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ANALYSIS OF HERDING BEHAVIOR IN THE STOCK MARKET: A CASE STUDY OF THE ASEAN-5 AND THE US

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ABSTRACT

We construct a new dataset to examine herding behavior in the ASEAN-5 (Indonesia, Singapore, Malaysia, the Philippines and Thailand) and the US stock market. Our dataset consists of daily closing prices on the most liquid stock indices in the ASEAN-5 and the US stock market. Based on the Newey–West estimator, we show that the dominant global factor influencing herding behavior is the US federal funds rate, while the cross-market herding of the Singaporean stock market is the dominant regional factor that influence the other ASEAN stock markets. We find that herding behavior, caused by stock market index, spikes only occur in the Philippine stock market.

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I. INTRODUCTION

In the last few decades, predicting or explaining financial market fluctuations has been the focus of researchers, investors, and related agencies or authorities (Indars and Savin, 2017). To this end, two opposing views explain the mechanisms underlying financial market behavior. The first view is the so-called efficient market hypothesis, which contends that financial markets are efficient, if asset prices reflect all available information (Iyke, 2019, 2020a). The second view contends that there are behavioral biases of market participants, which make the efficient market hypothesis inappropriate in explaining the mechanism of asset price formation (see Chiang and Zheng, 2010). In other words, psychological factors of market participants tend to largely influence their investment decisions on financial markets and ultimately determine asset prices (see also, Baker and Wurgler, 2006; Iyke, 2020b).[1] Our study is in line with this second view, in that we construct a new dataset to examine herding behavior in the ASEAN-5 and the US stock market.

Amid increasing uncertainty, especially when extreme price movements occur, some market participants tend to imitate the collective actions of other market participants. These individual market participants ignore the private information they have, and their investment decisions tend to follow the collective actions taken by other market participants—this is the so-called herding behavior (Chiang and Zheng, 2010). Usually herding behavior occurs without a market leader (market leader) directing price movements in a certain direction, or it occurs naturally when the market is under pressure (market stress) (see Sharma *et al.*, 2015).

In recent years, emerging countries, especially the ASEAN countries, have become attractive investment destinations for global investors due to excess liquidity and the unconventional monetary policies in advanced economies (Finger and Murphy 2019; Balakrishnan *et al.* 2013). In addition, investment in emerging countries generally offers a greater return (yield) compared to investment in developed countries (Lakhan, 2018). Generally, capital flows into a country's financial market enter the country's capital (stock) market. Stock is an investment instrument that has been chosen by many investors because it is able to provide a competitive level of profit compared to investments in other financial market instruments (IDX, 2019). Most of the efforts devoted to understanding stock markets are attributable to the consensus that a vibrant stock market can spur economic activity (Ho and Iyke, 2017; Juhro et al., 2020). For example, Levine and Zervos (1996), Levine and Zervos (1998), Bencivenga *et al.* (1996), Bake and Javanovic (1993), Rousseau and Wachtel (2000), Henry (2003), and Juhro et al. (2020) show that the stock market fosters a country's economic growth. Juhro et al. (2020), in particular, demonstrate that the development of the Islamic stock market can foster R&D, innovation, and total productivity growth. In this sense, any shocks that occur in the stock market can pose potential risks to a country's economic stability. During the subprime mortgage crisis of 2008/2009, the ASEAN-5 and the US stock indexes declined by 45-60 percent, and this posed significant challenges to their economic progress (Reinhart and Rogoff, 2009).

[1] Such factors induce human-related errors that create inefficiencies in the financial markets (Iyke, 2019).

Against this background, we examine the herding behavior in the stock markets of the ASEAN-5 countries and the US. This issue is interesting and important because understanding the herding behavior in these stock markets allows policymakers to mitigate the potential risks associated with this behavior, thereby ensuring financial market and economic stability. We construct a new dataset that consists of daily closing prices on the most liquid stock indexes in the ASEAN-5 and the US stock market. In our preliminary analysis, which is based on a sample period of January 4th 2000 – December 28th 2018, evidence suggests that the Indonesian stock market recorded the highest average daily returns during the study period of 0.209 percent, and is followed by Thailand (0.127 percent), the Philippines (0.088 percent), Malaysia (0.055 percent), Singapore (0.047 percent), and the US (0.003 percent). The standard deviations are consistent with the returns, which confirm the well-known finance theory that returns reflect risks that must be borne. Aside this, the highest correlation is found between the Singapore stock index and the other stock indices. This indicates that Singapore is a financial market hub in the ASEAN region. These results also reinforce the idea that market sentiments originating from the Singaporean financial market have more impact on ASEAN financial markets than market sentiments originating from the US financial market.

Our main results, which are based on the Newey–West estimator, suggest that herding behavior is present in the ASEAN-5 and the US stock market. Herding behavior in these markets are driven by different factors. Among the six stock markets, the factors tend to largely influence the the Indonesian and the Singaporean stock markets. The dominant global factor determining herding behavior is the US federal funds rate. This factor is found to largely drive the Indonesian, Singaporean, Thailand, and the Philippine stock markets. The dominant regional factor influencing herding behavior is the cross-market herding of the Singaporean stock market—it is found to influence all but the Thailand stock market. Additionally, we find that dummy market up influences herding behavior only in the Philippine stock market, while dummy market down influences herding only in the Malaysian stock market.

Empirical investigations of herding behavior in financial markets are divided four strands. The first strand focuses on the cross-sectional correlation dispersion in stock returns in response to excessive changes in market conditions. The earlier study conducted by Christie and Huang (1995) examines the investment behavior of market participants in the US equity market. Christie and Huang (1995) developed a test of herding behavior by utilizing the cross-sectional standard deviation of returns (CSSD) as a measure of the average proximity of individual asset returns to the realized market average. Chang *et al*. (2000) examine herding behavior using equity returns. They used a non-linear regression specification to examine the relation between the level of equity return dispersions (as measured by the cross-sectional absolute deviation of returns, i.e., CSAD), and the overall market return. Subsequent studies, such as Chiang and Zheng (2010), Indars and Savin (2017), and Economou *et al.* (2018), examine herding behavior using the cross-sectional dispersion approach based on the seminal work of Christie and Huang (1995) and Chang *et al.* (2000).

The second strand of literature focuses on cross market herding and herding that can be attributed to other market dynamics due to their implications for international diversification, contagion, and market destabilization (Economou *et al.*, 2018). These studies include, *inter alia*, Chiang and Zheng (2010), Economou, Kostakis, and Philippas (2011), Chiang *et al.* (2013), Balcilar, Demirer, and Hammoudeh (2013), Mobarek *et al.* (2014), and Economou *et al.* (2015) and find that herding behavior exists across stock markets.

The third strand of literature examines whether a relationship exists between herding behavior and market volatility. For instance, Forbes and Rigobon (2002) find that financial markets are somehow interdependent during high volatility periods. The CBOE volatility index (VIX) was introduced in 1993 and expresses the expected future market volatility over the next 30 calendar days, based on the S&P500 options (Economou *et al.*, 2018). A number of studies employ this index (VIX) to test the impact of the US investor sentiment on the US (Philippas *et al.* 2013) or other international stock markets (Chiang *et al.* 2013; Economou *et al.* 2015).

The fourth strand of literature tests the sensitivity of herding behavior estimates to different market states relative to market performance and volume. For instance, Chang *et al.* (2000), Demirer *et al.* (2010), Chiang and Zheng (2010), Chen (2013), Philippas *et al.* (2013), and Mobarek *et al.* (2014) find that herding behavior is expected to be more pronounced during down-market periods. There is also evidence of significant asymmetric herding behaviour during up-market periods (Tan *et al.* 2008; Economou, Kostakis, and Philippas 2011; Economou *et al.* 2015).

Our paper contributes to the herding behavior literature by documenting evidence of herding behavior in the ASEAN-5 and the US stock market. Our study differs from previous research in the following ways. We used a larger dataset in order to test herding behavior. Our data is daily and covers equity returns at the firm level. Specifically, we extract the most liquid stocks to construct the most liquid stock index for each country in our sample. Our study is also the first to analyze herding behavior in the ASEAN-5 and the US stock market. It is also the first to consider the influence of global, regional, and domestic factors influencing the formation of herding behavior in stock markets.

The rest of the article is structured as follows. Section II presents the conceptual framework and develops our hypotheses. Section III presents the data and the methodology employed to examine herding behavior. Section IV reports and discusses the empirical results, while Section V concludes the study.

II. CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

In this section we present the conceptual framework regarding herding behavior, which allows us to develop our hypothesis. The classical asset pricing theory states that the return of an asset is influenced by changes in economic fundamentals in a rational framework (Ryu *et al.*, 2016; Iyke and Ho, 2020). However, some recent behavioral finance research found empirical evidence that the sentiments and trading behavior of market participants in financial markets significantly influences asset returns (Baker *et al.*, 2012; Brown and Cliff, 2004; Greenwood and

Shleifer 2014; Kim *et al.*, 2014; Iyke, 2020b). Several previous studies found that trading behaviors, such as abnormal trading behavior and crowded trading, affect variations in cross-sectional stock returns (Kelley and Tetlock, 2013; Yao *et al.*, 2014). One of the common trading behaviors is herding behavior.

Herding behavior is defined as the tendency of investors to imitate the actions of other investors, especially when uncertainties in the market increase (Gleason *et al.*, 2004). Bikhchandani *et al.* (1992), Welch (2000), and Hirshleifer and Teoh (2003) argued that herding behavior refers to correlated trading originating from a behavior that mimics the actions of other parties. Indars and Savin (2017) argued that herding behavior can be observed when a group of investors conduct trading transactions in the same direction over a certain period. Herding behavior becomes increasingly important when large investors (institutional investors) dominate the market. This is because the performance of institutional investors is evaluated based performance of other institutional investors (Chang *et al.*, 2000). In addition, institutional investors base their decisions on the transaction decisions made by professional market participants (Shiller and Pound, 1989). Some empirical research found weak evidence of herding behavior by institutional investors in stocks with low capitalization and no evidence of herding behavior in stocks with large capitalization (Lakonishok, *et al.*, 1992).

Herding behavior is expected to occur more frequently in periods of market stress or extreme market conditions as indicated by increased uncertainty in the market and significant market fluctuations (Economou *et al.*, 2018). Under market stress conditions, fear and panic could appear in the market, and as a result market participants—individual, institutional, and retail—tend to follow the market consensus (Christie and Huang, 1995). However, herding behavior is expected to occur more frequently in the down-market period (Chang *et al.*, 2000; Demirer *et al.*, 2010; Chiang and and Zheng, 2010; Chen, 2013; Philippas *et al.*, 2013; Mobarek *et al.*, 2014).

According to Bikchandani and Sharma (2000), herding behavior caused by asymmetric information occurs when investors operate in an environment with imperfect information. Under these conditions, investors try to summarize information based on the historical behavior of other investors. Choi (2016) found that the exchange of information between market participants triggered herding behavior both by individuals and institutions in the Korean stock market.

Graham (1999) found that an investment manager is likely to herd with other investment managers when the investment manager lacks knowledge and ability and has an interest in maintaining his/her reputation. Casavecchia (2016) also found evidence of herding behavior based on the importance of maintaining reputation in a sample of mutual funds in the US. Meanwhile, Gümbel (2005) and Hedesström *et al.* (2015) found that herding behavior is driven by compensation. Gumbel (2005) found that investment managers tend to invest in assets that have a large return in order to obtain greater compensation.

Economou *et al.* (2018) found that herding behavior in emerging markets usually occurs because of the behavior of market participants regarding opportunities for higher profits, and this usually does not occur in large countries whose stock markets are sufficiently deep. Furthermore, asymmetric information, lack of transparency and information disclosure, low trading volumes, inadequate

regulatory frameworks can encourage herding behavior in the context of emerging market (Kallinterakis and Kratunova 2007).

Based on the evidence of herding behavior in international stock markets, as documented by prior studies, we hypothesize that herding behavior exists in the ASEAN-5 and the US stock market. We also hypothesize that global, regional, and domestic factors drive herding behavior in these stock markets. To test the hypotheses, we use the CSAD model proposed by Chang and Zheng (2000) and the Newey–West estimator.

III. DATA AND METHODOLOGY

A. Data

We construct a new dataset to examine herding behavior. Our data are daily and cover equity returns at the firm level. Specifically, we extract the most liquid stocks to construct the most liquid stock index for each country in our sample from January 4, 2000 to December 28, 2018. For each stock market, there are groups of leading stocks and we used them as a benchmark for measuring the overall performance of shares in each country.

In addition, these leading stocks contribute largely to the dynamic changes in the representative country stock price indices, namely the LQ45 index of the Indonesian market, the FTSE Kuala Lumpur Composite Index of Malaysia, the Strait Times Index of Singapore, the Stock Exchange of Thailand (50 Index), the Philippines Stock Exchange Index, and the Dow Jones Index Average of the US stock market. By using the index data of the leading stocks in each country, we eliminate the bias or spurious estimates resulting from stocks that only contribute largely to the overall index occasionally but are not always responsive to the dynamic changes in the financial markets as a whole.

Apart from these stock index, we collect data on the factors that influence herding behavior, including the VIX index, the Asian Dollar Index (ADXY), the benchmark interest rates of each ASEAN-5 and the US, and world oil prices. Table in the appendix contains the descriptions and sources of our data.

B. Methodology

B1. Measuring herding behavior

Based on the conditional capital asset pricing model introduced by Black (1972), the relationship between CSAD and market returns can be formulated as follows:

$$E_t(R_i) = \gamma_0 + \beta_i E_t(R_m - \gamma_0) \tag{1}$$

where R_i denotes the return on an asset i , R_m denotes the return on the market portfolio, $E_t(\cdot)$ denotes the expectation in period t, γ_0 is the zero-beta portfolio, β_i is the time-invariant systematic risk measure of the security, $i = 1,...,N$, and β_m is the systematic risk of an equally-weighted market portfolio, which can be formulated as:

$$\beta_m = \frac{1}{N}\sum_{i=1}^{N}\beta_i \tag{2}$$

The absolute value of deviation (AVD) of the expected return of a security *i* is:

$$AVD_{i,t} = |\beta_i - \beta_m|E_t(R_m - \gamma_0) \tag{3}$$

Therefore, the expected CSAD of stock returns during period -*t* is:

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

The linear and increasing function relationships between dispersion and time-varying market expected return are described as:

$$\frac{\partial\, ECSAD}{\partial E_t(R_m)} = \frac{1}{N}\sum_{i=1}^{N}|\beta_i - \beta_m| > 0 \tag{5}$$

$$\frac{\partial^2\, ECSAD}{\partial E_t(R_m)^2} = 0 \tag{6}$$

$CSAD_t$ and $R_{m,t}$ are used as proxies of the unobservable $ECSAD_t$ and E_t ($R_{m,t}$). To measure the presence or absence of herding behavior, we advise against looking at it from the perspective of the value $CSAD_t$, but rather from the relationship between $CSAD_t$ and $R_{m,t}$.

Following Chang *et al.* (2000), we can measure herding behavior using the formula:

$$CSAD_t = \frac{\sum_{i=1}^{N}|R_{i,t} - R_{m,t}|}{N} \tag{7}$$

where $CSAD_t$ is a measure of return dispersion, $R_{i,t}$ is the equity *i*'s percentage log differenced return on day *t*, $R_{m,t}$ is the market's return on day *t* that is calculated as the equally weighted average return of the individual equities on day *t*, and finally *N* is the number of all listed equities in the market under examination on day *t*.

Market stress can be determined using the standard deviation from average market return. Let μ be the average market return. Then observations outside the average market return ± 2 times the standard deviation are categorized as the upper/lower extreme tail observations. Mathematically, this can be written as follows:

$$Upper\ Band = \mu + 2 * Standard\ Deviation \quad (8)$$

Dummy market up = 1, if return > upper band, 0 otherwise.

$$Lower\ Band = \mu - 2 * Standard\ Deviation \quad (9)$$

Dummy market down = 1, if return < lower band, 0 otherwise.

B2. Effect of Global Factors on Herding Behavior

To examine the impact of global factors on herding behavior, we estimate the following regression:

$$CSAD_{m,t} = \alpha_0 + \alpha_1|R_{m,t}| + \alpha_2 R_{m,t}^2 + \alpha_3 OILPRICE_t + \alpha_4 VIX_t + \alpha_5 FFR_t + \varepsilon_t \quad (10)$$

where $CSAD_{m,t}$ is the cross-sectional absolute deviation of returns on the m market at the t-time which measures the distance between the returns obtained by the issuer individually and the overall market return; $R_{m,t}$ is the market return at the t-time obtained from the equally weighted average of individual issuer's returns; $OILPRICE_t$ is the price of West Texas Intermediate crude oil at the t-time; VIX_t is Chicago Board of Exchange volatility index at the t-time; and FFR_t is US monetary policy interest rates.

B3. Effect of Regional Factor on Herding Behavior

To examine the impact of regional factors on herding behavior, we estimate the following regression:

$$CSAD_{m,t} = \alpha_0 + \alpha_1|R_{m,t}| + \alpha_2 R_{m,t}^2 + \alpha_3 CSAD_{k,t} + \alpha_4 R_{k,t}^2 + \alpha_5 ADXY_t + \varepsilon_t \quad (11)$$

where $CSAD_{k,t}$ is cross sectional absolute deviation of returns on the market k at the t-time; $R_{k,t}$ is market return k at the t-time is obtained from the equally weighted average of individual issuer returns, this variable shows the cross-market herding from market k to market m; and $ADXY_t$ is the ASIAN Dollar Index at the t-time.

B4. Effect of Domestic Factor on Herding Behavior

To examine the impact of domestic factors on herding behavior, we estimate the following regression:

$$CSAD_{m,t} = \alpha_0 + \alpha_1|R_{m,t}| + \alpha_2 R_{m,t}^2 + \alpha_3 D^{UP}|R_{m,t}| + \alpha_4 D^{UP} R_{m,t}^2 + \alpha_5 D^{LOW}|R_{m,t}| + \alpha_6 D^{LOW} R_{m,t}^2 + \varepsilon_t \quad (12)$$

where $D^{UP}|R_{m,t}|$ is the interaction between dummy market up variable and absolute market return variable; $D^{UP}R_{m,t}^2$ is the interaction between dummy market up variable and quadratic variable of market return; and $D^{LOW}|R_{m,t}|$ is the interaction between dummy market low variable with absolute market return variable.

IV. MAIN FINDINGS

A. Descriptive Statistical Analysis

Table 1 shows that the Indonesian stock index recorded the highest average daily returns (i.e. 0.209 percent) over the sample period, followed by Thailand (0.127 percent), the Philippines (0.088 percent), Malaysia (0.055 percent), Singapore (0.047 percent), and the US (0.003 percent). Aside from having the highest average return, the Indonesian stock index also has the highest standard deviation returns (i.e. 1.039 percent), followed by the Philippines (1.027 percent), Thailand 0.980 percent), the US (0.820 percent), Singapore (0.819 percent), and Malaysia (0.648 percent). These results confirm the well-known stylized fact in finance theory that returns reflect the risks that must be borne (Lakhan, 2018).

Table 1.
Descriptive Statistics of the Daily Returns of the ASEAN-5 and the US Stock Index

This table reports descriptive statistics on daily, equally weighted cross-sectional absolute deviations ($CSAD_t$) for six stock markets, namely Indonesia (LQ45), Malaysia (FTSE KLCI), Singapore (STI), the Philippines (PSEi), Thailand (SET50), and the US (DJIA). The starting date for all stock markets is January 4th 2000 and the end date is December 28th 2018. The stock return dispersion is defined as:

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

	RM_DJIA	RM_FTSE	RM_LQ45	RM_PSEI	RM_SET50	RM_STI
Mean	0.003	0.0548	0.208	0.088	0.127	0.047
Median	0.008	0.0204	0.136	0.015	0.059	0.024
Maximum	5.286	6.904	9.353	12.789	16.878	15.545
Minimum	-27.024	-7.82	-7.894	-11.721	-8.855	-9.491
Std. Dev.	0.820	0.649	1.040	1.027	0.980	0.819
Skewness	-7.36	-0.357	0.034	0.829	0.973	1.504
Kurtosis	244.291	24.220	8.890	20.288	27.011	43.074
Jarque-Bera	12043105.000	92901.02	7148.615	62157.22	119589.6	332825.1
Probability	0.000	0.000	0.000	0.000	0.000	0.000

Table 2 displays the descriptive statistics regarding the CSAD of the ASEAN-5 and the US stock index. Three stock indexes with the highest CSAD average are stock indexes in the emerging markets, namely the Indonesian stock index (0.708 percent), the Philippines (0.639 percent), and Thailand (0.629 percent). Meanwhile, the US and Singapore, which have more advanced stock markets recorded a quite low CSAD average (i.e. the value is below 0.50 percent). The lowest CSAD average is recorded by the Malaysian stock index (i.e. 0.375 percent).

Table 2.
Descriptive Statistics of the Cross-Sectional Absolute Deviation of the ASEAN-5 and the US Stock Index

This table lists descriptive statistics of daily, equally weighted cross-sectional absolute deviations ($CSAD_t$) for six stock markets, including Indonesia (LQ45), Malaysia (FTSE KLCI), Singapore (STI), Philippines (PSEi), Thailand (SET50), and US (DJIA). The starting date for all stock markets is January 2000 – December 2018. stock return dispersion is defined as:

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

	CSAD_ DJIA	CSAD_ FTSE	CSAD_ LQ45	CSAD_ PSEI	CSAD_ SET50	CSAD_STI
Mean	0.469	0.375	0.708	0.639	0.629	0.484
Median	0.296	0.231	0.502	0.436	0.438	0.320
Maximum	26.092	7.465	9.101	12.207	16.333	14.873
Minimum	0.000	0.000	0.000	0.000	0.000	0.000
Std. Dev.	0.639	0.500	0.745	0.756	0.725	0.624
Skewness	14.534	4.607	2.542	4.201	4.600	6.086
Kurtosis	530.408	40.635	14.695	39.948	60.161	85.880
Jarque-Bera	57497382	309392.4	33514.54	295880.7	690796.9	1446133.
Probability	0.000	0.000	0.000	0.000	0.000	0.000

The low CSAD occurs because returns from individual assets do not stray too far from the overall market return. This happens when individual investors disregard the trust and information they have, and their investment decisions are based solely on market behavior. This shows herding behavior. Based on the literature, low CSAD indicates a tendency for herding in the market by investors, and vice versa. Based on CSAD estimates, the possibility of herding is greater in developed countries when compared to developing countries.

Table 3.
Pearson Correlation of the Daily Returns of the ASEAN-5 and the US Stock Index

Pearson's correlation coefficient is the test statistics that measures the statistical relationship, or association, between two continuous variables. If the value is near ± 1, then it said to be a perfect correlation: as one variable increases, the other variable tends to also increase (if positive) or decrease (if negative), and vice versa if the value is near 0, then it said to be no correlation.

	RM_DJIA	RM_FTSE	RM_LQ45	RM_PSEI	RM_SET50	RM_STI
RM_DJIA	**1.000**					
RM_FTSE	0.042	**1.000**				
RM_LQ45	0.040	0.221	**1.000**			
RM_PSEI	0.025	0.186	0.198	**1.000**		
RM_SET50	0.087	0.212	0.210	0.188	**1.000**	
RM_STI	0.098	0.277	0.305	0.201	0.234	**1.000**

Table 3 shows Pearson correlation coefficients between each of the returns. Pearson correlation analysis is commonly used to establish the short-term relationship between stock indices in the literature. Compared to other stock

indices, the correlation between the Singaporean stock index and the other stock indices is the highest, ranging between 0.098 and 0.303. Conversely, the correlation between the US stock index and the other five stock indices is the lowest, ranging between 0.025 and 0.098. The highest correlation (0.305) is between the Singaporean stock index and the Indonesian stock index. Meanwhile, the Philippine and the US stock index showed the lowest correlation (i.e. 0.025). This suggests that Singapore is a financial hub in the ASEAN region. In addition, these results reinforce the notion that for the ASEAN countries, sentiments emanating from the Singaporean financial market are more impactful than those emanating from the US financial market (see citation).

Table 4.
Pearson Correlation of the Cross-Sectional Absolute Deviation of the ASEAN-5 and the US Stock Index

Pearson's correlation coefficient is the test statistics that measures the statistical relationship, or association, between two continuous variables. If the value is near ± 1, then it said to be a perfect correlation: as one variable increases, the other variable tends to also increase (if positive) or decrease (if negative), and vice versa if the value is near 0, then it said to be no correlation.

	CSAD_ DJIA	CSAD_ FTSE	CSAD_ LQ45	CSAD_ PSEI	CSAD_ SET50	CSAD_STI
CSAD_DJIA	**1.000**					
CSAD_FTSE	0.126	**1.000**				
CSAD_LQ45	0.085	0.169	**1.000**			
CSAD_PSEI	0.067	0.130	0.137	**1.000**		
CSAD_SET50	0.087	0.151	0.118	0.117	**1.000**	
CSAD_STI	0.131	0.221	0.187	0.143	0.135	**1.000**

B. Results based on the Newey–West Estimator

We analysed herding behavior in the ASEAN-5 and the US stock market using the Newey–West estimator. An obstacle to analyzing herding behavior in stock markets across countries is incomplete observations, which is caused by differences in national holidays. To overcome this obstacle, we follow Jeon and Von Furstenberg (1990) and Hirayama and Tsutsui (1998) and adopt the Occam's Razor method. That is, we fill in the missing holiday observation with the preceding day's observation. We then apply the Newey–West estimator to this data and find the following.

B1. The Impact of Global Factors on Herding Behavior in the ASEAN-5 Stock Market

Table 5 shows the results regarding the impact of global factors on herding behavior in the ASEAN-5 stock market. We use world oil prices (*OIL_PRICE*), the US federal funds rate (FFR), and the VIX as proxies for global sentiments because these three variables are often used as indicators that influence the dynamics of global financial markets in the literature (see e.g.Jouini, 2013; Alotaibi and Mishra, 2015; Basher *et al.*, 2012).

The influence of the FFR on herding behavior is significant in the stock indices of Indonesia, the Philippines, Thailand, and Singapore. In his study, Kim (2009) showed that the FFR, in addition to impacting the financial markets of the US, has a spillover effect on the stock markets in the Asia Pacific region. According to Wongswan (2009), the spillover effect of the FFR can occur first because any changes in the FFR contain information about the future economic activities that can affect firms' cash flows. Second, changes in the FFR encourage changes in international interest rates that can affect changes in equity prices in other countries. The US monetary policy influences equity prices in other countries. This influence is transmitted through the financial links of the US with other countries. The US monetary policy affects the discount rate component of other countries' equity prices. This means that the US monetary policy might be a risk factor for global equity markets (Wongswan, 2009).

We find that the effect of the FFR on herding behavior in the Malaysian stock market is insignificant. The variable is significant and did not encourage herding on the US stock market. According to Wongswan (2009), countries that apply capital controls, such as Malaysia, tend not to be affected by changes in monetary policy in other countries, and this happens because with controls on capital outflows, financial linkages with other countries will automatically be limited.

Furthermore, the results suggest that the *OIL_PRICE* has a significant effect on all the stock indices but suggest no indication of herding behavior because the coefficient on *OIL_PRICE* is positive. Several previous studies have shown the significance of *OIL_PRICE* in international stock markets (see Narayan and Sharma, 2011; Huang and Zhang, 2020; Prabheesh et al. 2020; Liu et al. 2020). Changes in oil prices influence firms' current and future cash flows and subsequently affect stock returns on the international market (Jones and Kaul, 1996; Park and Ratti, 2008).

The transmission mechanism of world oil prices to the economy varies, both through the supply effect, demand effect, and term of trade channels (Iwayemi & Fowowe, 2011). Similarly, Basher and Sadorsky (2006) have shown that firms' cash flow can be influenced by world oil prices either through the supply side (i.e. increasing oil prices can increase production costs) or through demand side (i.e. increasing oil prices can reduce purchasing power parity consumers and can subsequently lead to a reduction in demand). Bhar and Nikolova (2009) showed that a country's stock market's response to oil prices depends on whether the country is a net importer or net exporter of oil. Countries that are classified as net exporters will respond positively, whereas countries classified as net importers will respond negatively to oil prices.

Previous research (Hamilton, 1983; Kilian, 2009) shows that shocks to oil supply have a significant effect on global economic activity. However, as Kilian (2009) points out, transmission of changes in oil prices to firms' cash flow and, subsequently, the economy requires time lag. While herding is a short-term phenomenon, the effect of world oil prices on herding behavior cannot be proven. According to Wang *et al.* (2013), although shocks to oil supply affect the global economy almost immediately, it takes more than one month for the global economy to respond to other oil-specific shocks.

The VIX index, which is a barometer of changes in sentiment in the financial markets, has a significant influence on the stock indices of the US, Malaysia, the

Philippines, and Singapore, but there is no indication of herding behavior because the VIX coefficient is positive. We find that an increase in VIX is associated with an increase in the cross-sectional absolute deviation of returns, meaning that the response of each investor tends to vary when the VIX index increases. Changes in VIX will affect investors' risk appetite for the stock market. An increase in VIX usually occurs during a financial crisis, when investors overreact and therefore sell their financial assets to limit losses (Giot, 2003). Large volatility is usually an interesting signal for long-term investors to enter or invest. We find that VIX has no significant effect on on the Indonesian and Thailand stock indices. Consequently, other factors are more influential on herding behavior in both markets.

Table 5.
Estimates of Herding Behavior Incorporating Global Factors

This table reports estimates of herding behavior incorporating global factors. The parentheses denote the *p*-value. Finally, *, ** and *** denote statistical significance at the 10%, 5% and 1%, respectively.

Independent Variables	Dependent Variable: CSAD					
	$CSAD_{DJIA}$	$CSAD_{FTSE}$	$CSAD_{LQ45}$	$CSAD_{PSEi}$	$CSAD_{SET50}$	$CSAD_{STI}$
$\lvert R_{m,t}\rvert$	0.964000	0.954332	0.964426	0.956851	0.969153	0.960866
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$R^2_{m,t}$	5.60E-05	0.000798	0.000627	-9.54E-05	-1.51E-05	-0.000202
	(0.0000)	(0.0482)	(0.1373)	(0.6208)	(0.8648)	(0.0143)
FFR	0.000214	-4.16E-05	**-0.001389**	**-0.000175**	**-0.000553**	**-0.000161**
	(0.0000)	(0.5179)	**(0.0000)*** **	**(0.0344)** **	**(0.0000)*** **	**(0.0577)***
OIL_PRICE	5.08E-06	7.80E-06	8.48E-05	5.20E-05	2.60E-05	3.69E-05
	(0.0680)	(0.0172)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
VIX	7.78E-05	5.60E-05	-1.09E-05	9.29E-05	-1.01E-05	8.81E-05
	(0.0000)	(0.0000)	(0.7847)	(0.0000)	(0.5226)	(0.0000)

B2. Impact of Regional Sentiment on Herding Behavior in the ASEAN-5 Stock Market
We examine the impact of regional sentiments, measured in terms of the Asian Dollar Index (ADXY), on herding behavior and cross-market herding between stock markets in ASEAN-5 countries. The ADXY index is a benchmark index of several Asian currencies and is commonly used by market participants as an indicator of the sentiments related to the movement of the US dollar against Asian currencies. The estimates are reported in Table 6. The results suggest that the ADXY index has a significant effect but did not encourage herding behavior in the ASEAN-5 stock markets. The ADXY index has no significant effect on the US stock market. In other words, fluctuations in the US dollar against Asian currencies have no significant impact on the DJIA index.

Indars and Savin (2017) state that herding behavior can be driven by spillovers from the financial markets of other countries that encourage greater uncertainty in their markets. They find evidence of cross-market herding behavior in stock markets. We find mixed evidence regarding cross-market herding behavior in estimates. We find that when there is an extreme market returns on the US stock market, herding behavior occurs in the Malaysian and Singapore stock markets.

Similarly, when there is extreme market returns on the Malaysian stock market, we find herding behavior on the US stock market. We also find that the occurrence of extreme market returns on the Philippine stock market affects the formation of herding behavior on the Indonesian and Singaporean stock markets, but does not significantly influence the stock markets of the US, Malaysia, Thailand, and the Philippines itself. Meanwhile, the occurrence of extreme market returns on the Indonesian and Thailand stock markets has an insignificant impact on the other stock markets. Occurrence of extreme market returns on the Singaporean stock market encourages herding behavior in all the stock markets in our sample, except the Thailand stock market.

Based on these results, we can conclude that there is a mutual relationship between the US stock market and the Malaysian stock market, as well as between the Philippine stock market and the Singaporean stock market. Besides, there is a spillover effect from the Singaporean stock market to all stock markets, except the Thailand stock market. The Thailand stock market has no influence on the other stock markets.

Table 6.
Estimates of Herding Behavior Incorporating Regional Factors

This table reports estimates of herding behavior incorporating regional factors. The parentheses denote the *p*-value. Finally, *, ** and *** denote statistical significance at the 10%, 5% and 1%, respectively.

Independent Variables	Dependent Variable:					
	$CSAD_{DJIA}$	$CSAD_{FTSE}$	$CSAD_{LQ45}$	$CSAD_{PSEi}$	$CSAD_{SET50}$	$CSAD_{STI}$
$\lvert R_{m,t} \rvert$	0.964474	0.954086	0.964330	0.956937	0.969135	0.960848
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ADXY	1.93E-06	3.89E-05	0.000530	0.000233	0.000161	0.000165
	(0.8508)	(0.0053)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$CSAD_{DJIA}$		0.000420	-0.000717	0.000133	-0.000677	0.000162
		(0.0231)	(0.2047)	(0.6488)	(0.0208)**	(0.5788)
$CSAD_{FTSE}$	0.000420		-0.000426	1.07E-05	-0.000542	0.000923
	(0.0911)		(0.5032)	(0.9828)	(0.1949)	(0.0432)
$CSAD_{LQ45}$	0.000181	0.000545		0.000475	0.000151	0.000468
	(0.2915)	(0.0069)		(0.1579)	(0.5912)	(0.0729)
$CSAD_{PSEi}$	-0.000104	0.000168	0.000498		-0.000430	0.000663
	(0.5358)	(0.3177)	(0.1899)		(0.1256)	(0.0025)
$CSAD_{SET50}$	0.000150	-8.98E-05	1.60E-05	0.000237		0.000439
	(0.2809)	(0.5794)	(0.9670)	(0.3855)		(0.0519)
$CSAD_{STI}$	0.000608	0.000845	0.000743	0.001550	0.000448	
	(0.0019)	(0.0000)	(0.1116)	(0.0002)	(0.1637)	
$R^2_{m,t}$_DJIA	3.94E-05	**--2.11E 05**	1.55E-05	5.72E-05	1.55E-05	**-1.92E-05**
	(0.0000)	**(0.0016)*** **	(0.4317)	(0.0000)	(0.1303)	**(0.0646)** **
$R^2_{m,t}$_FTSE	**-8.27E-05**	0.000831	3.04E-05	-7.03E-05	-1.73E-05	-0.000127
	(0.0267) **	(0.0397)	(0.8204)	(0.3861)	(0.8068)	(0.1864)
$R^2_{m,t}$_LQ45	4.31E-05	-6.05E-05	0.000661	-1.18E-05	5.10E-05	-4.33E-05
	(0.4382)	(0.1157)	(0.1144)	(0.8943)	(0.4605)	(0.4797)

Table 6.
Estimates of Herding Behavior Incorporating Regional Factors (Continued)

Independent Variables	Dependent Variable:					
	$CSAD_{DJIA}$	$CSAD_{FTSE}$	$CSAD_{LQ45}$	$CSAD_{PSEi}$	$CSAD_{SET50}$	$CSAD_{STI}$
$R^2_{m,t}$_PSEi	4.69E-05	-3.07E-05	**-0.000118**	-9.93E-05	9.44E-05	**-8.13E-05**
	(0.1942)	(0.2455)	**(0.0081)*** **	(0.6071)	(0.1389)	**(0.0039)*** **
$R^2_{m,t}$_SET50	-1.25E-05	-1.56E-06	2.06E-05	-6.07E-06	-1.24E-05	-1.87E-05
	(0.2913)	(0.8913)	(0.5934)	(0.8384)	(0.8860)	(0.3375)
$R^2_{m,t}$_STI	**-3.55E-05**	**-7.29E-05**	**-6.75E-05**	**-0.000147**	-1.16E-05	**-0.000204**
	(0.0394)**	**(0.0009)*** **	**(0.0754)****	**(0.0000)*** **	(0.8541)	**(0.0110)****

B3. Impact of Domestic Sentiment on Herding Behavior in the ASEAN-5 Stock Market
Herding behavior, in addition to being caused by global and regional sentiments, can be caused by domestic sentiments/factors in the form of shocks to domestic macroeconomic variables. We considered changes in policy interest rates (POLICY_RATE) and extreme market return conditions as the domestic factors that can induce herding behavior. Table 7 reports the impact of domestic sentiments on herding behavior. We find that herding behavior driven by changes in policy rates is found to occur in the Indonesian and Thailand stock markets. Besides, changes in policy rates, measured in terms of interest rates, also influence herding behavior in the stock markets of the US, the Philippines, Singapore, and Malaysia.

Economou *et al.* (2018) state that herding behavior is expected to occur more frequently in periods of market stress or extreme market conditions, as indicated by increased uncertainty in the markets and significant market fluctuations. The results suggest that market stress, as indicated by a sharp decrease in market returns (market down), significantly affects herding behavior on the Malaysian stock market. Meanwhile, when market returns experience a sharp increase (market up), market stress only significantly affects herding on the Philippine stock market.

Table 7.
Estimates of Herding Behavior Incorporating Domestic Factors

This table reports estimates of herding behavior incorporating domestic factors. The parentheses denote the *p*-value. Finally, *, ** and *** denote statistical significance at the 10%, 5% and 1%, respectively.

Independent Variables	Dependent Variable: CSAD					
	$CSAD_{DJIA}$	$CSAD_{FTSE}$	$CSAD_{LQ45}$	$CSAD_{PSEi}$	$CSAD_{SET50}$	$CSAD_{STI}$
$\lvert R_{m,t} \rvert$	0.963970	0.955863	0.970921	0.955873	0.969728	0.960903
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$R^2_{m,t}$	5.55E-05	0.001213	0.000567	8.12E-05	-6.60E-05	-0.000247
	(0.0000)	(0.0000)	(0.0659)	(0.7297)	(0.3855)	(0.0000)
POLICY_RATE	0.000180	0.000451	**-0.000953**	0.001707	**-0.000215**	-0.000656
	(0.0000)	(0.0760)	**(0.0000)*** **	(0.0474)	**(0.0377)****	(0.0000)
$D_{LOW} \lvert R_{m,t} \rvert$	0.000438	0.002686	0.000104	-0.000997	-0.000305	-0.000586
	(0.1217)	(0.0045)	(0.9142)	(0.3379)	(0.6246)	(0.6971)

Table 7.
Estimates of Herding Behavior Incorporating Domestic Factors (Continued)

Independent Variables	Dependent Variable: CSAD					
	$CSAD_{DJIA}$	$CSAD_{FTSE}$	$CSAD_{LQ45}$	$CSAD_{PSEi}$	$CSAD_{SET50}$	$CSAD_{STI}$
$D^{LOW} R^2_{m,t}$	0.000252	**-0.001089**	-0.000332	0.001412	0.000254	0.000517
	(0.0022)	**(0.0144)****	(0.3817)	(0.0001)	(0.0160)	(0.5402)
$D^{UP} \lvert R_{m,t} \rvert$	0.000905	9.51E-05	-0.004348	0.003440	-0.001022	-0.002886
	(0.1505)	(0.9032)	(0.0426)	(0.0029)	(0.4585)	(0.0019)
$D^{UP} R^2_{m,t}$	0.000102	1.39E-05	0.001408	**-0.000744**	0.000100	0.001497
	(0.5564)	(0.9656)	(0.0813)	**(0.0019)*****	(0.8501)	(0.0000)

V. CONCLUDING REMARKS

In this paper, we examined herding behavior in the ASEAN-5 and the US stock market. We did this by constructing a new dataset consisting of daily closing prices on the most liquid stock indices in these stock markets. Using the Newey–West estimator, we demonstrated that the dominant global factor influencing herding behavior is the US federal funds rate, while the cross-market herding of the Singaporean stock market is the dominant regional factor that influence the other ASEAN stock markets. We further demonstrated that herding behavior caused by market spikes only occurs in the Philippines stock market, while market crashes only occur in the Malaysian stock market.

Global financial markets are highly integrated and as a result experience large capital inflows and outflows, making the tasks of central banks and financial market authorities more complicated in their quest to maintain financial market stability. The policy strategy of managing foreign capital flows, especially short-term capital flows, in order to mitigate the risk of herding behavior among investors in the event of a shock to global financial markets is very important for the ASEAN policymakers. In this case, the management of short-term capital flows can be done through macroprudential policies as part of the policy mix from central banks to support the effectiveness of monetary policy. Our findings suggest that policymakers should strengthen the coordination and synergy of policies between the ASEAN countries, especially with the Singaporean financial market authority, because until now the country is still the financial hub in the ASEAN market.

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APPENDIX

Data Descriptions
A description of variables used in our paper are explained here.

Variables	Descriptions	Measurement	Frequency	Sources
LQ45, DJIA, FTSE KLCI, STI, PSEi, SET50 Stock Market Indices	Daily closing rate from all listed equities from each stock markets, LQ45 (45 companies); SET (50 companies); FTSE KLCI, STI, and DJIA (30 companies). Then, we calculate each stock index using volume weighted average.	Weighted average: $CSAD_t = \sum_{i=1}^{N} \lvert R_{i,t} - R_{m,t} \rvert$ $R_{i,t} = (\log P_{it} - logP_{it-1})100.w_{it}$ $w_{i,t} = \frac{V_{it}}{V_{mt}}$ $R_{i,t}$ = equity i's return on day t $R_{m,t}$ = market return on day t P = price of equity N = number of all listed equities in the market w_{it} = weighted average of equity i's on day t which calculated by dividing trading volume of equity i's (V_{it}) with market trading volume (V_{mt})	Daily	Bloomberg
Policy Rate	ID, US, MY, SG, PHP, THAI monetary policy interest rate	-	Daily	Bloomberg
Asian Dollar Index (ADXY)	Daily index of some Asian currencies against the US dollar (USD), daily frequency	-	Daily	Bloomberg
Volatility Index (VIX)	Real-time market index that represents the market's expectation of 30-day forward-looking volatility, based on the price inputs of the S&P 500 index options	-	Daily	Bloomberg
Oil Price	Crude oil futures, NY Merchantile Exchange for 1 month delivery	-	Daily	Bloomberg