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Does Firm Size Matter in Herding Behavior? Evidence from Quantile Regression Analysis in the Pakistan Stock Exchange

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ABSTRACT

This study examines whether herding behavior varies with firm size in the Pakistan Stock Exchange (PSX) and evaluates whether quantile regression provides additional evidence beyond conventional ordinary least squares (OLS) estimation. Using daily stock-price data for 128 firms from August 1, 2016, to September 30, 2024, firms are classified according to market capitalization, with particular attention given to the smallest and largest firms. Herding is examined using the cross-sectional standard deviation (CSSD) and cross-sectional absolute deviation (CSAD) approaches during extreme market movements defined by the 5% criterion and under nonlinear specifications. In addition to OLS estimation, quantile regression is applied on the lower quantiles ($t=10\%$, 25%) and on the upper quantiles ($t=75\%$, 90%) quantiles to capture heterogeneous herding behavior across the conditional distribution of returns. The OLS results provide limited evidence of herding, primarily among large firms during downward market movements, and fail to detect nonlinear herding across either firm-size group. In contrast, quantile regression identifies more pronounced herding at lower quantiles, particularly during downward market movements, for both the smallest and largest firms using the CSAD specification. Nonlinear quantile estimation also identifies herding among the smallest firms at the 25% quantile. Overall, the findings demonstrate that herding is state-dependent and more evident during periods of market stress, while quantile regression provides greater sensitivity than OLS in detecting heterogeneous herding behavior in the PSX. The study contributes to the literature by highlighting the importance of firm size and distributional heterogeneity when examining investor herding in emerging markets.

KEYWORDS

Herding Behavior, CSAD, CSSD, Quantile Regression, Firm Size,
Pakistan Stock Exchange.



INTRODUCTION

Herding behavior has gained recognition in recent times, as traditional finance theories have not adequately explained the deviation of stock prices from their intrinsic values. Traditional finance theories assumed that all investors are rational and financial markets are informationally efficient (EMH) (Malkiel & Fama, 1970). However, Shleifer (2000) criticized EMH by asserting that it would be unrealistic and impractical for a market to comprise rational investors. Investors tend to exhibit irrational behavior that may cause herding. Herding primarily explains the psychological behavior, where investors tend to ignore the fundamentals and follow the crowd in making investments. In such cases, investors tend to form clusters, all taking the same decisions, hence driving asset prices in a certain direction (Gebka & Wohar, 2013). Herding occurs when investors completely ignore the forecasted outcomes and personal evaluations and blindly imitate the investing decisions of the crowd (Spyrou, 2013). Usually, when investors believe others possess better information, they tend to imitate their trading decisions. Behavioral biases such as greed and Fear of Missing Out (FOMO) cause investors to blindly replicate the actions of others (Rahmawati & Raharja, 2024).

The behavior biases that influence the decision-making criteria of an investor leads to irrationality. Such irrational behavior causes market imbalances and imprecise valuation of securities (Demirer & Kutan, 2006; Nadarajah & Chu, 2017). The volatility in the market is created by this irrationality that may lead to a stock market crash (Ajaz & Kumar, 2018). Existing empirical literature on herding behavior presents mixed results in stock markets worldwide. Some are supporting the existence of herding behavior in stock markets worldwide (for, instance, Ahn et al., 2024; Wanidwaranan et al., 2025; Wong et al., 2024) whereas others are proving the non-existence of herding behavior (see, for example, Alaraj, 2025; Cao et al., 2025; Shantha, 2019). However, the literature reveals that herding behavior is more profound in emerging markets as compared to developed markets (Demirer et al., 2010; Khan et al., 2024; Yasir & Önder, 2022).

According to recent categorization of International Monetary Fund (IMF), Pakistan has been classified as a rapidly emerging economy and one of the fastest growing countries in Asia (Shah et al., 2024). In Pakistan, investors are lacking stock market education, sufficient training, knowledge about rules and regulations of the market, so their investment decisions are less informed and mostly driven by socio cultural values (Qayyum & Khalid, 2025). Information asymmetry is one of the main reasons that may cause herding in the Pakistan stock market (Perveen et al., 2024; Safdar & Khan, 2024). The stock market of Pakistan is dominated by large investors, and the small investors usually imitate the large investors' decisions because they believe that they are lacking sufficient information. This behavior may be the major cause of herding in the Pakistan stock market (Ahmed et al., 2024).

In the context of Pakistan, researchers have explored herding in different perspectives such as sectoral level, market wide and firm-based herding. However, herding behavior with respect to firm size has rarely been studied in the context of Pakistan. This examination is important because presumably, investors do not usually pay attention to small stocks, hence resulting in liquidity problems. Whereas larger stocks grab more attention from the market participants. Investors tend to focus more on prominent stocks, usually stocks with larger market capitalization (Kahneman & Tversky, 1973). Therefore, it is believed that herding behavior tends to be different with respect to firm size. Complimenting this notion, Shah et al. (2017) claimed that classifying firms on the basis of size can produce confounding results.

Previously, the research studies in the context of Pakistan stock market (PSX) used the OLS techniques to detect the presence of herding behavior, but the majority of studies failed to detect it. Further, pointed out the limitation of the OLS technique to detect herding behavior and suggested quantile regression as an



alternative technique to traditional linear models (Perveen et al., 2024). Quantile regression performs analysis on different points of the distribution, also taking into consideration outliers, and gives more reliable results. Therefore, this research attempts to explore herding behavior firms of PSX categorized into two firm sizes (smallest size and largest size) for the period, August 1, 2016, to September 30, 2024, by employing OLS techniques along with quantile regression during extreme movements and through non-linearity. By employing both OLS and quantile regression, this study contributes to literature in three ways. First, it provides new evidence on the role of firm size in shaping herding dynamics in an emerging market. Second, it evaluates the robustness of herding detection methods by comparing OLS with quantile regression. Finally, it offers relevant policy insights for regulators and investors seeking to mitigate the risks associated with irrational market behavior.

LITERATURE REVIEW

Generally, herding behavior can be classified into two broad categories, which are “rational herding” and “irrational herding”. Christie and Huang (1995) defined irrational herding as the phenomenon in which investors rely entirely on other market participants for their investment decisions and disregard the fundamentals. Devenow and Welch (1996) defined irrational herding as the phenomenon in which investors completely ignore their beliefs and fundamentals and blindly imitate the majority. In contrast, the rational herding is defined as the phenomenon that occurs when investors have a motive to herd. Usually, because of reputational concerns, investors tend to replicate what the crowd does, ignoring their fundamental values and private information. Scharfstein and Stein (1990) proposed the “reputational-based herding theory,” which follows the principal-agent problem where investors tend to imitate the actions of others due to fear of standing out if wrong, thus preserving their reputation. Banerjee (1992) identified the “Informational Cascades Theory of Herding”, caused by information asymmetry, where investors assume the crowd has more reliable and accurate information, thus exhibiting herding behavior.

One of the primary studies in this domain was by Christie and Huang (1995). The research was to evaluate the movements in stock returns concerning the market using “Cross-sectional standard deviation (CSSD)” but failed to find the existence of herding in the US stock market. This study was further modified by C. P. Chang et al. (2000). They used “absolute deviation” in place of “standard deviation”, hence, employing “Cross-sectional absolute deviation (CSAD)”. This research included the stock markets of Japan, Taiwan, South Korea, Hong Kong, and the USA. The study focused on the relationship between “absolute return deviation” and “absolute market return”. They found evidence of considerable herding behavior in the markets of Taiwan and South Korea, and slight herding behavior in the markets of Japan. In the case of American markets, the results were identical to those of Christie and Huang (1995). Herding was also absent in Hong Kong.

The phenomenon of herding behavior has been widely studied across different global locations, presenting mixed results. Chaffai and Medhioub (2018) explored the stock markets of the Gulf Cooperation Council (GCC) (Bahrain, Kuwait, Qatar, Saudi Arabia, and UAE). Using the models of CSSD, CSAD, and GARCH, results provided evidence of herding behavior in the markets of Saudi Arabia and Qatar. Whereas, in the case of Kuwait and the Emirates, herding occurred with respect to the conventional markets. Duygun et al. (2021) applied quantile regression along with CSSD and CSAD to analyze herding in the markets of central and eastern Europe (CEE) as well as the US stock markets. The results revealed the existence of herding behavior in the US markets as well as in the Eurozone markets. Jiang et al. (2022) explored the East Asian and Southeast Asian markets: Tokyo (TOPIX), South Korea (KOSDAQ), China (Shanghai A- market), along with the Taiwan, Hong Kong, and Singapore stock markets. The study concludes the existence of severe herding.

A vast body of literature examined the herding behavior during the crisis period. Research conducted by Humayun Kabir (2018) explored the commercial banks, investment banks, and insurance companies of the US financial markets during the 2008 crisis. The sample comprised daily data for the period 2003 to 2012,



also including the financial crisis. The models employed were CSAD and seemingly unrelated regression (SUR). According to the results, there was evidence of spurious herding in commercial banks and investment banks in down markets. Similarly, intentional herding was found during normal market trends. Whereas, signs of herding behavior were rarely found in insurance companies. Bogdan et al. (2022) also studied the European Markets, classifying the region further into three categories: Developed markets, frontier markets, and developing markets. Results showed that herding was more significant in developing markets than in frontier markets. Whereas the weakest herding was found in developed markets. Further, developed markets were more stable, and the investors in these markets were more independent and confident.

Previous studies have mainly examined herding behavior in the context of crisis periods and extreme market movements, mostly in emerging countries and specifically, European and American Markets. Many researchers have studied herding in the context of Pakistan. Researchers have used different methods to find herding. For instance, Ahmed et al. (2022) measured herding under extreme market conditions and provided evidence that Pakistan displayed signs of herding. The study of Jabeen et al. (2023) was based on both firm-wise herding as well as sectoral herding, but could not find any signs of herding in PSX. Alvi and Rehan (2023) performed a study exploring investor behavior and its impact on markets of multiple countries, including Pakistan, as a part of their study. CSAD and quantile regression were the methodologies of this study. They failed to find the presence of herding behavior. Yawar et al. (2024) conducted a study specifically on the textile sector of Pakistan. Their data type was primary data, where questionnaires were sent to investors of different firms belonging to the textile sector. The response rate was satisfactory. Results displayed evident signs of herding in the textile sector of Pakistan.

Furthermore, most research studies focused on conventional linear models, whereas measures like quantile regression are rarely used. Malik and Elahi (2014) studied Karachi Stock Exchange (KSE) using quantile regression, CSSD, and CSAD. Empirical results proved evidence of herding in both lower and upper quantiles during normal as well as abnormal market conditions. The majority of the studies in the context of Pakistan attempt to detect herding using OLS measures. However, linear methods are only based on the mean of the data. These techniques fail to consider outliers, which tend to distort herding coefficients. Therefore, OLS measures are presumed to give misleading results. Current literature draws attention to the need to equip a more robust model that takes into consideration the non-linear relationships among dependent and independent variables. Quantile regression has rarely been used in the context of Pakistan. For this purpose, the study attempts to fill this gap and investigate herding behavior in the firms listed on PSX by employing OLS techniques and quantile regression, considering two firm sizes; smallest size firms and largest size firms.

DATA AND METHODOLOGY

The study utilized the daily stock prices of the firms listed on the “Pakistan Stock Exchange” covering the period from August 1, 2016, to September 30, 2024. However, firms with no trading for consecutive 5 or more days were excluded from the sample, leaving a total of 128 firms in the sample. The reason for taking daily data is that herding prevails more in short periods (De Long et al., 1990). Historical data was obtained from www.investing.com and www.psx.com.

Firm Classification by Size

To examine the effect of firm size on herding, the sample firms were categorized into four groups based on market capitalization, following the methodology of Chun et al. (2008) and Narayan and Sharma (2011). Firms were ranked in ascending order of market capitalization and then equally divided into four groups. Group 1 represents the smallest size firms, while Group 4 represents the largest size firms. For this study, particular attention is given to the smallest (Group 1) and the largest (Group 4) firms and are reported in Table 1.



Table 1: Categorization of Firms.

Size	Total firms	Market Capitalization (Billion)
Smallest Size firms	32	Rs. 0.209 - 4.87
Largest Size firms	32	Rs. 117.29 – 975.32

Econometric Model Specification

Gleason et al. (2004) have used both CSSD and CSAD to detect herding behavior. CSSD and CSAD are both linear methods that are commonly used to find herding behavior.

Calculation of Stock Returns

Stock return of an individual firm is calculated by the following formula:

$$R_{i,t} = \ln \left[\frac{P_t}{P_{t-1}} \right] \times 100 \quad (1)$$

Here,

$R_{i,t}$ = stock return of firm i at time t

P_t = closing price of stock at time t

P_{t-1} = closing price of stock at time t-1

The “cross-sectional average return” of N stocks ($R_{m,t}$) is calculated as follows:

$$R_{m,t} = \frac{\sum R_{i,t}}{N} \quad (2)$$

Where,

$R_{i,t}$ = stock return of firm i at time t

N = Number of firms in the sample

Christie and Huang (1995) proposed “Cross-sectional standard deviation (CSSD)” for detecting the presence of herding. Its purpose is to detect herd behavior by estimating individual stock returns with respect to the market return. CSSD is elaborated below

$$CSSD = \sqrt{\frac{\sum_{i=1}^N (R_{i,t} - R_{m,t})^2}{N - 1}} \quad (3)$$

Here,

N = total number of firms under study

$R_{i,t}$ = return of stock i at time t

$R_{m,t}$ = cross-sectional average stock of N returns at time t

This study explores the presence of herding behavior among firms listed on PSX. For this purpose, two methodologies proposed by Christie and Huang (1995) and E. C. Chang et al. (2000), identified as CSSD and CSAD, are used.



In order to find herding behavior during extreme market movements, CSSD is calculated on the basis of a constant term and two dummy variables. This relationship is expressed in the equation below:

$$CSSD_t = \alpha + \beta_1^U D_t^U + \beta_2^L D_t^L + \varepsilon_t \quad (4)$$

The above equation explains the return distribution at time t . If the return of the market portfolio lies in the extreme upper tail 5% of the distribution, $D_t^U = 1$; otherwise $D_t^U = 0$. Similarly, if returns of the market portfolio lie in the extreme lower tail 5%, $D_t^L = 1$, otherwise $D_t^L = 0$. Negative and statistically significant β_1^U and β_2^L suggest the existence of herding.

E. C. Chang et al. (2000) proposed an alternative approach to detect herding behavior. This model is known as “Cross-sectional absolute deviation (CSAD)”. Despite the fact that CSAD is based on the assumptions of CSSD, it is considered to be a more refined model. This approach deals with the absolute deviation of returns and is more suitable to capture herding behavior during extreme market movements. CSAD is demonstrated as follows:

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

Here N = total number of firms

$R_{i,t}$ = return of stock i at time t

$R_{m,t}$ = cross-sectional average stock of N returns at time t

Furthermore, E. C. Chang et al. (2000) introduced another approach to observe herding behavior. They proposed a nonlinear relation between CSAD and $R_{m,t}$. In a market where herding is absent, individual stock returns and market return tend to move in opposite directions, representing an increased linear association. However, in the presence of herding, the relation between individual returns and dispersions represents a decreasing pattern. Therefore, this approach introduces a nonlinear term in the regression to find herding more effectively. The quadratic relation between $CSAD_t$ and $R_{m,t}$ is expressed below:

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

A non-linear term $R_{m,t}^2$ is added in the above equation. During market stress, the relationship between $CSAD_t$ and $R_{m,t}^2$ is nonlinear and negative. In the above equation, γ_1 will stay constant and positive for extreme movements in the market. A negative and significant γ_2 indicates that herding is present. But a positive and insignificant γ_2 will indicate the absence of herding.

Gleason et al. (2004) argued that non-linear herding during periods of market stress could also be detected if CSAD was made dependant variable. To obtain a more comprehensive analysis, Gleason et al. (2004) proposed a new alternative for detection of herding by interchanging dependent variable of Equation (4) and (6) forming two new equations for testing:

$$CSAD_t = \alpha + \beta_1^U D_t^U + \beta_2^L D_t^L + \varepsilon_t \quad (7)$$

$$CSSD_t = \gamma_\sigma + \gamma_1 |R_{m,t}| + \gamma_2 R_{m,t}^2 + \varepsilon_t \quad (8)$$



Ordinary Least Square Versus Quantile Regression

Literature draws attention to limitations of OLS techniques, such as, it does not capture the non-linear and asymmetric herding behavior in the stock market. OLS measures are based on only the means of stock return. At times, these measures have failed to detect herding, whereas quantile regression- a method used to capture asymmetric information has been successful in finding herding (Perveen et al., 2024). In imperfect market conditions, outliers can significantly affect the tail values of a distribution; consequently, herding coefficients become inaccurate. Quantile regression can remove issues caused by outliers and is more efficient as compared to linear regression (Filip et al. (2015). Chiang and Li (2012) stated that quantile regression is a more reliable method than OLS measures and gives more reliable results. In order to obtain quantile estimates for low returns, the study will follow the methodology of Malik and Elahi (2014) and undergo a setting of $t = 10\%, 25\%, 75\%, 90\%$. This study applied the two methods OLS and quantile regression to examine the herding behavior.

RESULTS AND DISCUSSIONS

The results are presented on the firms categorized into smallest size and largest size based on their market capitalization in the following sequence; Descriptive statistics, results from traditional regression using the CSSD and CSAD models during extreme market movements and in nonlinearity relationship, same models are tested by applying quantile regression at lower quantiles ($t=10\%, 25\%$) and upper quantiles ($t= 75\%, 90\%$). In the last, the comparison of results obtained from traditional regression and quantile regression are presented.

Descriptive Statistics

The Table 2 provides the detail of descriptive statistics for daily data, including $R_{m,t}$, $CSSD_t$, and $CSAD_t$. These variables are examined with respect to their mean values and standard deviation. A large value of mean indicates large variations among variables studied, whereas a large standard deviation represents higher volatility among variables studied. Standard deviation is positive for both groups of firms.

Table 2: Descriptive Statistics.

Size	Variables	No. of Observations	Mean	Max %	Min %	Standard Deviation
Smallest size firms	$R_{m,t}$	2019	-0.00063	13.36652	10.98925	1.642066
	$CSSD_t$	2019	1.179932	13.36652	0.000188	1.141688
	$CSAD_t$	2019	2.765578	24.02649	0.149655	1.953181
	$R_{m,t}$	2019	0.009427	6.375763	-7.55693	1.094188
Largest size firms	$CSSD_t$	2019	0.770733	7.556926	0.000300	0.776457
	$CSAD_t$	2019	1.580907	15.95729	0.000000	1.325037

Herding Results using OLS Regression

Following are the results of using CSSD and CSAD models during extreme market movements and nonlinearity by applying the traditional regression.

Regression Results during Extreme Market Movements using CSSD and CSAD

The results obtained from the OLS regression method using linear CSSD and CSAD models during extreme market movements for the smallest sized firms and the largest sized firms are presented in Table 3. Two dummy variables, i.e. D_t^U and D_t^L , are introduced, which explain the difference in investors' behavior during extreme movements in the market. This study analyses extreme movements at a 5% criterion. CSSD and CSAD are taken as dependent variables. Negative and statistically significant values of β_1^U and β_2^L will indicate the presence of herding.



Table 3: Extreme Market Movements using CSSD and CSAD at 5% Criterion.

Size		CSSD		CSAD	
		β_1^U	β_2^L	β_1^U	β_2^L
Smallest size firms	Coefficient value	0.467	2.578	2.088	1.824
	T – stat	4.734	37.512	40.307	35.201
	Probability	0.000	0.000	0.000	0.000
Largest size Firms	Coefficient value	6.865	-0.615	4.312	-0.981
	T–stat	36.811	-4.730	46.997	-10.69
	Probability	0.000	0.000	0.000	0.000

Table 3 demonstrates a negative and statistically significant β_2^L (downward movement) for largest sized firms using both CSSD and CSAD models. This implies that herding exists for the largest size firms when market is under stress or moving downward. Whereas the coefficients are positive and statistically significant for the smallest size firms using both models under the extreme market movements implying the absence of herding. This means that during market stress the investors prefer to invest in the largest size firms considering the firms more stable and shock absorbent as compared to the smallest size firms.

Regression Results for Non-Linear Models using CSSD and CSAD

Table 4 provides a detailed description of the regression results for non-linear models using both CSSD and CSAD as dependent variables. A negative and significant γ_2 will represent herding behavior.

Table 4: Non- Linearity using CSSD and CSAD at 5 % Criterion.

Size	Particulars	CSSD		CSAD	
		γ_1	γ_2	γ_1	γ_2
Smallest Size firms	Coefficient value	1.000	2.050	1.000	3.240
	T – stat	3.040	38.168	2063.6	0.028
	Probability	0.000	0.000	0.000	0.978
Largest Size Firms	Coefficient value	0.607	0.033	0.174	0.189
	T – stat	9.519	3.175	2.746	12.43
	Probability	0.000	0.002	0.006	0.000

Table 4 shows γ_2 is positive and statistically insignificant for both small and large sized firms using CSSD and CSAD returns, showing the absence of herding through non-linear models. These findings are in accordance with Shah et al. (2017), who claim that firms in PSX herd around their respective industry.

Herding Results using Quantile Regression

The quantile regression is employed, which is used to contemplate multiple curves of independent variables against each quantile of the dependent variable, i.e., CSSD and CSAD. This study considers four quantiles (t= 10%, 25%) for lower quantiles and (t= 75%, 90%) for upper quantiles. Results for herding in Extreme market movements and non-linearity, as estimated by quantile regression at four quantiles are presented below.

Extreme Market Movements using CSSD and CSAD

Table 5 provides a detailed description of quantile regression results during extreme movements using CSSD and CSAD daily data over four quantiles (t= 10%, 25%, 75%, 90%). The results indicated that the β_1^U (upward movement) and β_2^L (downward movement) using CSSD model are positive and significant for smallest sized firms and largest sized firms at the four quantiles explaining no herding behavior. However, in case of CSAD model, β_2^L (downward market movement) is negative



and highly statistically significant for both smallest sized and largest sized firms at lower quantiles ($t=10\%, 25\%$) and herding was not found at the upper quantiles. Further, herding was not detected for smallest size firms during upward movement at all the four quantiles. In case of largest sized firms, β_2^L (downward movement) is negative and statistically significant at lower quantiles ($t=10\%, 25\%$) and at upper quantile ($t=75\%$). Whereas, as no herding was detected during upward market movement at any of the four quantiles. The results clearly indicate that CSAD model is more helpful in explaining herding behavior. Further, it is also observed that the herding is more pronounced in both smallest size firms and largest sized firms when the market movement is downward or stressed. Since in case of Pakistan where the financial literacy is not very high, this is logical because when there is a fear of loss the investors rely more on the other well-informed investors than their own judgment. It is also worth noted that the results vary across the smallest size firms and largest size firms, the reason for the variation is that smallest size firms are different in terms of their capitalization, lack of management skills, borrowing capacity, high cost of acquiring funds and risk management skills (Brown & Kapadia, 2007; Faulkender & Petersen, 2006; Rostamkalaei & Freel, 2016).

Table 5: Quantile Regression: Extreme Market Movements using CSSD and CSAD.

Size	Tau Value	Particulars	CSSD		CSAD	
			β_1^U	β_2^L	β_1^U	β_2^L
Smallest size Firms	$\tau = 10\%$	Coefficient	0.315	2.360	5.968	-0.652
		T – stat	5.154	85.371	48.945	-10.288
		Probability	0.000	0.000	0.000	0.000
	$\tau = 25\%$	Coefficient	0.577	2.214	6.661	-0.939
		T – stat	6.555	60.480	35.308	-12.186
		Probability	0.000	0.000	0.000	0.000
	$\tau = 75\%$	Coefficient	0.141	2.754	7.847	1.541
		T – stat	0.256	5.448	20.324	8.440
		Probability	0.798	0.000	0.000	0.000
	$\tau = 90\%$	Coefficient	0.302	3.220	5.211	1.588
		T – stat	1.103	20.228	11.879	6.292
		Probability	0.270	0.000	0.000	0.000
Largest size Firms	$\tau = 10\%$	Coefficient	1.635	1.559	3.317	-0.400
		T – stat	44.836	49.532	38.824	-12.451
		Probability	0.000	0.000	0.000	0.000
	$\tau = 25\%$	Coefficient	1.700	1.600	3.585	-0.581
		T – stat	23.143	32.534	31.435	-16.996
		Probability	0.000	0.000	0.000	0.000
	$\tau = 75\%$	Coefficient	2.117	1.774	4.413	-1.305
		T – stat	12.469	13.632	15.631	-24.703
		Probability	0.000	0.000	0.000	0.000
	$\tau = 90\%$	Coefficient	2.449	2.217	5.540	1.667
		T – stat	14.657	7.404	19.479	18.503
		Probability	0.000	0.000	0.000	0.000

Quantile Regression Results: Non-linearity using CSSD and CSAD

Table 6 gives a detailed description of the regression results obtained by using quantile regression for non-linearity. Significant negative γ_2 will indicate the presence of herding, whereas insignificant or positive γ_2 indicates the absence of herding. From Table 6, it is evident that γ_2 is negative and statistically significant



for the smallest size firms using CSSD and CSAD returns at the lowest quantile of returns ($\tau=25\%$). However, the non-linear specification of both models failed to detect herding in the largest size firms at any of the four quantiles. This implies that when the returns are distributed at the lower percentile the smallest size firms are considered more vulnerable by the investors and leads to the herding behavior. Behavioral biases such as Fear of Missing Out (FOMO) may cause investors to blindly replicate the actions of others (Rahmawati & Raharja, 2024)

Table 6: Quantile Regression: Non-Linearity using CSSD and CSAD.

Size	Tau Value	Particulars	CSSD		CSAD	
			γ_1	γ_2	γ_1	γ_2
Smallest Firms	$\tau = 10\%$	Coefficient	1.000	-1.818	-0.494	0.043
		T – stat	7.530	-0.202	-5.683	1.804
		Probability	0.000	0.840	0.000	0.071
	$\tau = 25\%$	Coefficient	1.000	-4.590	-0.491	-0.052
		T – stat	1.450	-0.648	-4.308	1.679
		Probability	0.000	0.0397	0.000	0.046
	$\tau = 75\%$	Coefficient	1.000	8.060	1.092	0.119
		T – stat	6.650	1.570	10.352	4.384
		Probability	0.000	0.117	0.000	0.000
	$\tau = 90\%$	Coefficient	1.000	-2.160	1.222	0.091
		T – stat	6.720	-0.770	10.890	3.252
		Probability	0.000	0.441	0.000	0.001
Largest Size Firms	$\tau = 10\%$	Coefficient	1.000	-5.790	-0.553	0.091
		T – stat	1.660	-4.960	-10.618	4.807
		Probability	0.000	1.000	0.000	0.000
	$\tau = 25\%$	Coefficient	1.000	-4.840	-0.540	0.095
		T – stat	2.260	-0.429	-6.278	2.709
		Probability	0.000	0.668	0.000	0.007
	$\tau = 75\%$	Coefficient	1.000	3.870	1.147	0.169
		T – stat	7.640	0.119	8.772	3.013
		Probability	0.000	0.905	0.000	0.003
	$\tau = 90\%$	Coefficient	1.000	6.630	1.126	0.179
		T – stat	2.490	0.616	10.410	4.267
		Probability	0.000	0.538	0.000	0.000

Comparison between OLS and Quantile Regression Results

The OLS results provide limited evidence of herding behavior during extreme market movements. Under the linear specification, herding was detected only among the largest-sized firms during downward market movements, as indicated by the negative and statistically significant coefficient for the CSAD and CSSD models. In contrast, the smallest-sized firms exhibited positive and statistically significant coefficients, suggesting no herding during extreme movements. The nonlinear OLS models also failed to identify significant herding for either firm-size group. These findings suggest that OLS, which estimates the average relationship across the conditional distribution, may overlook herding behavior that occurs only under specific market conditions.

The quantile regression results provide substantially stronger and more nuanced evidence of herding. Unlike OLS, which identified herding mainly among large firms during downward market movements, quantile regression revealed significant herding at specific points of the return distribution, particularly at the lower quantiles ($\tau = 10\%$ and 25%). Using CSAD, herding was evident in both the smallest- and largest-sized firms during downward market movements, while no herding was observed during upward movements. Among



large firms, herding also persisted at the 75th quantile. The nonlinear quantile specification further identified herding among the smallest firms at the 25th quantile, whereas no significant nonlinear herding was detected among large firms. Overall, the comparison demonstrates that quantile regression is more effective than OLS in capturing heterogeneous and state-dependent herding behavior, particularly during periods of market stress. The stronger evidence at lower quantiles suggests that investors are more likely to imitate others when negative returns and uncertainty intensify, while the differences between firm-size groups indicate that firm characteristics and perceived vulnerability may influence the intensity of herding.

The results also differ because the two methodologies differ in their approaches. The quantile regression considers the different quantiles and also incorporated the excessive outliers which is not possible in traditional regression. Since it covers different quantiles, this method is better to locate the extreme values that have fat tails or skewed distribution (Barnes & Hughes, 2002; Chiang et al., 2010).

CONCLUSION

This study investigated herding behavior in the Pakistan Stock Exchange (PSX) with a focus on firm size, using daily data from 1st August 2016 to 30th September 2024. While OLS regression provided limited evidence of herding, detecting it only among large firms during downward market movements, quantile regression revealed more consistent patterns across both smallest and largest size firms, particularly in lower quantiles. These results highlight the methodological strength of quantile regression in capturing non-linear investor behavior that conventional approaches overlook.

The findings have practical implications for policymakers, investors, and managers. Evidence of herding, especially among smaller firms during adverse market conditions, underscores the need for transparent information dissemination and enhanced investor education to mitigate irrational trading. Future research may expand this analysis by incorporating primary data, distinguishing between institutional and individual investors, and exploring additional firm-level characteristics to better understand the dynamics of herding in emerging markets.

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