Industry-wise Sentimental Herding: An Application of State-Space Model in Pakistan

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Abstract

In recent decades, the worldwide consecutive catastrophes in the financial markets emphasize the accelerating prominence of investors' sentiment on the financial market. Therefore, within academia, a shift from conventional finance to behavioral finance can be noticed and the most eminent topic of interest is the exploration of herding behavior. Inspired by the ongoing altercation on the magnitude and presence of herding in the stock markets, the present study aspires to explore the Pakistan stock market concerning herding behaviour. Investors' industry-wise market-based herding behavior in the Pakistan stock market has been examined by employing daily data obtained from Bloomberg starting from January 2000 to April 2016. Cross-sectional variabilities in the factor sensitivities (Beta) have been employed to estimate investors' sentimental herding behavior, following the model of Hwang and Salmon (2004). The study found herding to be significant and persistent, independent from market fundamentals, like levels of market returns and volatility of returns. Findings also show that investors do herd considering the industrial classification of financial assets; hence it leads to mispricing of stocks. The study also presents industry differences in herding. Sugar and banking sectors are found to be more prone to herding while textile and manufacturing sectors are found less prone to herding. The results entail cogent implications for the investors pursuing diversification in the Pakistan stock market.

Keywords: State-space model; herding behavior; sentimental herding; market returns; market volatility.

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1. Introduction

Behavioral finance has been an emerging trend within the financial literature as it coalesces investors' emotions and thoughts in the stock market investment decision. Investment decision-making is a complex contrivance assimilating diverse concepts including the return, time, risk, and other factors. The investment decision is a versatile decision-making process that is unique; however, distinguished diversely by different types of investors. Stock market behavior can be contemplated as a reflection of investors' attitudes towards multiple factors. Conventional finance theories regard humans as rational agents. Whereas, behavioral finance theories emphasize the cognitive, social, and emotional factors of investors. As human reactions are the outcomes of various events, behavioral finance theories provide the realistic specification of clustered market volatility. Hence, the behavioral aspect of market anomalies depends on social and psychological aphorism where the investors are regarded as the victims of cognitive biases and errors (Litimi, 2017). Perhaps, excessive volatility is emanated from volatile beliefs and emotions and is persistent as long the investors exhibit erroneous pitfalls (Litimi, 2017).

Investment decisions are primarily grounded on the investors' expectations about risk and returns. However, conforming to herding behavior investors either due to inappropriate information or due to limited capital or confused status of the market, sometimes follow other collective investors blindly and ignore the market fundamentals which results in mispricing of underlying assets. Simultaneous buy (sell) of the same stocks following the buy (sell) of others is regarded as herding (Espinosa-Méndez & Arias, 2021; Lakonishok et al., 1992).

Herding behavior can create market bubbles which ultimately eventuate in market disequilibrium and generates exaggerated volatility. This behavior is often impelled by certain psychological components, for instance, confidence in the stock price increase, wishful thinking, influence of other investors' judgments as well as pressure to adapt (Bikhchandani & Sharma, 2000). Substantial mispricing and risks in the financial market can be the result of herding behaviour and the instances of these can be the global financial crisis (GFC) and the impact of the COVID-19 pandemic in different financial markets (Chang et al., 2020; Espinosa-Méndez & Arias, 2021). The herding phenomenon has been also observed during the regime of the information technology (IT) bubble (2000-2002) (Choi & Yoon, 2020). Therefore, the detection of herding behavior bears significance which can challenge the conventional rational theories of investment (Choijil et al., 2022; Lao & Singh, 2011).

One of the preliminary works covering herding behavior is the study of Christie and Huang (1995), who used the Cross-Sectional Standard Deviation (CSSD) of returns as a method of individual asset returns' average proximity to the realized market returns. Their work was extended by Chang et al. (2000) who modelled the nonlinear relationship between the Cross-Sectional Absolute Deviations (CSAD) of returns and market returns.

Nevertheless, Hwang and Salmon (2004) criticized Christie and Huang (1995)'s model as their methodology only accounts for intense market returns, either positive or negative, it is subjective and can be best in defining extreme situations. Moreover, employing positive and negative dummy variables for positive and negative CSSD stock returns will result in strong correlation which ultimately affected the model to identify whether these changes are due to result of herding. Hence, the arguments of Hwang and Salmon (2004) weakened the Christie and Huang (1995)'s approach, considering herding as a result of investors' unobserved sentiments, they applied a state-space model to impart herding behavior empirically towards the market.

To understand the herding behaviour' existence in the financial markets, through the application of various methods, many studies have reported interesting empirical results from Asia (Chong et al., 2020; Yousaf et al., 2018; Zheng et al.,2017) and Western contexts (Litimi et al., 2016; Pochea et al., 2017; Stavroyiannis & Babalos, 2020). However, the findings do not yield identical empirical consensus or results concerning the existence of herding behaviour. While continues appeal from the previous research has indicated the importance of exploring herding behaviour constituting different industries from various nations with the suitable model application (Ahmed et al., 2019; Dewi & Candraningrat, 2019; Choi & Yoon, 2020; Chong et al., 2020; Stavroyiannis & Babalos, 2020).

In Asia, as an emerging stock market, focussing towards Pakistan stock market, the herding behaviour has been captured in diverse studies in this decade (Jabeen, 2019; Javaira & Hassan, 2015; Javed et al., 2013; Jhandir & Hanif, 2014) applying the criticized methodology of Christie and Huang (1995), Chang et al. (2000) and Chiang and Zheng (2010) as well as lacking focus on industry-wise herding in Pakistan stock market. Although Ahmed et al. (2019) recently studied this practice in the Pakistan stock market; however, the data coverage of this study is minimal. Furthermore, due to the fallacious formulae (modified herding proxy for mathematical easiness) to capture this behavior, the actual scenario is not reflected. Therefore, studies are encouraged (Ahmed et al., 2019; Choijil et al., 2022; Jabeen, 2019) to learn more about herding behavior in the Pakistan stock market. The truancy of austere research in Pakistan has motivated the researchers to inspect this phenomenon further intensely into the diverse prominent sectors instead of the overall market.

Hence, the present study endeavors to examine the industry-wise market-based herding behavior of investors in the Pakistan stock market using the conducive Hwang and Salmon (2004) methodology of State-Space model covering data for a long period (2000-2016). Financial, textiles, fuel and energy, sugar, and manufacturing industries are examined to broaden the understanding concerning herding behavior.

The contribution of the study entails controlling the effect of market return, volatility, and financial crisis. This study further discusses the conceivable implications of various industry-wise herding levels in the Pakistan Stock Exchange (PSX). To get a better understanding of the functioning of the market, this study thus can provide insights on the herding practice which can eventually aid the academicians as well as practitioners in understanding market efficiencies and anomalies. Based on the nature of herding persuasion, this can help in providing more precise valuation, estimation, and risk perception in investment decision making.

The remaining of this paper is as follows: Section 2 describes the relevant literature on herding behaviour; the methodology of this study is discussed in Section 3; Section 4 delineates the results; finally, concluding remarks together with implications and future research directions are discussed in Section 5.

2. Literature Review

This section strives to discuss herding behaviour literature from the global as well as Pakistan perspective. Various methodological differences and findings can be ascertained from the following discussions.

2.1 Herding Behavior

Conventional economics and finance investment theories like Expected utility theory (EUT), Capital Asset Pricing Model (CAPM), Efficient Market Hypothesis (EMH), Modern portfolio theory (MPT), and Arbitrage Pricing Theory (APT) consider humans as a rational economic agent. It also presumes that the investors' investment decision is essentially based on the trade-offs between risk-returns. Despite their continuous application in investment decisions (Apergis & Rehman, 2018; Dellano-Paz et al., 2017; Kisman & Restiyanita, 2015; Zabarankin et al., 2014) these theories are repeatedly criticized for their frailty in reflecting the multifaceted attitudes and preferences of investors. Besides, irrational behavior by the small individual investors has been noticed in practice meaning, certain investors while encountered with new information, do not respond rationally (Belhoula & Naoui, 2011).

Consequently, behavioral finance literature started to argue with various models and theories to aid in understanding investment behavior and decision making. While exploring these behavioral factors, herding behavior came to the light of the literature. Based on either private or public information or knowledge about other investors' behaviour, investors tend to mimic them (Chang et al., 2020) subsiding their own beliefs and judgment. Thus, following the market sentiment primarily relates to herding behaviour (Choi & Yoon, 2020). While discerning the herding behavior, most of the studies primarily depend on diverse models like Cross-Sectional Standard Deviation (CSSD), Portfolio Change Measure (PCM), State-Space Model, Cross-Sectional Absolute Deviation (CSAD), and Lakonishock et al. (1992) (LSV) model (Chang et al., 2000; Christie & Huang, 1995; Hwang & Salmon, 2004; Lakonishok et al., 1992).

Various researchers have strived to explain the causes of herding behaviour among investors. For instance, according to Bikhchandani and Sharma (2000), three explanations can be detected for herding behaviour including reputation-based, informational cascades, and compensation-based. Reputation-based herding can be espied among the fund managers who want to assure their reputation by following other fund managers' decisions due to the inconsistency between their private and public information (Graham, 1999). Informational cascade refers to the investors' following the previous decision makers' preferences in making their own decisions. Compensation-based herding, on the other hand, indicates the herding behaviour among the fund managers whose compensation depends on their performance and this leads them towards herding (Bikhchandani & Sharma, 2000). Herding behaviour can also be expressed in different forms namely, trading in the unidirectional form with others, following the previous trends, imitating or correlating the behaviours with others, etc. (Kyriazis, 2020). Thus, it is imperative to delve into the herding phenomena for a better understanding of the financial markets.

2.2 Herding Behaviour: A Global Outlook

Worldwide the herding behaviour utilizing divergent methods has been producing mixed results incorporating distinct factors. For example, Bekiros et al.(2017), in an exploration on the USA market using the CSAD approach found intense herding under intense market conditions where the impact of volatility is also noted for the irrational behaviour. Benmabrouk (2018), while investigating this behaviour within the crude oil and stock market including market volatility and investor sentiment in NASDAQ100 and VIX index (2000 to 2016) depicts the reduction of herding by volatility influence. Additionally, a lack of sufficient information fuels this practice. They used both CSSD and CSAD to come up with such results. Similarly, BenSaïda (2017) expresses that during the turmoil periods, in most of the sectors of the American stock market herding existed intensely. The studies that modified the CSAD model depict the impact of volume turnover and herding on conditional volatility.

Among Latin American and Asian markets, China, Malaysia, India, Singapore, Brazil, and Argentina do not display any nonlinearity (Kabir & Shakur, 2018). The findings were obtained by utilizing the Smooth transition regression (STR) to study these two regions' herding behaviour. During the market stress, volatility is the prime reason for herding rather than fewer returns. Furthermore, Zheng et al. (2017) found evidence of intense herding within the financial and technology industries, in the Asian markets whereas, within the utility industry it was relatively weaker. Litimi (2017) conducted a study to learn about this practice in the French stock market. His study used CSAD and Generalized autoregressive conditional heteroskedasticity (GARCH) models including investors' sentiment and trading volume. The herding existence is depicted during the crisis period particularly for certain sectors for the entire time. Additionally, this behaviour has an impending impact on the market's conditional volatility. From the context of Central and East European (CEE) countries, except for

Romania and Poland, herding is observed (Pochea et al., 2017). This study was conducted using the Chang et al. (2000) model and quantile regression analysis (QRA) model for the period 2003-2013 and herding behaviour is detected in the market up and down periods.

Moving towards the Korean context, the KOSPI and KOSDAQ stock markets herding behaviour were studied by Choi and Yoon (2020) employing the quantile regression method and CSAD approach covering the data from 2003 to 2018. Their findings relate to the herding behaviour during extreme and down-market conditions. The study also confirms that investors' sentiment is a prime reason for herding behaviour. The application of the Cross-Sectional Dispersion Approach (CSDA) was identified in a study by Economou et al. (2018). This study was conducted in the financial markets of the UK, USA, and Germany and implies the influence of fear on herding behavior. Hudson et al. (2020) used Hwang and Salmon (2004)'s model and found that institutional investors' sentiment is a significant factor of herding behavior in the UK. Mutual fund managers specifically herd on size, portfolio, and value factors. Interestingly, sentiment factors affecting herding behavior are different among closed-end and open-end fund managers.

In the Indonesian capital market (LQ-45 index), using Vector Auto Regression (VAR) method for the period of 2013 to 2016, Dewi and Candraningrat (2019) assert that the type of investor is an influential factor in herding behaviour. Herding behaviour is also evident in the stock markets of the Islamic Gulf Cooperation Council (GCC) (Chaffai & Medhioub, 2018). This study used Chiang and Zheng (2010) model, GARCH, and QRA to express that herd information is negative during the upward trend of the market which follows the movement found in Japan, China, and Hong Kong.

The appearance of herding is even detected in the cryptocurrency market according to the findings of Silva et al. (2019) who adopted CSAD, CSSD, and Hwang and Salmon (2004) for their study conducted for 2015 to 2018. Analysts' market sentiments and herding behaviour have been captured by Chiang and Lin (2019) and the results show that the analysts' lean-to heard while issuing recommendations and this impulse accelerates with market sentiment. Conversely, in all USA stocks (2000 to 2017) the altered CSAD model demonstrates the absenteeism of herding in all sectors (crude oil and stock market) (BenMabrouk & Litimi, 2018). Additionally, fear sentiment reduces herding tendencies. Equivalently, according to Stavroyiannis and Babalos (2020), within Eurozone stock markets (2000-2016) negative herding (anti-herding) behaviour is observed. Consequently, herding behaviour research has a long way to proceed with compelling aspects.

2.3 Herding Behaviour: Pakistan Perspective

Herding behavior studies from the Pakistan stock market provide highly mixed results. For instance, Javed et al. (2013) explored the monthly yields of the Karachi Stock

Exchange (KSE) for 8 years using CSSD and CSAD of returns but did not account for volatility which sometimes may overlap herding. No herding evidence was there in KSE for their studied span. The potential reason behind this was methodology as well as the period they use. They used Christie and Huang (1995) and Chang et al. (2000) methods, also the sampling period might be comprising normal market situations. A similar methodology was used by Javaira and Hassan (2015) to investigate herding behavior in the Pakistan stock market from 2002 through 2007 using daily and monthly returns of stocks from KSE100 claiming non-existence of herding behavior.

Jabeen (2019) while exploring the herding behaviour (1998-2018) with Chiang and Zheng (2010)' model in PSX involving 528 listed firms' daily closing prices established the lack of presence of herding behaviour in PSX with exceptions in certain sectors. Correspondingly, Kiran et al. (2020) detect no herding for the span of 2004 to 2017 within the PSX involving 663 listed companies. They used Christie and Huang (1995) and Chang et al. (2000) models for the estimation. The lack of existence of this behaviour can be due to the belongings of these firms to various sectors that follow the respective industry portfolio rather than the overall market. Another study (Shah et al., 2017) on PSX describes that individual companies do not herd usually concerning market index apart from experiencing negative returns. However, when large companies face extreme market movements, they do herd. They covered the herding behaviour for the period of 2004 to 2013 constituting 609 listed companies.

Conversely, Jhandir and Hanif (2014) used CSAD of returns to capture herding behavior around the macroeconomic announcement. They employed daily data of 249 listed firms with the period of 2003 to 2013. They concluded that herding in Pakistan was prominent around policy rate and inflation rate announcement but not prominent around budget, fuel price, and industrial production announcement. Similarly, herding exists in the Pakistani Stock market during the bearish and bullish market (Malik & Elahi, 2014). A study conducted by Ahmed et al. (2019) in Pakistan utilizing Hwang and Salmon (2004) model finds the existence of herding behaviour between 2013 and 2018 with the intensity of herding within the cement industry. However, the period covered in this study is quite limited. The survey of Qasim et al. (2019); however, entails that investors' decision making in the Pakistan stock market is highly influenced by overconfidence biases and herding. Yousaf et al. (2018) tried to capture this practice within the Pakistani stock market with particular focus to crisis period and Ramadan effect covering data from 2004 to 2014 using Christie and Huang (1995) and Chang et al. (2000). They delineate herding's presence during low trading volume days with its absence during the period of Ramadan. Whereas herding behaviour is found amidst the global financial crisis as information asymmetry and higher uncertainly were conceived by the market participants.

In a nutshell, it can be said that the difference in findings in capturing herding behaviour globally can be due to the different factors and methodological differences as bounteous studies have been utilizing either the Christie and Huang (1995) or Chang et al. (2000) models which have limitations in absorbing the herding in normal periods whereas reporting herding behaviour's existence in extreme situations. Therefore, Choi and Yoon (2020) invited academia to explore the investment sentiment from various stock exchanges to learn about the factors behind this tendency. Moreover, increasing criticisms about mainstream finance doctrines in explaining financial market rigidities, fluctuations and abnormalities have led the doors open for discussion about one of the core areas of behavioral finance, specifically herding behavior (Syriopoulos & Bakos, 2019). Emerging markets seemed to be more prone to herding behaviour due to the incentives and market participants characteristics compared to the developed markets with more professional peers. Hence, there are rooms for exploration to know about the herding behaviour from the developing and emerging countries' contexts (Choijil et al., 2022; Economou et al., 2018).

Therefore, it is deemed necessary (Chiang & Lin, 2019; Choi & Yoon, 2020; Jabeen, 2019) to explore this behavior with a more comprehensive Hwang and Salmon (2004)'s State-Space model of Beta herding to detect herding. Thus, employing the State-Space model into the Pakistan stock exchange (PSX) along with the industry-wise level will allow this study to capture herding more comprehensively as this State-Space model does not rely only on the deviation of returns but also accounts for systematic risk present in the market. Besides, the use of CAPM and CSSD to apprehend comprehensive findings on market return, volatility, and financial crisis make the present study literature enhancing.

3. Methodology

3.1 Method

This study utilizes Hwang and Salmon (2004) model for the estimations. This model provides emphasis on the sentiment of investors which moves in alliance with the risk indicator beta. This model used the cross-sectional behavior of assets similar to Christie and Huang (1995). Despite this, their model was different as in market-wised herding they used betas of individual stocks instead of returns. Perhaps, in market-wide herding, investors clinch to pursue market trends and this ultimately results in the co-movement of individual returns and market returns in the same direction.

As time passes, sentiments of the investor may vary, which will result in a change of the beta value of the stock from the investors' constant initial value and converging to market beta of unity.

Hwang and Salmon (2004)'s model is grounded on an association between biased beta ($\beta^b{}_{imt}$) which is observed and unobserved true beta (β_{imt}) as follows:

$$\frac{E_t^b(r_{it})}{E_t(r_{mt})} = \boldsymbol{\beta_{imt}^b} = \boldsymbol{\beta_{imt}} - \boldsymbol{h_{mt}}(\boldsymbol{\beta_{imt}} - \mathbf{1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(1)}$$

Where $E^b{}_t\,(r_{it})$ is the biased short-run conditional expectation on the excess returns of asset I at time t. Additionally, $E_t\,(r_{mt})$ is the expectation of the market's return at time t. The unobserved herding behavior indicator h_{mt} is the parameter postulated proportional to the deviation of the individual true beta from market beta unity. The cross-sectional variation of $\beta^b{}_{imt}$ becomes:

$$\boldsymbol{Std_c}(\boldsymbol{\beta_{imt}^b}) = \boldsymbol{Std_c}(\boldsymbol{\beta_{imt}})(\mathbf{1} - \boldsymbol{h_{mt}})\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(2)}$$

Taking logarithms of both sides of Eq. (2), we get,

$$\ln[\boldsymbol{Std_c}(\boldsymbol{\beta_{imt}^b})] = \ln[\boldsymbol{Std_c}(\boldsymbol{\beta_{imt}})] + \ln(\mathbf{1} - \boldsymbol{h_{mt}})\ldots\ldots\ldots\ldots\ldots\ldots\ \mathbf{(3)}$$

We may now re-write Eq (3) as

$$\ln[\boldsymbol{Std_c}(\boldsymbol{\beta_{imt}^b})] = \boldsymbol{\mu_{mt}} + \boldsymbol{H_{mt}}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(4)}$$

Where μ_{mt} = ln[Std$_c$ (β_{imt})] is a postulated constant in the short time and H_{mt}= ln (1- h_{mt}). Hence, Hwang and Salmon (2004) allowed herding, H_{mt}, to comply a dynamic process AR(1), such that the system is as follows:

$$\ln[\boldsymbol{Std_c}(\boldsymbol{\beta_{imt}^b})] = \boldsymbol{\mu_{mt}} + \boldsymbol{H_{mt}} + \boldsymbol{\vartheta_{mt}}\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(5.1)}$$
$$\boldsymbol{H_{mt}} = \boldsymbol{\varphi_m}\boldsymbol{H_{mt-1}} + \boldsymbol{\omega_{mt}}\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(5.2)}$$

Here, respectively the two error terms are $\vartheta_{mt} \sim iid\ (0, \sigma^2{}_{m\vartheta})$and $\omega_{mt} \sim iid\ (0, \sigma^2{}_{m\omega})$.

The two equations in Eq (5) constitute the standard State-space model. In our estimation, Equation (5) is referred to as Model 1. Here, a key parameter of interest in Eq. (5) is the variance of the error term of the state equation $\sigma^2{}_{m\omega}$. When $\sigma^2{}_{m\omega}$ is zero, it entails that there is a lack of herding, since $H_{mt} = 0$ for all t. However, a statistically significant value of $\sigma^2{}_{m\omega}$ would mean the herding existence in the market. Additionally, a significant φ_m , if |φ_m |≤1, would assist the autoregressive process. By comprising market returns and market volatility in the first equation of their model, Hwang and Salmon (2004) also assessed the robustness of the model. According to their argument, if H_{mt} turns into insignificant after the incorporation of the market fundamentals into their model, consequently changes in Std_c ($\beta^b{}_{imt}$) may be interpreted by market fundamentals instead of herding. Therefore, Model 1 can be adjusted to incorporate these market fundamentals as control variables to test for robustness as follow:

$$\ln[\boldsymbol{Std_c}(\boldsymbol{\beta_{imt}^b})] = \boldsymbol{\mu_{mt}} + \boldsymbol{H_{mt}} + \boldsymbol{\theta_{c1}}\ln\boldsymbol{\sigma_{mt}} + \boldsymbol{\theta_{c2}}\boldsymbol{r_{mt}} + \boldsymbol{\vartheta_{mt}}\ldots\ldots\ldots\ldots\ldots\ldots(6.1)$$
$$\boldsymbol{H_{mt}} = \boldsymbol{\varphi_m}\boldsymbol{H_{mt-1}} + \boldsymbol{\omega_{mt}}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(6.2)$$

Where ln σ_{mt} and r_{mt} represent market volatility and log yield in time t. Hence, the two equations, 6.1 and 6.2 constitute our Model 2.

However, as our sample data involves the 2007-2008 global financial crisis (GFC), hence controlling the impact of this crisis in our model is equally important. Hence, our Model 3 has one more controlling variable namely, Financial Crisis Dummy for the last quarter of 2008.

$$\ln\left[Std_c\left(\beta^b_{imt}\right)\right] = \mu_{mt} + H_{mt} + \theta_{c1}\ln\sigma_{mt} + \theta_{c2}r_{mt} + \theta_{c3}D_{FC} + \vartheta_{mt} \ldots\ldots\ldots\ldots(7.1)$$
$$H_{mt} = \varphi_m H_{mt-1} + \omega_{mt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(7.2)$$

In Equation 7.1 of Model 3, D_{FC} refers to Dummy Variable for the last 3 months of 2008 controlling the effect of the Financial Crisis.

3.2 Data and Beta Estimation

The daily share prices for the listed firms in the KSE-All Index as well as the Index level were obtained from Bloomberg which provides us daily shares prices of 420 firms out of 554 listed companies. The daily data covers the dates between January 1, 2000, and April 28, 2016, providing us 4259 usable observations for each i firm.

Once we had betas, we then calculated the CSSD of betas for each month based on the following formula:

$$Std(beta)_t = \frac{\sqrt{\sum_{i=1}^{n}(beta_{it} - \overline{beta_t})^2}}{n-1}$$

Where t represents the month, i represents the firm i, and $\overline{beta_t}$ represents the cross-sectional average of all betas in month t.

To control market fundamentals, monthly market log-returns were calculated as under:

$$R_{mt} = \log\left(\frac{Index_t}{Index_{t-1}}\right)$$

Where t represents the last day of each month of the sample data.
The volatility of market return has been calculated as follows:

$$\sigma_{mt} = \sum_{i=1}^{n}(R_{mi} - \overline{R_{mt}})^2$$

Where i represent the day in t month and R_miis daily market returns.

After obtaining those 196 monthly betas of all 420 listed firms, Industry-wise classification of PSX is applied and five prominent industries of financial, textiles, sugars, fuel and energy, and manufacturing sectors were identified at first descriptive statistics industry-wise and then Hwang and Salmon (2004) model of State-space was applied for sentimental herding.

4. Results and Analysis

In this section, at first, the descriptive results of all firms along with industry-wise cross-sectional betas are shown. Then this study's Final Model 3 is presented for overall firms as well as for five sample industries.

Table 1:
Sample descriptive statistics of Cross-Sectional Std. (β^b)

	Std. Dev. of Betas	**Log (Std. Dev. of Betas)**
Panel A: Descriptive including 2008 Crisis		
Mean	1.67128	0.12478
Std. Dev.	2.08277	0.24664
Skewness	7.47779	1.29809
Kurtosis	67.3471	7.32167
JarqueBera	35641.1	207.572
Panel B: Descriptive excluding 3 months of 2008 Crisis		
Mean	1.375844	0.278427
Std. Dev.	0.403458	0.285719
Skewness	0.993271	-0.018760
Kurtosis	4.547244	3.412721
JarqueBera	50.98666	1.381128

The descriptive statistics of Panel B refers to the case when three months of crisis (October 2008 to December 2008) were removed, the period being an outlier, which was making our data distribution not Gaussian.

Table 1 depicts the descriptive statistics of Cross-Sectional Standard Deviation (CSSD) of Beta for all 420 firms. Panel A's results are showing that our data is not normal and visual inspection of the beta series highlighted the peak in the financial crisis of 2008. Panel B shows that excluding three months of crisis makes our distribution Gaussian thus further analysis may be followed according to normality assumptions. All the rest of the industries' descriptive statistics are shown in Table 2 below.

Table 2:
Descriptive statistics of observed Cross-Sectional Betas (β^b)

	Financial	Textile	Sugar	Fuel &Energy	Manufacturing
Mean	0.138861	0.11239	-0.05009	-0.10975	-0.030177
Std. Dev.	0.225962	0.244364	0.203925	0.167686	0.221904
Skewness	0.605042	0.197242	0.116561	0.65696	0.598115
Kurtosis	3.927184	3.346427	3.61578	3.449203	3.850593
JarqueBera	18.68864	2.21652	3.486308	15.50568	17.32556
Number of Firms in the Industry	87	137	26	20	45

In Table 2, descriptive statistics of observed Betas [bias beta due to herding; see Hwang and Salmon (2004) model stated earlier] are presented. Here, the mean log of betas for financial and textile sectors are positive whereas the sugar sector, fuel, energy, and manufacturing sector have a negative mean of log of betas. It may indicate that portfolio managers can achieve benefits of diversification easily if they include all types of industries in their portfolios. Moreover, only major industries are reported, miscellaneous groups or industries having less than 20 firms were discarded.

Method: Maximum likelihood (Marquardt)
Included observations: 196
Convergence achieved after 31 iterations

Table 3:
State-Space model regression with control variables (market return, volatility and financial

Variable	Coefficient	Std. Error	z-Statistic	Prob.	De standardized Co-efficient
μ	0.396602	0.103902	3.81708	0.0001	0.396602
φ	0.873738	0.05406	16.16246	0.0045	0.873738
σ	-2.23406	0.136097	-16.41520	0.0001	0.32725
σ	-3.60425	0.395467	-9.11392	0.0021	0.164948
θ_1 (Market Return)	4.326626	0.745173	5.80621	0.0034	4.326626
θ_2 (Market Volatility)	-1.49785	0.228719	-6.54885	0.0022	-1.49785
θ_3(2008 Crisis dummy)	2.348413	0.404053	5.81214	0.0010	2.348413
Log-likelihood					
σ $\log Std\,\beta$	-99.9666	Akaike info criterion		1.091496	0.577307
Parameters	7	Schwarz criterion		1.208572	
Diffuse priors	0	Hannan-Quinn criterion		1.138894	

The maximum likelihood measures of the State-space model for the general industry are depicted in Table 3. The estimated value of the coefficient of state equation φ_m is statistically significant. The value of $\sigma_{m\omega}/\log Std\beta$ (signal to noise ratio) is 57.7%. The results also show that Std_c (β^b_{imt}) decreases with market volatility but increases with market returns. We may, therefore, conclude that Std_c (β^b_{imt}) decreases when the market is more volatile and is descending. Similarly, the coefficient of σ_mω(standard deviation of the error in state equation) is as well significant. Therefore, the above results indicate strong testimony of herding in the PSX. The high value of "signal to noise ratio" indicates that the process of herding is exhausting. In the above table, we have reported model 3, which included the value of market return, volatility, and the dummy of the financial crisis of 2008. The signal to noise ratio of model 1 (not reported here) is 0.89. If we compare the signal to noise ratios between model 1 and model 3[1], the signal to noise ratio declines from 0.89 to 0.58, which relates that market returns and volatility are the partial contributors of herding behavior in the PSX. The overall results of Table 3 show the evidence of herding in the PSX.

Investors' sentiment is found to be a strong factor for herding behavior which is according to the findings of Choi and Yoon (2020) conducted in the Korean stock market. However, they used the CSAD and quantile regression method for the estimation. Kabir and Shakur (2018) and Benmabrouk (2018) also reported relevant results of the influence of the USA market sentiments on investors' herding practices. The herding is also robust as significant testimony of herding was found after controlling market fundamentals and 2008 GFC. These findings are aligned with Hwang and Salmon (2004) and Demir et al. (2014) Briefly, the results show that the herding behavior in PSX is not only significant but is independent of the conditions pertaining to the market.

Table 4:
State-Space Model regression with control variable of market return, volatility and financial crisis of 2008 (Model 3) for all the industries separately
Method: Maximum likelihood (Marquardt); Included observations: 196

Industry classes	**Overall**	**Financial**	**Textile**	**Sugar**	**Fuel &energy**	**Manufacturing**
Variable			**DE standardized Co-efficient**			
μ	0.3966 02	0.179011	0.171069	0.006274	-0.065762	0.003331
φ	0.873738	0.846462	0.890632	0.740366	0.871543	0.914182
σ	0.32725	0.168262	0.165472	0.166639	0.123927	0.172531
σ	0.164948	0.073033	0.072703	0.070994	0.053281	0.050667
θ_1 (Market Return)	4.326626	1.770271	2.142281	2.135592	1.531651	1.124806
θ_2 (Market Volatility)	-1.49785	-0.488842	-0.661407	-0.608195	-0.468338	-0.410326
θ_3(2008 Crisis dummy)	2.348413	0.894444	1.125189	1.187529	1.074103	0.425679
Convergence achieved after iterations	31	19	204	22	46	25
Log likelihood	-99.9666	38.86342	39.02989	46.46189	97.78593	43.67726
Akaike info criterion	1.091496	-0.325137	-0.326836	-0.402672	-0.926387	-0.374258
σ $\log S\ t\ d\ \beta$	0.577307	0.323209	0.297521	0.348136	0.317745	0.22833

[1] Model 1 was not controlling for any market fundamentals; Model 2 was controlling for Market fundamentals i.e. Market Return and Volatility and Model 3 were also controlling for 2008 financial crisis dummy along with Market fundamentals.

Table 4 shows the industry-wise results of our state-space model 3. The estimated values of all industry coefficients of state equation φ_m are statistically significant. Additionally, the coefficients of $\sigma_{m\omega}$(standard deviation of the error in state equation) are indicated as significant in all the sectors. The results also show that $Std_c\ (\beta^b_{imt})$ decreases with market volatility but accelerates with market returns for all the industries. The value of $\sigma_{m\omega}/\log Std\beta$ (signal to noise ratio) is higher in the sugar sector, while the signal-to-noise ratio of the manufacturing sector is low. The rationale behind the higher herding effects (signal to noise ratio) in the sugar sector may be attributed to seasonal effects[2]. Another prominent herding is noted in the financial sector. The herding of the financial sector may be influenced by the monetary policy shocks, which create more signal-to-noise ratios as compared to other sectors. The herding in the oil and gas sector is the third-highest due to its signal-to-noise ratio among all the industries. The oil and gas sectors are mostly affected by the international crude oil price changes. The lower herding effect is found in the textile and manufacturing sector (real sector), which shows that these two sectors are stable in terms of herding behavior as compared to other sectors. The findings of Table 4 show that the evidence of herding is robust by one sector to another sector by industry effects.

Although, the influence of sentiment on herding behavior using various models has been noted in previous studies (Benmabrouk, 2018; Choi & Yoon, 2020; Kabir & Shakur, 2018), the present study affixes value to the existing herding literature base by adding additional compelling findings on sectorial herding behavior which may differ based on cultural, economic or other relevant factors. Furthermore, controlling for market return, volatility, and use of the dummy variable for Financial Crisis 2008 have made the study contribute to the literature with further insights. Market returns and volatility are the partial contributors to herding in Pakistan. Market volatility and its connection with herding conforms with Bekiros et al. (2017) and Benmabrouk (2018) in the USA and contradicts in the Turkish stock market (Cakan & Balagyozyan, 2014) and Argentina and Brazil stock markets (Kabir & Shakur, 2018). About market returns, the findings of partial herding in the PSX align with the USA stock market (Litimi et al., 2016), Indonesian stock market (Rizal & Damayanti, 2019) as well as Chinese stock market (Mahmud & Tiniç, 2018). Despite this, it must be noted that in Pakistan, herding due to market returns is relatively partial.

[2] In Pakistan, raw material of sugar industry (sugar cane) is not available throughout the year. It is based on seasonal production of sugarcane.

4.1 Conclusion

Investors' herding behavior is obtaining continuous attention from various communities to understand their investment decision-making patterns. This study explores the investors' herding behavior in the Pakistan Stock Exchange (PSX). The State-Space model, as proposed by Hwang and Salmon (2004) is utilized to make herding observable. It has been argued that the measure of herding under this approach is preferable to other popular measures of herding, especially when investors' sentiments may cause herding under stress. The prime trigger for the investors in PSX to plunge into a cumulative herding movement varies sector-wise. Significant differences in industry-wise betas have been identified, hence investors may get the benefits of diversification by holding heterogeneous stocks in their portfolio.

The conclusive evidence shows that herding is significant and persistent in Pakistan across different industries. It means that investors are ignoring market fundamentals and following the market movements by imitating the other investors. After controlling for industrial differences along with market fundamentals of returns and volatility, herding evidence was detected. Findings indicate that market returns and volatility are the partial contributors to herding in Pakistan. In conclusion, it can be stated that instead of market fundamentals, investors' sentiments regarding the choice of stocks, specifically, their preference for the specific type of industry, may also be one of the prime contributors to herding behavior. Therefore, the sectorial evaluation in the PSX could be enhanced by the intense exploration of the herding phenomenon.

4.2 Implications

The rationale behind the higher herding effects (signal to noise ratio) in the sugar sector may be attributed to seasonal effects[3]. Another prominent herding is noted in the financial sector. The herding of the financial sector may be influenced by the monetary policy shocks, which create more signal-to-noise ratios as compared to other sectors. The herding in the oil and gas sector is third-highest due to its signal-to-noise ratios among all the industries. The oil and gas sectors are mostly affected by the international crude oil price changes. Comparatively, a lower herding effect is found in the textile and manufacturing sector (real sector), which shows that these two sectors are stable in terms of herding behavior as compared to other sectors. As the sugar industry is seasonal, a monetary policy statement is issued every two months, and oil and gas sectors are dependent on international crude price, whereas, textile and manufacturing sectors are relatively stagnant than the sugar sector. Hence, based on the above results we can conclude that Pakistani investors are more sensitive towards frequent news about any stocks and show herding behavior. Perhaps, investors in Pakistan may prone to react more in less stagnant industries.

[2] In Pakistan, raw material of sugar industry (sugar cane) is not available throughout the year. It is based on seasonal production of sugarcane.

4.3 Future Research

Future studies can be conducted encompassing various factors in emerging as well as developed countries which can consort interesting findings on investors' rational or irrational behaviour. Apart from encompassing various factors of emerging and developed countries, the impact of economic stress on people affecting their investing decision may be explored where COVID-19 pandemic or terrorism-based periods can be used as economic distress proxy. Additionally, cross-market herding behaviour can be an alluring topic of discussion for expanding this area of behavioural finance literature.

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