market for the full sample, in high trading volumes, in low trading volumes, and in downside markets. However, herding is not found to exist in upside markets. Further, we demonstrate that herd behavior on the Ho Chi Minh stock exchange (HOSE) is triggered by COVID-19's fourth wave outbreak, however, investors on the Hanoi Stock Exchange (HNX) appear not to exhibit herd behavior. In the context of the serious outbreak of the fourth wave of COVID-19 in Vietnam, we observed the herding tendencies increasing sharply on the HOSE when stock prices dropped and high trading volumes. Our findings identify potential risks and provide the basis for an appropriate investment strategy in the Vietnamese stock market during the fourth wave of the COVID-19 pandemic and subsequently, during similar uncertainties in the future.

The remainder of our paper is organized as follows. Section 2 discusses the related literature and sets up the research hypotheses. Section 3 introduces the data and methodology. Section 4 shows and discusses the empirical results. Section 5 concludes the paper and provides practical and policy implications for the relevant participants.

2. Literature review and hypotheses

Herd behavior exists in a number of fields, especially in financial economics (Raafat et al., 2009). In terms of finance, herd behavior is considered to be the process where market participants mimic each other's actions and/or make their decisions based upon the actions of others (Spyrou, 2013) such that, as a group, they all move in the same direction during a specific period of time (Nofsinger and Sias, 1999).

Theoretical studies concentrate on clarifying either individual or institutional herd decision-making in financial markets, its disequilibrium and inefficiency implications, and how to conceptualize ‘herds’. For example, Scharfstein and Stein (1990) survey some forces which lead to herd behavior in investment and apply a learning model to the equity market and a decision within firms. Christie and Huang (1995) provide herding identification and different insights into the influence of herding under various market conditions. Bikhchandani and Sharma (2000) distinguish between “spurious” herding and “intentional” herding and report some causes of herding as well as its impact on the financial markets. Spyrou (2013) offers a valuable overview of the theory of herding, summarizes some relevant empirical results, and provides significant conceptual insights into herd behavior.

From an empirical perspective, numerous studies have explored the existence of herd behavior in different countries, types of assets, and sectors. Examining herding in the Chinese share

³ In August 2021, Public Health England (PHE) reported secondary attack rate in household contacts of non-travel or unknown cases for Delta to be 10.8% vis-à-vis 10.2% for the Alpha variant.

⁴ Socio-economic reports for 2021 and the first 6 months of 2022 are compiled by the Vietnamese General Statistics Office.

⁵ Department of National Accounts System — Vietnamese General Statistics Office (GOS).

market, [Chiang et al. \(2010\)](#) employ the least-squares method and find the existence of herding in both the Shanghai and Shenzhen A-share markets but find no signal of herding within the B-share markets. The authors detect the presence of herd behavior in both A-share and B-share investors conditional on the dispersions of returns in the lower quantiles by applying QR analysis. [Tan et al. \(2008\)](#) find evidence of herding in both the Shanghai and Shenzhen A-share markets dominated by domestic individual investors and within B-share markets that target foreign institutional investors. They also document the existence of herding under both rising and falling market conditions and they find that herd behavior by A-share investors in the Shanghai market is more pronounced when the market is up, when trading volume is high, and when market volatility is high. [Huang and Wang \(2017\)](#) detect herding in Taiwan by utilizing the volatility index (VIX) as a barometer of investors' fear. Their results show that herd behavior is encouraged by an increase in investors' fear and that it tends to occur on days with large trading volumes. [Zheng and Chiang \(2017\)](#) show that herding behavior in Asian stock markets is more pronounced in the Technology and Financial industries, and less pronounced in the Utility industry.

In Vietnam, [My and Truong \(2011\)](#) find evidence of herding in the stock market during different market periods and for alternative model specifications. They found that upward markets have fewer return dispersions than downward markets. [Bui et al. \(2018\)](#) support the presence of herd behavior in Vietnam and indicate that herding was exhibited on the HNX, and with all-stock portfolios being affected by the U.S stock market. By contrast, they could not establish that herding occurred with respect to HOSE portfolios. A series of subsequent studies have found evidence of herd behavior in the Vietnamese stock market including markets with different volumes, markets with different price movement thresholds, and during the 2008 GFC ([Vo and Phan, 2016, 2017, 2019](#)). However, there are two major drawbacks to herd behavior research in Vietnam's capital market. Firstly, research on the herd phenomenon in Vietnam ends in 2016. Secondly, to the best of our knowledge, the QR approach has not been used to investigate the potential herd behavior of investors in unstable scenarios. To address the above drawbacks, we propose to examine the following hypothesis:

H1: Herd behavior exists at different dispersions of stock returns in both the HNX and the HOSE stock exchanges between January 2016 and May 2022.

Investor biases are derived from herding, information asymmetry, lack of confidence, and investment knowledge can lead to excessive co-movement and trigger financial instability ([Mnif and Jarboui, 2021](#)). Indeed, prior studies demonstrate that during the 2008 GFC, herding in the stock markets was triggered ([Sharma et al., 2015; Vo and Phan, 2017](#)). Recently, the most unexpected exogenous shock of the deadly COVID-19 virus caused massive disruptions to the global economy and stock markets ([Kizys et al., 2021](#)). The substantial instability led to the rise of herding behavior during the 2020 international market crash ([Jiang et al., 2022](#)). Herding evidence during the COVID-19 crisis is largely shown by [Espinosa-Méndez and Arias \(2021a,b\)](#), [Kizys et al. \(2021\)](#) and [Wen et al. \(2022\)](#). In contrast, herd behavior occurred only slightly more than usual in the Chinese stock market during the COVID-19 period ([Wu et al., 2020](#)).

The 2008 GFC and the COVID-19 period are heterogeneous scenarios ([Chang et al., 2020](#)). The first one was known as an endogenous hit to financial markets whereas the second one is an exogenous shock to the financial system. [Vo and Phan \(2017\)](#) indicate that the prevalence of herd behavior in the post-2008 GFC rather than in the pre-2008 GFC, implying that numerous

investors in the Vietnamese stock market joined post-crisis with a belief in the stock market recovery. The Vietnamese stock market experienced significant fluctuations from April 27, 2021, to May 31, 2022, due to the effect of the fourth COVID-19 wave. This event prompts us to examine potential changes in the herd behavior of securities investors that may be spurred by this disaster wave. Up to this time, there have not been any studies examining the drastic impact of the fourth wave of the COVID-19 pandemic on the herd behavior of stock investors on the Vietnamese stock exchanges. The QR approach is efficient for examining the presence of herd behavior at different dispersions of securities returns when the COVID-19 pandemic outbreaks ([Kizys et al., 2021; Jiang et al., 2022](#)). These studies show that as the COVID-19 pandemic unfolds, it greatly affects capital market conditions, changing stock prices and trading volumes. Therefore, we seek to test the following second hypothesis:

H2: The occurrence of herd behavior in both the HNX and the HOSE stock exchanges during the fourth wave of the COVID-19 pandemic outbreak is more pronounced than before the fourth wave of the COVID-19 pandemic outbreak.

Several studies examine herd behavior in the context of bullish and bearish markets and find differences in herding between these two conditions ([Chiang and Zheng, 2010; Mobarek et al., 2014](#)). Focusing on the Chinese equity market, [Yao et al. \(2014\)](#) find that investors exhibit different degrees of herd behavior and that herding strongly exists in the B-share markets. They find that herd behavior is more prevalent at the industry-level, and more pronounced under conditions of declining markets. [Bui et al. \(2018\)](#) show a herd trend of Vietnamese investors in both upside and downside markets from January 1, 2007, to October 17, 2014. [Zheng et al. \(2017\)](#) examine herd behavior at the industry level for Asian markets and find the existence of herding in these markets. The evidence also shows that industry herding is more pronounced when markets go down and when trading volume is lower for most markets. [Ju \(2019\)](#) examines herd in both A- and B-share markets and documents that investors in A-share markets herd only when the market is down in value or large stock portfolios. This phenomenon may be interpreted as the fear of potential loss in declining markets being more powerful than the satisfaction of potential gain in rising markets ([Gleason et al., 2003](#)). Thus, herding is expected to be more prevalent in declining markets than in rising markets ([Yao et al., 2014](#)). On this basis, we posit the third hypothesis:

H3: Herd behavior is more pronounced in a bearish market than in a bullish market, especially during the fourth wave of the COVID-19 pandemic.

The role of high market returns on subsequent trading volume can be formidable ([Statman et al., 2006](#)). When the market goes down, investors continue to sell due to contagious panic and fear, pushing prices down even further ([Pochea et al., 2017](#)). [Vo and Phan \(2017\)](#) examine the herd wave in the Vietnamese stock market from April 2005 to April 2015. They find that herd behavior is evident during high and low trading volume days; however, it is stronger in low-volume scenarios. In the US stock market, [Ukpong et al. \(2021\)](#) test for herding over the period 1990–2020 and conclude that no evidence of industry herding in either high or low-volume contexts. During the COVID-19 pandemic outbreak, trading volumes surged because lockdowns encourage investors to trade from their homes. Especially, an increase in trading volumes is more pronounced among countries with higher trust ([Chiah and Zhong, 2020](#)). The number of newly opened accounts by Vietnamese securities investors in 2021 was enormous, resulting in a more than 40% increase in the value of trading securities compared to the ones in 2020.⁶ This indicates

⁶ Synthesized data from the Vietnamese Securities Depository (CSD).

significant penetration of new investors into the Vietnamese capital market. Thus, in the three quarters of 2021, the total capital mobilization for the economy of the Vietnamese stock market reached 292.1 trillion VND, up 12% over the same period in 2020.⁷ Derived from this actual state, we posit the fourth hypothesis to test the herd behavior concerning high and low trading volumes during the fourth wave of the COVID-19 pandemic which is believed to be more pronounced at high trading volumes:

H4: Herd behavior is more pronounced at high trading volumes than at low trading volumes, especially during the fourth wave of the COVID-19 pandemic.

Finally, we built the fifth hypothesis to investigate and compare potential differences in herd behavior between the two largest stock exchanges in Vietnam, the HOSE and the HNX as the fourth COVID-19 wave occurred. Following Bui et al. (2018), two of these exchanges differ in their market capitalization, regulatory requirements for listed companies, and volatility price-bounds. Inherent differences between HOSE and HNX may control the quality of the stock's listed companies and investor behavior on each stock exchange in turbulence.

H5: Herd behavior is different between the HOSE and the HNX stock exchanges given the impact of the fourth wave of the COVID-19 pandemic outbreak and other extreme market conditions.

3. Methodology

3.1. Data

In this study, we collect the daily closing prices of all stocks listed on the HOSE and the HNX from January 2016 to May 2022. Our sample includes 752 listed companies on both exchanges, resulting in 1,598 daily observations. We obtained the data from the Refinitiv Datastream database. To examine the impact of the fourth wave of the COVID-19 pandemic on herd behavior among investors on the HOSE and HNX exchanges in the Vietnamese stock market, we divide the data into two sub-periods. Our analysis covers the entire sample as well as two additional sub-samples.

- (1) The whole sample starting from January 2016 to May 2022.
- (2) The pre-period of the fourth wave of the COVID-19 pandemic (PRE-COVID19) covering January 2016 to April 26, 2021.
- (3) The fourth wave of the COVID-19 pandemic (DUR-COVID19) from April 27, 2021, to May 31, 2022.

3.2. Fundamental models and variables

Two main return dispersion models are widely used in investigating herd behavior by considering individual stock returns and stock market returns, namely, Christie and Huang (1995) and Chang et al. (2000). Christie and Huang (1995) apply the cross-sectional standard deviation (CSSD) model to detect herd behavior which is defined as follows:

$$RD_t = \alpha + \beta^L D_t^L + \beta^U D_t^U + \varepsilon_t \quad (1)$$

where RD_t is the return dispersion at time t . D_t^L is a dummy variable taking on the value of unity when the market return at time t lies in the extreme lower tail of the distribution and zero otherwise; D_t^U is an indicator variable with a value of unity when the market returns at time t lie in the extreme up-

per tail of the distribution and zero otherwise. To calculate the return dispersion, Christie and Huang (1995) propose the cross-sectional standard deviation (CSSD) method, which is calculated as follows:

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

where $R_{i,t}$ and $R_{m,t}$ represent the returns of stock i at time t , and the whole market return at time t , respectively. Munkh-Ulzii et al. (2018) show the drawback of 'Christie and Huang's (1995) approach in that it requires a definition of extreme returns. The term 'extreme returns' is arbitrary, so in reality, traders do not always arrive at the same opinion about extreme returns, and the characteristics of the return distribution may change over time. Chiang et al. (2010) point out that herd behavior may be present during the entire return distribution and become more dominant during the period of market stresses whereas Christie and Huang (1995) only recognize herd behavior under the condition of 'extreme returns'.

Chang et al. (2000) and Gleason et al. (2003) suggest utilizing an alternative calculation, namely, the cross-sectional absolute deviation (CSAD) model, which facilitates the detection of herd behavior over the entire distribution of market returns. An advantage of the CSAD model compared to the CSSD approach is taking into account the linear relationship between the dispersion of individual stock return ($CSAD_{i,t}$) and stock market return ($R_{m,t}$). The CSAD model is defined as follows:

$$CSAD_{i,t} = \gamma_0 + \gamma_1 |R_{m,t}| + \gamma_2 R_{m,t}^2 + \varepsilon_{i,t} \quad (3)$$

where $CSAD_{i,t}$ is the cross-sectional absolute deviation of a company i at time t . $|R_{m,t}|$ and $R_{m,t}^2$ are the absolute equally weighted average stock return and squared value of market return in the dual-listed portfolio consisting of N companies during the period t . Note that γ_2 is the coefficient of squared market return that can be considered as the 'herding coefficient'. $CSAD_t$ is considered as a measure of return dispersion and calculated as follows:

$$CSAD_t = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{m,t}| \quad (4)$$

where $R_{m,t}$ is the return of the market portfolio at time t and $R_{i,t}$ is the return of stock i at time t . If the "herding coefficient" (γ_2) is statistically negative, it proves the presence of herd behavior in the Vietnamese stock market.

As the direction of market returns can cause asymmetric effects on herd behavior, we use two independent herding regressions, for positive and negative market returns, to investigate both upside and downside market conditions, as follows:

$$CSAD_t^{up} = \alpha + \gamma_1^{up} |R_{m,t}^{up}| + \gamma_2^{up} (R_{m,t}^{up})^2 + \varepsilon_t \quad (5)$$

$$CSAD_t^{down} = \alpha + \gamma_1^{down} |R_{m,t}^{down}| + \gamma_2^{down} (R_{m,t}^{down})^2 + \varepsilon_t \quad (6)$$

where $R_{m,t}^{up}$ is stock market returns at time t when the equity market rises and $R_{m,t}^{down}$ represent the stock market returns at time t when the stock market declines. $CSAD_t^{up}$ ($CSAD_t^{down}$) is an average absolute value of each stock return relative to the return of the equally-weighted market portfolio at time t consequent to rising (falling) market returns. A market is considered to be rising if its stock market returns are greater than zero ($R_{m,t} > 0$); in contrast, it is regarded as falling when stock market returns are less than zero ($R_{m,t} < 0$). In nonlinear Eqs. (5) and (6), γ_2^{up} and γ_2^{down} indicate the presence of herd behavior if they are negative and significant.

⁷ Reports from the National Institution for Finance (NIF).

In order to examine herd behavior during high and low trading volumes, we employ the following empirical models:

$$CSAD_t^{high} = \alpha + \gamma_1^{high} |R_{m,t}^{high}| + \gamma_2^{high} (R_{m,t}^{high})^2 + \varepsilon_t \quad (7)$$

$$CSAD_t^{low} = \alpha + \gamma_1^{low} |R_{m,t}^{low}| + \gamma_2^{low} (R_{m,t}^{low})^2 + \varepsilon_t \quad (8)$$

where $|R_{m,t}^{high}|$ refers to the absolute value of market return at time t when trading volume is high. $CSAD_t^{high}$ is an average absolute value of each stock return relative to the return of the equally-weighted market portfolio at time t consequent to the market with high trading volume; $(R_{m,t}^{high})^2$ is the squared value of stock market returns at time t when trading volume is high, α is intercept and ε_t is an error term at time t . Similarly, the low superscript low of variables refers to the scenario when trading volume is low. Herd behavior exists when γ_1^{high} and γ_2^{low} are statistically negative. Trading volume is considered to be high (low) if on day t it is greater (lesser) than the previous 30-day moving average (MA30).

3.3. Quantile regression (QR)

An outstanding drawback of the OLS methodology is that it concentrates on the mean as a measure of location (Koenker and Bassett, 1978; Koenker, 2005; Barnes and Hughes, 2002), which can result in ignoring the tails of a distribution (Chiang et al., 2010). OLS method only considers symmetric linear relationships between variables and does not distinguish between the dependencies between them in up and down markets or between large and small stock price movements, or even extreme conditions (Mensi et al., 2014; Jareño et al., 2016). Chiang and Tan (2010), Pochea et al. (2017), Mishra and Mishra (2021), and Wen et al. (2022) indicate that the QR is more efficient than other methods in measuring dispersions, particularly in non-stable environments. In order to overcome the drawbacks of OLS and open insight into herding in the Vietnamese stock market during the fourth wave of the COVID-19 outbreak, we employ the QR approach to provide more efficient estimates for identifying herd behavior (Chiang et al., 2010; Pochea et al., 2017). The QR approach was originally proposed by Koenker and Bassett (1978) and the linear conditional quantile function is as follows:

$$QY_i(\tau | X = x) = x_i' \gamma \quad (9)$$

where Y_i is a dependent variable, x_i' is a vector of independent variables, and γ is a vector of coefficients. The $\hat{Y}_{(quantile \tau)}$ estimator results from the following weighted minimization:

$$\hat{Y}_{(quantile \tau)} = \arg \min \sum_{i=1}^n \rho_\tau(y_i - x_i' \beta) \quad (10)$$

where ρ_τ is a weighting factor, also called the check function. For any $\tau \in (0,1)$ a weighting function is defined, as follows:

$$\rho_\tau(u_i) = \begin{cases} \tau u_i & \text{if } u_i \geq 0 \\ (\tau - 1) u_i & \text{if } u_i < 0 \end{cases} \quad (11)$$

where $u_i = y_i - x_i' \gamma$. Eq. (11) implies that:

$$\begin{aligned} \hat{Y}_{(quantile \tau)} &= \arg \min \left(\sum_{i: y_i > x_i' \gamma} \tau |y_i - x_i' \gamma| + \sum_{i: y_i < x_i' \gamma} (1 - \tau) |y_i - x_i' \gamma| \right) \end{aligned} \quad (12)$$

Eq. (12) states that the QR estimators can be achieved by minimizing a weighted sum of the absolute errors, where the weights are dependent on the quantile values. When $\tau = 0.5$, the quantile regression becomes the median regression. The quantile

regression is not restrictive at the median level; it allows us to estimate the interrelationship between a dependent variable and its explanatory variables at any specific quantile. Thus, it provides a broader picture in helping us examine the relation between $CSAD_t$ and $R_{m,t}$.

QR is applied for estimating the $CSAD_t$ dependent variable and a set of X_t independent variables at (τ) quantile, which is formulated as follows:

$$Q_\tau(\tau | X_t) = \gamma_{0,\tau} + \gamma_{1,\tau} |R_{m,t}| + \gamma_{2,\tau} (R_{m,t})^2 + \varepsilon_{\tau,t} \quad (13)$$

$$Q_\tau(\tau | X_t) = \gamma_{0,\tau} + \gamma_{1,\tau}^{up} |R_{m,t}^{up}| + \gamma_{2,\tau}^{up} (R_{m,t}^{up})^2 + \varepsilon_{\tau,t}, R_{m,t} > 0 \quad (14)$$

$$Q_\tau(\tau | X_t) = \gamma_{0,\tau} + \gamma_{1,\tau}^{down} |R_{m,t}^{down}| + \gamma_{2,\tau}^{down} (R_{m,t}^{down})^2 + \varepsilon_{\tau,t}, R_{m,t} < 0 \quad (15)$$

where X_t is a vector of the right-hand-side variables of Eqs. (13), (14) and (15); Eqs. (14) and (15) are utilized to examine herd behavior in upside and downside market conditions. If the results find evidence of herd behavior, $\gamma_{2,\tau}$, $\gamma_{2,\tau}^{up}$ and $\gamma_{2,\tau}^{down}$ coefficients are expected to be significantly negative.

Eqs. (16) and (17) are used to measure herd behavior in high and low trading volumes as follows:

$$Q_\tau(\tau | X_t) = \gamma_{0,\tau} + \gamma_{1,\tau}^{low} |R_{m,t}^{low}| + \gamma_{2,\tau}^{low} (R_{m,t}^{low})^2 + \varepsilon_{\tau,t}, R_{m,t} > 0 \quad (16)$$

$$Q_\tau(\tau | X_t) = \gamma_{0,\tau} + \gamma_{1,\tau}^{high} |R_{m,t}^{high}| + \gamma_{2,\tau}^{high} (R_{m,t}^{high})^2 + \varepsilon_{\tau,t}, R_{m,t} < 0 \quad (17)$$

where X_t is a vector of the right-hand-side variables of Eqs. (16) and (17). These equations are utilized to examine herd behavior in the stock market with low or high trading volumes, respectively. If the estimated results show evidence of herd behavior, the coefficients $\gamma_{2,\tau}^{low}$ and $\gamma_{2,\tau}^{high}$ are expected to be significantly negative.

To shed more light on the second and fifth hypotheses, we estimate Eqs. (13)–(17) during two separate periods including the pre-fourth COVID-19 wave period (PRE-COVID19) and the fourth COVID-19 wave period (DUR-COVID19). We expect that the herding coefficients in the DUR-COVID19 period to be more formidable than those during the PRE-COVID19 period.

3.4. Robust tests

Owing to the COVID-19 outbreak, most governments around the world issued social distancing and lockdown measures to protect public health, which immediately disrupted the global supply chain and placed pressure on corporate logistics. Coping with health risks and difficulties in socioeconomic life pushed up investors' fear (Vuong et al., 2022). Fig. 1 shows that the GSCPI index has increased since January 2020, remaining above one from December 2020 to December 2022 and peaking at levels greater than 2.5 from April 2021 to May 2022. We expect that the surge in the disruption to the global supply chain pressure may trigger herd behavior in the Vietnamese equity market through the heightened dispersion of returns. To examine the robustness of our main results, we use the Global Supply Chain Pressure Index (GSCPI)⁸ as a control variable in Eq. (13). Besides, we continue dividing our sample into two sub-samples: the first from January 2016 to March 2021 (PRE-COVID19) and the latter from April 2021 to May 2022 (DUR-COVID19). We conjecture that the positive coefficient of GSCPI in the first sample is greater than the one in the latter. Empirical results from sub-periods confirm the triggering effect of the fourth COVID-19 wave on the herding behavior of Vietnamese investors.

⁸ <https://www.newyorkfed.org/research/policy/gscpi#/interactive>.

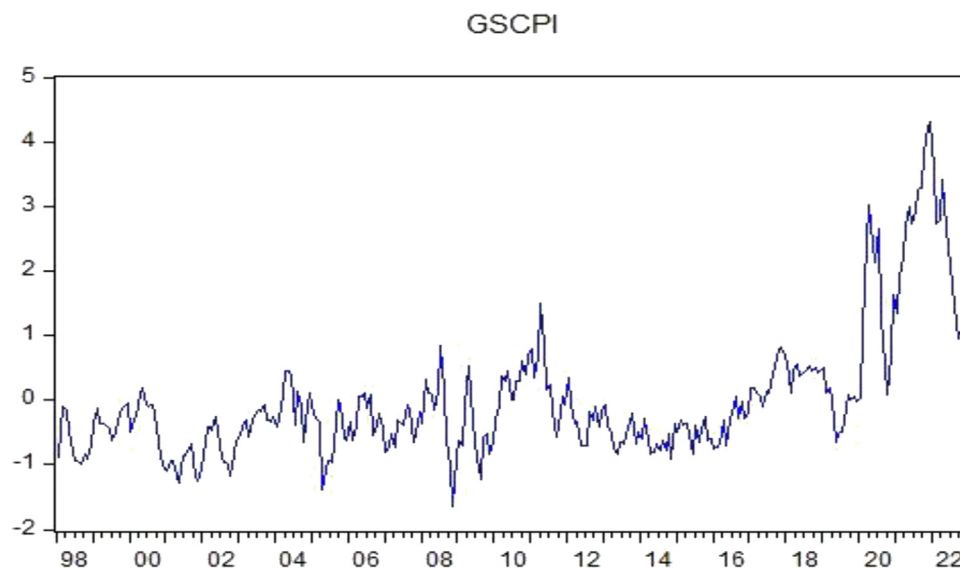


Fig. 1. Global Supply Chain Pressure Index (GSCPI). (January 1998–December 2022)

4. Discussion on empirical results and robust tests

4.1. Basic statistics

Table 1 shows the fundamental statistics for the cross-sectional absolute deviation (CSAD) and stock market returns in both the HOSE and the HNX markets. The Augmented Dickey–Fuller (ADF) and Phillips–Perron test (PP) tests are significant both for the market returns and the CSAD, indicating that these series are stationary. In addition, Fig. 2 displays the cross-sectional absolute deviation (CSAD) for both the HOSE and the HNX. The red line shows the movement of the CSAD of the HNX while the dark blue line shows the change of the CSAD of the HOSE. We see that the range of CSAD of the HNX seems to be much wider

than the one of the HOSE. It may be a consequence of the regulation on the range of stock price fluctuations of the two stock exchanges.

4.2. Herd presence

Table 2 shows the sign and statistical significance of herding coefficients in Eq. (13) for the HOSE and the HNX, respectively. Because the OLS regressions may be distorted by the news that appears in the financial markets as extreme outliers. Hence, we apply QR estimates to examine herd behavior in the returns of the CSAD distribution tails. Estimated results are reported at five quantile levels ($\tau = 10\%$; $\tau = 25\%$; $\tau = 50\%$; $\tau = 75\%$; $\tau = 90\%$). The coefficient γ_2 demonstrates a nonlinear relationship between the CSAD and the stock market returns. Besides, negative and

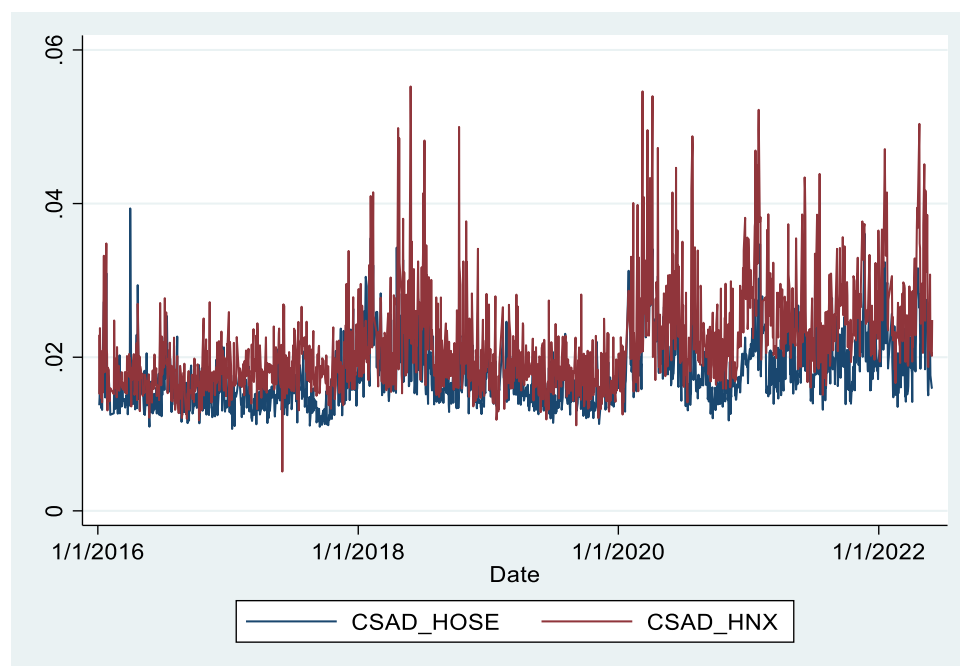


Fig. 2. HOSE and HNX's Cross-Sectional Absolute Deviation (CSAD). (January 2016–December 2022)

Table 1
Descriptive statistics.

Stock exchange	Obs.	Variables	Mean	Std. Dev	ADF test	PP test
HNX	1,598	CSAD	0.0218	0.0066	−7.2505***	−34.6369***
		Rm	0.0009	0.0127	−25.1318***	−38.3835***
HOSE	1,598	CSAD	0.0277	0.0043	−7.7020***	−32.3300***
		Rm	0.0005	0.0114	−37.9869***	−38.2058***

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.**Table 2**
Empirical results of QR model (Eq. (13)) for both the HOSE and the HNX (January 2016–May 2022).

Ho Chi Minh Stock Exchange (HOSE)								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R^2
q10	Coef	0.5763***	(40.11)	−5.5156***	(−15.73)	0.0112***	(124.48)	0.3442
	Std. Err	0.0264		1.1010		0.0001		
q25	Coef	0.5345***	(34.57)	−4.2046***	(−11.14)	0.0123***	(127.08)	0.3768
	Std. Err	0.0180		0.7002		0.0001		
q50	Coef	0.4997***	(29.07)	−2.2909***	(−5.46)	0.0135***	(125.32)	0.3963
	Std. Err	0.0254		0.9813		0.0001		
q75	Coef	0.4625***	(15.64)	−0.4341	(−0.60)	0.0151***	(81.84)	0.3958
	Std. Err	0.0398		1.3350		0.0002		
q90	Coef	0.4308***	(7.85)	−0.1813	(−0.14)	0.0176***	(51.22)	0.3892
	Std. Err	0.0556		1.5205		0.0003		
Hanoi Stock Exchange (HNX)								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R^2
q10	Coef	0.7446***	(35.56)	−3.5586***	(−7.72)	0.0127***	(86.66)	0.4854
	Std. Err	0.0209		0.4609		0.0001		
q25	Coef	0.7497***	(45.45)	−2.7055***	(−7.45)	0.0138***	(119.20)	0.5244
	Std. Err	0.0165		0.3630		0.0001		
q50	Coef	0.7472***	(43.26)	−2.0221***	(−5.32)	0.0151***	(124.52)	0.5593
	Std. Err	0.0172		0.3801		0.0001		
q75	Coef	0.7144***	(26.51)	−1.4612**	(−2.46)	0.0171***	(89.96)	0.5802
	Std. Err	0.0269		0.5932		0.0002		
q90	Coef	0.7026***	(14.14)	−1.4071	(−1.29)	0.0193***	(55.43)	0.5977
	Std. Err	0.0497		1.0936		0.0003		

Note: *t* statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

significant coefficients (γ_2) suggest the presence of herding toward the market among investors. QR methodology depicts a more comprehensive view of the conditional distribution of the CSAD of returns. The herding coefficient is negative and significant in lower quantile levels ($\tau = 10\%$; $\tau = 25\%$; $\tau = 50\%$) in both two stock exchanges. On the HNX, herding does not appear at the highest quantile ($\tau = 90\%$) and we cannot see herd behavior on the HOSE at two quantile levels ($\tau = 75\%$; $\tau = 90\%$). The presence of herd behavior on both Vietnamese stock exchanges stimulated us to further investigate the bias of this phenomenon under different market conditions.

Table 3 shows the sign and statistical significance of the γ_2^{up} , γ_2^{down} coefficients under upside markets (Panel A) and downside markets (Panel B), respectively. We apply the QR analysis to estimate the empirical models in Eqs. (14)–(15). In the upside market, estimated results in Table 3 (Panel A) verify that herd behavior is an isolated phenomenon at the lowest quantile ($\tau = 10\%$) in both the HOSE and the HNX. In the downside market, herding is present on both stock exchanges regardless of the overall quantile levels. Empirical results of parallel herding in both upside and downside markets may be driven differently by the investors' behaviors. Our findings in Table 3 (Panel B) indicate that Vietnamese investors are overenthusiastic and overreact to the downside market, hence they tend to sell out stocks massively. On the other hand, investors are quite rational when the market is moving upward. In an upside market, securities investors tend to mimic the actions of others to gain more profits. In a downside market, the lack of transparency along with the quality of information disclosed by Vietnamese listed companies

also contributes to increased risk aversion. Fear causes individual investors to tend to ignore their proprietary information and make collective decisions based on market trends.

Table 4 shows the sign and statistical significance of the γ_2^{high} , γ_2^{low} coefficients under high trading volume (Panel A) and low trading volume (Panel B), respectively. We apply the QR analysis to estimate the empirical models in Eqs. (16)–(17). Table 4 (Panel A) shows that herding is present only in the CSAD quantiles from low to medium levels for both stock exchanges. Aggressive market activity can result from investors' over-zealousness and overreaction, increasing the tendency to herd. It can be seen that the herd behavior of investors in the Vietnamese stock market with high trading volume exists mainly at the middle CSAD quantiles ($\tau = 50\%$) or less. Additionally, Table 4 (Panel B) shows that the herding phenomenon cannot be found at the highest quantile ($\tau = 90\%$) but it appears in all other lower quantiles. The lackluster market activity can be the result of investors being fearful and overreacting, increasing the tendency to herd. In short, regression results in Table 4 (Panels A and B) confirm that Vietnamese investors are rational and cautious at the high CSAD.

4.3. The triggering role of the fourth wave of the COVID-19 pandemic in herding

Table 5 (Panel A and Panel B), show the estimated results of herding in the period before the fourth wave of the COVID-19 pandemic outbreak (PRE-COVID19) and during the outbreak of the fourth wave of the COVID-19 pandemic (DUR-COVID19) in

Table 3

Empirical results of QR models (Eqs. (14) and (15)) for both the HOSE and the HNX at various market conditions (during upside and downside markets).

Panel A: In the upside market								
Ho Chi Minh Stock Exchange (HOSE)								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5707***	(20.87)	−5.8761***	(−6.88)	0.0113***	(74.73)	0.3320
	Std. Err	0.0489		2.0170		0.0002		
q25	Coef	0.4654***	(18.57)	−0.9009	(−1.15)	0.0126***	(90.82)	0.3680
	Std. Err	0.0398		2.1670		0.0001		
q50	Coef	0.4417***	(17.19)	0.7875	(0.98)	0.0137***	(96.18)	0.3856
	Std. Err	0.0275		1.1790		0.0001		
q75	Coef	0.3835***	(8.72)	3.0258**	(2.20)	0.0154***	(63.09)	0.3660
	Std. Err	0.0568		1.7690		0.0003		
q90	Coef	0.3657***	(4.93)	2.0424	(0.88)	0.0176***	(42.81)	0.3632
	Std. Err	0.0788		2.8130		0.0004		
Ha Noi Stock Exchange (HNX)								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.7774***	(20.69)	−2.8719***	(−2.77)	0.0126***	(53.65)	0.4815
	Std. Err	0.0407		1.3885		0.0002		
q25	Coef	0.7313***	(28.82)	−0.8317	(−1.19)	0.0188***	(87.18)	0.5200
	Std. Err	0.0254		0.8731		0.0001		
q50	Coef	0.7305***	(27.97)	−1.0585	(−1.47)	0.0152***	(93.06)	0.5395
	Std. Err	0.0231		0.6416		0.0001		
q75	Coef	0.6833***	(14.42)	−0.4170	(−0.32)	0.0174***	(58.54)	0.5418
	Std. Err	0.0365		0.9015		0.0003		
q90	Coef	0.6168***	(8.33)	0.3023	(0.15)	0.0201***	(43.06)	0.5396
	Std. Err	0.0601		1.3341		0.0005		
Panel B: In the downside market								
Ho Chi Minh Stock Exchange (HOSE)								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5932***	(21.79)	−5.7284***	(−9.58)	0.0111***	(62.16)	0.3742
	Std. Err	0.0373		1.3324		0.0001		
q25	Coef	0.5459***	(22.53)	−4.3495***	(−8.17)	0.0121***	(76.39)	0.3986
	Std. Err	0.0303		0.8918		0.0002		
q50	Coef	0.5389***	(20.49)	−3.5075***	(−6.07)	0.0132***	(76.89)	0.4182
	Std. Err	0.0366		1.1759		0.0002		
q75	Coef	0.5061***	(12.10)	−2.3405**	(−2.55)	0.0151***	(54.76)	0.4317
	Std. Err	0.0504		1.5326		0.0002		
q90	Coef	0.5571***	(5.27)	−3.9889*	(−1.72)	0.0175***	(25.17)	0.3933
	Std. Err	0.0987		2.2576		0.0005		
Hanoi Stock Exchange (HNX)								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.7205***	(32.03)	−3.2504***	(−7.34)	0.0127***	(77.71)	0.5075
	Std. Err	0.0280		0.8329		0.0002		
q25	Coef	0.6937***	(26.39)	−1.8053***	(−3.49)	0.0139***	(73.19)	0.5387
	Std. Err	0.0399		1.1138		0.0002		
q50	Coef	0.7086***	(28.70)	−1.7851***	(−3.67)	0.0152***	(84.49)	0.5868
	Std. Err	0.0320		0.8318		0.0001		
q75	Coef	0.7126***	(19.56)	−1.5186**	(−2.12)	0.0168***	(63.38)	0.6261
	Std. Err	0.0358		0.8194		0.0002		
q90	Coef	0.7786***	(9.83)	−3.0821*	(−1.98)	0.0187***	(32.54)	0.6588
	Std. Err	0.0720		1.2688		0.0004		

Note: *t* statistics in parentheses, **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

Vietnam. For the HNX, in the period during the outbreak of the fourth wave of the COVID-19 pandemic, herd behavior seems to disappear, but makes a striking appearance in the period before that. With respect to the HOSE, we observe the presence of herding during the fourth wave of COVID-19 from 10% to 90% quantiles. Before the outbreak of COVID-19, herding coefficients are negative significantly only from low to medium quantiles. Additionally, the magnitude of the herding coefficients in Panel B for the HOSE seems to completely overwhelm the ones in Panel A at higher CSAD distributions. Further, the herding coefficients in Panel B for the HOSE tend to be larger from lower to higher

quantiles. Experimental results suggest that the outbreak of the fourth COVID-19 pandemic wave in Vietnam increased investors' fears and caused a loss of rationality on the HOSE, which led to an significant increase in herding by securities investors.

4.4. The triggering role of the fourth wave of the COVID-19 pandemic in herding at various market conditions

Tables 6 and 7 present the QR estimations of the CSAD models in different market conditions and consider the influence of extreme scenarios during the fourth wave of the COVID-19

Table 4

Empirical results of QR models (Eqs. (16) and (17)) for both the HOSE and the HNX at various market conditions (during high and low trading volumes).

Panel A: In high trading volume								
Ho Chi Minh Stock Exchange (HOSE)								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.6044***	(20.88)	−6.1976***	(−9.56)	0.0113***	(58.00)	0.3607
	Std. Err	0.0508		1.655		0.0003		
q25	Coef	0.5369***	(29.38)	−4.3072***	(−10.52)	0.0125***	(101.71)	0.3986
	Std. Err	0.0266		0.9517		0.0001		
q50	Coef	0.5234***	(21.45)	−3.3233***	(−6.08)	0.0137***	(83.38)	0.4011
	Std. Err	0.0397		1.3033		0.0002		
q75	Coef	0.4738***	(10.52)	−1.6586*	(−1.68)	0.0157***	(51.53)	0.3750
	Std. Err	0.0499		1.4195		0.0003		
q90	Coef	0.3894***	(4.33)	−0.4004	(−0.20)	0.0188***	(30.98)	0.3621
	Std. Err	0.0718		1.7015		0.0005		
Hanoi Stock Exchange (HNX)								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.6642***	(20.50)	−0.6712	(−0.93)	0.0135***	(58.11)	0.4838
	Std. Err	0.0371		0.7451		0.0002		
q25	Coef	0.6974***	(29.62)	−1.1219**	(−2.13)	0.0143***	(85.32)	0.5315
	Std. Err	0.0244		0.6696		0.0002		
q50	Coef	0.7149***	(25.92)	−1.2456**	(−2.02)	0.0155***	(78.86)	0.5601
	Std. Err	0.0228		0.5738		0.0001		
q75	Coef	0.6853***	(13.27)	−1.0269	(−0.89)	0.0176***	(47.83)	0.5702
	Std. Err	0.0340		0.7567		0.0003		
q90	Coef	0.6228***	(7.30)	−0.1191	(−0.06)	0.0206***	(33.77)	0.5758
	Std. Err	0.0813		1.8982		0.0005		
Panel B: In low trading volume								
Ho Chi Minh Stock Exchange (HOSE)								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.5662***	(18.33)	−5.3634***	(−6.06)	0.0111***	(65.04)	0.3431
	Std. Err	0.0348		0.9967		0.0002		
q25	Coef	0.5194***	(18.29)	−4.1509***	(−5.10)	0.0121***	(77.44)	0.3657
	Std. Err	0.0336		1.4308		0.0002		
q50	Coef	0.4252***	(16.73)	1.3193*	(1.81)	0.0135***	(96.45)	0.3900
	Std. Err	0.0473		2.4219		0.0002		
q75	Coef	0.3493***	(8.90)	4.0771***	(3.63)	0.0151***	(69.80)	0.4147
	Std. Err	0.0407		1.2807		0.0002		
q90	Coef	0.3735***	(5.39)	2.2703	(1.15)	0.0169***	(44.21)	0.4342
	Std. Err	0.0863		2.2054		0.0004		
Hanoi Stock Exchange (HNX)								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.7562***	(31.11)	−3.6551***	(−6.96)	0.0125***	(74.09)	0.4976
	Std. Err	0.0265		0.6679		0.0001		
q25	Coef	0.7922***	(35.37)	−4.2562***	(−8.79)	0.0134***	(86.72)	0.5245
	Std. Err	0.0315		0.8088		0.0001		
q50	Coef	0.7671***	(33.47)	−2.9377***	(−5.93)	0.0149***	(93.69)	0.5603
	Std. Err	0.0398		1.3407		0.0002		
q75	Coef	0.7192***	(21.06)	−1.4839**	(−2.01)	0.0167***	(70.76)	0.5859
	Std. Err	0.0463		1.2096		0.0003		
q90	Coef	0.7127***	(11.23)	−1.9835	(−1.45)	0.0189***	(43.02)	0.6215
	Std. Err	0.0526		1.2274		0.0004		

Note: *t* statistics in parentheses, **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

pandemic. Five quantile points are estimated for Eqs. (14)–(17) in two distinct stock exchanges and considered for two separate periods (PRE-COVID19 and DUR-COVID19). Significant negative ($\gamma_{2,\tau}$) coefficients in Table 6 reveal the existence of herding in a bullish market (Panel A) and in a bearish market (Panel B), while significant negative ($\gamma_{2,\tau}$) coefficients in Table 7 represent a herd behavior during high trading volume (Panel A) and low trading volume (Panel B).

Table 6 results show that, in the upside market (Panel A), we find that most of the herding coefficients are insignificant

or positive at different quantile levels when we consider the herd behavior in the Vietnamese stock market in two separate periods (PRE-COVID19 and DUR-COVID19). These results strongly reinforce our findings from Table 3 that Vietnamese investors are more cautious and rational when stock prices are moving upward (Vo and Phan, 2017). In the downside market, we detect strong herd behavior during the fourth wave of the COVID-19 pandemic outbreak on the HOSE. For the HOSE, most negative ($\gamma_{2,\tau}$) coefficients during the fourth wave of the COVID-19 pandemic are significant and larger than the herding coefficients before the fourth

Table 5

Empirical results of QR model (Eq. (13)) for both the HOSE and the HNX in two separate periods (PRE- and DUR-COVID19).

Panel A: Before the fourth wave of the COVID-19 pandemic (PRE-COVID19)							
Ho Chi Minh Stock Exchange (HOSE)							
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	Pseudo R ²
q10	Coef	0.5769***	(29.46)	−4.9994***	(−10.52)	0.0111***	0.3814
	Std. Err	0.0355		1.5639		0.0001	
q25	Coef	0.5541***	(33.86)	−4.0381***	(−10.17)	0.0120***	0.4243
	Std. Err	0.0275		1.2295		0.0001	
q50	Coef	0.4882***	(31.39)	−1.0908***	(−2.89)	0.0132***	0.4653
	Std. Err	0.0289		1.1211		0.0001	
q75	Coef	0.4249***	(18.49)	0.9069	(1.63)	0.0147***	0.4957
	Std. Err	0.0314		1.2671		0.0001	
q90	Coef	0.4432***	(10.91)	0.6601	(0.67)	0.0162***	0.5062
	Std. Err	0.0387		1.0629		0.0002	
Hanoi Stock Exchange (HNX)							
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	Pseudo R ²
q10	Coef	0.7417***	(16.38)	−2.2174***	(−4.12)	0.0126***	0.495
	Std. Err	0.0452		1.3689		0.0002	
q25	Coef	0.7325***	(44.03)	−1.5033***	(−4.11)	0.0137***	0.546
	Std. Err	0.0309		1.0124		0.0001	
q50	Coef	0.7326***	(44.62)	−1.2543***	(−3.47)	0.0149***	0.6031
	Std. Err	0.0196		0.5146		0.0001	
q75	Coef	0.7327***	(31.25)	−1.2323***	(−2.39)	0.0162***	0.6484
	Std. Err	0.0244		0.6189		0.0002	
q90	Coef	0.7375***	(17.41)	−1.5689*	(−1.68)	0.0179***	0.6861
	Std. Err	0.0349		0.7724		0.0002	
Panel B: During the fourth wave of the COVID-19 pandemic (DUR-COVID19)							
Ho Chi Minh Stock Exchange (HOSE)							
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	Pseudo R ²
q10	Coef	0.3553***	(7.05)	−2.7121**	(−2.17)	0.0139***	0.2222
	Std. Err	0.0551		1.2668		0.0003	
q25	Coef	0.3371***	(6.31)	−2.2251*	(−1.68)	0.0152***	0.2052
	Std. Err	0.0599		1.3274		0.0004	
q50	Coef	0.3363***	(5.21)	−2.4564*	(−1.74)	0.0170***	0.1993
	Std. Err	0.0913		1.4103		0.0005	
q75	Coef	0.6172***	(5.72)	−8.5348***	(−3.18)	0.0180***	0.2304
	Std. Err	0.0983		2.2027		0.0005	
q90	Coef	0.5764***	(3.79)	−9.1366**	(−2.42)	0.0210***	0.2205
	Std. Err	0.0853		1.7828		0.0005	
Hanoi Stock Exchange (HNX)							
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	Pseudo R ²
q10	Coef	0.4088***	(7.04)	1.1363	(0.91)	0.0173***	0.409
	Std. Err	0.0643		1.1785		0.0006	
q25	Coef	0.4595***	(9.36)	−0.0168	(−0.02)	0.0183***	0.4156
	Std. Err	0.0395		1.1410		0.0002	
q50	Coef	0.4854***	(8.74)	0.2098	(0.18)	0.0202***	0.4424
	Std. Err	0.0651		1.3289		0.0005	
q75	Coef	0.5338***	(6.55)	−1.3581	(−0.78)	0.0222***	0.4732
	Std. Err	0.0929		1.6173		0.0005	
q90	Coef	0.7257***	(5.86)	−4.7269**	(−2.20)	0.0238***	0.4735
	Std. Err	0.1102		2.1470		0.0011	

Note: *t* statistics in parentheses, **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

wave of the COVID-19 pandemic. In contrast, herd behavior exists at all quantiles on the HNX before the fourth COVID-19 pandemic wave, yet it seems not to be present during the fourth wave of the COVID-19 pandemic outbreak. The $\gamma_{2,\tau}$ coefficient is solely statistically significant at the highest quantile level ($\tau = 10\%$). Normally, information asymmetry and risk aversion make investors act according to others instead of rationality when stock prices go down (Bui et al., 2018). Fear and uncertainty about the impact of the pandemic will drive less-informed investors to give up their beliefs and follow more-informed ones (Espinosa-Méndez and Arias, 2021b). Hence, herd behavior will be more pronounced when the market is down in the context of a health crisis.

Results presented in Table 7 show that the herding effect is generally weak or non-existent in markets with high and trading volumes during the fourth wave of the COVID-19 pandemic outbreak. According to the estimated results in Panel A of Table 7, $\gamma_{2,\tau}$ coefficients are significant and negative from 10% to 75% quantiles in the PRE-COVID19 period, however, they also have similar signs at two high quantiles ($\tau = 75\%$, $\tau = 90\%$) on the HOSE during the fourth wave of the COVID-19 pandemic. The behavior of investors on HNX deviates from that of HOSE at high trading volumes, indicating that herd behavior is non-existent in both the PRE-COVID19 period and the DUR-COVID19 period in HNX.

Table 6

Empirical results of QR models (Eqs. (14) and (15)) for both the HOSE and the HNX at various market conditions (during upside and downside markets) and during two separate periods (PRE- and DUR-COVID19).

Panel A: In the upside market								
Ho Chi Minh Stock Exchange (HOSE) – PRE-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5341***	(15.44)	−3.4538***	(−3.17)	0.0113***	(60.48)	0.3682
	Std. Err	0.0454		2.1131		0.0002		
q25	Coef	0.4835***	(19.00)	−0.6924	(−0.86)	0.0124***	(89.74)	0.4148
	Std. Err	0.0313		1.4948		0.0001		
q50	Coef	0.4391***	(18.91)	1.3006*	(1.78)	0.0135***	(107.25)	0.4540
	Std. Err	0.0269		1.2160		0.0001		
q75	Coef	0.410***	(11.08)	2.6867**	(2.30)	0.0148***	(73.94)	0.4608
	Std. Err	0.0480		1.6431		0.0002		
q90	Coef	0.431***	(5.87)	1.1669	(0.50)	0.0164***	(41.13)	0.4586
	Std. Err	0.0585		1.9333		0.0003		
Ho Chi Minh Stock Exchange (HOSE) – DUR-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.3033***	(3.74)	−1.6362	(−0.67)	0.0139***	(27.91)	0.1912
	Std. Err	0.0827		3.2159		0.0003		
q25	Coef	0.3119***	(4.10)	−2.3938	(−1.04)	0.0152***	(32.60)	0.1626
	Std. Err	0.0967		3.8041		0.0005		
q50	Coef	0.2562***	(3.94)	−1.9956	(−1.02)	0.0170***	(42.63)	0.1446
	Std. Err	0.1379		6.8436		0.0006		
q75	Coef	0.2166	(1.47)	6.7136	(1.51)	0.0185***	(20.52)	0.1307
	Std. Err	0.2126		1.0635		0.0007		
q90	Coef	0.5402**	(2.93)	−6.4728	(−1.16)	0.0199***	(17.60)	0.2174
	Std. Err	0.2690		1.1093		0.0012		
Hanoi Stock Exchange (HNX) – PRE-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.7793***	(19.38)	−2.0390*	(−1.71)	0.0125***	(51.94)	0.5079
	Std. Err	0.0402		1.1955		0.0002		
q25	Coef	0.7298***	(30.87)	−0.5304	(−0.94)	0.0137***	(85.09)	0.5536
	Std. Err	0.0236		0.5653		0.0001		
q50	Coef	0.7397***	(32.51)	−1.0845*	(−1.68)	0.0149***	(126.06)	0.6008
	Std. Err	0.0227		0.6454		0.0001		
q75	Coef	0.7152***	(18.06)	−0.6911	(−0.71)	0.0165***	(64.63)	0.6374
	Std. Err	0.0396		0.9862		0.0002		
q90	Coef	0.6352***	(10.99)	0.4802	(0.34)	0.0188***	(38.94)	0.6637
	Std. Err	0.0577		1.4067		0.0004		
Hanoi Stock Exchange (HNX) – DUR-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.2691**	(2.11)	5.4809	(1.51)	0.0184***	(23.32)	0.3227
	Std. Err	0.1278		3.6241		0.0009		
q25	Coef	0.3839***	(3.98)	2.1828	(0.67)	0.0189***	(31.94)	0.2966
	Std. Err	0.1176		4.1828		0.0006		
q50	Coef	0.3253**	(2.13)	5.1667	(1.39)	0.0211***	(31.07)	0.3071
	Std. Err	0.1527		5.5414		25.73		
q75	Coef	0.4273*	(1.71)	2.3685	(0.3)	0.0223***	(15.74)	0.2906
	Std. Err	0.2501		8.4134		16.67		
q90	Coef	0.5535**	(2.15)	−5.5991	(−0.68)	0.0259***	(13.16)	0.2598
	Std. Err	0.2570		8.2728		16.31		
Panel B: In the downside market								
Ho Chi Minh Stock Exchange (HOSE) – PRE-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5862***	(18.07)	−5.1534***	(−7.34)	0.0110***	(52.07)	0.3985
	Std. Err	0.0379		1.7227		0.0001		
q25	Coef	0.5739***	(25.36)	−4.4218***	(−9.03)	0.0118***	(79.45)	0.4475
	Std. Err	0.0369		1.3455		0.0002		
q50	Coef	0.5259***	(23.46)	−2.6074***	(−5.37)	0.0130***	(88.45)	0.4881
	Std. Err	0.0394		1.3731		0.0001		
q75	Coef	0.4154***	(13.28)	0.8746	(1.29)	0.0147***	(71.77)	0.5388
	Std. Err	0.0465		1.7344		0.0002		
q90	Coef	0.4645***	(7.83)	−0.0629	(−0.05)	0.0159***	(41.01)	0.5526
	Std. Err	0.0884		2.4241		0.0003		

(continued on next page)

Table 6 (continued).

Ho Chi Minh Stock Exchange (HOSE) – DUR-COVID19								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.3577***	(4.02)	−2.3155	(−1.36)	0.0143***	(24.28)	0.2893
	Std. Err	0.0890		1.7019		0.0006		
q25	Coef	0.5166***	(5.49)	−6.0141***	(−3.03)	0.0151***	(26.35)	0.2846
	Std. Err	0.0940		1.8792		0.0005		
q50	Coef	0.5935***	(5.45)	−7.9259***	(−3.68)	0.0164***	(22.05)	0.2953
	Std. Err	0.1089		2.2847		0.0007		
q75	Coef	0.6229***	(5.72)	−9.4199***	(−4.33)	0.0193***	(22.39)	0.2788
	Std. Err	0.1089		2.1984		0.0008		
q90	Coef	0.5700***	(3.74)	−9.8349***	(−3.39)	0.0228***	(16.8)	0.1883
	Std. Err	0.1522		2.9004		0.0013		
Hanoi Stock Exchange (HNX) – PRE-COVID19								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.7181***	(28.64)	−3.2125***	(−6.58)	0.0127***	(64.95)	0.5038
	Std. Err	0.0323		1.4225		0.0002		
q25	Coef	0.6866***	(25.84)	−1.0631**	(−2.06)	0.0138***	(73.86)	0.5451
	Std. Err	0.0472		1.4979		0.0002		
q50	Coef	0.7078***	(28.6)	−0.9403*	(−1.95)	0.0149***	(85.61)	0.608
	Std. Err	0.0370		0.9722		0.0002		
q75	Coef	0.7352***	(24.03)	−1.4741**	(−2.48)	0.0161***	(74.85)	0.6635
	Std. Err	0.0424		1.0879		0.0002		
q90	Coef	0.7871***	(15.8)	−2.4721**	(−2.55)	0.0174***	(49.89)	0.7167
	Std. Err	0.0678		1.7399		0.0002		
Hanoi Stock Exchange (HNX) – DUR-COVID19								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.4024***	(5.66)	1.3151	(−0.94)	0.0171***	(27.88)	0.4999
	Std. Err	0.0934		1.6569		0.0008		
q25	Coef	0.5004***	(6.05)	−0.5980	(−0.37)	0.0179***	(25.07)	0.537
	Std. Err	0.0877		1.7299		0.0005		
q50	Coef	0.5935***	(7.11)	−1.7006	(−1.03)	0.0194***	(26.87)	0.5756
	Std. Err	0.0827		1.6198		0.0007		
q75	Coef	0.6027***	(5.33)	−2.6191	(−1.17)	0.0221***	(22.67)	0.6201
	Std. Err	0.1155		2.232		0.0007		
q90	Coef	0.8048***	(7.41)	−5.7581***	(−3.04)	0.0228***	(24.29)	0.608
	Std. Err	0.0940		1.8681		0.0008		

Note: *t* statistics in parentheses, **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

Moreover, it was noticed that when the markets are less active (see Table 7 (Panel B)), herd behavior is more pronounced for the HOSE in the DUR-COVID19 period at 75% and 90% quantiles. On the HNX, we cannot find the herd behavior of investors during the fourth COVID-19 outbreak. In the PRE-COVID19 period, only the $\gamma_{2,\tau}$ coefficient is significant and negative at the lowest level ($\tau = 10\%$) on the HOSE. On the other hand, herding coefficients are negative and significant from 10% to 75% quantiles on the HNX. Our findings imply that investors on the HNX are over-pessimistic and over-reacted with shrunken trading volumes before the fourth wave of the COVID-19 pandemic but seem to have a sanguine attitude with slumped trading volumes during the fourth wave of the COVID-19 pandemic outbreak.

The evident herding behavior at high trading volumes during the fourth COVID-19 wave outbreak can be reasonably explained as follows. Investors tend to be more active during the pandemic because social distancing and lockdowns required people to work from their homes (Chiah and Zhong, 2020). In the Vietnamese stock market, trading volumes spiked in 2021 when the fourth wave of the COVID-19 outbreak. According to VSD, the total trading volumes at HOSE at the end of 2021 reached 184.32 billion shares, an increase of 118.68% compared to the end of 2020. In addition, the quantity of newly opened accounts has dramatically increased. It shows fresh investors significantly entered the stock market when the fourth wave of the COVID-19 pandemic outbreak. These less-informed investors mimic the activity's more-informed investors. As a result, herd behavior at

high trading volumes is obviously exhibited in HOSE-the largest stock exchange in Vietnam during the fourth of the COVID-19 wave outbreak. Our finding is consistent with the results of Huang and Wang (2017).

Overall, we find that the herd behavior of investors on Vietnamese two largest exchanges was comparatively different when the fourth wave of the COVID-19 pandemic broke out in Vietnam from April 27, 2021, to May 31, 2022. Although herd behavior was observed and increased in the HOSE during the outbreak of the fourth wave of the COVID-19 pandemic, it appears to be mild or absent in the HNX. Moving forward to more specific scenarios, our empirical results provide a deeper understanding of herding in the Vietnamese financial markets across various scenarios. We found it interesting that when stock prices fell during the COVID-19 pandemic, the behavior of investors was entirely different on the two stock exchanges with respect to herding. While investors on the HOSE simultaneously sold off stocks, investors on the HNX were quite rational. It seems likely that investors on the HNX believed in the recovery of the Vietnamese stock market after the fourth wave of the COVID-19 pandemic whereas the investors on the HOSE did not.

4.5. Estimated results from robust tests

We perform robust checks to examine the impact of the fourth wave of the COVID-19 pandemic on herd behavior after controlling for the GSCPI variable. In Panel A of Table 8, the GSCPI

Table 7

Empirical results of QR models (Eqs. (16) and (17)) for both the HOSE and the HNX at various market conditions (during high and low trading volumes) and during two separate periods (PRE- and DUR-COVID19).

Panel A: In high trading volume								
Ho Chi Minh Stock Exchange (HOSE) – PRE-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.6051***	(20.61)	−5.5829***	(−8.70)	0.0112***	(56.41)	0.3911
	Std. Err	0.0459		1.7203		0.0002		
q25	Coef	0.5534***	(29.05)	−4.2401***	(−10.18)	0.0123***	(95.62)	0.4442
	Std. Err	0.0277		1.0869		0.0001		
q50	Coef	0.5078***	(22.25)	−2.023***	(−4.06)	0.0134***	(87.07)	0.4715
	Std. Err	0.0388		1.4147		0.0001		
q75	Coef	0.5059***	(14.90)	−1.9667**	(−2.65)	0.0148***	(64.52)	0.4838
	Std. Err	0.0393		1.2080		0.0002		
q90	Coef	0.4969***	(6.76)	−1.7065	(−1.06)	0.0166***	(33.44)	0.4853
	Std. Err	0.0683		1.6096		0.0005		
Ho Chi Minh Stock Exchange (HOSE) – DUR-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.3676***	(3.03)	−2.4625	(−0.77)	0.0144***	(19.23)	0.2195
	Std. Err	0.0913		2.4674		0.0007		
q25	Coef	0.3551***	(3.92)	−3.0597	(−1.17)	0.0162***	(26.35)	0.1899
	Std. Err	0.0905		2.2385		0.0007		
q50	Coef	0.2242*	(1.84)	0.4718	(0.15)	0.0183***	(24.34)	0.1761
	Std. Err	0.1676		3.9640		0.0008		
q75	Coef	0.4461**	(2.44)	−5.6492*	(−1.67)	0.0204***	(18.05)	0.1984
	Std. Err	0.1339		3.3951		0.0008		
q90	Coef	0.6387**	(2.18)	−1.1559**	(−2.17)	0.0227***	(12.53)	0.1605
	Std. Err	0.2219		5.3357		0.0010		
Hanoi Stock Exchange (HNX) – PRE-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.3036***	(3.27)	3.3228	(1.38)	0.0182***	(26.03)	0.3906
	Std. Err	0.1127		2.8805		0.0007		
q25	Coef	0.4918***	(4.22)	0.6898	(0.23)	0.0186***	(21.16)	0.367
	Std. Err	0.1235		3.2758		0.0008		
q50	Coef	0.4688***	(3.87)	0.2327	(0.07)	0.0210***	(22.96)	0.3781
	Std. Err	0.0940		2.4542		0.0007		
q75	Coef	0.5247**	(2.68)	−2.2546	(−0.45)	0.0237***	(16.06)	0.3635
	Std. Err	0.2204		5.0489		0.0019		
q90	Coef	0.6487**	(2.08)	−5.8158	(−0.72)	0.0265***	(11.28)	0.3709
	Std. Err	0.1715		4.3846		0.0010		
Hanoi Stock Exchange (HNX) – DUR-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.6561***	(19.46)	−0.4292	(−0.59)	0.0134***	(57.04)	0.5034
	Std. Err	0.0434		1.0068		50.85		
q25	Coef	0.7093***	(30.64)	−1.1371	(−1.29)	0.0141***	(87.23)	0.5623
	Std. Err	0.0311		0.8823		78.34		
q50	Coef	0.7221***	(30.23)	−1.2591	(−1.62)	0.0152***	(91.36)	0.6095
	Std. Err	0.0278		0.7767		94.57		
q75	Coef	0.6907***	(19.22)	−0.4519	(−0.48)	0.0168***	(67.12)	0.648
	Std. Err	0.0298		0.9348		79.29		
q90	Coef	0.6687***	(12.58)	−0.4035	(−0.32)	0.0191***	(51.6)	0.684
	Std. Err	0.0537		1.2667		44.6		
Panel B: In low trading volume								
Ho Chi Minh Stock Exchange (HOSE) – PRE-COVID19								
		Absolute return	(t-stat)	Squared return	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5174***	(14.07)	−2.1656*	(−1.87)	0.0111***	(59.60)	0.3752
	Std. Err	0.0477		2.1579		0.0002		
q25	Coef	0.4575***	(16.28)	0.8039	(0.91)	0.0120***	(84.49)	0.4173
	Std. Err	0.0460		2.2655		0.0001		
q50	Coef	0.3703***	(13.88)	4.4789***	(5.34)	0.0133***	(98.62)	0.4664
	Std. Err	0.0307		1.1935		0.0001		
q75	Coef	0.3195***	(9.01)	5.8823***	(5.28)	0.0146***	(81.40)	0.5142
	Std. Err	0.0302		1.0952		0.0002		
q90	Coef	0.3409***	(5.58)	4.2924**	(2.23)	0.0159***	(51.22)	0.5486
	Std. Err	0.0449		1.4845		0.0003		

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Table 7 (continued).

Ho Chi Minh Stock Exchange (HOSE) – DUR-COVID19								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.3019***	(6.21)	−1.6139	(−1.40)	0.0139***	(43.31)	0.2366
	Std. Err	0.0631		1.3784		0.0004		
q25	Coef	0.3276***	(4.98)	−1.8725	(−1.20)	0.0148***	(34.13)	0.2306
	Std. Err	0.0713		2.0979		0.0004		
q50	Coef	0.3118***	(3.99)	−1.9788	(−1.07)	0.0162***	(31.46)	0.2234
	Std. Err	0.1099		3.3695		0.0006		
q75	Coef	0.5195***	(4.30)	−6.3788**	(−2.23)	0.0173***	(21.72)	0.2728
	Std. Err	0.1670		5.5376		0.0005		
q90	Coef	0.6906***	(4.70)	−10.5339**	(−3.03)	0.0187***	(19.29)	0.3266
	Std. Err	0.1691		5.3652		0.0009		
Hanoi Stock Exchange (HNX) – PRE-COVID19								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.7811***	(34.44)	−3.9180***	(−7.76)	0.0122***	(80.93)	0.5015
	Std. Err	0.0494		1.9738		0.0002		
q25	Coef	0.7867***	(31.66)	−3.4340***	(−6.21)	0.0132***	(80.26)	0.5325
	Std. Err	0.0639		2.3342		0.0002		
q50	Coef	0.7245***	(32.43)	−0.7040	(−1.42)	0.0146***	(99.05)	0.5922
	Std. Err	0.0462		1.5588		0.0002		
q75	Coef	0.7446***	(27.21)	−1.5538**	(−2.55)	0.0159***	(87.88)	0.6492
	Std. Err	0.0387		1.0898		0.0001		
q90	Coef	0.7325***	(17.15)	−1.2862	(−1.35)	0.0173***	(61.37)	0.7009
	Std. Err	0.0522		1.3642		0.0003		
Hanoi Stock Exchange (HNX) – DUR-COVID19								
		Absolute return	(<i>t</i> -stat)	Squared return	(<i>t</i> -stat)	_cons	(<i>t</i> -stat)	Pseudo R ²
q10	Coef	0.4036***	(4.93)	1.1854	(0.72)	0.0172***	(25.42)	0.4315
	Std. Err	0.0901		1.5584		0.0001		
q25	Coef	0.4291***	(7.62)	0.4975	(0.44)	0.0183***	(39.48)	0.4551
	Std. Err	0.0662		1.4547		0.0004		
q50	Coef	0.4329***	(6.41)	0.7525	(0.56)	0.0198***	(35.53)	0.4885
	Std. Err	0.0690		1.3537		0.0005		
q75	Coef	0.4702***	(5.19)	0.1306	(0.07)	0.0216***	(28.92)	0.5651
	Std. Err	0.0913		1.6221		0.0005		
q90	Coef	0.6491***	(5.79)	−3.1934	(−1.42)	0.0229***	(24.74)	0.6010
	Std. Err	0.1040		2.0729		0.0006		

Note: *t* statistics in parentheses, **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

coefficient is positive and significant at all quantiles. The positive coefficients of the GSCPI variable are larger at higher quantiles. As the global supply chain pressure accelerates, the degree of stock return dispersions also increases. This evidence suggests the moderating role of the COVID-19 pandemic in the herding of the Vietnamese stock market. Panel B of Table 8 reports the impact of GSCPI on the stock return dispersions in two subsamples (PRE-COVID19 and DUR-COVID19). For HOSE, the magnitude of the GSCPI positive coefficient in the PRE-COVID19 sample is significantly higher than the one in the DUR-COVID19 sample. For HNX, the coefficient of the GSCPI variable is significantly negative or insignificantly positive in the DUR-COVID19 sample. Estimated results show that herding in the HOSE is triggered by the increased pressure on the global supply chain caused by the fourth wave of the COVID-19 pandemic. In both Panels A and B, the sign and significance of the main independent variables (Absolute return ($R_{m,t}$) and Square return ($R_{m,t}^2$)) did not change compared to previous results. Overall, our previous findings are robust.

5. Conclusions

This study examines the herd behavior of investors in the Vietnamese stock market from January 2016 to May 2022. Our empirical model proposed by Chang et al. (2000) was used to test herding in the HOSE and the HNX – two quite different kinds of stock markets. The QR estimations are applied to consider the herd behavior at different dispersions of stock returns. Our research

provides a depth insight to investors and policymakers about stock pricing and market risk management in the COVID-19 crisis.

This study contributes to behavioral finance literature in the following respects. Firstly, consistent with the previous studies on the Vietnamese stock market, our findings confirm and extend the evidence for the existence of investors' herd behavior from January 2016 to May 2022. Results show that investors tend to herd in high trading volume, low trading volume, and downside markets. However, no evidence of herd behavior was found in upside markets. These findings are robust for both stock exchanges (HOSE and HNX). Secondly, participants on the HOSE showed irrationality during the fourth wave of the COVID-19 outbreak with herd behavior detected. Conversely, investors in the HNX proved to be relatively immune when the fourth wave of the COVID-19 pandemic broke out in Vietnam. Thus, Vietnamese policymakers have to be concerned about potentially destabilizing effects on the HOSE (the largest stock exchange in Vietnam). Thirdly, the fourth wave of the COVID-19 pandemic was unprecedented and affected Vietnamese markets considerably, with a serious impact on HCMC. The reliable information to HOSE investors might be limited and combined with high investors' fear might have led to them imitating the behavior of others or relying too much on public behaviors, consequently, leading to mistakes in the valuation and trading of stocks. Moreover, results show that excessive investors' fear during the fourth COVID-19 pandemic outbreak became more extreme during the declining market phase.

Table 8

Robust tests.

Panel A: Robust check for the whole sample

Ho Chi Minh Stock Exchange (HOSE)

		Absolute return	(t-stat)	Squared return	(t-stat)	GSCPI	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5216***	(40.11)	−5.1191***	(−4.53)	0.0005***	(12.01)	0.0113***	(73.31)	0.3851
	Std. Err	0.0309		1.1297		0.0000		0.0001		
q25	Coef	0.5002***	(20.43)	−4.0655***	(−4.93)	0.0007***	(11.03)	0.0122***	(104.93)	0.4328
	Std. Err	0.0244		0.8241		0.0001		0.0001		
q50	Coef	0.4886***	(18.51)	−2.535**	(−2.17)	0.0009***	(25.74)	0.0131***	(114.58)	0.4848
	Std. Err	0.0264		1.1671		0.0000		0.0001		
q75	Coef	0.4568***	(17.04)	−0.7767	(−0.73)	0.0013***	(17.53)	0.0141***	(103.84)	0.5272
	Std. Err	0.0268		1.0695		0.0001		0.0001		
q90	Coef	0.4157***	(13.84)	0.7651	(0.75)	0.0019***	(18.26)	0.0152***	(115.21)	0.5656
	Std. Err	0.0329		1.0147		0.0001		0.0001		

Hanoi Stock Exchange (HNX)

		Absolute return	(t-stat)	Squared return	(t-stat)	GSCPI	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.6645***	(24.67)	−2.7519***	(−7.72)	0.0008***	(12.35)	0.0129***	(89.17)	0.5305
	Std. Err	0.0269		0.6733		0.0001		0.0001		
q25	Coef	0.6528***	(22.22)	−1.9484**	(−2.19)	0.0009***	(15.35)	0.0139***	(93.47)	0.5772
	Std. Err	0.0293		0.8889		0.0001		0.0002		
q50	Coef	0.6576***	(30.37)	−1.2686*	(−1.79)	0.0012***	(21.18)	0.0149***	(116.5)	0.6326
	Std. Err	0.0216		0.3801		0.0001		0.0001		
q75	Coef	0.6465***	(31.66)	−0.5136	(−0.79)	0.0015***	(23.16)	0.0161***	(140.97)	0.6874
	Std. Err	0.0204		0.5932		0.0001		0.0002		
q90	Coef	0.7030***	(22.28)	0.1341	(0.19)	0.0018***	(22.33)	0.0174***	(84.37)	0.7291
	Std. Err	0.0497		0.7224		0.0001		0.0002		

Panel B: Robust check for two sub-samples

Ho Chi Minh Stock Exchange (HOSE) – PRE-COVID19

		Absolute return	(t-stat)	Squared return	(t-stat)	GSCPI	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5487***	(12.04)	−4.8593***	(−2.66)	0.0006***	(6.53)	0.0111***	(48.43)	0.3875
	Std. Err	0.0456		1.8273		0.0001		0.0002		
q25	Coef	0.5244***	(23.82)	−4.0229***	(−4.63)	0.0007***	(6.14)	0.0122***	(94.59)	0.4425
	Std. Err	0.0220		0.8692		0.0001		0.0001		
q50	Coef	0.5014***	(19.23)	−2.6775**	(−2.27)	0.0010***	(9.7)	0.0131***	(101.64)	0.506
	Std. Err	0.0261		1.1794		0.0001		0.0001		
q75	Coef	0.4285***	(11.73)	0.4878	(0.37)	0.0014***	(8.43)	0.0142***	(69.76)	0.5704
	Std. Err	0.0365		1.3346		0.0002		0.0002		
q90	Coef	0.3778***	(14.54)	2.1211**	(2.56)	0.0021***	(17.6)	0.0154***	(87.56)	0.6238
	Std. Err	0.0260		0.8278		0.0001		0.0002		

Hanoi Stock Exchange (HNX) – PRE-COVID19

		Absolute return	(t-stat)	Squared return	(t-stat)	GSCPI	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.7212***	(20.87)	−2.6075**	(−2.36)	0.0009***	(10.18)	0.0127***	(68.45)	0.5589
	Std. Err	0.0346		1.1059		0.0001		0.0002		
q25	Coef	0.6955***	(24.60)	−1.4829*	(−1.77)	0.0010***	(9.37)	0.0138***	(108.70)	0.6074
	Std. Err	0.0283		0.8384		0.0001		0.0001		
q50	Coef	0.6697***	(25.80)	−0.5797	(−0.71)	0.0012***	(13.21)	0.0149***	(117.41)	0.6659
	Std. Err	0.0260		0.8211		0.0001		0.0001		
q75	Coef	0.6664***	(20.86)	−0.7154	(−0.83)	0.0015***	(13.16)	0.0161***	(112.33)	0.7239
	Std. Err	0.0319		0.8592		0.0001		0.0001		
q90	Coef	0.6240***	(18.45)	0.5687	(0.53)	0.0014***	(8.04)	0.0174***	(80.16)	0.7674
	Std. Err	0.0338		1.0708		0.0002		0.0002		

Ho Chi Minh Stock Exchange (HOSE) – DUR-COVID19

		Absolute return	(t-stat)	Squared return	(t-stat)	GSCPI	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.3822***	(7.59)	−3.0157**	(−2.23)	0.0008**	(1.94)	0.0111***	(7.89)	0.2442
	Std. Err	0.0503		1.3526		0.0004		0.0014		
q25	Coef	0.3017***	(6.76)	−1.7607*	(−1.62)	0.0014***	(6.12)	0.0112***	(11.95)	0.2537
	Std. Err	0.0447		1.0874		0.0002		0.0009		
q50	Coef	0.4111***	(5.64)	−3.3933*	(−1.97)	0.0014***	(4.5)	0.0118***	(12.64)	0.2456
	Std. Err	0.0729		1.7212		0.0003		0.0009		
q75	Coef	0.5515***	(5.37)	−6.7599***	(−3.02)	0.0024***	(5.44)	0.0103***	(6.57)	0.2704
	Std. Err	0.1027		2.2397		0.0004		0.0004		
q90	Coef	0.6542***	(6.59)	−9.6699***	(−4.94)	0.0031**	(2.61)	0.0103**	(2.75)	0.2685
	Std. Err	0.0992		1.9579		0.0012		0.0037		

(continued on next page)

Table 8 (continued).

Hanoi Stock Exchange (HNX) – DUR-COVID19										
		Absolute return	(t-stat)	Squared return	(t-stat)	GSCPI	(t-stat)	_cons	(t-stat)	Pseudo R ²
q10	Coef	0.5062***	(5.32)	−1.5997***	(−0.88)	−0.0016**	(−2.49)	0.0215***	(10.80)	0.4736
	Std. Err	0.0952		1.8109		0.0007		0.0020		
q25	Coef	0.5299***	(7.85)	−1.5098	(−0.77)	−0.0020***	(−3.11)	0.0235***	(15.19)	0.4940
	Std. Err	0.0675		1.9485		0.0007		0.0015		
q50	Coef	0.5780***	(11.75)	−1.2494	(−0.94)	−0.0007***	(−2.72)	0.0216***	(32.45)	0.5519
	Std. Err	0.0492		1.3315		0.0003		0.0007		
q75	Coef	0.6404***	(7.72)	−2.7231	(−1.56)	0.0002	(0.35)	0.0211***	(18.17)	0.6073
	Std. Err	0.0830		1.7452		0.0005		0.0005		
q90	Coef	0.7275***	(10.86)	−3.4033**	(−2.44)	0.0001	(0.18)	0.0224***	(13.12)	0.6142
	Std. Err	0.0670		1.3969		0.0006		0.0017		

Note: *t* statistics in parentheses, **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

Our findings suggest several implications for policymakers and securities investors during both usual and unexpected market conditions in Vietnam. Firstly, the State Securities Commission should issue more detailed policies to increase information quality and transparency, fostering investor confidence in official announcements by enterprises. Secondly, the government should impose severe sanctions for insider trading, price speculation, and manipulation to create a safer investment environment. Thirdly, policies should be implemented to improve investors' analytical skills and knowledge to make informed decisions. Lastly, as individual investors make up the majority in Vietnam's stock market, the government should enact policies to protect their interests. Our empirical results encourage investors to be vigilant and to avoid imitating others' behavior in the face of crisis, as this accelerates investment risks. Investors should be equipped with fundamental investment knowledge, be careful with available information flows, and analyze information thoroughly before making investment decisions in turmoils. Further, the usage of derivative contracts may help investors hedge risks caused by unexpected shocks in the stock market.

A limitation of this research is that we did not examine herd behavior between individual and institutional investors during the fourth wave of COVID-19 in Vietnam. Thus, future research can investigate herding among different investor groups in emerging markets in unstable periods.

CRedit authorship contribution statement

Huu Manh Nguyen: Conceptualization, Data curation, Methodology, Software, Formal analysis, Writing – original draft, Writing – review & editing. **Walid Bakry:** Conceptualization, Funding acquisition, Data curation, Methodology, Software, Formal analysis, Writing – original draft, Writing – review & editing. **Thi Huong Giang Vuong:** Conceptualization, Data curation, Methodology, Software, Formal analysis, Writing – original draft, Writing – review & editing.

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