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ORIGINAL RESEARCH

Frontier Markets, Liberalization and Informational Efficiency: Evidence from Vietnam

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Abstract
This paper examines the equity market opening in Vietnam, a frontier market that has taken gradual steps of relaxing capital control, by analysing whether liberalization policies in the period 2009–15 have had an impact on informational efficiency. We applied time-varying Hurst exponent during the liberalization period and tested Adaptive Market Hypothesis. The results confirm the role of foreign investors in improving the local market's efficiency, however, the findings show that the liberalization does not always result in the increase of foreign participation, which then has a limited impact on the efficiency. The study also indicates the importance of governance policies, along with liberalization policies, in completing market structure and market dynamics, that promote equity price reflects truly firm's intrinsic value.

Keywords Foreign investment · Frontier markets · Hurst exponent · Liberalization · Market efficiency · Vietnam

JEL Classification F620 · F650 · G120 · G180

1 Introduction

This paper examines stock market liberalization in Vietnam, a frontier market that has been receiving increasing social and academic attention.The country's shift from a centrally planned to a market economy, with the annual economic growth remained above 5.2% during the period 2010–17,[1] facilitated a rapid expansion of equity market capitalization. According to MSCI (2018),[2] Vietnam accounts for

[1] World Bank (2018)—Data Country. Link https://data.worldbank.org/indicator.
[2] MSCI (2018)—MSCI Frontier Market Index. Link https://www.msci.com/documents.

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17.41%, ranked 2nd, of total capitalization among 28 frontier markets countries. Before liberalization, foreign ownership limitation in publicly listed companies was 30%. The milestone commenced in January 2007, when Vietnam became a member of WTO and opened the market to foreign capital flows under General Arrangement on Trade in Services Commitment. On 1st June 2009, this limitation was opened to 49% with the issuance of Decree 55/2009/QD–TTg. From 1st September 2015, the Decree 60/2015/ND-CP allows foreign investors to own 100% shares of public companies in some certain areas.[3] To the best of our knowledge this is the first study examining impacts of liberalization policies on market structure and market competition in Vietnam, with the focus on informational efficiency.

In literature, effects of market opening on informational efficiency was evidenced in emerging markets, where the liberalization process took place from the 1980s to 1990s. This is the successful period of liberalization as many emerging markets were opened to non-resident investors, mainly from developed countries, who were seeking for higher investment yields and international diversification. Empirical studies showed that the participation of foreign investors would affect market structure and market competition (Henry, 2000a, b; Bekaert et al., 2002; Lee & Wong, 2012; Aymen & Adel, 2013). Foreign investors are usually institutional investors and actively involved in informed trading. They adopt long term horizon investment strategies and utilize well developed technology and highly skilled financial experts. The increased foreign participation, thus, is supposed to have an impact on price mechanism, facilitate equities to be traded at true fair value, and improve informational efficiency of developing stock markets.

By introducing the case of Vietnam, another contribution of this paper is to bring empirical study about frontier markets. Although frontier markets share several similarities with the original emerging markets back to the 1980s and 1990s, there are some significant differences about structure between these markets. In fact, deregulation of foreign investment in frontier markets was accompanied by much more market conditions that resulted from the consequences of Asian financial crisis 1997 and global market downturn 2008. The interlinked capital market, which is attributed to financial contagion among nations, illustrated that liberalization is not a risk-free policy and brought many lessons for policymakers in frontier markets in the 2000s. Thus, it is necessary to have rigorous research about the liberalization process in frontier markets and how foreign capital flows affect their market efficiency.

This study employs long range dependence parameter, Hurst exponent, to trace the changes of market efficiency degree before and after official liberalization dates. In addition, a set of important milestones is used to find out whether there are any other events, that relate to market adjustments in the post crisis period, are associated with the changes of time-varying Hurst exponents. Adaptive Market Hypothesis (AMH) is the main research theory. The paper is organized as follows: Sect. 2 describes an overview of Stock Market Liberalization in Vietnam. Section 3 provides Theoretical framework on Market Efficiency, The Adaptive Market Hypothesis (AMH), and Stock Market Liberalization. Section 4 mentions the methodology

[3] State Securities Commission of Vietnam (2015)—Link https://www.ssc.gov.vn/ubck.

and data used in the study. Empirical results and discussion are provided in Sects. 5 and 6, respectively. Section 7 shows research implication in terms of liberalization and governance policies, and theory development. Section 8 concludes the study.

2 Stock Market Liberalization in Vietnam

The stock market in Vietnam was initiated in July 2000, later than other markets in the South East Asian region. This establishment is one part of financial system reform in "Doi Moi" (Renovation) policy, which aims at supporting high demand of capital for industrialization. The operation of the Vietnam stock market is monitored by State Securities Commissions (SSC). Hochiminh Stock Exchange (HoSE) and Hanoi Stock Exchange (HNX) are two main listing exchanges in Vietnam. Generally, HoSE has stricter requirements and in fact, almost all blue-chip equities are listed on this stock exchange. HoSE also accounts for the biggest proportion in terms of market capitalization. On 31st July 2018, there were 367 companies listed on HoSE with market capitalization of 130.2 billion USD (Fig. 1). The number of companies on HNX was 378 and market capitalization was 8.3 billion USD.[4]

Since 2007 both Morgan Stanley Capital International (MSCI) and Financial Times Stock Exchange (FTSE) classified Vietnam stock market into frontier markets group, which is characterised as modest market capitalization, limited liquidity, and few market information sources. The percentage of market capitalization to GDP of Vietnam on 31st December 2017 was 52.2%, which was still low in comparison with other countries in the region, for example Singapore 299.6%, Hongkong 1,267.1% and Thailand 116.4%.[5] Vietnam, however, is predicted as one of the most promising markets in Asia thanks to the sustainable economic growth, young population structure and urbanization dynamics which create a larger local consumer market and additional room for financial deepening. In addition, the prospect of the market is improved by the Government's commitments to create an attractive business environment, including maintaining political stability, implementing monitoring frameworks, and facilitating foreign investment. Among these measurements, liberalization is expected to address the shortage of domestic capital as well as bring positive externalities for market operation. The maximum foreign ownership, often referred as the "room", is the basis for trading stocks of foreign investors. Before liberalization, foreign ownership limitation in publicly listed companies was 30%. The milestone commenced in January 2007, when Vietnam became a member of WTO and opened the market to foreign capital flows under General Arrangement on Trade in Services Commitment. On 1st June 2009, this limitation was opened to 49% with the issuance of Decree 55/2009/QD–TTg. From 1st September 2015, Decree 55/2009/QD–TTg was replaced by the Decree 60/2015/ND-CP, which allows foreign investors to own 100% shares of public companies in some certain areas (Table 1).

[4] Listing of companies on Hochiminh Stock Exchange https://www.hsx.vn/Modules/Listed, and Hanoi Stock Exchange https://www.hnx.vn/vi-vn/co-phieu-etfs.

[5] CEIC Data (2018). Country Data. Link https://www.ceicdata.com/en/countries.

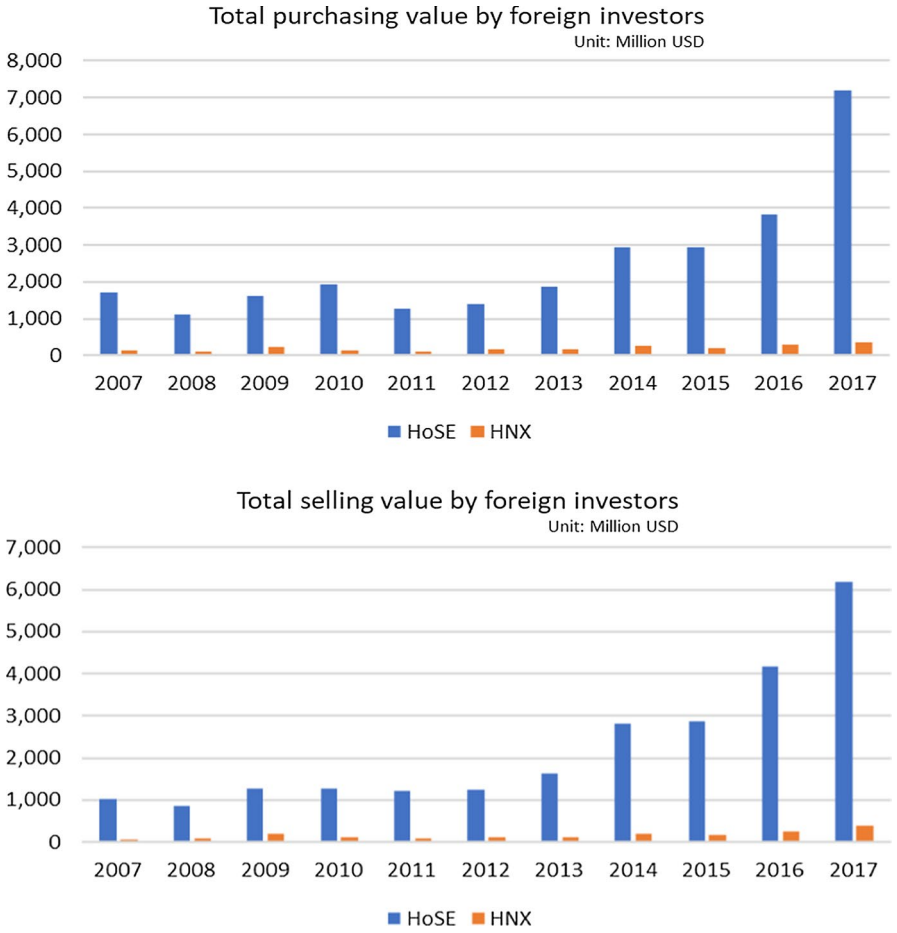


Fig. 1 Value traded by foreign investors in Hochiminh Stock Exchange and Hanoi Stock Exchange (Unit: Million USD). This Table illustrates the total value traded, including purchasing and selling, by foreign investors in Hochiminh Stock Exchange and Hanoi Stock exchange from 2007 to 2017. Because of the advantage on market size and information disclosure, HoSE is the main target of foreign capital flows to Vietnam stock market. In 2017, the total purchasing and selling value in HoSE was 7190 and 6186 million USD respectively, while the purchasing and selling value in HNX was 369 and 380 million USD Source: Hochiminh Stock Exchange, 2018; Hanoi Stock Exchange, 2018).

3 Theoretical Background

3.1 Market Efficiency and the Adaptive Market Hypothesis

When markets become efficient, securities prices will be explained by all available information about company business and financial markets. In this situation, equities are priced fairly, ownership investing would be traded by the amount at which it deserves, and individuals can invest in the market without much uncertainty. Fama (1970) defined this concept more specifically in the efficient market hypothesis

Table 1 History and Liberalization process in Vietnam. (Source: State Securities Commission of Vietnam, 2015)

Time	History and liberalization process
July 20th 2000	Vietnam stock market was established, there were only two listed companies, capitalization of 986 billion VND
August 1st 2003	Decree No. 146/2003/QD–TTg, maximum foreign ownership in public companies was 30%
March 8th 2005	Hanoi Stock Exchange was established
January 1st 2007	Vietnam became member of World Trade Organization
June 1st 2009	**Decree No. 55/2009/QD–TTg, maximum foreign ownership in public companies was 49%**
June 24th 2009	UPCoM market was monitored and supervised by HNX
September 15th 2012	Decree No. 58/2012/ND–CP, maximum foreign ownership in securities companies was 100%
September 1st 2015	**Decree No. 60/2015/ND-CP, maximum foreign ownership in public companies was 100%**

Vietnam initiated stock market in July 2000, later than other markets in South East Asia region. This establishment is one part of financial system reform in "Doi Moi" (Renovation) policy, which aims at supporting high demand of capital for industrialization. This Table summarizes important milestones in the development of Vietnam Stock market. This paper examines effect of two main event highlighted, Decree No. 55/2009/QD-TTg on June 1st 2009 and Decree No. 60/2015/ND-CP on September 1st 2015, on market efficiency: (1) Decree 55/2009/QD-TTg on June 1st 2009 that increase the limitation of foreign ownership in public companies from 30 to 49%; (2) Decree 60/2015/ND-CP on September 1st 2015 that entitles foreign investors to acquire 100% equity of public companies in certain sectors

For the timelines with important milestones in the Vietnam stock market, two important milestones which are associated with market liberalization, on June 1st 2009 and on September 1st 2015, were in bold text

(EMH), which classifies the degree of market efficiency into the weak form, semi-strong form, and strong form.

However, the EMH receives critical arguments about its validity from academic researchers. The most criticism comes from the assumption that market efficiency is a static characteristic. According to Self and Mathur (2006, p. 3154) *"The true underlying market structure of asset prices is still unknown"*. Market price determination is a complicated mechanism which is affected by both micro-level factors, such as market microstructure, arbitrage limitation, and the existence of market imperfections, and macro-level factors such as macro institutions, market regulations and technology innovations. Those factors change overtime, resulting in the evolution of market structure where asset prices are determined. Therefore, it is inaccurate to assume market efficiency in the absolute sense or all-or-none condition (Lim & Brooks, 2011). In addition, the naive approach of EMH was challenged by the school of Behavioural Finance. The weakness in assumption of EMH is assuming that all investors are rational profit maximisers (Gupta et al., 2014). In fact, however, actions of investors might be influenced by emotion, such as optimistic or pessimistic attitudes, overreactions, and herding behaviours. Behavioural Finance emphasizes that various market anomalies still exist due to these emotional factors. Thus, future stock prices are somewhat predictable even in efficient markets.

Lo (2004) proposed a new paradigm of market efficiency, Adaptive Market Hypothesis (AMH), which is an evolutionary alternative to EMH and co-exist with Behavioural Finance theory. In the view of AMH, the existence of market anomalies is consistent with evolutionary models of human behaviour including competition, adaption, and natural selection. Instead of being a static characteristic, the efficiency is time-varying and depends on evolutionary dynamics of market structure and market competition. One of the most practical implications from AMH is that it does not negate the existence of arbitrage opportunities in financial markets. The AMH admits profit opportunities exist from time to time but is quickly exploited by investors. As one opportunity is eroded, other new ones are continually being created. Technical analysis is still effective to detect profit opportunities from historical price movements however, these will be eroded quickly due to market competition. Another significant difference between EMH and AMH is about the market dynamics. While EMH asserts that stock return series are random, AMH implies that cycles, trends, bubbles, and crashes can exist in efficient markets, but their dynamics become more complex over time. The occurrence of the Dot-com bubble 2000–02 and the financial turmoil of 2008 are highlighted examples of recent complex crisis cycles implied in the AMH.

3.2 Market Efficiency and Stock Market Liberalization

The management of foreign capital flows on the equity market, usually via liberalization policies, is one of the most important issues that many financial policymakers pay attention to. Broadly speaking, stock market liberalization refers to actions of the Government that open the market to foreign capital flows in terms of regulations, taxation, and other areas relating to stock markets. Due to the complication in definition, however, this study focuses only on regulations that adjust foreign ownership limitations in domestic stock markets. According to Henry (2000a, b, p. 529), stock market liberalization is defined as "a decision by a country's government to allow foreigners to purchase shares in that country's stock market". This definition is widely accepted in some other research (Kawakatsu & Morey, 1999; Laopodis, 2003; Nguyen & Fontaine, 2006). Liberalization provides new opportunities for foreign investors, mostly from developed markets, who seek for higher investment yields and international diversification. The increased foreign participation then would have an impact on market structure and market competition of the hosting countries. Foreign investors are usually institutional investors and more actively involved in informed trading than domestic investors (Kim & Yi, 2015). Any mispriced equity will be exploited to gain profit that leads to market price being adjusted instantly and approach its intrinsic value. In addition, their investment strategies adopt a long term horizon and utilize well developed technology and highly skilled financial experts, which are advantages over local investors' (Batten & Vo, 2015). Thus, liberalization is expected to facilitate information to be incorporated quickly and accurately into stock price, improving informational efficiency of emerging stock markets (Kawakatsu & Morey, 1999; Aymen & Adel, 2013). However, liberalization is not a risk-free policy. The arguments against market opening

claim that interlinked capital markets are attributed to financial crises and contagion among nations. Less developed equity markets, where regulatory framework and market structure are not complete, could experience negative effects of sudden capital outflows in recession periods (Singh, 1997; Schmukler, 2004; Baele et al., 2005; Bae & Zhang, 2015). Therefore, at initial stages of development, foreign ownership in publicly listed companies is regulated by a certain limitation. When regulatory framework and market infrastructure are completed, this limitation is gradually lifted to the thresholds that allow non-resident investors to control public companies. In literature, the effect of market opening on informational efficiency as evidenced mainly in emerging markets. One of the earliest researches about liberalization effects was done by Kawakatsu and Morey (1999). The prediction given is that the increased foreign participation in emerging markets leads to more intensive competition among investors. The investors would exploit all information surrounding markets, and therefore stock prices will reflect all available information. Laopodis (2003) explained that because markets become more transparent after liberalization, so much more information would be used in trading stocks. The author collected data from Athens Stock Exchange, conducted several tests including efficiency tests, recursive residuals, structural changes, and random walk tests. Nguyen and Fontaine (2006) collected data from eight emerging countries: Argentina, Brazil, Chile, Colombia, Malaysia, Mexico, Thailand, and Venezuela from June 1976 to March 2000. The arguments given are similar to implications of AMH paradigm, which states that market efficiency is not a static situation. Lim et al. (2016) argued that because foreign investors are well-skilled in processing systematic market-wide information, so they would evaluate securities price at fair value and trade stocks at the near intrinsic value.

Generally, research results indicated that liberalization would bring positive effects on informational efficiency in emerging markets, where stock prices are uncorrelated to fundamental information. However, the sign of this effect is not clear as empirical results tend to be country-specific (Nguyen & Fontaine, 2006). Although opening markets to non-resident investors is supposed to affect market structure and market competition, it requires some other conditions in terms of transaction costs, information disclosure and regulatory frameworks to be present for a liberalized market to become efficient. The degree of efficiency would be significantly different between before and after liberalization (Lim et al., 2016), or continue to converge trend to the weak-form efficiency around official announcement dates (Nguyen & Fontie, 2006; Cajueiro et al., 2009). In some countries, because markets had been efficient before liberalization took place, the impact of market opening was not evidenced (Kawakatsu & Morey, 1999; Laopodis, 2003).

3.3 Research Questions

This study identifies liberalization policies in a frontier market, which has not been addressed in the literature. With the available data from HoSE and HNX, the research analyses the case study of Vietnam with the main research questions: *Has the Vietnamese stock market become more informationally efficient after*

liberalization policies were implemented? When answering this question, there are some noticeable features in the market opening process in Vietnam, which might be concerned about:

First, most of the companies in Vietnam are small or micro-cap, which could deliver higher returns over the long term but also have considerable levels of risk. This is the common feature of almost frontier markets where market size is relatively small compared to emerging and developed markets. Also, many public companies are not well-known, and this could bring opportunities for active managers to look for overvalued or undervalued stocks and outperform the market index. Moreover, information disclosure is another limitation in Vietnam. There has not been any compulsory regulation for public companies to provide information in English and most companies only have official information channels in the local language. This made obstacles for foreign investors to access information and created unequal competition between local and non-resident investors.

Second, Vietnam opened its domestic stock market in June 2009 when the market was recovering from the big downturn in 2008. The market had experienced rapid growth in 2007, however, the bubble burst at the beginning of 2008 due to consequences of contractionary monetary policy and effects from the US subprime mortgage crisis 2007–2008. Vietnam stock market started recovering in March 2009 thanks to the Government's decisive actions such as reducing interest rate, implementing fiscal stimulus, amending Securities Laws, and adjusting price limits system. Foreign capital flow was also one important pushing factor that contributed to the recovery in this period when individual domestic investors had lost their optimism in the market.

Third, Vietnam is still in the equitization process of state-owned enterprises and this feature could have an impact on the country's liberalization. Many state-owned enterprises successfully changed to publicly listed companies and some of those became the top market capitalization companies in stock exchanges. However, the high proportion stocks of these companies are still owned by the Government with a low free-floating ratio. In addition, according to Fang et al. (2017), the transition from a centralized planning economy to a socialist-oriented market economy is often accompanied by uncertain market conditions, especially in the early stages of the transition process. Foreign investors would face the risks of foreign exchange rates, lax insider trading restrictions, less liquidity, and a poor corporate governance system. As a consequence, this would reduce the participation motivation of foreign investors and neither market competition nor informational efficiency could not change significantly after liberalization.

Besides, the research method employs a set of important milestones to find out whether there are any other events, that relate to market adjustments in the post-crisis period, are associated with the changes of time-varying Hurst exponents. Thus, another research question in this study is: *Are there any other Government policies on equity markets, rather than liberalization policies, have impacts on informational efficiency?*

4 Research Method

4.1 Data

In this paper, we use daily closing price of VN-Index and HNX-Index as proxies for Vietnam stock market performance. The VN-Index comprises all equity listing on the Hochiminh Stock Exchange (HoSE) and is considered as the benchmark index for large, blue chips, and more established stocks. The HNX-Index includes the newer, smaller-cap companies listing on the Hanoi Stock Exchange (HNX). The data is provided from EIKON database. Figure 2 illustrates the performance of VN-Index and HNX-Index during the period from 14th July 2005 to 28th September 2017. Both indexes shared similar trends pre and during the crisis of 2008. They hit their peaks in March 2007, then decreased significantly in the recession period and reached the bottom of 235.5 and 78.06 for VN-Index and HNX-Index, respectively. The market started recovering by the end of March 2009. In the post-crisis period, performance of the two indexes is different. While VN-Index kept going up and nearly come back to their peak in 2007, HNX-Index experienced a downward trend.

The research uses series of return to carry out analysis

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100 \tag{1}$$

where r_t is the return and P_t is the closing price of index on day t. Daily return of VN-Index and HNX-Index is illustrated in Fig. 3.

4.2 Long-Range Dependence

To examine daily time series of VN-Index and HNX-Index, long-range dependence is used as the main research method in our study. The dependence refers to the correlation structure of time series at long lags. More specifically, it measures the decay rate of autocorrelation between two points as we increase the distance between them. The time series is considered to have long-range dependence if the rate of decay is slower than exponential decay. The existing of long-range dependence means that distant observations are significantly autocorrelated. In this situation, past stock returns could be employed to predict future stock returns, that violate the assumptions of market efficiency. The efficiency requires the arrival of new information be quickly arbitraged away, so future stock returns are unpredictable.

Another reason for the choice of method is that long-range estimates could provide time-varying efficiency, which enables us to examine the validity of the AMH hypothesis. The estimates could be calculated into rolling sample technique to illustrate the evolvement of market efficiency in discrete time intervals. Some studies used this method to find out whether the changes in time-varying time-series dependence is associated with economic events or policies: Cajueiro et al. (2009) studied the effect of liberalization on the Athens Stock Exchange, Aloui (2011) examined the impact of market opening on the stock market in Tunisia, Mynhardt et al. (2014) analysed the effect of financial crises on Ukrainian equity market.

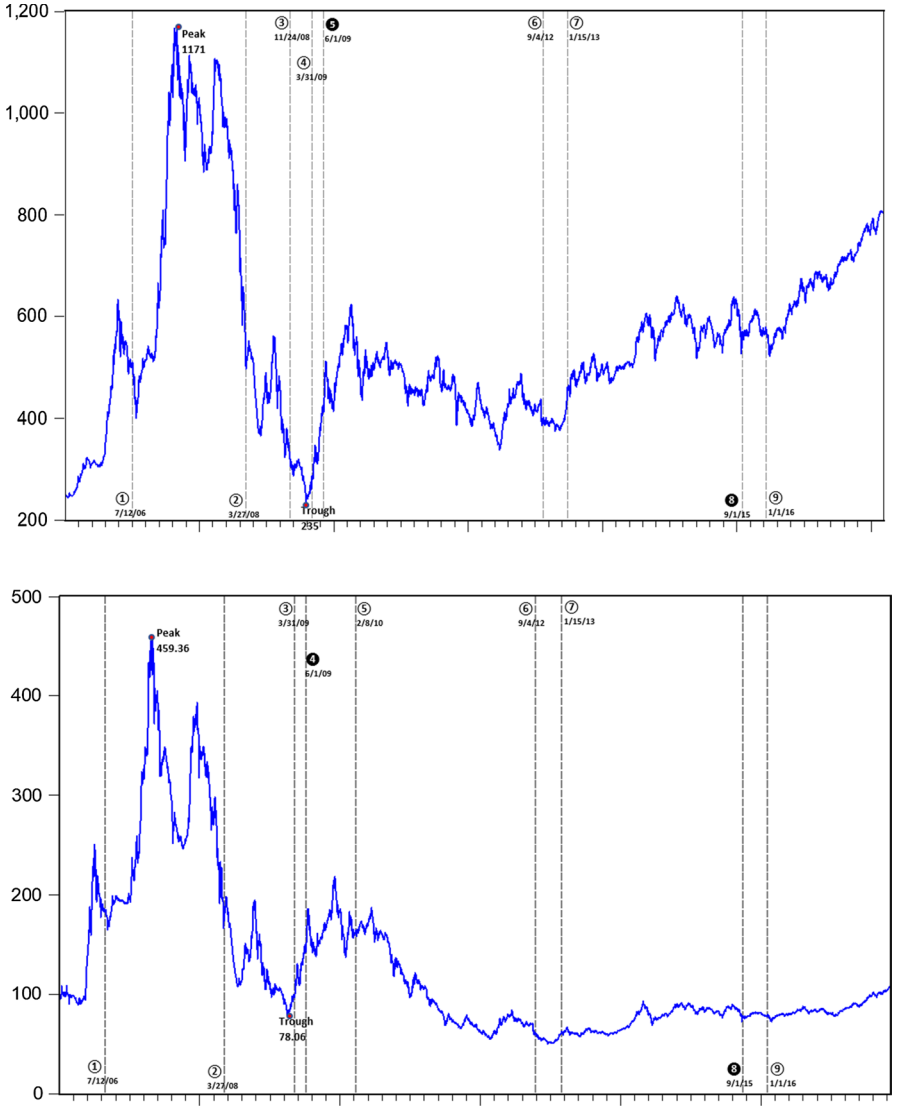


Fig. 2 Performance of VN-Index and HNX-Index from 14th July 2005 to 28th September 2017. This figure illustrates closing price of VN-Index and HNX-Index from 14th July 2015 to 28th September 2017. The data is provided from EIKON database. **a** Some events are highlighted: ① Securities Laws on Jul 12th 2006—② Crisis started March 27th 2008—③ Online HoSE transaction on November 24th 2008—④ Crisis ended March 31st 2009—❺ Foreign ownership limitation to 49% on June 1st 2009—⑥ t+3 on September 4th 2012—⑦ Price limits to 7% in HoSE and 10% in HNX on January 15th 2013—❽ Foreign ownership limitation to 100% on September 1st 2015—⑨ t+2 on January 1st 2016. **b** Some events are highlighted: ① Securities Laws on Jul 12th 2006—② Crisis started March 27th 2008—③ Crisis ended March 31st 2009—❹ Foreign ownership limitation to 49% on June 1st 2009—⑤ Online transaction HNX February 8th 2010—⑥ t+3 on September 4th 2012—⑦ Price limits to 7% in HoSE and 10% in HNX on January 15th 2013—❽ Foreign ownership limitation to 100% on September 1st 2015—⑨ t+2 on January 1st 2016

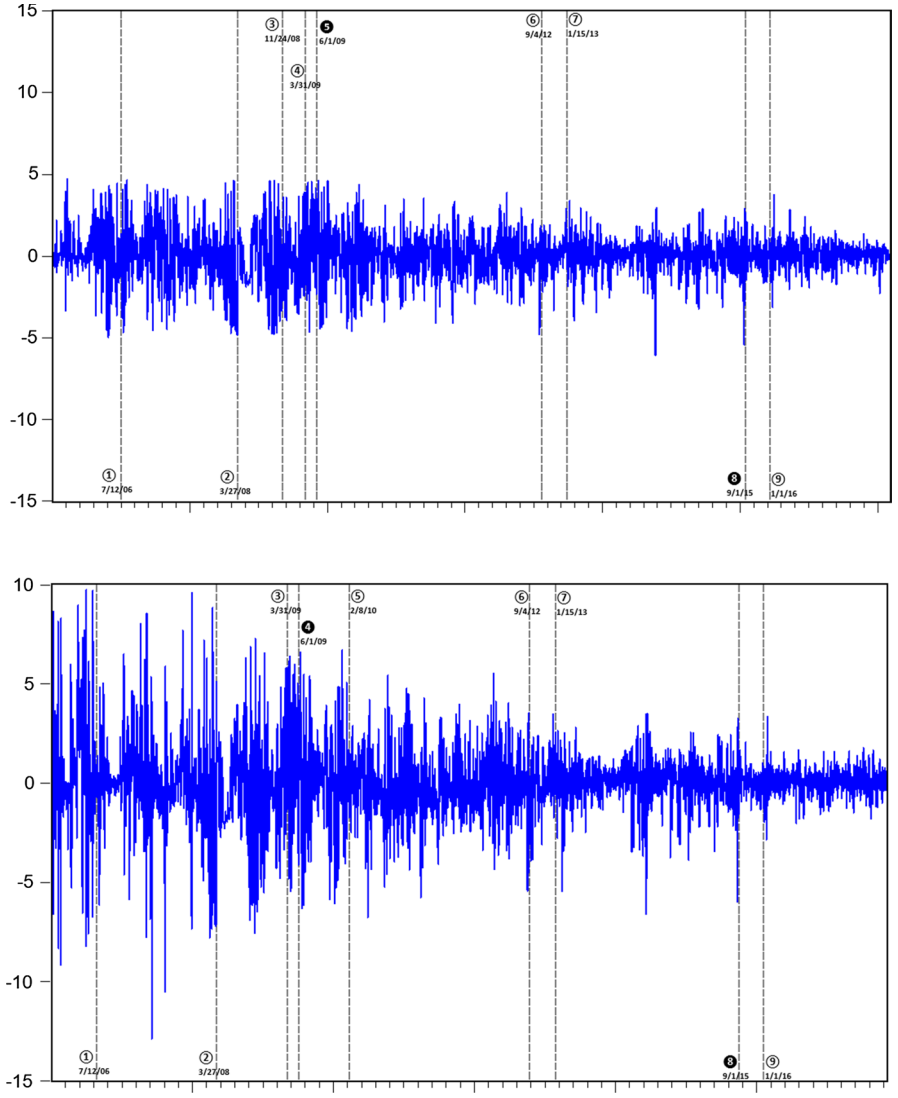


Fig. 3 VN-Index and HNX-Index Return from 14th July 2005 to 28th September 2017. The period under examination is from 14th July 2005 to 28th September 2017, including 6002 observations of both VN-Index and HNX-Index. The data is provided from EIKON database. The analysis is carried using the series of returns as: $r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100$ (1), where r_t is the return and P_t is the closing price of index on day t. Daily return of VN-Index and HNX-Index is illustrated in Fig. 2. **a** Some events are highlighted: ① Securities Laws on Jul 12th 2006—② Crisis started March 27th 2008—③ Online HoSE transaction on November 24th 2008—④ Crisis ended March 31st 2009—❺ Foreign ownership limitation to 49% on June 1st 2009—⑥ t+3 on September 4th 2012—⑦ Price limits to 7% in HoSE and 10% in HNX on January 15th 2013—❽ Foreign ownership limitation to 100% on September 1st 2015—⑨ t+2 on January 1st 2016. **b** Some events are highlighted: ① Securities Laws on Jul 12th 2006—② Crisis started March 27th 2008—③ Crisis ended March 31st 2009—④ Foreign ownership limitation to 49% on June 1st 2009—❺ Online transaction HNX February 8th 2010—⑥ t+3 on September 4th 2012—⑦ Price limits to 7% in HoSE and 10% in HNX on January 15th 2013—❽ Foreign ownership limitation to 100% on September 1st 2015—⑨ t+2 on January 1st 2016

Various techniques have been developed to quantify the long-range dependence. The advantages and shortcomings of different methods were well discussed in the research of Tiwari et al. (2018) and Fernandez (2011). Tiwari et al. (2019) constructed an efficiency index that combines the estimates from different techniques of GPH, LAD, LS, CMA-MAF, CMA-MSF, DFA, and QML. As our research focuses on examining the efficiency of daily stock return series, we use the Rescale range (R/S) Hurst to detect the long-range dependence. According to Fernandez (2011), based on Monte Carlo simulation, R/S Hurst performs reasonably well as regards with bias in the unit-roots test.

Considering return series in a specific period: $r_1, r_2, r_3, \ldots r_\tau$:

$$\left(\frac{R}{S}\right)_\tau \equiv \frac{1}{\hat{\sigma}\tau}\left[max_{1\le t\le\tau}\sum_{t=1}^{\tau}(rt-\overline{r\tau}) - min_{1\le t\le\tau}\sum_{t=1}^{\tau}(rt-\overline{r\tau})\right] \tag{2}$$

where $\overline{r\tau}$ and $\hat{\sigma}\tau$ are the sample mean and standard deviation, respectively.

$$\overline{r\tau} = \frac{1}{\tau}\sum_{t=1}^{\tau} r(t) \tag{3}$$

$$\hat{\sigma}\tau = \frac{1}{\tau}\sum_{t=1}^{\tau}\left(rt-\overline{r\tau}\right)^2 \tag{4}$$

Then the Hurst (H) is estimated by the $\left(\frac{R}{S}\right)_\tau$ through the following relation:

$$\left(\frac{R}{S}\right)_\tau = \left(\frac{\tau}{2}\right)^{\mathrm{H}} \tag{5}$$

The value of Hurst exponents ranges from 0 to 1. H of 0.5 indicates stock return series follows random walk. If $0<\mathrm{H}<0.5$, the return series are anti-persistent or mean-reverting. If $0.5<\mathrm{H}<1$, the return series are persistent, positive (negative) trends tend to continue positive (negative) ones. The further values of H from 0.5, the more strength in the autocorrelation between distant observations. In this case, past returns could be exploited to predict future returns, and markets are more inefficient. A market is considered as weak-form efficiency when the H value approaches nearly 0.5.

Along with detecting long-range dependence, the research uses some statistical unit roots tests in the daily index returns. The sample is used flexibly for various tests. Starting with the test for the whole sample in the period 14th July 2005 to 28th September 2017 (Sect. 5.1), then Hurst exponents are examined in sub-samples when the structural break dates are known (Sect. 5.2.1), and when the dates are unknown (Sect. 5.2.2). Finally, time-varying Hurst exponents across the sample are presented in Sect. 5.3.

Table 2 Test of market efficiency in the sample period 2005–2017

Test	VN-Index	HNX-Index
Hurst	0.6205	0.6112
ADF Test (tau statistics)		
Random walk	− 42.1905**	− 46.1400**
Random walk with drift	− 42.2102**	− 46.0700**
Random walk with drift and trend	− 42.2002**	− 46.0502**
Phillips-Perron Test		
Random walk	10.3005**	5.0902**
Random walk with drift	10.3021**	5.1200**
Random walk with drift and trend	10.3001**	5.1005**

This Table illustrates R/S Hurst, Augmented Dickey-Fuller and Phillips-Perron tests for VN-Index and HNX-Index in the sample period from 14th July 2005 to 28th September 2017

**Statistically significant at 5% level

5 Findings

5.1 Test of Market Efficiency in the Sample Period 2005–2017

The tests start by examining market efficiency hypothesis in the sample period 14th July 2005 to 28th September 2017. Table 2 presents Hurst exponents, Augmented Dickey-Fuller and Phillips-Perrons tests for daily returns of VN-Index and HNX-Index. The Hurst values for the two indices are 0.6205 and 0.6112, respectively. Both unit root tests, Augmented Dickey-Fuller and Phillips-Perrons, rejected the hypothesis of stock returns to follow a random walk, including with drifts and trends. Thus, it could be concluded that the Vietnamese stock market is not informationally efficient.

However, this conclusion is based on all-or-none conditions. With the aims of examining effects of liberalization policies, the following sections present the tests that are examined for different samples, enabling us to compare the changes of market efficiency level according to Hurst exponents.

5.2 Hurst Exponents in Non-Overlapping Sub-Samples

5.2.1 Sub-Samples with Known Structural Break Dates

Table 3 shows the Hurst values calculated in time-intervals of 12 months, 15 months, 18 months, 21 months and 24 months, before and after the liberalization announcement dates. These intervals enable us to compare the changes of market efficiency in the years post liberalization, from one year to the longer span of two years.[6] The

[6] Because the data is calculated to September 2017, that is two years after the second liberalization dates, the maximum Hurst non-overlapping sub-samples is two years.

Table 3 Hurst exponents before and after liberalization. This Table illustrates the rescaled Hurst exponents pre and post-liberalization in different periods: 12 months, 15 months, 18 months, 21 months, and 24 months

HNX-Index	First liberalization on June, 1, 2009	Second liberalization on September, 1, 2015
12 months pre	0.7179	0.4930
12 months post	0.5961	0.6286
15 months pre	0.6107	0.5778
15 months post	0.6082	0.6195
18 months pre	0.6458	0.5812
18 months post	0.5876	0.6176
21 months pre	0.6939	0.6135
21 months post	0.5241	0.6165
24 months pre	0.6630	0.6230
24 months post	0.5279	0.6237
VN-Index	First liberalization on June, 1, 2009	Second liberalization on September, 1, 2015
12 months pre	0.7615	0.6305
12 months post	0.5445	0.6296
15 months pre	0.6688	0.5804
15 months post	0.6119	0.5959
18 months pre	0.6650	0.5517
18 months post	0.5954	0.5805
21 months pre	0.7050	0.5348
21 months post	0.5806	0.5558
24 months pre	0.6728	0.5654
24 months post	0.5549	0.5418

comparison is made between two sub-samples, pre and post-liberalization, which have the same interval. In terms of the first liberalization, the results indicate that value of Hurst in 12 months, 15 months, 18 months and 24 months pre-liberalization, are all higher than Hurst in the same length intervals post-liberalization. This implies that the first liberalization, which was in effect on June 1, 2009, affected weak-form efficiency of Vietnam stock market. The efficiency was improved after foreign ownership limitation was increased to 49%.

Regarding to the second liberalization, Table 3 shows that Hurst exponents of HNX-Index do not decline while the trend of VN-Index Hurst is unclear after the official dates 1st September 2015. This result brings conclusion that the completely removing foreign ownership limitation did not improve market efficiency of HNX-Index, which includes small and less-regulated stocks. In the meanwhile, the improvement was evidenced in some time-intervals of 12 months and 24 months of VN-Index, which is constituted of blue-chips and well-regulated equities.

Table 4 Hurst exponents in sub-samples division with unknown structural break dates

HNX-Index	Date	Hurst exponents
Period 1	14/07/2005–06/05/2008	0.6677
Period 2	07/05/2008–03/11/2010	0.6236
Period 3	04/11/2010–17/02/2014	0.6380
Period 4	18/02/2014–28/09/2017	0.6101
VN-Index	Date	Hurst exponents
Period 1	14/07/2005–19/03/2008	0.7109
Period 2	20/03/2008–20/01/2014	0.5941
Period 3	21/01/2014–04/12/2015	0.5127
Period 4	05/12/2015–28/09/2017	0.5271

We employ a standard framework that allows the structural changes through any of the model parameters was proposed by Bai and Perron (1998), and then Gil-Alana (2008) developed it to the procedure that is based in regression models for the fractional differencing parameters. From the daily time series of VN-Index and HNX-Index, we detected there are 3 structural break dates in each series. This Table presents the sub-sample division with the detected break dates and the relevant Hurst exponents

5.2.2 Sub-Samples with Unknown Structural Break Dates

Dividing sub-samples based on announcement dates might provide inaccurate conclusions because there are sometimes delaying effects when the policies are implemented. Thus, we make another sub-sample division with unknown break dates. The standard framework that allows the structural changes through any of the model parameters was proposed by Bai and Perron (1998), and then Gil-Alana (2008) developed it to the procedure that is based in regression models for the fractional differencing parameters. From the daily time series of VN-Index and HNX-Index, we detected there are 3 structural break dates in each series. Table 4 presents the sub-sample division with the detected break dates and the relevant Hurst exponents:

In the first period, HNX-Index (14/07/2005–06/05/2008) and VN-Index (14/07/2005–19/03/2008), both indexes have the highest value of Hurst. These intervals coincide with the hot "booming" period of Vietnam stock markets. The Hurst exponents decreased significantly from the second phase, HNX-Index (07/05/2008–03/11/2010) and VN-Index (20/03/2008–20/01/2014). The second period covers the most important milestones of policies in two stock exchanges, for example, the adoption of electronic trading systems and liberalization policies. For the VN-Index, Hurst exponent continued to decrease sharply in the third period (21/01/2014–04/12/2015).

To examine more about the changes of market efficiency level across the implementation of important policies, the next section presents the time-varying Hurst performance.

Table 5 Summary of Hurst Exponents of two indexes, VN-Index and HNX-Index

	HNX-Index			VN-Index		
	12 months	18 months	24 months	12 months	18 months	24 months
Mean	0.6548	0.6347	0.6227	0.6367	0.6264	0.6016
Median	0.6611	0.6494	0.6229	0.6191	0.6189	0.5839
Max	0.8152	0.7240	0.7744	0.8324	0.7578	0.7997
Min	0.4525	0.5042	0.4949	0.4233	0.4863	0.4683
Std. dev	0.0635	0.0454	0.0500	0.0812	0.0663	0.0744
Skewness	− 0.6594	− 0.8584	0.0352	0.2705	0.1617	0.4726
Kurtosis	3.6234	2.8156	2.6749	2.2707	1.8963	2.1261
Jarque–Bera	240.1471**	321.9315**	11.3472**	95.9597**	147.6476**	176.0187**

This Table shows descriptive statistics summary of Hurst Exponent series. Jarque–Bera value of series are all statistically greater than the critical value at the confidence level of 5%, indicating that all series of Hurst exponents do not match normal distribution

**Statistically significant at 5% level

5.3 The Time-Varying Hurst Performance

Time-varying Hurst exponents is an alternative approach that detects the evolvement of long-range dependence in time series data. The method was employed in previous studies of Cajueiro et al. (2009), Mensi et al. (2014), and Hoon et al. (2014). The series of Hurst exponents are calculated by "rolling sample" technique. The estimation starts with a specific window of returns. Then, the oldest observation is dropped off and the next observation is added as the sample selection moved forward in time. This process continues until the last observation is added to the calculation. The window sizes examined in this research are 250, 370, and 500 observation windows, which are approximately 12 months, 18 months, and 24 months, respectively.

5.3.1 Preliminary Analysis

Table 5 shows descriptive statistics summary of Hurst Exponent series. In the same window size, generally, all of VN-Index Hurst means and medians are smaller and closer to value 0.5 than the ones of HNX-Index. Jarque–Bera value of series is all statistically greater than the critical value at the confidence level of 5%, indicating that all series of Hurst exponents do not match normal distribution. Thus, non-parametric was employed to test the hypothesis of Hurst exponents' median equality between two indexes, in the same window size. Table 6 shows the equality test by different methods, including Wilcoxon, Med. Chi-square, Kruskal–Wallis, and Van der Waerden. The *p*-value of all test are less than 5%, so the hypotheses of Hurst median equality are all rejected. Combining test results from Table 5 and 6, it could be concluded that Hurst VN-Index outperforms Hurst HNX-Index in terms of randomness, or the former is more informationally efficient than the latter.

Table 6 Tests of the equality of medians

Methods	Wilcoxon/Mann–Whitney (tie-adj.)	Adj. Med. Chi-square	Kruskal–Wallis (tie-adj.)	Van der Waerden
Hurst 12 months	11.6343** (0.0000)	229.3029** (0.0000)	135.3554** (0.0000)	68.0108** (0.0000)
Hurst 18 months	6.3758** (0.0000)	164.8703** (0.0000)	40.6511** (0.0000)	7.9213** (0.0049)
Hurst 24 months	13.8770** (0.0000)	380.2371** (0.0000)	192.5771** (0.0000)	152.1597** (0.0000)

This Table shows the equality test by different methods, including Wilcoxon, Med. Chi-square, Kruskal–Wallis, and Van der Waerden. The *p*-value in brackets () of all test are less than 5%, so the hypotheses of Hurst median equality are all rejected

**Statistically significant at 5% level

This conclusion is supported by the comparison in terms of trading value between two stock exchanges, which was presented previously in Fig. 1. Stocks on HoSE have stricter listing requirements and in fact, almost of blue-chip equities are listed on this stock exchange. The participation of foreign capital flows on HoSE is also much more than on HNX, illustrated by both trading and selling values from 2007 to 2017. Because of asymmetric information in less developed markets, non-resident investors prefer well-informed stocks to high-growth rate and risky ones. The competition between individual and institutional investors, and between local and non-resident investors make market structure and market competition of HoSE become more complete, which results in a higher level of market efficiency than HNX (Fig. 4).

5.3.2 Time-Varying Levels of Weak-Form Efficiency

The center theme of analysis is two liberalization policies, the first one which was in effect on 1st June 2009 and the second one which was implemented on 1st September 2015. In addition, this study takes into consideration of other important policies in the period 2005–17. They are policies that regulate directly operation of Vietnam stock market, including (i) issuance of the Securities Laws was on 12th July 2006[7]; (ii) the adoption of electronic trading system in Hochiminh Stock Exchange on 24th November 2008, and in Hanoi Stock Exchange on 8th February 2010[8]; (iii) adjusting price limits system back to 10% and 7% for Hanoi Stock Exchange and Hochiminh Stock Exchange, respectively, on 15th January 2013[9]; (iv) adjusting settlement period to t + 3 on 4th September 2012 and t + 2 on 1st January 2016.[10] Because the market has been liberalized after the crisis of 2008, this recession period is also taken into the timelines as an independent event. Determining

[7] Ministry of Justice Vietnam (2006). The issuance of Securities Laws. Link http://www.moj.gov.vn.

[8] Hochiminh Stock Exchange (2014). Guidelines on transaction regulations, and Hanoi Stock Exchange (2016). Milestones in development. Link https://hnx.vn/vi-vn/gioi-thieu-hnx-lspt.html.

[9] Hochiminh Stock Exchange (2014). Guidelines on transaction regulations.

[10] Hanoi Stock Exchange (2018). Regulations on transactions. Link https://www.hsc.com.vn/vn/help-center/trading-regulations.

Fig. 4 Net Purchase value traded by foreign investors in 2009 and 2015. (Source: Hochiminh Stock Exchange, 2018; Hanoi Stock Exchange, 2018). The striking point of both Hanoi and Hochiminh stock exchanges in (**a**) is that purchase value continued to be greater than selling value after foreign cap had been adjusted to 49% in June 2009. The increase of foreign ownership limitation was positively correlated to the net capital inflows. **b** illustrates that purchase value tended to be less than selling value after foreign limitation had been completely removed in September 2015. The second liberalization did not result in the increase of net foreign investment ▶

the crisis period is based on Government announcements and specialist opinions. The starting time was on 27th March 2008 when the State Securities Commission of Vietnam officially announced the crisis and adjusted price limits system of both Hanoi Stock Exchange and Hochiminh Stock Exchange to 2% and 1%, respectively. The market started going on an upward trend and was announced recovery by the end of March 2009.[11] This paper uses the ending of March 2009 as the point of time when the crisis ended.

The timeline of those events is illustrated in Fig. 5. It can be seen from the figure that the policies and events could be grouped into four sub-periods: in the initial period 2006–07, issuance of Securities Laws is the most important milestone. In the following period from the end of 2008 to 2010, the Government's actions focused on liberalization and facilitating the online trading system. From 2012 to 2013 policies are about settlement period and price limit systems. Removing completely foreign ownership limitation and adjusting settlement period were the main policies in 2015–2016 when market structure become more complete.

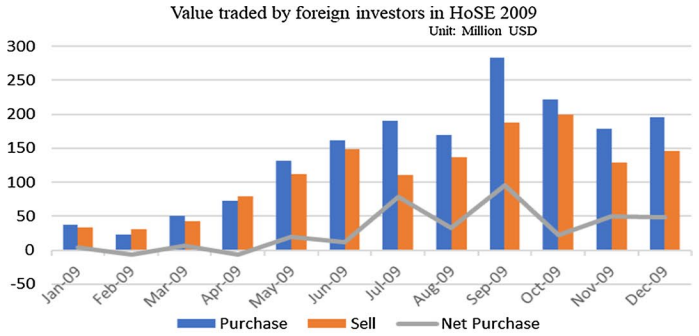
The time-varying Hurst exponents of VN-Index and HNX-Index are illustrated in Figs. 6 and 7, respectively. Four sub-periods are highlighted in grey areas. Here, the study aims to answer the important question: *Has Vietnam stock market become more informationally efficient after liberalization policies were implemented?* Thus, the analysis focuses on time paths of Hurst exponents in the second grey area, which covers the first deregulation in June 2009, and the fourth grey area, which includes the second market opening in September 2015.[12]

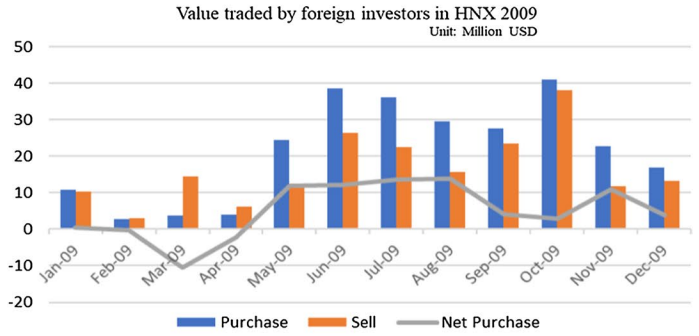
Figure 6 shows that the second-period witnesses a downward trend across milestones (3), (4), and (5) in all VNX-Hurst 250, 370, and 500 window-size series. In the fourth period, only the 250 observation-window time-path decreases after milestone (8) whereas the 370 and 500 observation ones do not show clear trends. In terms of HNX Hurst illustrated in Fig. 7, the second grey area also experienced a declining trend in all Hurst time-paths, however, in the fourth period non-time-varying series do decrease.

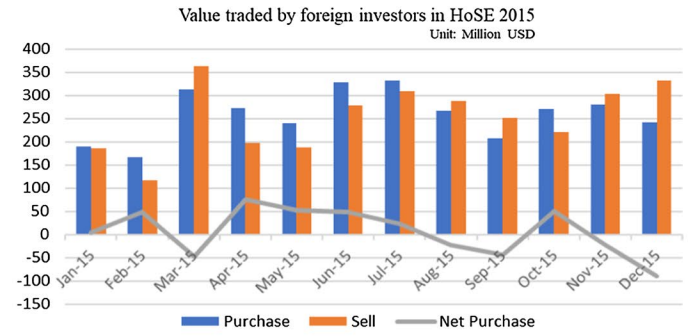
The time-varying Hurst exponents show that during the first deregulation period, the Government policies had a significant impact on long-term memories of both VN-Index and HNX-Index return. Hurst series decreased and approached closer to value 0.5 indicates market returns were toward more randomness. The likelihood

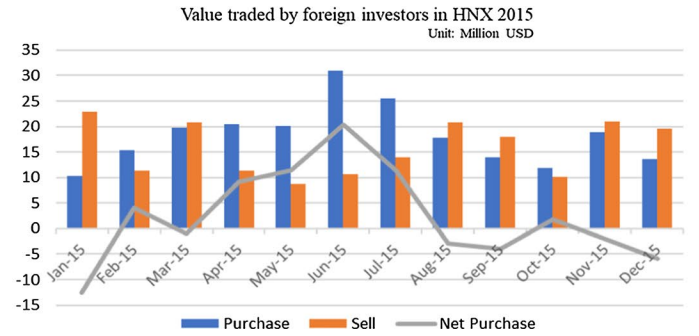
[11] Nguyen (2013). Vietnam stock market and the crisis 2008: the last knock-out. Link http://vneconomy.vn/chung-khoan/chung-khoan-viet-va-con-song-than-2008-cu-knock-out-cuoi-cung-20130914081150982.htm.

[12] Because of limited observations, 500 observation-window time-paths do not cover milestone (9).


Value traded by foreign investors in HoSE 2009
Unit: Million USD
300
250
200
150
100
50
0
-50
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Purchase
Sell
Net Purchase


Value traded by foreign investors in HNX 2009
Unit: Million USD
50
40
30
20
10
0
-10
-20
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Purchase
Sell
Net Purchase


Value traded by foreign investors in HoSE 2015
Unit: Million USD
400
350
300
250
200
150
100
50
0
-50
-100
-150
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Purchase
Sell
Net Purchase


Value traded by foreign investors in HNX 2015
Unit: Million USD
35
30
25
20
15
10
5
0
-5
-10
-15
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Purchase
Sell
Net Purchase

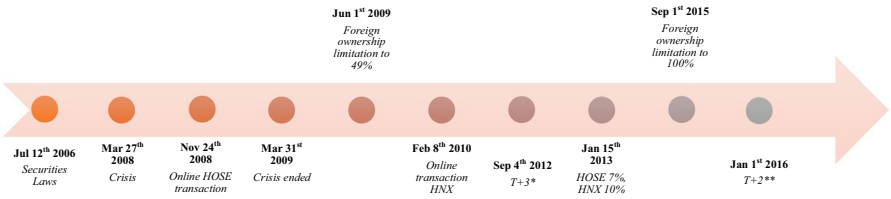


Fig. 5 The set of events and policies timeline. In the research period from 2005 to 2017, there are numbers of important events and policies that are supposed to affect market structure and market competition in Vietnam stock markets. In the initial period 2006–2007, issuance of Securities Laws is the most important milestone. The following period from the end of 2008 to 2010, the Government actions focused on liberalization and facilitating online trading system. From 2012 to 2013 policies are about settlement period and price limit systems. Removing completely foreign ownership limitation and adjusting settlement period were the main policies in 2015–2016 when market structure become more complete

of predicting future returns by looking at their past performance would decrease, meaning that market became more informational efficient. On the other hand, in the second liberalization period, HNX-Hurst did not converge to a value of 0.5 while the trend of VNX-Hurst was unclear. This research result suggests that deregulation of foreign investment does not always help market to become more efficient. The adjusting foreign ownership limitation from 30 to 49% in June 2009 opened more investment spaces for non-resident investors, which had impacted on market structure and market competition, contributing to the efficiency improvement. In the meanwhile, the completely removing foreign cap in September 2015 did not affect significantly weak-form efficiency, and as it was indicated in sub-samples analysis the second deregulation only impacted on foreign ownership of VN-Index top-tier equities.

6 Discussion

Both periods and time-varying Hurst methods bring the same answer for the first research questions: *Has the Vietnam stock market become more informationally efficient after liberalization policies were implemented?* The improvements in market efficiency were found, however, adjusting foreign ownership limitations do not always result in efficiency effects, for example of the completely removing foreign cap in September 2015. Thus, the theoretical framework about liberalization and market efficiency is challenged.

We return to the mechanism of how liberalization policies have an impact on information efficiency, which is explained by the participation of foreign investors in local equity markets. Although liberalization creates more spaces for foreign investors to participate in, their actual investment depends on other market conditions in the hosting country. Figure 4 illustrates purchase, selling, and net purchase value traded by foreign investors in the years 2009 and 2015 when ownership limitation was adjusted. The striking point in Fig. 4a is that purchase value continued to be greater than selling value after the foreign capitalization had been adjusted to 49%

in June 2009 on both Hanoi and Hochiminh stock exchanges. The increase of foreign ownership limitation was positively correlated to the net capital inflows. In the meanwhile, Fig. 4b illustrates that purchase value tended to be less than selling value even though foreign limitation had been completely removed in September 2015. The second liberalization did not result in an increase of net foreign investment.

Regarding the first liberalization in June 2009, the adjusting foreign cap to 49% took place after the Vietnam stock market had undergone the crisis of 2008. During the second half of 2008, trading behaviours of domestic and foreign investors are in two opposite directions. While individual domestic investors had lost their optimism on equity markets, foreign investors started buying stocks when the equities approached the lowest prices. Many abroad institutional investors were reallocating assets portfolio in this period and their selection of Vietnam equities was consolidated by prediction of market recovery in the short run as the result of the country's economic growth and implementing fiscal stimulus by Vietnam Government at the beginning of 2009. The purchase power of foreign investors, especially institutional investors, was one of the important factors pushing the market back to the recovery from May 2009. Foreign ownership in many companies reached to a limitation of 30% and it was necessary to lift the foreign cap in this period. The Decree 55/2009/QD–TTg, which was in effect on 1st June 2009, adjusting foreign ownership limitation to 49%, created more spaces for foreign capital inflows. The improvement of market efficiency after the first liberalization is explained by the increase in actual foreign investment.

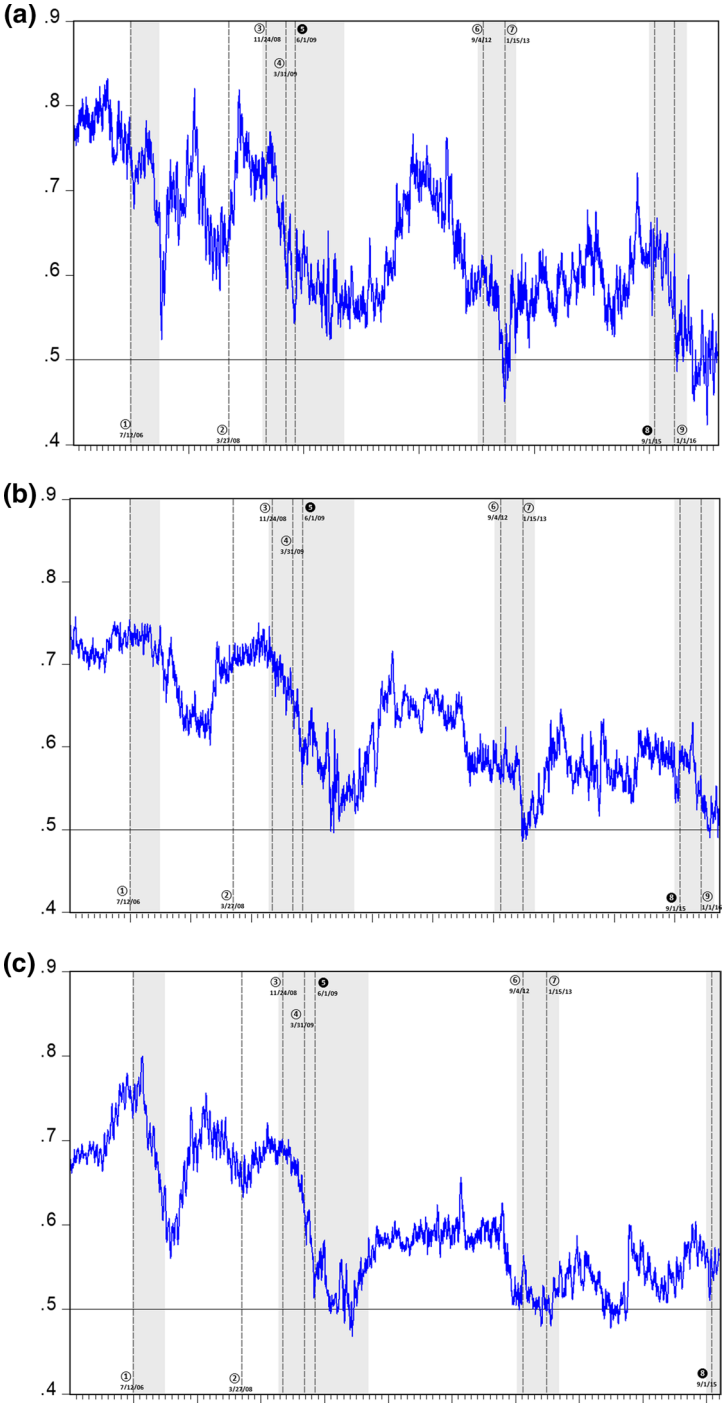
The second liberalization took place in September 2015 when foreign ownership in some public companies reached the limitation of 49%. This period also experienced that the Vietnamese Government was aggressively pushing for equitization of state-owned enterprises. In this situation, the removing foreign investment limitation aimed at supporting domestic supply of capital market. It was also expected that the second liberalization would bring positive effects for market performance and market efficiency like the first liberalization in 2009 had done. However, what happened in Vietnam stock market was different from the predictions. Figure 4b illustrates net foreign investment, on both Hochiminh and Hanoi stock exchanges, decreased in September 2015, slightly increased in the following month, but then declined significantly in the last two months of 2015. Both removing foreign cap and equitization process increased the supply of domestic stocks for non-resident investors, however, their demand was unchanged. Most of foreign investors in Vietnam stock market are institutional investors whose strategies are to create a diversified portfolio, instead of taking control of company business. At the end of 2015, there were only 20 companies in Hochiminh stock exchange whose foreign investors own more than 51% of stocks, and all are blue-chip equities of VN-Index. Besides, the decrease of crude oil price and the Vietnam Central Bank adjusting VND/USD exchange rate influenced negatively market performance, which resulted in the decrease of net foreign investment on both stock exchanges in the second half of 2015. Foreign participation only increased in the top performance of VN-Index stock group, but this could not offset the capital outflows in the lower tier equities. Thus, there is an unclear trend about the changes in market efficiency of VN-Index after the second liberalization. In the meanwhile, the completely removing foreign cap did not increase net foreign

Fig. 6 Time-varying Hurst exponents of VN-Index from July 2015 to September 2017. This figure illustrates time-varying Hurst exponents of VN-Index from July 14th 2015 to September 28th 2017. The series of Hurst exponents is calculated by "rolling sample" technique in 250, 370 and 500 observation windows, which are approximately 12 months, 18 months, and 24 months, respectively. Some events are highlighted: ① Securities Laws on Jul 12th 2006—② Crisis started March 27th 2008—③ Online HoSE transaction on November 24th 2008—④ Crisis ended March 31st 2009—❻ Foreign ownership limitation to 49% on June 1st 2009—⑥ t+3 on September 4th 2012—⑦ Price limits to 7% in HoSE and 10% in HNX on January 15th 2013—❽ Foreign ownership limitation to 100% on September 1st 2015—⑨ t+2 on January 1st 2016. **a** Time-varying Hurst exponent in 250 observation-window. **b** Time-varying Hurst exponent in 370 observation-window. **c** Time-varying Hurst exponent in 500 observation-window

investment in Hanoi stock exchange, and the improvement of market efficiency was not evidenced in this market opening.

The performance of time-varying Hurst exponents enables to answer the next research question: *Are there any other Government policies on equity markets, rather than liberalization policies, have impacts on informational efficiency?* In the first period of foreign investment deregulation, it could not be denied the impact of the adoption of online trading system. This effect is illustrated by the decrease of time-paths Hurst across milestone (4) in Fig. 6 and milestones (5) in Fig. 7. At the initial stage of development, the market infrastructure in Vietnam was not complete. The traditional trading floor system, for example, was a barrier to the participation of non-resident investors, who had been familiar with the global online trading. Thus, the adoption of an online trading system was an important complementary policy of liberalization process, which facilitate the foreign capital flows into Vietnam stock market. This allows foreign investors to trade domestic stocks more easily and reduces their cost of transactions. Online trading system also reduces information asymmetry and enables foreign investors to react as soon as new information arrives. In the second deregulation period, the adjusting settlement period to t+2, which is presented by milestone (9) on both graphs 6 and 7, is one important complementary policy. However, as explained in sub-sample Hurst analysis that the second liberalization only impacted on blue-chip equities of VN-Index, only the 250 observation-window VNX-Hurst decreases across milestone (9). The impact of settlement period t+2 was not evidenced in other time-varying Hurst series.

Effect of policies in other periods was also detected from time-path Hurst series. In the period 2006–07, the issuance of Securities Laws, which is presented by milestone (1), did not improve efficiency level. The long-term memory increased significantly on both HNX-Index and VN-Index during the market boom period 2007 and crisis period 2008, which is illustrated by the rise of Hurst series before and after milestone (2). During these periods, the market index fluctuated extremely. Individual domestic investors were the main participants and their herding behaviours pushed stock prices to be far away from the true values. Then, after milestone (3), when market was in the recovery period and the first deregulation of foreign investment took place, the efficiency level was improved, and market become more efficient. In the period 2012–13, the adjusting settlement period to t+3, milestone (6), had impact on the improvement of VN-Index efficiency. Both HNX-Index and VNX-Index did not become more efficient after price limits system was adjusted on 15th January 2013, represented by milestone (7).


(a)
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.6
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.4
(b)
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.7
.6
.5
.4
(c)
.9
.8
.7
.6
.5
.4

Fig. 7 Time-varying Hurst exponents of HNX-Index from July 2015 to September 2017. This figure ▶ illustrates time-varying Hurst exponents of HNX-Index from July 14th 2015 to September 28th 2017. The series of Hurst exponents is calculated by "rolling sample" technique in 250, 370 and 500 observation windows, which are approximately 12 months, 18 months, and 24 months, respectively. Some events are highlighted: ① Securities Laws on Jul 12th, 2006—② Crisis started March 27th 2008—③ Crisis ended March 31st 2009—❹ Foreign ownership limitation to 49% on June 1st 2009—⑤ Online transaction HNX February 8th 2010—⑥ t + 3 on September 4th 2012—⑦ Price limits to 7% in HoSE and 10% in HNX on January 15th 2013—❽ Foreign ownership limitation to 100% on September 1st 2015—⑨ t + 2 on January 1st 2016. **a** Time-varying Hurst exponent in 250 observation-window. **b** Time-varying Hurst exponent in 370 observation-window. **c** Time-varying Hurst exponent in 500 observation-window

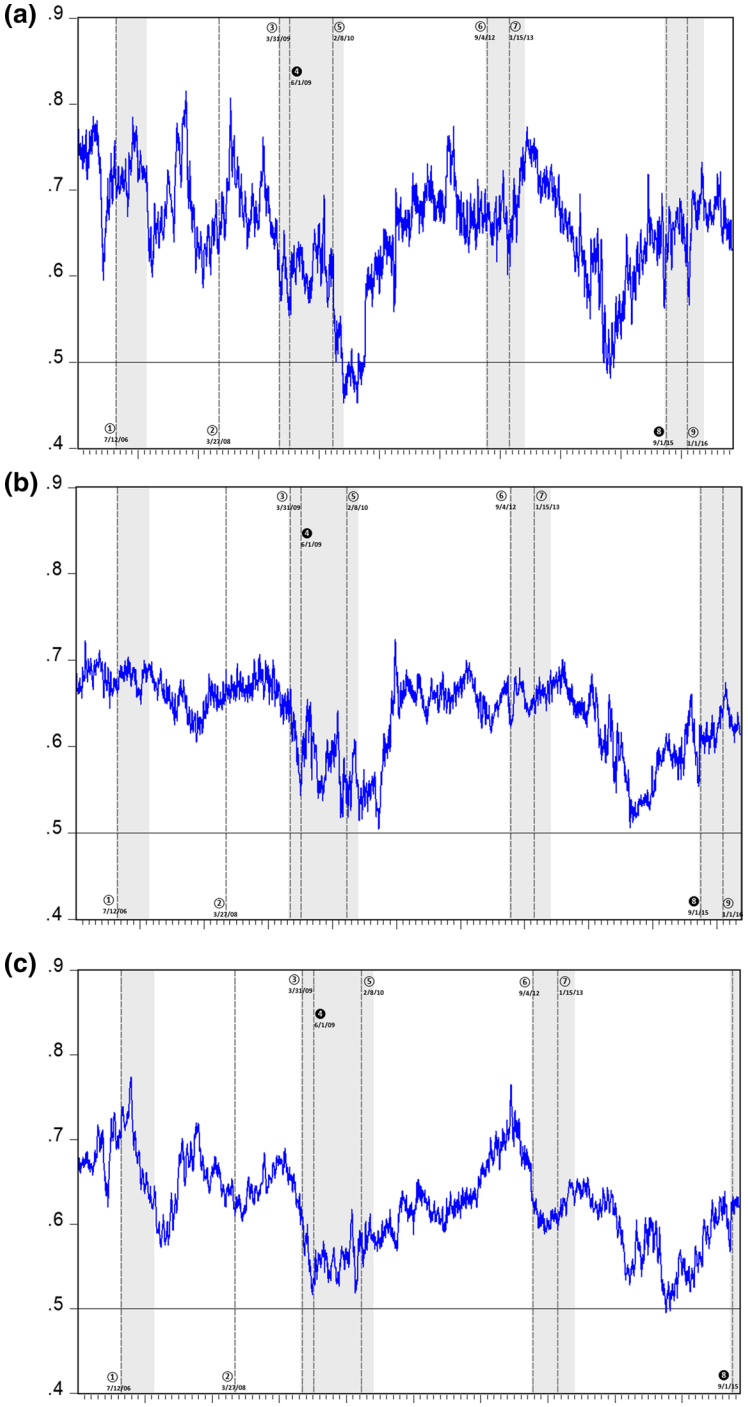
7 Research Implications

7.1 For Liberalization and Governance Policies

Literature research emphasized the role of foreign investors in improving market efficiency of the developing markets. Foreign investors are usually institutional investors and are more actively involved in informed trading. Their investment strategies adopt a long term horizon and utilize well-developed technology and highly skilled financial experts, which are advantages over local investors. Thus, the participation of foreign investors is expected to have an impact on market competition and market price mechanism, that promotes equity price reflecting the intrinsic value of the company (Henry 2000a, b; Bekaert et al. 2002; Lee & Wong (2012; and Aymen & Adel 2013). By examining the case study of Vietnam, this paper contributes some empirical evidence about the role of foreign investors in the frontier stock market. First, when market liberalization increases foreign investors' participation, for example of the first liberalization in Vietnam in June 2009, informational efficiency of the market was improved. Second, by comparing between Hochiminh Stock Exchanges and Hanoi Stock Exchanges, it was shown that the former has a higher degree of efficiency than the latter. One explanation given is that foreign investors participate more in Hochiminh Stock Exchanges, illustrated by both buying and selling volume, that makes market competition of Hochiminh Stock Exchanges more complete than the latter.

However, the research shows that liberalization policies are only a "necessary condition" for market efficiency improvement. Market opening does not always increase foreign participation, which then has a limited impact on efficiency. For frontier markets, the markets are often characterized as uncertain and vulnerable. Most of the foreign institutional investors strategize diversifying portfolio rather than taking control of local firms. In the second equity liberalization in Vietnam in September 2015, removing completely foreign cap increased the supply of domestic stocks, however, the demand from non-resident investors was unchanged. This results in market efficiency of Vietnam was not improved after the second liberalization like it was in the first market opening in June 2009. According to Lim et al. (2016), liberalization improves market efficiency, but this improvement disappears after foreign ownership exceeds a certain threshold level.

Not only about effects of market opening, but also our research brings evidence to illustrate how other governance policies influence market efficiency. The Hurst


(a)
.9
.8
.7
.6
.5
.4
① 7/12/06
② 3/21/08
③ 3/31/09
④ 6/1/09
⑤ 2/8/10
⑥ 9/4/12
⑦ 1/15/13
⑧ 9/1/15
⑨ 1/1/16
(b)
.9
.8
.7
.6
.5
.4
① 7/12/06
② 3/21/08
③ 3/31/09
④ 6/1/09
⑤ 2/8/10
⑥ 9/4/12
⑦ 1/15/13
⑧ 9/1/15
⑨ 1/1/16
(c)
.9
.8
.7
.6
.5
.4
① 7/12/06
② 3/21/08
③ 3/31/09
④ 6/1/09
⑤ 2/8/10
⑥ 9/4/12
⑦ 1/15/13
⑧ 9/1/15

values from sub-samples division with unknown break dates (Sect. 5.2.2) and time-varying Hurst exponents (Sect. 5.3) indicate the significant changes in market efficiency before and after the implementation of governance policies. In the early of development, Vietnam stock market experienced a hot "booming" period in 2007 and the market was at the least efficiency level in this period. According to Selmi et al. (2018), speculation has become more popular rather than investment in any young and not well-regulated markets. The lack of regulatory framework also facilitates the groups of investors to use a tactical approach for holding positions. Thus, the upward trend in this period often results in "market bubbles" and is associated with informational inefficiency. The efficiency starts improving only if markets offer equal chances for all investors to access transparent information and allows fair competition among participants. For the case study of Vietnam, we can observe that market efficiency improved significantly after the adoption of online trading system in November 2008, which then was followed by many other policy implementations in terms of transaction, liberalization and public information.

7.2 For Theory Development

Adaptive Market Hypothesis (Lo, 2004) is adopted in the research method to examine hypotheses of market efficiency. This theory is an evolutionary alternative to EMH and co-exists with Behavioural Finance theory, which states that the efficiency is time-varying and depends on dynamics of market structure and market competition. In this study, the analysis of time-paths Hurst exponents of Vietnam equity market in the period 2005–17 proved that market efficiency is not an all-or-none condition. Weak form efficiency is sensitive to stages of market development and policy implementation. The Hurst graphs indicate that a high level of efficiency could be achieved in some periods, but then market could turn back to be less efficient in the next time intervals. These conclusions bring an important contribution to the traditional theory of EMH and implication to the modern theory of market efficiency when the financial market dynamics become increasingly complex over time.

In addition, the AMH suggests a new research approach for future studies about informational efficiency, especially for those markets in the early stage of development when the market condition is still vulnerable. Based on more flexible assumptions, the AMH enables an examination of the market efficient hypothesis in more complex scenarios, extends the assumption of statistic characteristics and absolute sense of traditional EMH, and perform the time-varying efficiency that even suits markets with limited historical data.

8 Conclusion

This research contributes the case study of Vietnam to the literature of small and frontiers equity markets, which have been receiving increasing social and academic attention. In the early development of those markets, regulation about foreign capital

flows, usually via liberalization, is one of the most important policies that aim at both facilitating foreign investment and ensuring the stability of stock markets. However, because market conditions are characterized as uncertain and vulnerable, market openings in frontier markets might not bring positive outcomes as expected. This study of Vietnam concludes that liberalization does not always increase foreign participation, which then has a limited impact on informational efficiency. Completing market structure and governance policies is the "sufficient condition", along with the "necessary condition" of liberalization, to facilitate small markets to take advantage of benefits from foreign capital flows.

Furthermore, liberalization is not a risk-free policy. The wave of financial liberalization in emerging markets in the 1980s and 1990s, which created an interlinked global capital market and, also attributed to financial contagion among nations, for examples the Asian financial crisis 1997 and global financial crisis 2008, brought many lessons for policymakers of frontier markets in the later periods. In this respect, future studies may have to consider the challenging and risk assessment, configuring long term sustainable development models for small equity markets in the trends of liberalization and globalization.

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