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Adaptive Market Hypothesis And Overconfidence Bias

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Abstract: This paper examines the effect of excessive investor confidence on market efficiency. We study this impact for 21 developed markets and 25 emerging markets for a period from January 2006 until June 2020. First, we estimate weak market efficiency using the auto-correlation test (Ljung-Box, 1978). Thus, based on the adaptive approach, we assume that the overconfidence of investors has a negative impact on market efficiency. Concerning the over-confidence variable; we use the transaction volume decomposition method of Chuang and Lee (2006). Finally, we used the logit panel model to study the impact the impact of investor overconfidence on market efficiency. The result shows that during our study period, the trust bias had no impact either on the efficiency of developed markets or on the efficiency of emerging markets. We attribute this result to successive crises during our study period, including the subprime crisis, the eurozone crisis, the stock market crash in China, and the COVID crisis, which likely caused investors to become pessimistic and lose confidence in the stock market.

Keywords: Efficient Market Hypothesis, Behavioral Finance, Adaptive Market Hypothesis, Overconfidence Bias

1. Introduction

The market efficiency hypothesis (EMH) proposed by Fama (1970), although well-known and influential in the theory and practice of finance, is still controversial regarding the predictability of stock market returns. The existence of stock market anomalies, undermining this hypothesis, has led to the establishment of a new financial approach known as "behavioural finance." This approach combines psychology and finance to explain investor behaviour, the psychological factors influencing their investment decisions, and their effects on financial markets (Barber and Odean, 2001; Shiller, 2003; Subash, 2012; Kahneman and Smith, Nobel Prize, 2002).

The central question in this debate is whether stock market movements are predictable. Lo (2004) attempted to answer this question, leading to the development of the Adaptive Market Hypothesis (AMH). Lo's (2004) reasoning suggests that much of the evidence for investor irrationality is consistent with the evolutionary pattern of human behaviour, such as the overconfidence bias. Researchers emphasize the importance of the overconfidence bias in their studies. For instance, Barber and Odean (2001) and Subash (2012) suggest that investors commonly exhibit overconfidence bias, leading them to be overly confident in themselves and prone to avoiding regret. These insights prompt us to explore whether the overconfidence bias indeed affects stock market efficiency.

This paper is the first to directly study the impact of excessive investor confidence on market efficiency. We examine this impact across 21 developed markets and 25 emerging markets from January 2006 to June 2020, using a logit panel model. We assess weak market efficiency using the auto-correlation test (Ljung-Box, 1978) monthly for each country from January 2006 to June 2020. The Ljung-Box test (1978) is applied monthly, adjusted for the number of days in each month. If the test reveals no auto-correlation, the market is deemed efficient in the weak sense; otherwise, it is considered inefficient. Our dependent variable is binary, taking the value of 1 for efficient markets and 0 for inefficient ones. Guided by the adaptive approach, we hypothesize that investor overconfidence negatively impacts market efficiency.

Regarding the overconfidence variable, we employ the transaction volume decomposition method of Chuang and Lee (2006). Our results show negative coefficients between overconfidence and efficiency for both types of markets. However, we do not find evidence of a negative effect of overconfidence on market efficiency during the study period. This result contradicts the adaptive market approach, which posits that investor irrationality, such as the overconfidence bias, explains market inefficiency. We attribute this finding to the numerous crises experienced globally during our study period, including the subprime crisis, the

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eurozone crisis, the Arab revolution, the Chinese stock market crash, and the COVID-19 pandemic. These crises likely instilled fear in investors, leading to heightened negative emotions and pessimism. Many researchers agree that investor fear intensifies during crises (Abbes, 2013; Mushinada and Veluri, 2018; Giglio et al., 2021; Naseem et al., 2021; Shrotryia and Kalra, 2021).

The structure of the remaining paper is as follows: Section 2 provides a literature review, Section 3 presents the data and methodology, Section 4 discusses empirical findings, and the final section concludes the paper.

2. LiteratureReview

The concept of "financial market efficiency" was first defined by Eugene Fama (1965). According to him, a financial market is efficient if all available market information is reflected in asset prices, suggesting that at any given time, a security's current price accurately represents its intrinsic value. This hypothesis implies that asset prices instantaneously and fully incorporate all available information, rendering technical analysis ineffective in outperforming the market. It assumes that asset prices consistently align with their fundamental values.

Fama delineates three forms of market efficiency: weak, semi-strong, and strong. In the weak form, only past price data is known, with investors lacking access to financial or economic information. In the semi-strong form, all public information is accessible to investors. In the strong form, all information, including private data, is available to all stakeholders, precluding insider trading.

In the early 1980s, doubts arose regarding the efficiency of markets. Despite empirical support for market efficiency, certain situations persistently manifest inefficiencies, termed anomalies, challenging researchers to explain their existence. Frankfurter and McGoun (2001) define anomalies as deviations from established principles, noting various anomalies such as excess volatility, trading volumes, and cyclical effects observed between 1969 and 1999. Rossi (2015) conducted a systematic review of calendar abnormalities and their relation to EMH.

In response to stock market anomalies undermining efficiency theory, behavioral finance emerged. This interdisciplinary approach integrates psychology and behavior into financial models, acknowledging that traditional models fail to fully explain or predict financial decisions. For instance, Thaler (1999) attributed the dot-com bubble crash to behavioral factors, critiquing EMH and human economic rationality. Shiller (2003) demonstrated the influence of emotions on market fluctuations during the dot-com bubble, reinforcing the role of behavioral biases in market anomalies.

Lo (2004) proposed an adaptive approach reconciling EMH and behavioral finance. He suggests that markets oscillate between efficiency and inefficiency based on investors' adaptive behaviors, citing behaviors such as loss aversion and overconfidence as contrary to EMH. Lo (2004) derived behavioral biases from Simon's (1955) concept of bounded rationality, advocating for alternative approaches to neoclassical economics' rationality assumptions. This adaptive approach suggests that financial markets adapt and fluctuate between efficiency and inefficiency over time.

Overconfidence, a prevalent behavioral bias, leads individuals to overestimate their abilities and underestimate risks (Thaler, 2005). Investors' overconfidence, as noted by Daniel et al. (1998, 2001) and Odean (1998), often stems from assigning excessive importance to private signals and misinterpreting information. Montier (2006) and Pikulina et al. (2017) found evidence of overconfidence among fund managers and individual investors, respectively, highlighting its potential impact on investment decisions and market efficiency.

Despite the belief that investor overconfidence reflects market inefficiency, no study has directly examined how overconfidence bias affects market efficiency. This study aims to empirically explore the impact of overconfidence bias on market efficiency.

3. Methodology

In this paper, we study 21 stock markets in developed countries and 25 stock markets in emerging countries for a period from January 2006 to June 2020.

Table 1: Stock Market Sample

Developed markets			Emerging markets		
Country	**Code**	**Market Index**	**Country**	**Code**	**Market Index**
Canada	CAN	S&P/TSX	Argentina	ARG	Merval
The United States	USA	Dow Jones	Brazil	BRA	Bovespa
Australia	AUS	S&P/ASX 200	Chile	CHL	IPSA
Belgium	BEL	BEL 20	Mexico	MEX	IPC
Finland	FIN	OMXH25	Czech.R	CZE	PX
France	FRA	CAC 40	Egypt	EGY	EGX 30
Germany	DEU	DAX	Greece	GRC	Athex 20
Ireland	IRL	ISEQ	Hungary	HUN	BUX
Italy	ITA	FTSE	Poland	POL	WIG 20
Netherlands	NLD	AEX	Qatar	QAT	QSI

Norway	NOR	OBX	Russia	RUS	MOEX
Portugal	PRT	PSI 20	Saudi Arabia	SAU	Tadawul
Spain	ESP	Ibex 35	South Africa	ZAF	JTOPI
Sweden	SWE	OMXS30	Turkey	TUR	ISE100
Switzerland	CHE	SMI	China	CHN	SSEC
United Kingdom	GBR	FTSE 100	India	IND	Nifty
Hong Kong	HKG	HIS	Indonesia	IDN	IDX Composite
Japan	JPN	Nikkei 225	South Korea	KOR	Kospi
Singapore	SGP	STI	Malaysia	MYS	KLCI
New Zealand	NZL	NZSX50	United Arab Emirates	ARE	ADX General Index
			Thailand	THA	SETI
			Philippines	PHL	PSEI
			Morocco	MAR	MASI
			Tunisia	TUN	Tunindex

Source: Extract from the Results of 2the 020 MSCI Annual Market Classification Review.

We use the panel logit model to estimate the impact of investor overconfidence on market efficiency. The Panel Logit model is written as follows :

$$\mathbf{Pr}(\,\boldsymbol{y_{it}} = \mathbf{1}) = \int (\boldsymbol{\beta} + \sum_{k=1}^{n} (\boldsymbol{\beta_k} \boldsymbol{X_{i,t}^k})$$

Thus, $\boldsymbol{y_{it}}$_it a binary dependent variable (1 or 0),with i denoting the cross-sectional units and $\boldsymbol{t = 1}; \ldots \boldsymbol{T}$ a time indicator. This model is determined by a set of exogenous regression variables $(\boldsymbol{X_{it}})$ and $\boldsymbol{\beta'}$ a vector of parameters. $\boldsymbol{k}$ the vector of coefficients to be estimated and $\int$ ⬚denotes the logistic function of type: $\int(\boldsymbol{Z}) = \frac{e^z}{1+e^z}$.Then our model is written as follows:

$$\boldsymbol{EF_{it}} = \frac{\mathbf{1}}{[\mathbf{1} + \mathbf{exp}(-(\boldsymbol{\beta_0} + \boldsymbol{\beta_1 OC_{it}} + \boldsymbol{\beta_2 NOC_{it}}))]}$$

Thus, our dependent variable is low market efficiency (EF) and the independent variables are overconfidence (OC) and non-overconfidence (NOC).

We estimate weak market efficiency using the auto-correlation test (Ljung-Box, 1978) for each month and each country from January 2006 to June 2020. If the test result shows the absence of autocorrelation, then the market is efficient in the weak sense; otherwise, the market is inefficient. Thus, our dependent variable is a binary variable that equals 1 when the market is efficient and 0 when the market is inefficient. Thus, based on the adaptive approach, we assume that the overconfidence of investors harms market efficiency.

According to Abedini (2009), the coefficient of autocorrelation test developed by Ljung and Box (1978) is an excellent statistical method for determining the extent to which data in a time series are autocorrelated between the current period (t) and previous periods (t-1). For this reason, Aumeboonsuk and Dryver (2014) found that this test is the best for studying weak market efficiency.

The formula for the classical first-order linear autocorrelation test is written as follows:

$$= \infty + \boldsymbol{\rho P_{t-1}} + \boldsymbol{\varepsilon_t}$$

∞ : The expected price change which is unrelated to the previous day's price change, and is assumed on average to be positive given the expected reward for risk ;$\boldsymbol{\rho}$: The correlation existing between the price of the market index at the moment $\boldsymbol{t}$ $(\boldsymbol{P_t})$ and with its delayed value $(\boldsymbol{P_{t-1}})$.

Fama (1965) recommended that correlation tests are commonly used to determine whether there is dependence in successive values of newspaper price changes. In this sense, « n » serial correlation coefficients $\boldsymbol{P_t}$ are estimated from the change in two prices and then compared with zero at a specified significance level.

If $\boldsymbol{P_t}$ is not significantly different from zero, then the price changes are independent; otherwise, the price changes are dependent. This test is parametric.

The auto-correlation function is written as follows:

$$\boldsymbol{\rho_k} = \frac{\sum_{t=1}^{n-k}(\boldsymbol{p_t} - \overline{\boldsymbol{p}}_t)(\boldsymbol{p_{t+k}} - \overline{\boldsymbol{p}}_t)}{\sum_{t=1}^{n}(\boldsymbol{p_t} - \overline{\overline{\boldsymbol{p}}}_t)^2}$$

With:

$\boldsymbol{\rho_k}$: ACF of price change of lag k.

$\boldsymbol{n}$: Number of observations.

$\boldsymbol{p_t}$: Price change over period t.

$\overline{\boldsymbol{p}}_t$: The sample mean of the price change.

p_{t+k}: Price change over period t+k.

k : Lag of period.

The alternative and null hypotheses for the serial correlation tests are as follows:

- H_0: $\rho_k = 0$ (Price changes are independent ↔ No serial auto-correlation (efficient market).
- H_1: $\rho_k \neq 0$ (Price changes are not independent ↔ Presence of serial autocorrelation (inefficient market).

The null hypothesis indicates that the correlation is not significantly different from zero, and the test will be carried out at a significance level of a = 0.05. And if this hypothesis is not rejected, then we can conclude that the market is efficient in its weak form. But, if we reject the null hypothesis, then we can conclude that the market is not efficient in its weak form.

We can use the Ljung-Box (Q) statistics to test the hypothesis when all autocorrelations are zero or identical.

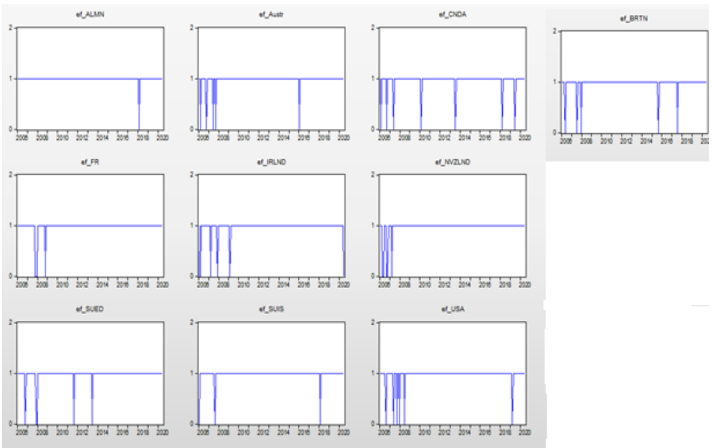
The Ljung-Box-Q statistic (Q_{LB}) is given by:

$$Q_{LB} = n(n+2)\sum_{k=1}^{m}\frac{\rho_k^2}{n-k}$$

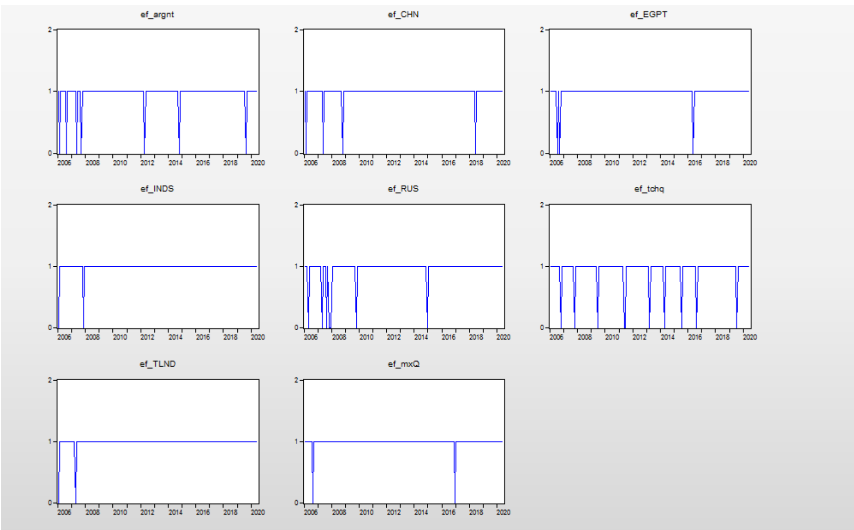
If one of the following two conditions is met:

- Q_{LB} is less than the 5% threshold.
- The statistic (Q_{LB}) is greater than or equal to the corresponding critical value obtained from the Chi-square table.

The figures (N°1,N°2) below represent the efficiency series of some markets in our sample constructed following the estimation of low market efficiency by the auto-correlation test (Ljung-Box,1978). These figures show that there are periods when markets reflect high efficiency but are interspersed with moments of inefficiency. Our result therefore supports the adaptive market hypothesis. This discrepancy between market efficiency and inefficiency may be due to irrational investor behaviour such as overconfidence.



Graph 1: Low-efficiency series for developed markets. Source: Author's Compilation



Graph 2: Low-efficiency series for emerging markets. Source: Author's Compilation

In order to construct the overconfidence and non-overconfidence series, we will apply the transaction volume decomposition method used by Chuang and Lee (2006). This idea is also used by several researchers, such as (Boujelben et al., 2009; Naoui and Khaled, 2011; Jlassi et al., 2014; Mushinada and Veluri, 2018; Boussaidi, 2020; Chkioua, 2021). The idea of this method is to distinguish between trading volume that is related to investor overconfidence levels due to historical market returns and trading volume that is not associated with investor overconfidence. Following Chuang and Lee (2006), trading volume ($\boldsymbol{V_t}$)is decomposed into two components using the following calculation:

$$V_t = \alpha + \sum_{j=1}^{j} \beta_j R_{t-j} + \varepsilon_t$$

$$V_t = \left[\sum_{j=1}^{j} \beta_j R_{t-j}\right] \quad + \quad [\alpha + \varepsilon_t]$$

$$V_t = [Over - Confidence_t] + [No\ Over - Confidence_t]$$

$$V_t = OC_t + NOC_t$$

With:

$\boldsymbol{V_t}$:Transaction volume is defined as the difference between the logarithm of the current transaction volume and logarithm of past trading volume,

$\boldsymbol{R_t}$: Represents the market return for day t,

$\boldsymbol{R_{t-j}}$: The market return on day t-j,

$\boldsymbol{j}$: The optimal number of delays,

$\boldsymbol{\beta_j}$: The coefficient that captures the relationship between past market returns and current trading volume transactions,

$\boldsymbol{OC_t}$: The "Overconfidence" component corresponds to the portion of trading volume due to the trading activity of overconfident investors,

$\boldsymbol{NOC_t}$: Not overconfident (The effect of other factors),

$\boldsymbol{\alpha}$: Is the constant term.

$\boldsymbol{\varepsilon_t}$: Denotes the error term.

Chuang and Lee (2006) define the component of trading volume that is unrelated to investor overconfidence ($\boldsymbol{NOC_t}$) as the sum of the constant and error terms. As such, the component of trading volume that is related to excess investor confidence overconfidence ($\boldsymbol{OC_t}$) is calculated as trading volume minus the sum of the constant and error terms, i.e.,the difference between $\boldsymbol{V_t}$ and$\boldsymbol{NOC_t}$.

4. Results and Discussion

From Table (2), we notice that the values have skewness less than 0, so the data has a left-skewed distribution. Moreover, all series have kurtosis values greater than 3. So they have a leptokurtotic distribution. Furthermore, the descriptive results show that we reject the normal-distribution null hypothesis for all variables, as all Jarque-Bera test probabilities for both panels are less than 5%.

Table 2: Descriptive test result

	Panel A : Developed markets			Panel B : Emerging markets		
	EF	**OC**	**NOC**	**EF**	**OC**	**NOC**
Mean	0.974399	-0.008436	-0.017451	0.972701	0.003287	-0.007913
Median	1.000000	0.012325	-0.002518	1.000000	0.006063	-0.009070
Maximum	1.000000	1.712857	2.705332	1.000000	1.961743	2.165849
Minimum	0.000000	-24.73801	-2.793946	0.000000	-2.712111	-3.388070
Std. Dev.	0.157983	0.594506	0.344049	0.163011	0.198220	0.387930
Skewness	-6.00728	-37.67724	-1.436378	-5.801693	-2.388363	-1.838014
Kurtosis	37.08750	1566.228	21.08148	34.65964	55.20885	20.64561
Jarque-Bera	104178.0	1.95E+08	26731.61	65944.35	159417.7	18843.08
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1865.000	-16.14610	-33.40079	1354.000	4.575686	-11.01486
Sum Sq. Dev.	47.74556	676.1267	226.4419	36.96264	54.65424	209.3314

Source: Author's Compilation

Drury (2008) has documented that if the multicollinearity between two variables is 70% or more, then this is a worrying case. In the present study, we do not find any serious cases of multicollinearity since, according to Table 3, the maximum correlation in panel (A) is (-0.025) between the variables (NSC) and (EF). For panel (B), the maximum correlation is between the variables (SC) and (NSC), which is equal to 0.3941. Furthermore, for panel (A), we find that there is a negative relationship between investor overconfidence and developed market efficiency equal to -0.0037. Also, there is a negative relationship between the two independent variables (-0.0041). For Panel (B), there is only one negative relationship between investor overconfidence and emerging market efficiency (-0.00017).

Table 3: Correlation test results

	Panel A : Developed markets			Panel B : Emerging markets		
	EF	**OC**	**NOC**	**EF**	**OC**	**NOC**
EF	1	-0.0037	0.0249	1	-0.00017	0.0086
SC	-0.0037	1	-0.0041	-0.00017	1	0.3941
NSC	0.0249	-0.0041	1	0.0086	0.3941	1

Source: Author's Compilation

The unit root tests (Table 4) show that all the series are stationary at the level.

Table 4: Unit root test result

	Panel A : Developed markets			Panel B : Emerging markets		
Constant	**EF**	**OC**	**NOC**	**EF**	**OC**	**NOC**
Levin, Lin, Chu	-25.5358 (0.000)***	-18.2199 (0.000)***	-40.9237 (0.000)***	27.9156 (0.000)***	-28.3523 (0.000)***	-53.9303 (0.000)***
Breitung-stat	-	-	-	-	-	-
Im, Pesaran, Shin	-29.6793 (0.000)***	25.7105 (0.000)***	-43.1764 (0.000)***	-29.9467 (0.000)***	-36.3252 (0.000)***	-48.4563 (0.000)***
Fisher–ADF	450.761 (0.000) ***	544.908 (0.000) ***	899.139 (0.000) ***	348.482 (0.000) ***	686.488 (0.000)***	797.516 (0.000)***
Fisher-PP	462.492 (0.000)***	637.107 (0.000)***	1116.11 (0.000)***	390.745 (0.000)***	655.420 (0.000)***	830.999 (0.000)***

Source : Author's Compilation;(Probabilité)*** < **1%**

Table 5 represents the results of the logit panel models for two types of markets (developed and emerging). This table shows that the coefficients between overconfidence and efficiency are negative, but there is no relationship between the OC and EF variables for the two types of markets. Therefore, according to this result, the overconfidence of investors has no impact on the efficiency of the markets during the period of our study from January 2006 until June 2020. This is contradictory to the idea of the adaptive market approach, which suggests that the irrational behavior of investors can explain the inefficiency of the markets, such as in the case of overconfidence bias.

Table 5: Logit panel model result

	Panel A : Developed markets			Panel B : Emerging markets		
	Coefficient	**z-Statistic**	**Prob.**	**Coefficient**	**z-Statistic**	**Prob.**
OC	-0.043104	-0.156469	0.8757	-0.123249	-0.137833	0.8904
NOC	0.403347	1.105825	0.2688	0.151833	0.346658	0.7288
C	3.655973	24.88841	0.0000	3.576265	21.67116	0.0000

Source: Author's Compilation

We can explain this result by the successive crises that the world experienced during the period of our study, such as the subprime crisis, eurozone crisis, Arab revolution, the stock market crash in China, and the COVID crisis. So, maybe these crises have affected the stock markets of these countries. In this regard, there are many researchers who believe that negative emotions and pessimism increase during crises because of investors' fear (Giglio et al., 2021; Naseem et al., 2021). Also, Abbes (2013) found that the overconfidence bias cannot explain volatility during the subprime financial crisis due to the loss of confidence by investors in financial markets. In addition, Mushinada and Veluri (2018) noticed that investors have become very pessimistic during periods of crisis, which can be explained by their fear. Recently, Shrotryia and Kalra (2023) found the absence of overconfidence bias during the COVID-19 crisis in developed stock markets, suggesting a loss or decline in investors' confidence. Returning to graphs 1 and 2, we can notice that in most of the markets, at the beginning and at the end of the graph, the curves tend towards 0, which explains the inefficiency of these markets. These periods likely reflect the subprime crisis and the COVID crisis, during which investor confidence decreased.

According to the results of our study and previous research, we can conclude that investor confidence decreased during the crisis period, explaining the rejection of our hypothesis that overconfidence has a negative effect on market efficiency. Therefore, based on our research findings, we recommend that money managers reduce transaction costs to encourage trading. Additionally, we suggest that companies implement good corporate governance practices to regain lost confidence by ensuring honest and transparent practices, especially during prolonged crisis periods.

5. Conclusions

The Efficient Market Hypothesis (EMH) has been the central proposition in finance for several years, suggesting that securities' prices must equal fundamental values due to rational investors or arbitrage eliminating price anomalies. However, studies by Kahneman and Tversky (1979), Hirshleifer and Shumway (2003), and Statman et al. (2006) indicate that investors are far from rational, challenging the efficient market assumptions. The ongoing debate on EMH initiated by Fama (1970) is influenced by the reasoning of behavioral finance specialists regarding investor rationality. Lo (2004) proposed the adaptive approach as a reconciliation between market efficiency and behavioral finance, suggesting that market efficiency oscillates between efficiency and inefficiency based on investors' adaptive behaviors, contradicting the efficient market hypothesis.

This paper examines the effect of excessive investor confidence on market efficiency, studying 21 developed markets and 25 emerging markets from January 2006 to June 2020 using a logit panel model. The results show that during our study period, the overconfidence bias had no impact on the efficiency of developed or emerging markets.

This result contradicts the adaptive market approach, suggesting that irrational investor behavior, such as overconfidence bias, can explain market inefficiency. We attribute this result to successive crises during our study period, including the subprime crisis, eurozone crisis, Arab revolution, stock market crash in China, and the COVID crisis, which likely caused investors to become pessimistic and lose confidence in the stock market. Based on our findings, we recommend that money managers reduce transaction costs to encourage trading and that companies implement good corporate governance practices to regain lost confidence during enduring crisis periods.

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