Another Look on Herd Behavior in Equity Markets: A Panel Approach

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Abstract

Given mixed findings on aggregate herd behavior in an individual country basis, we propose a new venue on identifying aggregate herd behavior by using panel analysis, including 56 countries around the globe. Four widely used herding detection models are selected for this investigation. We confirm existence of herd behavior for the whole dataset and among developing markets and of anti-herd behavior for developed markets. However, herd behavior is more dominant during down and crisis periods and the anti-herd behavior disappears. Especially, severe herd behavior is present during the crisis period. Our results are both statistical and economic significance, supporting the role of imitating trades in global equity markets. All models possess a similar power to detect herd behavior, yielding relatively similar results. Our estimation is not subjected to endogeneity.

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1. Introduction

Herd behavior is considered as similar actions that market participants follow observed activities with ignoring their own beliefs and information. Even though herd behavior among investors has been one of the most interesting topics in finance for more than 30 years, especially after the 2008 credit crisis (Choijil et al., 2022), empirical results are still mixed depending on employed herding detection models, sample periods, data types, and country sample. In general, herd behavior is stronger among developing countries (Venezia, Nashikkar, and Shapira, 2011; Laih and Liau, 2013; Chang and Lin, 2015) and during uncertain periods (Christie and Huang, 1995; Chang, Cheng, and Khorana, 2000; Wanidwaranan and Padungsaksawasdi, 2020). Nevertheless, some studies note different findings. For example, contradicting to the evidence of Chang et al. (2000) and Chiang and Zheng (2010), Hwang and Salmon (2004) suggest herd behavior in the U.S. Chiang and Zheng (2010) fail to find asymmetric herd behavior between positive and negative return markets in some European countries over the period of 1989-2009, however; Wanidwaranan and Padungsaksawasdi (2020) employing the Chang et al.'s (2000) model over the period of 1996-2018 demonstrate the evidence in Germany, Greece, Italy, and Spain. In addition, Hwang and Salmon (2004) show that herd behavior is weaker during crisis periods, which is opposite from the findings of Wanidwaranan and Padungsaksawasdi (2022). Different findings on herd behavior potentially depend on firm characteristics, investor types, and behavioral factors (Lakonishok, Shleifer, and Vishny, 1992; Choi and Sias, 2009; Dang and Lin, 2016; Galariotis, Krokida, and Spyrou, 2016). This ascertains that patterns of herd behavior are influenced by both observable and unobservable factors.

In this paper, we attempt to fill the gap in the literature by studying the herd behavior at the aggregate market level employing panel data rather than focusing on an individual country basis. Benefits of panel data analysis (Hsiao, 2007) overcome shortcomings found in a single sample basis as follows. First, estimated parameters of panel data analysis are more accurate than those of cross-sectional analysis because of more degrees of freedom and less measurement errors. This technique enhances the validity of our findings. Second, panel data are better to reflect a complexity of human behavior (hence, trading behavior-herding) than a pure single cross-sectional or time series data. Panel regression with fixed effect considers omitted variables and reveals a dynamic relationship. With these advantages of panel data analysis, we augment four well-known time-series herding detection models by analyzing different country samples together in order to form panel data are chosen that are the herding detection models of Chang, Cheng, and Khorana (2000), Yao, Ma, and He (2014),[1] and Bui, Nguyen, Nguyen, and Titman (2017). The sample includes 56 countries with more than 64,000 individual stocks around the globe, covering more than 80% of the world's GDP.[2] The period of the study starts from an inception of data provided by DataStream Refinitiv to August 13, 2019.

We contribute to prior literature at least twofold. First, we propose a different investigation of herd behavior in international equity markets by employing panel data rather than using time-series data. This fills the gap in prior findings of (non)existence of herd behavior in an individual country basis. Second, we compare efficacy of aforementioned four well-known herding detection models found in empirical research and find that each model possesses relatively similar power to detect herd behavior in international equity markets.

[1] Yao, Ma, and He (2014) propose two herding detection models.
[2] World Bank Data, GDP, The World Bank. Retrieved from https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

Overall, the findings of this paper fill the gap in prior literature on (non)existence of herd behavior in equity markets around the globe. We analyze, discuss, and present our results based on the full sample, developed countries, and developing countries and test aggregate trading behavior by employing four well-known herding detection models, namely Chang, Cheng, and Khorana (2000), Yao, Ma, and He (2014), and Bui, Nguyen, Nguyen, and Titman (2017), throughout the study.

The main results of all models demonstrate herd behavior in the full sample and developing countries. For example, considering the model of Chang, Cheng, and Khorana (2000), the standard deviation of the return squared (as a proxy of herd behavior) is 58.2599 and the estimated coefficient of the return squared is -0.0008. An increase in a one standard deviation of the return squared, the return dispersion reduces by 0.0466. Because the standard deviation of $CSAD$ is 1.7163, a change by 0.0466 represents a 0.0272% decrease. Nonetheless, anti-herd behavior is presented in developed countries because of less volatility, more public information, greater investor protection, and more institutional investors. The results are stronger when looking at asymmetric herd behavior between up and down return markets, showing that herd behavior is more prevalent during down markets in all cases of all models. For example, considering the model of Chang, Cheng, and Khorana's (2000), the standard deviation of the $D_{m,d,t}R_{m,t}^2$ (as a proxy of herd behavior) is 40.6759 and the estimated coefficient of the $D_{m,d,t}R_{m,t}^2$ is -0.0030. An increase in a one standard deviation of the $D_{m,d,t}R_{m,t}^2$, the return dispersion reduces by 0.1220. Because the standard deviation of $CSAD$ is 1.7163, a change by 0.1220 represents a 0.0711% decrease. Herd behavior during the 2008 financial crisis period is strongest, presenting severe herd behavior for the full sample and developing countries and herd behavior for developed countries. For example, considering the model of Yao, Ma, and He's (2014) for the full sample, the standard deviation and estimated coefficient of the $D_{c,t}\left|R_{m,t}\right|$ (as a proxy of severe herd behavior) are 0.3243 and -0.3338, respectively. An increase in a one standard deviation of the $D_{c,t}\left|R_{m,t}\right|$, the return dispersion reduces by 0.1083. Because the standard deviation of $CSAD$ is 1.7163, a change by 0.1083 represents a 6.3101% decrease. In addition, as a turmoil in financial markets is an exogenous shock, our results are not confounded by endogeneity. In terms of the efficacy of herding detection models, we find that all selected four models yield largely similar estimated coefficients, statistical significance, and the coefficient of determination (R^2). Thus, our findings are not driven by model selection and future studies can employ any herding detection model.

This paper is organized as follows. Section 2 summarizes pertinent literature and describe the development of herding detection models. Sections 3 and 4 demonstrate data and methodology employed in this study. Section 5 presents and discusses empirical results and the last section is conclusion.

2. Literature review and the development of herding detection models

There are two main approaches in studies of herd behavior in financial markets that are herd behavior of different investor types and that of aggregate market. As studies of herd behavior abounds, for brevity, we focus on existing evidence on the latter in equity markets as it is the focus of this paper.

Starting from the study of Christie and Huang (1995) in the U.S. by employing both daily and monthly data, the relationship between the standard deviation of stock returns and stock market returns is positive over up and down periods, suggesting an absence of herd behavior. On the other hand, Blasco and Ferreruela (2008) examining herd behavior in seven countries by only looking at the dispersion of cross-sectional standard deviation of returns (CSSD) defined in Christie and

Huang (1995) find imitative investors' behavior in Spain over both tranquil and turbulent periods. Chang et al. (2000) improving the Christie and Huang's (1995) herding detection model by employing the Black's (1972) CAPM and incorporating a nonlinear market return find nonexistence of herd behavior in the U.S. and Hong Kong, which is consistent with the finding of Christie and Huang (1995). However, they find partial evidence of herd behavior in Japan and pure herding in South Korea and Taiwan. These findings are inconsistent with Hwang and Salmon (2004), who find herd behavior in the U.S. by employing the Fama and French three factor model with the state-space technique. Moreover, herd behavior is weaker during crisis period, contradicting to prior understanding (Christie and Huang, 1995; Chang et al., 2000).

The herding detection model developed by Chang, Cheng, and Khorana (2000) is the most influential methodology in the study of herd behavior at the aggregate market level. A decade later, Chiang and Zheng (2010) modifying the Chang et al.'s (2000) model by adding the market return variable for the detection of asymmetric herd behavior and by testing 18 equity markets around the globe show that herd behavior is present in advanced economic countries (France, Germany, Japan, and the U.K.) and the Asian equity markets (China and Hong Kong). They do not find the evidence of herding among Latin American countries and the U.S. However, herding found in China and Hong Kong is opposite from the finding of Demirer and Kutan (2006), employing the models of Christie and Huang (1995) and Chang et al. (2000). In addition, Gębka and Wohar (2013) suggest that herd behavior prevails at the industry level, but not at the country level.

In terms of model specification, the Chiang and Zheng's (2010) model overcomes a problem of sample-splitting found in the models of Chang et al. (2000) and Christie and Huang (1995), however; it creates another problem of multicollinearity. This is later addressed by Yao, Ma, and He (2014), who include a demeaned market return for the nonlinear term and a lagged return dispersion in the herding detection model. They argue that multicollinearity found in the aforementioned models is a potential cause to underestimate an existence of herd behavior. Inclusions of these two additional variables could amplify the power of the model. In the same vein, Blasco, Corredor, and Ferreruela (2017) modify the Chiang and Zheng's (2010) model by including a lag value of cross sectional absolute deviation (CSAD) to improve a predictive power of the herding detection model and to reduce a multicollinearity problem. The results of Blasco et al. (2017) on Argentina, Australia, Brazil, Germany, and the U.S. are inconsistent to the findings of Chiang and Zheng (2010). To the best of our knowledge, the latest herding detection model is developed by Bui, Nguyen, Nguyen, and Titman (2017), extending from the Yao et al.'s (2014) model by replacing squared demeaned market return by demeaned absolute market return. They claim that the demeaned absolute market return is more powerful than market return in the Yao et al.'s model (2014) for detecting herd behavior and find that herd behavior in the Vietnamese equity market is present at both aggregate and sector levels, as well as during both up and down periods.

Notwithstanding various herding detection models over different periods of study demonstrating different findings, other variables or conditions at the macro level are also dominant to herd behavior in equity markets that are market states, return behavior, national culture, market-wide investor attention. Some studies (Wanidwaranan and Padungsaksawasdi, 2020 and 2022) document that herd behavior is more prevalent during down and financial crisis periods, confirming an asymmetry in herd behavior.[3] Wanidwaranan and Padungsaksawasdi (2020) investigating the effect of return jumps in eight stock markets find that herd behavior is more pronounced on return jump and negative return days, emphasizing an existence of asymmetric herd

[3] However, Chiang and Zheng (2010) investigating herd behavior in 18 countries find that imitating behavior is asymmetric, especially over the crisis periods, with more dominant herd behavior over up periods for the Asian equity markets.

behavior. The information cascade well explains this phenomenon, confirming superior information subsumed in return jump causing mimic actions among market participants. When looking at behavioral perspective, Wanidwaranan and Padungsaksawasdi (2022) demonstrate that market-wide investor attention affects investors' decisions, causing unintentional herd behavior. The more investors search for information from the internet, the more mimic trades are. However, the effects of investor attention diminish during down markets as investors discomfort, being consistent with the Ostrich effect. Chang and Lin (2015) find that herd behavior is stronger among countries with high masculinity, reflecting materialistic and associating with imitating trading behavior (buying high and selling low).

In summary, prior studies examine the aggregate herd behavior at an individual country basis and fail to reach the same conclusion for the same country samples or even during the overlapping or the same periods of study. Moreover, macroeconomic factors play a vital role in determining investors' behaviors, pushing similar trading patterns among market participants. To fill the gap found in prior literature as mentioned above, we employ panel regression models with 56 equity markets around the globe.

3. Data

We collect daily stock prices in unit of local currency of an individual country from the beginning record of DataStream Refinitiv until August 13, 2019. Daily individual stock data are more powerful to capture a return dispersion rather than industry index data because of a large number of observations inducing a powerful estimation and a better reflection of investor trading behavior.[4] The sample includes 56 countries, consisting of 23 developed countries and 33

[4] Because sector index and industry index are not tradable, they are not a good proxy of trading behavior.

developing classified by the MSCI as detailed in Table 1.[5] The total of top 50 countries' GDP accounts more than 80% of the world's GDP in our sample during the year 2020. Both delisted and listed companies are included in order to avoid the sample selection bias, covering more than 64,000 individual stocks around the world.

Panel A of Table 2 presents descriptive statistics of variables. An average of cross-sectional absolute deviation of stock returns ($CSAD$) around the globe is 2.08%, while that of stock market return ($R_{m,t}$) is 0.02%. This is promising for a potential positive risk-return relationship in global equity markets, which herd behavior might be less evident. Nonlinear variables in several measures are not much different, yielding an approximate 2.70%^{2}. Panel B of Table 2 presents the coefficient of correlation among main variables in the study. In general, the cross-sectional absolute deviation of stock returns is positively correlated to other measures, with the exception of the market return, promising a possible positive (non)linear risk-return relationship, which is consistent with the findings in Panel A. It is interesting to note that all nonlinear terms ($R_{m,t}^2$, $\left(R_{m,t} - \overline{R_m}\right)^2$, and $\left(\left|R_{m,t}\right| - \overline{R_m}\right)^2$) possess the perfectly positively correlated, showing that demeaned return squared variables occupy the same information as in the return squared variable. Thus, an estimation obtained from different models is likely to be the same.

4. Methodology

This paper employs four popular herding detection models based on panel data. The augmented models are presented as follows.

- Chang, Cheng, and Khorana (2000)

[5] MSCI, Market Classification. Retrieved from https://www.msci.com/our-solutions/indexes/market-classification

$$CSAD_{m,t} = \alpha + \gamma_1 |R_{m,t}| + \gamma_2 R_{m,t}^2 + \theta_C + \tau_{year} + \varepsilon_t \tag{1}$$

- Yao, Ma, and He (2014)

$$CSAD_{m,t} = \alpha + \gamma_1 |R_{m,t}| + \gamma_2 \left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t \tag{2}$$

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2 |R_{m,t}| + \gamma_3 \left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t \tag{3}$$

- Bui, Nguyen, Nguyen, and Titman (2017)

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2 |R_{m,t}| + \gamma_3 \left(|R_{m,t}| - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t \tag{4}$$

where

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

$CSAD_{m,t}$ is a cross-sectional absolute deviation of stock returns for country m at time t. N is the number of companies listed in the stock exchange of country m. $R_{i,t}$ is a stock return of firm i at time t, which is equal to $100 \times \left(\ln P_{i,t} - \ln P_{i,t-1}\right)$. $P_{i,t}$ and ln are a stock price of firm i at time t and natural logarithm, respectively. $R_{m,t}$ is an equally weighted portfolio return of all stocks in country m at time t. $\overline{R_m}$ is an average value of equally weighted portfolio return of all stocks in country m. $|R_{m,t}|$ denotes an absolute value of equally weighted portfolio return of all stocks in country m at time t. θ_C and τ_{year} are country and time fixed effects, respectively.

Moreover, we investigate asymmetric herd behavior during the down and crisis periods that are usually studied in prior literature. We adopt the methodology suggested by Wanidwaranan and Padungsaksawasdi (2020) to assign a dummy variable of the down and crisis periods into our augmented herding detection models[6] those are

[6] The herding detection model of Chang, Cheng, and Khorana (2000) separately testing positive and negative return periods causes a sample-splitting problem, reducing the number of observations and subsequently impairing a reliability of inferences. In addition, the model of Chiang and Zheng (2010) uses both D_t and $1 - D_t$ together with the intercept term in the regression models, causing a dummy variable trap to occur a perfect multicollinearity problem.

$$CSAD_{m,t} = \alpha + \gamma_1|R_{m,t}| + \gamma_2 R_{m,t}^2 + \gamma_3 D_{k,t} + \gamma_4 D_{k,t}|R_{m,t}| + \gamma_5 D_{k,t} R_{m,t}^2 + \theta_C + \tau_{year} + \varepsilon_t \quad (8)$$

$$CSAD_{m,t} = \alpha + \gamma_1|R_{m,t}| + \gamma_2\left(R_{m,t} - \overline{R_m}\right)^2 + \gamma_3 D_{k,t} + \gamma_4 D_{k,t}|R_{m,t}| + \gamma_5 D_{k,t}\left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t \quad (9)$$

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2|R_{m,t}| + \gamma_3\left(R_{m,t} - \overline{R_m}\right)^2 + \gamma_4 D_{k,t} + \gamma_5 D_{k,t} CSAD_{m,t-1} + \gamma_6 D_{k,t}|R_{m,t}| + \gamma_7 D_{k,t}\left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t \quad (10)$$

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2|R_{m,t}| + \gamma_3\left(|R_{m,t}| - \overline{R_m}\right)^2 + \gamma_4 D_{k,t} + \gamma_5 D_{k,t} CSAD_{m,t-1} + \gamma_6 D_{k,t}|R_{m,t}| + \gamma_7 D_{k,t}\left(|R_{m,t}| - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t \quad (11)$$

where $D_{k,t}$ is a dummy variable, which is equal to one on a negative market return date ($R_{m,t} < 0$) for country m ($D_{m,d,t}$) or on over the global financial crisis period of March 1, 2008 to March 31, 2009 ($D_{c,t}$).

5. Empirical results

5.1 Overall herd behavior

Panels A, B, and C of Table 3 present herd behavior using the pooled regression for the full sample, developed markets, and developing markets, respectively, with the herding detection models of Chang, Cheng, and Khorana (2000), Yao, Ma, and He (2014), and Bui, Nguyen,

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We decide to adopt the methodology suggested by Wanidwaranan and Padungsaksawasdi (2020) to address these issues.

Nguyen, and Titman (2017).[7] As the coefficient of $|R_{m,t}|$ signifies a linear association between market return and cross-sectional absolute deviation (a measure of return dispersion), we do not observe severe herd behavior because of positive significance of $|R_{m,t}|$ in all cases. Of Panels A and C, herd behavior is, however, found in the full sample and developing countries of all models as the coefficients of $R_{m,t}^2$, $\left(R_{m,t} - \overline{R_m}\right)^2$, and $\left(|R_{m,t}| - \overline{R_m}\right)^2$are negative and significant, demonstrating nonlinear relationship between stock market returns and their return dispersions. The larger the magnitude of stock returns, the larger the imitating trades are. Interestingly, we find weak anti-herding behavior among developed countries because of positive significance of $R_{m,t}^2$, $\left(R_{m,t} - \overline{R_m}\right)^2$, and $\left(|R_{m,t}| - \overline{R_m}\right)^2$ as shown in Panel B. These preliminary results support an existence of herd behavior in global equity markets especially among developing nations (Venezia, Nashikkar, and Shapira, 2011; Laih and Liau, 2013; Chang and Lin, 2015).

As the country sample is worldwide, the panel regression with fixed effects yields more reliable results and inferences with relatively higher R-squares than those in the pooled regression because it takes both observable and unobservable variables into consideration. Overall, we find that the results of panel regression with fixed effects shown in Table 4 are largely the same as those of pooled regression shown in Table 3. When considering an economic impact, we find that herd behavior is influential to a return dispersion in global equity markets. For example, looking at the model of Chang, Cheng, and Khorana (2000), the standard deviation of the return squared is 58.2599 and the estimated coefficient of the return squared is -0.0008. An increase in a one standard deviation of the return squared, the return dispersion reduces by 0.0466 (= 58.2599 × -0.0008). Because the standard deviation of $CSAD$ is 1.7163, a change by 0.0466 represents a

[7] For brevity, we exclude other two well-known herding detection models of Chiang and Zheng (2010) and Blasco, Corredor, and Ferreruela (2017) from our study because the results are qualitatively and quantitatively similar to those of Chang et al. (2000) and Bui et al. (2017), respectively. The results are available upon request.

0.0272% (= 0.0466 ÷ 1.7163) decrease. We perform a similar calculation for the remaining models and the results remain largely the same in terms of the magnitude. For developed countries as shown in Panel B, an economic impact is stronger for the anti-herd behavior. Focusing on the Bui, Nguyen, Nguyen, and Titman's (2017) model, the standard deviation of absolute demeaned return squared $\left(\left(|R_{m,t}| - \overline{R_m}\right)^2\right)$ is 57.9373 and its estimated coefficient representing herd behavior is 0.0179, thus an increase in a one standard deviation yields 1.0371 (= 57.9373 × 0.0179) change in the return dispersion, accounting for 0.6043% (= 1.0371 ÷ 1.7163) increase in the return dispersions ($CSAD$). Well-developed equity markets are usually less volatile, more informative, greater investor protection, and more institutional investors than less-developed equity markets, thus; anti-herding behavior prevails. In terms of the efficacy of the herding detection models, we do not observe any significant difference among the models, providing relatively similar R-squared values and magnitudes and signs of estimated coefficients. Thus, evidence across different models are similarly interpreted. In summary, herd behavior is globally prevalent especially among developing country, though anti-herd behavior is weakly observed in developed markets.

5.2 Asymmetric herd behavior

Panels A to C of Table 5 presents an asymmetry of herd behavior for the world, developed markets, and developing markets, respectively. Consistent with evidence on an individual country (Vo and Phan, 2019; Wanidwaranan and Padungsaksawasdi, 2020), herd behavior is more dominant when stock markets go down for all cases. Even among developed markets that anti-herding behavior is present as shown in Panel B of Table 4, we observe herd behavior among this group during negative return periods. The coefficients of $D_{m,d,t}R_{m,t}^2$, $D_{m,d,t}\left(R_{m,t} - \overline{R_m}\right)^2$, and $D_{m,d,t}\left(|R_{m,t}| - \overline{R_m}\right)^2$, which are of interest, are negative and significant for all cases, showing herd behavior. This confirms that herd behavior is asymmetric, emphasizing more mimicking trading patterns over the negative return dates. In terms of economic significance, the estimated coefficients of all nonlinear dummy interaction terms are relatively large in all models. For example, of the Chang, Cheng, and Khorana's (2000) model for the full sample as shown in Panel A, the standard deviation of the $D_{m,d,t}R_{m,t}^2$ is 40.6759 and the estimated coefficient of the $D_{m,d,t}R_{m,t}^2$ is -0.0030. An increase in a one standard deviation of the $D_{m,d,t}R_{m,t}^2$, the return dispersion reduces by 0.1220 (=40.6759 × -0.0030). Because the standard deviation of $CSAD$ is 1.7163, a change by 0.1220 represents a 0.0711% (= 0.1220 ÷ 1.7163) decrease. This confirms that herd behavior is more dominant during negative return days as the return dispersion is concentrated more than double comparing with the results of herd behavior as shown in Table 4. Likewise, all modified herding detection models on negative return days possess a similar power to identify herd behavior in global equity markets.

5.3 Herd behavior during the financial crisis

In this section, we investigate herd behavior in global equity markets during the period of financial turmoil as shown in Table 6. The results show that herd behavior during the most volatile period is strongest in all cases comparing to the above results. The coefficients of $D_{m,d,t}\left|R_{m,t}\right|$ are negative and significant for the full sample and developing countries as shown in Panels A and C, respectively, confirming severe herd behavior during the 2008 financial crisis. The magnitudes of $D_{m,d,t}\left|R_{m,t}\right|$ are largest, implying the greatest impact on worldwide trading behavior. For example, of Yao, Ma, and He's (2014) model for the full sample as shown in Panel A, the standard deviation and estimated coefficient of the $D_{c,t}\left|R_{m,t}\right|$ are 0.3243 and -0.3338, respectively. An increase in a one standard deviation of the $D_{c,t}\left|R_{m,t}\right|$, the return dispersion reduces by 0.1083 (=0.3243 × -0.3338). Because the standard deviation of $CSAD$ is 1.7163, a change by 0.1083 represents a 6.3101% (= (0.1083 ÷ 1.7163) ×100) decrease. However, evidence on developed countries as shown in Panel B demonstrates herd behavior as the coefficients of $D_{c,t}R_{m,t}^2$ $D_{c,t}\left(R_{m,t}-\overline{R_m}\right)^2$, and $D_{c,t}\left(\left|R_{m,t}\right|-\overline{R_m}\right)^2$, are negative and significant for all models. Similar to previous findings, the efficacy of all models are largely similar. In addition, as a turmoil in financial markets is an exogenous shock, our results are not confounded by endogeneity.

6. Conclusion

We shed a new light to study herd behavior at the aggregate market level by employing panel regression of global equity markets rather than time-series regression on an individual country in order to address mixed findings on herd behavior in a particular country found in prior literature. Different findings on herd behavior in each country are potentially driven by herding detection model, sample period, and type and frequency of data, thus panel regression herd detection models proposed in this study can assist to fill the gap. Our sample is comprehensive, covering 56 countries starting from an availability of data till August 13, 2019.

Overall, imitating trade among investors is a common phenomenon in equity markets around the globe. All selected four well-known herding detection models demonstrate similar results and interpretation. We do not observe difference in the magnitude, sign, and statistical significance of estimated coefficients in all models. Herd behavior among investors are especially found in developing countries, whereas anti-herd behavior is weakly found in developed markets. Different evidence is driven by the level of market efficiency, market transparency, investor types, and investor protection. Herd behavior is more dominant in the downturn markets and financial turmoil; in which we observe herd behavior in all cases. The more the volatility in financial markets, the more evidence on herd behavior is. Our results are both statistical and economic significance, supporting the role of imitating trades in global equity markets. Moreover, our findings are not confounding to endogeneity. In summary, we confirm an existence of aggregate market herding in global financial market.

References

Black, F. (1972). Capital market equilibrium with restricted borrowing. *Journal of Business*, *45*(3), 444–455.

Blasco, N., Corredor, P., & Ferreruela, S. (2017). Can agents sensitive to cultural, organizational and environmental issues avoid herding?. *Finance Research Letters*, *22*, 114-121.

Blasco, N., & Ferreruela, S. (2008), Testing intentional herding in familiar stocks: An experiment in an international context. *Journal of Behavioral Finance*, *9*(2), 72-84.

Bui, N. D., Nguyen, L. T. B., Nguyen, N. T. T., & Titman, G. F. (2017). Herding in frontier stock markets: Evidence from the Vietnamese stock market. *Accounting & Finance, 58*, 59-81.

Chang, E. C., Cheng, J. W., & Khorana, A. (2000). An examination of herd behavior in equity markets: An international perspective. *Journal of Banking & Finance*, *24*(10), 1651-1679.

Chang, C., & Lin, S., (2015). The effects of national culture and behavioral pitfalls on investors' decision-making: Herding behavior in international stock markets. *International Review of Economics & Finance*, *37*, 380-392.

Chiang, T. C., & Zheng, D. (2010). An empirical analysis of herd behavior in global stock markets. *Journal of Banking & Finance*, *34*(8), 1911-1921.

Choijil, E., Méndez, C. E., Wong, W. K., Vieito, J. P., & Batmunkh, M. U. (2022). Thirty years of herd behavior in financial markets: A bibliometric analysis. *Research in International Business and Finance*, *59*, 101506.

Choi, N., & Sias, R. W. (2009). Institutional industry herding. *Journal of Financial Economics*, *94*(3), 469–491.

Christie, W. G., & Huang, R. D. (1995). Following the pied piper: Do individual returns herd around the market?. *Financial Analysts Journal*, *51*(4), 31-37.

Dang, H. V., & Lin, M. (2016). Herd mentality in the stock market: On the role of idiosyncratic participants with heterogeneous information. *International Review of Financial Analysis*, *48*, 247–260.

Demirer, R., & Kutan, A. M. (2006), Does herding behavior exist in Chinese stock markets? *Journal of International Financial Markets, Institutions and Money*, *16*(2), 123-142.

Galariotisa, E. C., Krokida, S., & Spyrou, S. I. (2016). Herd behavior and equity market liquidity: Evidence from major markets. *International Review of Financial Analysis*, *48*, 140–149.

Gębka, B., & Wohar, M. E. (2013). International herding: Does it differ across sectors? *Journal of International Financial Markets, Institutions and Money*, *23*(1), 55-84.

Hwang, S., & Salmon, M. (2004). Market stress and herding. *Journal of Empirical Finance*, *11*(4), 585-616.

Hsiao, C. (2007). Panel data analysis—advantages and challenges. *Test*, *16*(1), 1-22.

Laih, Y., & Liau, Y., (2013). Herding Behavior during the Subprime Mortgage Crisis: Evidence from Six Asia-Pacific Stock Markets. *International Journal of Economics and Finance*, *5*(7), 71-84.

Lakonishok, J., Shleifer, A., & Vishny, R. W. (1992). The impact of institutional trading on stock prices. *Journal of Financial Economics*, *32*(1), 23–43.

Venezia, I., Nashikkar, A., & Shapira, Z., (2011). Firm specific and macro herding by professional and amateur investors and their effects on market volatility. *Journal of Banking and Finance*, *35*, 1599–1609.

Vo, X., & Phan, D., (2019). Herd behavior and idiosyncratic volatility in a frontier market. *Pacific-Basin Finance Journal*, *53*, 321–330.

Wanidwaranan, P., & Padungsaksawasdi, C. (2020). The effect of return jumps on herd behavior. *Journal of Behavioral and Experimental Finance*, *27*, 100375.

Wanidwaranan, P., & Padungsaksawasdi, C. (2022). Unintentional herd behavior via the Google search volume index in international equity markets. *Journal of International Financial Markets, Institutions and Money*, *77*, 101503.

Yao, J., Ma, C., & He, W. P. (2014). Investor herding behaviour of Chinese stock market. *International Review of Economics & Finance*, *29*, 12-29.

Table 1 List of countries

This table presents the list of 56 countries in our sample, which is classified into developed and developing countries according to MSCI. The beginning date in each country is not the same, depending on an availability of data provided by DataStream Refinitiv and the ending date in all country is August 13, 2019.

Country	Recording Date (Date/Month/Year)	Stock Exchange	Level of Development	No. of stocks
Argentina	13/1/1980	Buenos Aires Stock Exchange	Developing	164
Australia	1/1/1973	ASX Tradematch	Developed	3,881
Austria	1/1/1973	Vienna Stock Exchange	Developed	246
Bangladesh	1/1/1992	Dhaka Stock Exchange	Developing	435
Belgium	1/1/1973	Euronext Brussels	Developed	419
Brazil	3/1/1990	Sao Paulo Stock Exchange	Developing	860
Canada	1/1/1973	Toronto Stock Exchange	Developed	4,126
Chile	3/7/1989	Santiago Stock Exchange	Developing	366
China	2/1/1991	Shanghai Stock Exchange	Developing	1,562
Colombia	2/1/1992	Colombia Securities Exchange	Developing	167
Czech	28/6/1993	Prague Stock Exchange	Developing	279
Denmark	1/1/1973	Nasdaq Copenhagen	Developed	496
Ecuador	4/2/1993	Quito Stock Exchange	Developing	73
Egypt	18/10/1994	Cairo Stock Exchange	Developing	308
Finland	5/1/1987	Nasdaq Helsinki	Developed	336
France	1/1/1973	Euronext Paris	Developed	1,911
Germany	1/1/1973	Frankfurt Stock Exchange	Developed	1,689
Greece	4/1/1988	Athens Exchange	Developing	437
Hong Kong	1/1/1973	Stock Exchange of Hong Kong	Developed	2,421
India	1/1/1981	Bombay Stock Exchange	Developing	4,038
Indonesia	2/4/1990	Indonesia Stock Exchange	Developing	846
Iraq	29/6/2012	Iraq Stock Exchange	Developing	97
Ireland	1/1/1965	Euronext Dublin	Developed	115
Israel	3/1/1986	Tel Aviv Stock Exchange	Developed	966
Italy	1/1/1973	Borsa Italiana	Developed	780
Jamaica	21/6/2001	Jamaica Stock Exchange	Developing	48
Japan	1/1/1973	Tokyo Stock Exchange	Developed	4,049
Malaysia	1/1/1973	Bursa Malaysia	Developing	1,212
Mexico	9/9/1987	Mexican Stock Exchange	Developing	537
Netherlands	1/1/1973	Euronext Amsterdam	Developed	317
New Zealand	6/1/1986	New Zealand Exchange	Developed	384
Nigeria	19/6/2000	Nigerian Stock Exchange	Developing	214
Norway	1/1/1973	Euronext Oslo	Developed	770
Pakistan	30/12/1988	Pakistan Stock Exchange	Developing	444
Peru	2/1/1991	Lima Stock Exchange	Developing	392
Philippines	8/11/1976	Philippine Stock Exchange	Developing	390
Poland	22/4/1991	Warsaw Stock Exchange	Developing	1,525

Country	Recording Date (Date/Month/Year)	Stock Exchange	Level of Development	No. of stocks
Portugal	5/1/1988	Euronext Lisbon	Developed	179
Romania	20/11/1995	Bucharest Stock Exchange	Developing	217
Russia	5/9/1995	Moscow Exchange	Developing	357
Saudi Arabia	12/11/1999	Saudi Stock Exchange	Developing	194
Singapore	1/1/1973	Singapore Exchange	Developed	969
South Africa	1/1/1973	Johannesburg Stock Exchange	Developing	1,173
South Korea	4/1/1980	Korea Exchange	Developing	1,336
Spain	2/1/1986	Mercado Continuo Español	Developed	359
Sweden	1/1/1973	Nasdaq Stockholm	Developed	1,910
Switzerland	1/1/1973	SIX Swiss Exchange	Developed	695
Taiwan	8/9/1987	Taiwan Stock Exchange	Developing	1,167
Thailand	2/1/1987	Stock Exchange of Thailand	Developing	789
Turkey	4/1/1988	Borsa İstanbul	Developing	526
United Arab Emirates	31/12/2003	Abu Dhabi Securities Exchange	Developing	72
United Kingdom	1/1/1965	London Stock Exchange	Developed	7,180
United States of America	1/1/1973	New York Stock Exchange	Developed	9,269
Venezuela	11/1/1990	Caracas Stock Exchange	Developing	109
Vietnam	21/12/2006	Ho Chi Minh City Stock Exchange	Developing	411
Zimbabwe	20/1/1994	Zimbabwe Stock Exchange	Developing	109

Table 2 Summary statistics

This table presents summary statistics of variables employed in several herd detection models. $CSAD_m$ is a cross-sectional absolute deviation of returns of country m. R_m, $|R_m|$, and R_m^2 are stock market return, absolute of stock market return, and squared market return of country m, respectively. $D_{m,d,t}$ is a dummy variable, being equal to one on negative market return (d) on day t in country m, zero otherwise. $D_{c,t}$ is a dummy variable, being equal to one on date t of the financial period of March 1, 2008 to March 1, 2009, zero otherwise.

Panel A: Variables

	Mean	Std. Dev.	Min	Max	P25	P50	p75
$CSAD_m$	2.0804	1.7163	0.0000	223.5427	1.3158	1.7959	2.4668
$R_{m,t}$	0.0209	1.6449	-137.1930	119.0368	-0.4530	0.0413	0.5219
$\lvert R_{m,t}\rvert$	0.8367	1.4163	0.0000	137.1929	0.2083	0.4901	0.9984
${R_{m,t}}^2$	2.7061	58.2599	0.0000	18821.8930	0.0434	0.2402	0.9968
$\left(R_{m,t}-\overline{R_m}\right)^2$	2.7018	58.2108	0.0000	18829.0100	0.0443	0.2430	1.0008
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$	2.6393	57.9373	0.0000	18814.7750	0.0404	0.2298	0.9698
$D_{m,d}$	0.4721	0.4992	0.0000	1.0000	0.0000	0.0000	1.0000
$D_{m,d}R_{m,t}$	-0.4102	1.8686	-1040.4600	0.0000	-0.4530	0.0000	0.0000
$D_{m,d}\lvert R_{m,t}\rvert$	0.4102	1.8686	0.0000	1040.4604	0.0000	0.0000	0.4530
$D_{m,d}\left(R_{m,t}\right)^2$	1.3276	40.6759	0.0000	18821.8930	0.0000	0.0000	0.2052
$D_{m,d}\left(R_{m,t}-\overline{R_m}\right)^2$	1.3626	40.8783	0.0000	18829.0100	0.0000	0.0000	0.2236
$D_{m,d}\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$	1.2999	40.4859	0.0000	18814.7750	0.0000	0.0000	0.1962
$D_{m,c}$	0.0299	0.1705	0.0000	1.0000	0.0000	0.0000	0.0000
$D_{m,c}R_{m,t}$	-0.0086	0.3262	-25.0830	55.8079	0.0000	0.0000	0.0000
$D_{m,c}\lvert R_{m,t}\rvert$	0.0355	0.3243	0.0000	55.8079	0.0000	0.0000	0.0000
$D_{m,c}\left(R_{m,t}\right)^2$	0.1065	5.0684	0.0000	3114.5210	0.0000	0.0000	0.0000
$D_{m,c}\left(R_{m,t}-\overline{R_m}\right)^2$	0.1068	5.0023	0.0000	3052.7219	0.0000	0.0000	0.0000
$D_{m,c}\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$	0.1044	4.9574	0.0000	3052.7219	0.0000	0.0000	0.0000

Panel B: Coefficient of correlation

	$CSAD$	$R_{m,t}$	$\lvert R_{m,t}\rvert$	$R_{m,t}^2$	$\left(R_{m,t}-\overline{R_m}\right)^2$	$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$	$D_{m,d,t}$	$D_{c,t}$
$CSAD$	1.000							
$R_{m,t}$	-0.009	1.000						
$\lvert R_{m,t}\rvert$	0.486	-0.492	1.000					
$R_{m,t}^2$	0.037	-0.679	0.748	1.000				
$\left(R_{m,t}-\overline{R_m}\right)^2$	0.037	-0.679	0.748	1.000	1.000			
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$	0.037	-0.679	0.747	1.000	1.000	1.000		
$D_{m,d,t}$	0.002	-0.374	0.014	0.002	0.002	0.002	1.000	
$D_{c,t}$	0.058	-0.024	0.029	0.000	0.000	0.000	0.032	1.000

Table 3. Pure herd behavior: pooled regression estimation

Panels A, B, and C present estimated coefficients of pooled regression models for the full sample, developed countries, and developing countries, respectively. The herd detection models are

Chang et al. (2000): CCK	$CSAD_{m,t} = \alpha + \gamma_1\lvert R_{m,t}\rvert + \gamma_2 R^2_{m,t} + \varepsilon_t$
Yao et al. (2014): YMH1	$CSAD_{m,t} = \alpha + \gamma_1\lvert R_{m,t}\rvert + \gamma_2\left(R_{m,t} - \overline{R_m}\right)^2 + \varepsilon_t$
Yao et al. (2014): YMH2	$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2\lvert R_{m,t}\rvert + \gamma_3\left(R_{m,t} - \overline{R_m}\right)^2 + \varepsilon_t$
Bui et a. (2017): BNNT	$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2\lvert R_{m,t}\rvert + \gamma_3\left(\lvert R_{m,t}\rvert - \overline{R_m}\right)^2 + \varepsilon_t$

where $CSAD_{m,t} = \frac{1}{N}\sum_{i=1}^{N}\lvert R_{i,t} - R_{m,t}\rvert$. $CSAD$ is a cross-sectional absolute deviation of returns. N is the number of stock in a particular stock market. R is a stock market return. $\lvert\ \rvert$ and $\overline{\ }$ denote symbols of absolute value and average value, respectively. m and t index country and day, respectively. Robust t-statistics are shown in parentheses. $Adj.R^2$ is adjusted R-squared value.

Panel A: Full sample

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.3159***	1.3159***	0.8683***	0.8685***
	(16.07)	(16.07)	(12.85)	(12.84)
$CSAD_{m,t-1}$			0.2854***	0.2853***
			(5.22)	(5.22)
$\lvert R_{m,t}\rvert$	0.8557***	0.8557***	0.7411***	0.7408***
	(13.48)	(13.48)	(9.92)	(9.92)
$R^2_{m,t}$	-0.0008***			
	(-13.02)			
$\left(R_{m,t} - \overline{R_m}\right)^2$		-0.0008***	-0.0007***	
		(-13.02)	(-9.57)	
$\left(\lvert R_{m,t}\rvert - \overline{R_m}\right)^2$				-0.0007***
				(-9.57)
$Adj.R^2$	0.4767	0.4767	0.5499	0.5500

Panel B: Developed markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.6132***	1.6132***	0.5864***	0.5866***
	(14.68)	(14.68)	(4.19)	(4.20)
$CSAD_{m,t-1}$			0.5599***	0.5599***
			(5.63)	(5.63)
$R_{m,t}$				
$\lvert R_{m,t} \rvert$	0.5816***	0.5815***	0.4165***	0.4162***
	(8.57)	(8.57)	(5.04)	(5.02)
$R_{m,t}^2$	0.0147			
	(1.48)			
$(R_{m,t} - \overline{R_m})^2$		0.0147	0.0176*	
		(1.48)	(1.94)	
$(\lvert R_{m,t} \rvert - \overline{R_m})^2$				0.0176*
				(1.95)
$Adj. R^2$	0.2798	0.2798	0.5758	0.5758

Panel C: Developing markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.1799***	1.1800***	0.8977***	0.8979***
	(11.36)	(11.36)	(12.49)	(12.48)
$CSAD_{m,t-1}$			0.1906***	0.1906***
			(4.48)	(4.48)
$\lvert R_{m,t} \rvert$	0.9058***	0.9058***	0.8236***	0.8232***
	(11.71)	(11.71)	(9.71)	(9.71)
$R_{m,t}^2$	-0.0008***			
	(-11.33)			
$(R_{m,t} - \overline{R_m})^2$		-0.0008***	-0.0008***	
		(-11.33)	(-9.40)	
$(\lvert R_{m,t} \rvert - \overline{R_m})^2$				-0.0008***
				(-9.40)
$Adj. R^2$	0.5489	0.5489	0.5810	0.5810

Table 4: Pure herd behavior: panel regression with fixed effect estimation

Panels A, B, and C present estimated coefficients of panel regression with fixed effect estimation for the full sample, developed countries, and developing countries, respectively. The herd detection models are

Chang et al. (2000): CCK	$CSAD_{m,t} = \alpha + \gamma_1 \lvert R_{m,t} \rvert + \gamma_2 R_{m,t}^2 + \theta_C + \tau_{year} + \varepsilon_t$
Yao et al. (2014): YMH1	$CSAD_{m,t} = \alpha + \gamma_1 \lvert R_{m,t} \rvert + \gamma_2 \left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$
Yao et al. (2014): YMH2	$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2 \lvert R_{m,t} \rvert + \gamma_3 \left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$
Bui et a. (2017): BNNT	$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2 \lvert R_{m,t} \rvert + \gamma_3 \left(\lvert R_{m,t} \rvert - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$

where $CSAD_{m,t} = \frac{1}{N}\sum_{i=1}^{N}\lvert R_{i,t} - R_{m,t} \rvert$. $CSAD$ is a cross-sectional absolute deviation of returns. N is the number of stock in a particular stock market. R is a stock market return. θ_C and τ_{year} are country and year fixed effects, respectively. $\lvert \quad \rvert$ and $\overline{}$ denote symbols of absolute value and average value, respectively. m and t index country and day, respectively. Robust *t*-statistics are shown in parentheses. $Adj. R^2$ is adjusted R-squared value.

Panel A: Full sample

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.1556***	1.1556***	0.7891***	0.7892***
	(14.31)	(14.31)	(10.93)	(10.92)
$CSAD_{m,t-1}$			0.2703***	0.2703***
			(5.12)	(5.12)
$\lvert R_{m,t} \rvert$	0.8481***	0.8481***	0.7404***	0.7402***
	(13.30)	(13.30)	(9.94)	(9.94)
$R_{m,t}^2$	-0.0008***			
	(-12.85)			
$\left(R_{m,t} - \overline{R_m}\right)^2$		-0.0008***	-0.0007***	
		(-12.85)	(-9.59)	
$\left(\lvert R_{m,t} \rvert - \overline{R_m}\right)^2$				-0.0007***
				(-9.59)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj. R^2$	0.4916	0.4916	0.5576	0.5577

Panel B: Developed markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.4243***	1.4243***	0.6072***	0.6074***
	(14.83)	(14.83)	(4.23)	(4.24)
$CSAD_{m,t-1}$			0.5256***	0.5255***
			(5.01)	(5.01)
$\lvert R_{m,t}\rvert$	0.5939***	0.5939***	0.4265***	0.4262***
	(7.15)	(7.15)	(5.00)	(4.98)
$R_{m,t}^2$	0.0149			
	(1.50)			
$\left(R_{m,t}-\overline{R_m}\right)^2$		0.0150	0.0179*	
		(1.51)	(1.93)	
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				0.0179*
				(1.93)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.3517	0.3517	0.5905	0.5905

Panel C: Developing markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.0234***	1.0234***	0.7928***	0.7930***
	(9.60)	(9.61)	(9.00)	(9.00)
$CSAD_{m,t-1}$			0.1801***	0.1800***
			(4.48)	(4.48)
$\lvert R_{m,t}\rvert$	0.8928***	0.8928***	0.8223***	0.8220***
	(12.38)	(12.38)	(9.78)	(9.78)
$R_{m,t}^2$	-0.0008***			
	(-11.99)			
$\left(R_{m,t}-\overline{R_m}\right)^2$		-0.0008***	-0.0008***	
		(-11.99)	(-9.47)	
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				-0.0008***
				(-9.47)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.5589	0.5588	0.5867	0.5867

Table 5: Asymmetric herd behavior: panel regression with fixed effect estimation

Panels A, B, and C present estimated coefficients of panel regression with fixed effect estimation for the full sample, developed countries, and developing countries, respectively. The herd detection models are

Chang et al. (2000): CCK

$$CSAD_{m,t} = \alpha + \gamma_1|R_{m,t}| + \gamma_2 R_{m,t}^2 + \gamma_3 D_{k,t} + \gamma_4 D_{k,t}|R_{m,t}| + \gamma_5 D_{k,t} R_{m,t}^2 + \theta_C + \tau_{year} + \varepsilon_t$$

Yao et al. (2014): YMH1

$$CSAD_{m,t} = \alpha + \gamma_1|R_{m,t}| + \gamma_2\left(R_{m,t} - \overline{R_m}\right)^2 + \gamma_3 D_{k,t} + \gamma_4 D_{k,t}|R_{m,t}| + \gamma_5 D_{k,t}\left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$$

Yao et al. (2014): YMH2

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2|R_{m,t}| + \gamma_3\left(R_{m,t} - \overline{R_m}\right)^2 + \gamma_4 D_{k,t} + \gamma_5 D_{k,t} CSAD_{m,t-1} + \gamma_6 D_{k,t}|R_{m,t}| + \gamma_7 D_{k,t}\left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$$

Bui et a. (2017): BNNT

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2|R_{m,t}| + \gamma_3\left(|R_{m,t}| - \overline{R_m}\right)^2 + \gamma_4 D_{k,t} + \gamma_5 D_{k,t} CSAD_{m,t-1} + \gamma_6 D_{k,t}|R_{m,t}| + \gamma_7 D_{k,t}\left(|R_{m,t}| - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$$

where $CSAD_{m,t} = \frac{1}{N}\sum_{i=1}^{N}|R_{i,t} - R_{m,t}|$. $CSAD$ is a cross-sectional absolute deviation of returns. N is the number of stock in a particular stock market. R is a stock market return. θ_C and τ_{year} are country and year fixed effects, respectively. $D_{k,t}$ is a dummy variable, being one on a negative market return date for country m ($D_{m,d,t}$) or on over the global financial crisis period of March 1, 2008 to March 31, 2009 ($D_{c,t}$). $|\ \ |$and $\overline{\ \ }$ denote symbols of absolute value and average value, respectively. m and t index country and day, respectively. Robust *t*-statistics are shown in parentheses. $Adj.R^2$ is adjusted R-squared value.

Panel A: Full sample

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.2331***	1.2328***	0.8312***	0.8311***
	(15.87)	(15.87)	(10.30)	(10.30)
$CSAD_{m,t-1}$			0.2912***	0.2912***
			(5.51)	(5.51)
$\lvert R_{m,t}\rvert$	0.7605***	0.7613***	0.6348***	0.6348***
	(11.14)	(11.16)	(8.47)	(8.47)
$R_{m,t}^2$	0.0022**			
	(2.46)			
$(R_{m,t} - \overline{R_m})^2$		0.0022**	0.0021*	
		(2.50)	(1.83)	
$(\lvert R_{m,t}\rvert - \overline{R_m})^2$				0.0021*
				(1.83)
$D_{m,d,t}$	-0.1230***	-0.1227***	-0.0593	-0.0589
	(-2.93)	(-2.91)	(-1.45)	(-1.44)
$D_{m,d,t}CSAD_{m,t-1}$			-0.0404	-0.0405
			(-1.28)	(-1.28)
$D_{m,d,t}\lvert R_{m,t}\rvert$	0.0966*	0.0960*	0.1426**	0.1422**
	(1.88)	(1.86)	(2.32)	(2.32)
$D_{m,d,t}R_{m,t}^2$	-0.0030***			
	(-3.46)			
$D_{m,d,t}(R_{m,t} - \overline{R_m})^2$		-0.0030***	-0.0028**	
		(-3.53)	(-2.50)	
$D_{m,d,t}(\lvert R_{m,t}\rvert - \overline{R_m})^2$				-0.0028**
				(-2.50)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.4953	0.4953	0.5613	0.5613

Panel B: Developed markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.4431***	1.4436***	0.6488***	0.6488***
	(14.92)	(14.92)	(4.65)	(4.65)
$CSAD_{m,t-1}$			0.5231***	0.5231***
			(5.00)	(5.00)
$\lvert R_{m,t}\rvert$	0.5510***	0.5495***	0.3393***	0.3393***
	(6.96)	(6.89)	(3.85)	(3.85)
$R_{m,t}^2$	0.0377***			
	(5.41)			
$\left(R_{m,t}-\overline{R_m}\right)^2$		0.0379***	0.0436***	
		(5.49)	(6.41)	
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				0.0436***
				(6.41)
$D_{m,d,t}$	-0.0242	-0.0250	-0.0680***	-0.0677***
	(-1.07)	(-1.11)	(-3.18)	(-3.17)
$D_{m,d,t}CSAD_{m,t-1}$			0.0057	0.0057
			(0.53)	(0.52)
$D_{m,d,t}\lvert R_{m,t}\rvert$	0.0349	0.0369	0.1108***	0.1103***
	(0.93)	(0.98)	(4.31)	(4.30)
$D_{m,d,t}R_{m,t}^2$	-0.0290***			
	(-3.20)			
$D_{m,d,t}\left(R_{m,t}-\overline{R_m}\right)^2$		-0.0293***	-0.0336***	
		(-3.23)	(-6.16)	
$D_{m,d,t}\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				-0.0336***
				(-6.12)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.3575	0.3576	0.5962	0.5962

Panel C: Developing markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.1325***	1.1319***	0.8597***	0.8596***
	(10.75)	(10.76)	(8.86)	(8.86)
$CSAD_{m,t-1}$			0.2062***	0.2062***
			(4.96)	(4.96)
$\lvert R_{m,t}\rvert$	0.7835***	0.7847***	0.6964***	0.6964***
	(9.70)	(9.75)	(8.12)	(8.12)
$R_{m,t}^2$	0.0018*			
	(1.89)			
$\left(R_{m,t}-\overline{R_m}\right)^2$		0.0018*	0.0017*	
		(1.91)	(1.66)	
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				0.0017*
				(1.66)
$D_{m,d,t}$	-0.1820***	-0.1813***	-0.1061**	-0.1055**
	(-3.28)	(-3.27)	(-2.19)	(-2.18)
$D_{m,d,t}CSAD_{m,t-1}$			-0.0481	-0.0482
			(-1.54)	(-1.54)
$D_{m,d,t}\lvert R_{m,t}\rvert$	0.1435**	0.1426**	0.1815**	0.1808**
	(2.23)	(2.22)	(2.50)	(2.50)
$D_{m,d,t}R_{m,t}^2$	-0.0027***			
	(-2.89)			
$D_{m,d,t}\left(R_{m,t}-\overline{R_m}\right)^2$		-0.0027***	-0.0025**	
		(-2.93)	(-2.52)	
$D_{m,d,t}\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				-0.0025**
				(-2.51)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.5627	0.5627	0.5912	0.5912

Table 6: Herd behavior during financial crisis Panel regression with fixed effect estimation

Panels A, B, and C present estimated coefficients of panel regression with fixed effect estimation for the full sample, developed countries, and developing countries, respectively. The herd detection models are

Chang et al. (2000): CCK

$$CSAD_{m,t} = \alpha + \gamma_1|R_{m,t}| + \gamma_2 R_{m,t}^2 + \gamma_3 D_{k,t} + \gamma_4 D_{k,t}|R_{m,t}| + \gamma_5 D_{k,t} R_{m,t}^2 + \theta_C + \tau_{year} + \varepsilon_t$$

Yao et al. (2014): YMH1

$$CSAD_{m,t} = \alpha + \gamma_1|R_{m,t}| + \gamma_2\left(R_{m,t} - \overline{R_m}\right)^2 + \gamma_3 D_{k,t} + \gamma_4 D_{k,t}|R_{m,t}| + \gamma_5 D_{k,t}\left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$$

Yao et al. (2014): YMH2

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2|R_{m,t}| + \gamma_3\left(R_{m,t} - \overline{R_m}\right)^2 + \gamma_4 D_{k,t} + \gamma_5 D_{k,t} CSAD_{m,t-1} + \gamma_6 D_{k,t}|R_{m,t}| + \gamma_7 D_{k,t}\left(R_{m,t} - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$$

Bui et a. (2017): BNNT

$$CSAD_{m,t} = \alpha + \gamma_1 CSAD_{m,t-1} + \gamma_2|R_{m,t}| + \gamma_3\left(|R_{m,t}| - \overline{R_m}\right)^2 + \gamma_4 D_{k,t} + \gamma_5 D_{k,t} CSAD_{m,t-1} + \gamma_6 D_{k,t}|R_{m,t}| + \gamma_7 D_{k,t}\left(|R_{m,t}| - \overline{R_m}\right)^2 + \theta_C + \tau_{year} + \varepsilon_t$$

where $CSAD_{m,t} = \frac{1}{N}\sum_{i=1}^{N}|R_{i,t} - R_{m,t}|$. $CSAD$ is a cross-sectional absolute deviation of returns. N is the number of stock in a particular stock market. R is a stock market return. θ_C and τ_{year} are country and year fixed effects, respectively. $D_{k,t}$ is a dummy variable, being one over the global financial crisis period of March 1, 2008 to March 31, 2009 ($D_{c,t}$). $|\quad|$and $\overline{}$ denote symbols of absolute value and average value, respectively. m and t index country and day, respectively. Robust *t*-statistics are shown in parentheses. $Adj. R^2$ is adjusted R-squared value.

Panel A: Full sample

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.1531***	1.1531***	0.7963***	0.7964***
	(14.16)	(14.16)	(10.98)	(10.98)
$CSAD_{m,t-1}$			0.2635***	0.2634***
			(5.03)	(5.03)
$\lvert R_{m,t}\rvert$	0.8534***	0.8534***	0.7478***	0.7476***
	(13.15)	(13.15)	(9.88)	(9.88)
$R_{m,t}^2$	-0.0008***			
	(-12.71)			
$\left(R_{m,t}-\overline{R_m}\right)^2$		-0.0008***	-0.0007***	
		(-12.71)	(-9.54)	
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				-0.0007***
				(-9.54)
$D_{c,t}$	0.5427***	0.5452***	-0.1422	-0.1480
	(5.48)	(5.54)	(-0.91)	(-0.96)
$D_{c,t}CSAD_{m,t-1}$			0.2469***	0.2471***
			(2.60)	(2.60)
$D_{c,t}\lvert R_{m,t}\rvert$	-0.2598***	-0.2629***	-0.3338***	-0.3275***
	(-2.80)	(-2.86)	(-2.90)	(-2.80)
$D_{c,t}R_{m,t}^2$	0.0085***			
	(6.00)			
$D_{c,t}\left(R_{m,t}-\overline{R_m}\right)^2$		0.0088***	0.0087***	
		(6.12)	(6.78)	
$D_{c,t}\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				0.0083***
				(6.59)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.4927	0.4927	0.5599	0.5599

Panel B: Developed markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.4233***	1.4233***	0.6164***	0.6165***
	(14.70)	(14.70)	(4.18)	(4.19)
$CSAD_{m,t-1}$			0.5182***	0.5181***
			(4.81)	(4.81)
$\lvert R_{m,t}\rvert$	0.5960***	0.5959***	0.4341***	0.4339***
	(6.97)	(6.97)	(4.91)	(4.90)
$R_{m,t}^2$	0.0153			
	(1.52)			
$\left(R_{m,t}-\overline{R_m}\right)^2$		0.0153	0.0181*	
		(1.52)	(1.92)	
$\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				0.0181*
				(1.92)
$D_{c,t}$	0.4255***	0.4250***	-0.3156**	-0.3140**
	(5.43)	(5.42)	(-2.05)	(-2.04)
$D_{c,t}CSAD_{m,t-1}$			0.1921**	0.1923**
			(2.27)	(2.27)
$D_{c,t}\lvert R_{m,t}\rvert$	0.0860	0.0868	-0.0591	-0.0620
	(1.11)	(1.12)	(-0.77)	(-0.81)
$D_{c,t}R_{m,t}^2$	-0.0317**			
	(-2.36)			
$D_{c,t}\left(R_{m,t}-\overline{R_m}\right)^2$		-0.0319**	-0.0235**	
		(-2.37)	(-2.39)	
$D_{c,t}\left(\lvert R_{m,t}\rvert-\overline{R_m}\right)^2$				-0.0229**
				(-2.33)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.3533	0.3533	0.5924	0.5924

Panel C: Developing markets

	CCK	YMH1	YMH2	BNNT
$Intercept$	1.0211***	1.0211***	0.7959***	0.7961***
	(9.51)	(9.51)	(8.94)	(8.94)
$CSAD_{m,t-1}$			0.1760***	0.1759***
			(4.40)	(4.40)
$\lvert R_{m,t}\rvert$	0.8973***	0.8973***	0.8282***	0.8279***
	(12.26)	(12.25)	(9.68)	(9.67)
$R_{m,t}^2$	-0.0008***			
	(-11.88)			
$\left(R_{m,t} - \overline{R_m}\right)^2$		-0.0008***	-0.0008***	
		(-11.88)	(-9.37)	
$\left(\lvert R_{m,t}\rvert - \overline{R_m}\right)^2$				-0.0008***
				(-9.37)
$D_{c,t}$	0.4574***	0.4611***	0.0560	0.0462
	(2.71)	(2.74)	(0.40)	(0.34)
$D_{c,t}CSAD_{m,t-1}$			0.1763	0.1771
			(1.62)	(1.63)
$D_{c,t}\lvert R_{m,t}\rvert$	-0.2931*	-0.2980*	-0.3396*	-0.3293*
	(-1.80)	(-1.84)	(-1.94)	(-1.86)
$D_{c,t}R_{m,t}^2$	0.0089***			
	(2.96)			
$D_{c,t}\left(R_{m,t} - \overline{R_m}\right)^2$		0.0093***	0.0088***	
		(3.02)	(3.54)	
$D_{c,t}\left(\lvert R_{m,t}\rvert - \overline{R_m}\right)^2$				0.0083***
				(3.35)
$Country\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Year\ Fixed\ Effect$	Yes	Yes	Yes	Yes
$Adj.R^2$	0.5599	0.5599	0.5881	0.5881