Evidence of the Adaptive Market Hypothesis from Vietnam Stock Exchange

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Abstract

This paper uses the adaptive market hypothesis expounded by Lo (2004) to examine the degree of market efficiency in Vietnam Stock Exchange. The analysis focuses on the change of market efficiency amidst new regulations promulgated in critical economic contraction caused by Covid-19. For this purpose, this study uses the time-varying parameter model developed by Ito *et. al* (2014) to measure the degree of market efficiency in the VSE. The analytical results confirm that the degree of market efficiency in the VSE varied with time. More specifically, this study has substantiated the validity of the adaptive market hypothesis in the VSE from January 2010 to December 2021. Hence, the analytical results show that market efficiency in the VSE has increased in economic contraction caused by Covid-19. The empirical evidence indicates the degree of market efficiency in the VSE has declined slightly from in 2020 and early 2021. That said, not withstanding, this study confirms that the new regulation promulgated on 1 January 2021 gradually affects positively on the degree of efficiency in the VSE.

Keywords: Market efficiency, Adaptive market hypothesis, Vietnam Stock Exchange.
Interdisciplinary fields: Financial economics, Econometrics analysis, Economy in transition, Area studies.

1. Introduction

This paper intends to verify the adaptive market hypothesis in the Vietnam Stock Exchange (VSE) with respect to institutional change in the financial regulation amidst market shock caused by Covid-19. More specifically, our study estimates the degree of market efficiency in the VSE. Financial theory argues that efficiency of stock markets changes because of behavioral biases and structural changes attributed to institutional change.

Lo (2004) expounds the adaptive market hypothesis (AMH), which explains that prices reflect as much information as being determined by a spectrum of exogeneous economic variables. For instance, profit maximization from investment strategies depends on business conditions. Literature on AMH is well documented. Studies by Hull and McGroarty (2004), Lim and Brooks (2006), Neely *et al*. (2009), and Chong *et al*. (2012) have substantiated the adaptive market hypothesis. Moreover, Dzung *et al*. (2019) elucidates the validity of the AMH in the VSE. That said, however, their empirical investigation was conducted before 2019.

This paper intends to add value to existing literature. Our analysis addresses market efficiency in the VSE from two crucial perspectives: the influence of new regulations and market shocks caused by Covid-19 on AMH. Put differently, this study complements prior research on the AMH with two analytical focuses, viz., new regulations promulgated on 1 January 2019, and the effect of locked down caused by Covid-19.

In recent years, the VSE has increasingly influenced stock exchanges in Asia-Pacific region. Notwithstanding, the study of AMH in the VSE is still limited. Hence, this study aims to provide empirical evidence to domestic and foreign investors in Vietnam who want reliable information of the market efficiency in the VSE.

The remaining portion of this paper is structured as follows. Section 2 gives the literature review. Section 3 provides the methodology. Section 4 explains the data. Section 5 presents the estimated results. Section 7 discusses the findings. Section 7 concludes the paper.

2. Literature Review

Lo (2004) claims that efficiency changes in stock market for

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a variety of reasons. The most notable causes are behavioral factors and changes in fundamental conditions. Therefore, the efficient market hypothesis is unrealistic. He expounds the AMH, which argues that evidence validates an investor's irrationality is, in fact, consistent with the evolutionary model of human behavior. Prices reflect as much information as exogeneous variables being shaped by economy in general and the market conditions in particular.

The establishment of the AMH has triggered various analytical approaches in examining market efficiency in recent years. Ito *et al*. (2009) and Noda (2016) analyze the degree of market efficiency using a GLS-based time-varying auto-regression (TV-AR) model. The former investigated the US stock market, whereas the latter examines stock exchange in Japan.

Furthermore, many studies analyze the change in market efficiency with two different methodologies. The first approach measures market efficiency using the moving window method. For instance, Kim *et al*. (2011) use moving-window samples for the automatic variance ratio test. The analytical findings show that the predictability of returns fluctuates over time which is influenced by the change in market conditions.

On the other hand, Ito *et al*. (2014) and Noda (2016) use time-varying parameter auto-regressive models. It is worthy to note that the latter measures the degree of market efficiency with statistical inferences using a time-varying parameter model. Their findings show that the degree of market efficiency in the prewar stock exchange in Japan varied with time, and the variation occurred correspondingly with historical events.

This empirical study uses the time-varying degree of market efficiency to substantiate AMH. Subsequent sections explain our methodology and analytical findings.

3. Methodology

Empirical studies on the AMH in Vietnam is very limited. Therefore, this paper can contribute to the accumulation of literature in this important field of financial economics. the existing literature has not clarified the factor that influences the degree of market efficiency in VSE. For this reason, we intend to verify the validity of the AMH in VSE. Therefore, this study focuses on the analysis of the influence of government policy on the degree of market efficiency in the VSE.

More specifically, this study conducts two estimations. Firstly, the time-varying of the degree of market efficiency. Secondly, the relationship between government policy and the degree of market efficiency.

3-1. Hypothesis

This analysis intends to test three hypotheses: "The validity of the AMH in the VSE"; The effect of the market degree of efficiency being caused by the announcement of new regulations"; "The influence of economic contraction caused by Covid-19 on the VSE".

3-2. A time-varying autoregressive model approach

Many studies use auto-regressive model, as shown in (1), for estimating the coefficient of each independent variable.

$$x_t = \alpha_0 + \alpha_{1,t}x_{t-1} + \alpha_{2,t}x_{t-2} + \cdots + \alpha_{q,t}x_{t-q} + \varepsilon_t \qquad (1)$$

In this model, x_t is the stock return at time t, ε_t is the residuals. This model assumes that coefficients $\alpha_{1\ldots q}$ are constant in time series analysis.

Hence, Ito *et al*. (2014) use auto-regressive model for conducting a time series estimation of the coefficients of independent variables shown in (2).

$$x_t = \alpha_0 + \alpha_{1,t}x_{t-1} + \alpha_{2,t}x_{t-2} + \cdots + \alpha_{q,t}x_{t-q} + \varepsilon_t \qquad (2)$$

The definitions of x_t and ε_t are the same as (1). However, Ito *et al*. add (3), as shown below, for their estimation.

$$\alpha_{i,t} = \alpha_{i,t-1} + u_t, \qquad where\ i = 1,2 \ldots q \qquad (3)$$

In (3), x_t, α_i, u_t and ε_t, respectively is stock return at time t, the time-varying coefficients, u_t and ε_t are the residuals. This specification enables Ito *et al*. to use (2) and (3) as a set of simultaneous equations.

3-3. Time-varying degree of market efficiency

Ito *et al* (2014) compute the degree of market by the autoregressive estimated coefficients, $\hat{\alpha}_1 \ldots \hat{\alpha}_q$. In this respect, they formulate (4).

$$X_{t-1} = \begin{bmatrix} x_{t-1} \\ x_{t-2} \\ \vdots \\ x_{t-q} \end{bmatrix},\ A_t = \left[\alpha_{1,t}, \alpha_{2,t} \ldots \alpha_{q,t}\right] \qquad (4)$$

We denote I_q as an identity matrix of order q, then (3) and (4) can be expressed in matrix form. Also, (2) can be rewritten as shown in (5)

$$x_t = \alpha_0 + X_{t-1}^T A_t^T + U_t, \qquad (5)$$

Where $X_{t-1}^T A_t^T$ is the product of the transpose of $X_{t-1}$and A_t. Hence, (5) becomes,

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_T \end{bmatrix} = \begin{bmatrix} 1 & X_0^T & & & 0_{1\times T} \\ 1 & & X_1^T & & \\ 1 & & & X_2^T & \\ \vdots & & & & \ddots \\ 1 & 0_{1\times T} & & & X_{T-1}^T \end{bmatrix} \begin{bmatrix} \alpha_0 \\ A_1^T \\ A_2^T \\ \vdots \\ A_T^T \end{bmatrix} + \begin{bmatrix} u_0 \\ u_1 \\ u_2 \\ \vdots \\ u_T \end{bmatrix} \qquad (6)$$

We denote the following matrices.

$$y = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_T \end{bmatrix}, \quad M = \begin{bmatrix} 1 & X_0^T & & & & 0_{1\times T} \\ 1 & & X_1^T & & & \\ 1 & & & X_2^T & & \\ \vdots & & & & \ddots & \\ 1 & 0_{1\times T} & & & & X_{T-1}^T \end{bmatrix},$$

$$\beta = \begin{bmatrix} \alpha_0 \\ A_1^T \\ A_2^T \\ \vdots \\ A_T^T \end{bmatrix}, U = \begin{bmatrix} u_0 \\ u_1 \\ u_2 \\ \vdots \\ u_T \end{bmatrix}$$

$0_{1\times T}$ is a $1 \times T$ null matrix.

We can then rewrite (6) as (7).

$$y = M\beta + U \tag{7}$$

Similarly, we can rewrite (3) as follows.

$$y \begin{bmatrix} -A_0^T \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} = \begin{bmatrix} 0_{q\times 1} & -I_q & & & & 0_{q\times q} \\ 0_{q\times 1} & I_q & -I_q & & & \\ 0_{q\times 1} & & I_q & -I_q & & \\ \vdots & \vdots & & & \ddots & \\ 0_{q\times 1} & 0_{q\times q} & & & & -I_q \end{bmatrix} \begin{bmatrix} \alpha_0 \\ A_1^T \\ A_2^T \\ \vdots \\ A_T^T \end{bmatrix} + \begin{bmatrix} v_0 \\ v_1 \\ v_2 \\ \vdots \\ v_T \end{bmatrix}$$

We then define (8) as follows.

$$z = \begin{bmatrix} -A_0^T \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix},$$

$$W = \begin{bmatrix} 0_{q\times 1} & -I_q & & & & 0_{q\times q} \\ 0_{q\times 1} & I_q & -I_q & & & \\ 0_{q\times 1} & & I_q & -I_q & & \\ \vdots & \vdots & & & \ddots & \\ 0_{q\times 1} & 0_{q\times q} & & & & -I_q \end{bmatrix}, V = \begin{bmatrix} v_0 \\ v_1 \\ v_2 \\ \vdots \\ v_T \end{bmatrix} \tag{8}$$

(8) is rewritten to (9), (10) and (11) as shown below.

$$z = W\beta + V \tag{9}$$

$$z \begin{bmatrix} y \\ z \end{bmatrix} = \begin{bmatrix} M \\ W \end{bmatrix} \beta + \begin{bmatrix} U \\ V \end{bmatrix} \tag{10}$$

$$\alpha = \begin{bmatrix} y \\ z \end{bmatrix}, \quad B = \begin{bmatrix} M \\ W \end{bmatrix} \tag{11}$$

The analytical model is based on (12) and (13).

$$\hat{\beta} = (B^T B)^{-1} B^T \alpha \tag{12}$$

$$\varsigma_t = \left| \frac{\sum_{j=1}^{q} \hat{\alpha}_{t,j}}{1 - \sum_{j=1}^{q} \hat{\alpha}_{t,j}} \right|, \varsigma_t \text{ is the degree of efficiency.} \tag{13}$$

The model quantifies the market's divergence from efficiency. Notably, in the situation of an efficient market, where $\alpha_1 = \alpha_2 = \cdots = \alpha_q = 0$, ζ_t is 0. The value deviates from 0 when the degree of efficiency declines. Hence, ζ_t is the gauge for the degree of market efficiency. More specifically, market becomes inefficient if the estimated ζ_t is deviated from 0.

The aforementioned theoretical foundation determines the specification as shown in (14). This model uses a time series regression for testing the validity of AMH in the VSE. This model assumes a time invariant auto-regressive model with a constant and employing Schwarz's Bayesian information criteria (SBIC). This assumption supports the incorporation of a variable in the optimal lag order.

$$\zeta_t = \alpha_0 + \beta_1 New\_Regulation_t + \beta_2 Before\_Lock_t + \beta_3 During\_Lock_t + \varepsilon_t \tag{14}$$

where:

ζ_t is the degree of the market efficiency at that time t.

$New\_Regulation_t$ is a dummy variable that indicates the issuance of new regulations. It equals 1 between January 2019 and December 2020, and 0 otherwise.

$Before\_Lock_t$ is a dummy variable that indicates the first confirmed COVID-19 case until the nationwide social distancing period. It equals 1 if the day is during the period from January 30, 2020, to March 30, 2020, and 0 otherwise.

$During\_Lock_t$ is a dummy variable that indicates the nationwide social distancing period. It equals 1 if the day is during the period from April 1, 2020, to April 15, 2020, and 0 otherwise ε_t is a random disturbance term in the regression equation.

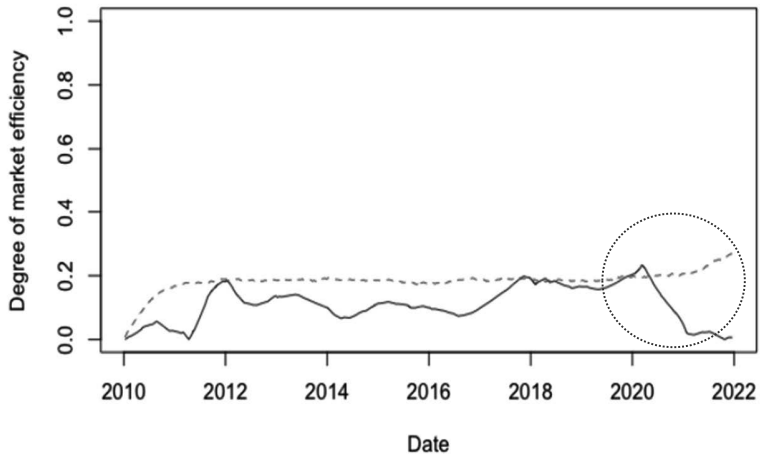
On this basis, the analysis uses a first-order autoregressive model for the estimation. Subsequently, we conduct the regression analysis of the TV-AR model. This part of regression uses Ito *et al*. (2014) for estimating the degree of market efficiency. After this, we undertake the bootstrap procedure to construct the confidence band for ζ_t.

The procedure is as follows. First, we evaluate the stock returns data with the residuals of autoregression estimation under the aforementioned hypothesis that all coefficients are zero (i.e., the validity of the AMH). Then we extract N samples regarding the distribution of the residuals. Secondly, we fit a time-varying autoregressive model to the N bootstrap samples and then derive N sets of their estimates. Thirdly, we compute the N bootstrap samples of ζ_t from the estimates. Finally, we build the confidence bands from the N bootstrap samples. Based on the estimated degree of market efficiency mentioned above (i.e., ζ_t), we examine whether the effect of the change in government regulations.

4. Data Collection

The data sample is derived from weekly stock returns in the VSE Index for testing the AMH. For the estimation of the market degree of efficiency (i.e., ζ_t), the analysis uses data

Figure 1 The Degree of the market from 2010 to 2021 period in the VNE Index



Note: The thick line in the graph plots the degree of market efficiency, and the dashed lines represent the 95% confidence bands of the time-varying in case of the efficient market. We run 2,000 times bootstrap sampling to calculate the confidence level.

Table 1 Estimated results

	Coefficient	Std. dev	t-statistic
constant	0.100	0.002	44.225***
new_regulation	0.052	0.005	8.814***
before_lock	0.065	0.014	4.380**
during_lock	0.064	0.036	1.749

*Note: This table presents a multiple regression analysis including interaction, which was performed using new regulations, Before_Lock and During_Lock in weeks as explanatory variables, and degree of market efficiency as the outcome. ***, **, * indicate significance at 1%, 5\%, and 10%levels respectively.*

sample from January 2010 to December 2021. There are 619 observations in this study. In addition, the estimation uses weekly stock returns on the VSE from January 1, 2019[1], which was the date of the promulgated new Securities Law 2019 for examining the effects of the new regulation. The end date of the weekly data stock is December 31, 2020[2]. The study examines the effects of COVID-19 before lockdown from January 23, 2020, which is the first confirmed COVID-19 case in Vietnam[3], to March 30, 2020. The lockdown period was from April 1, 2020, to April 15, 2020[4]. We use R package for the estimation.

5. Empirical Results

Our estimation selects the optimal lag order based on the assumption of a time invariant auto-regressive model with a constant and applying Schwarz's Bayesian information criteria (SBIC). In the estimation, we chose a first-order autoregressive model for the VNE Index. This investigation measures the stock market deviation from the efficient condition by using Equation (13). For example, considering the VNE Index, the degree of the market efficiency shows the deviation from the efficient market. If $\zeta_t = 0$ for time t, then market is efficient at that time t.

Figure 1 shows the estimated degree of market efficiency in the VSE. If the market was efficient for the entire data sample period, the statistics for degree of market efficiency must fall inside the confidence level. Figure 1 illustrates that the estimated degree of market efficiency is generally efficient. That said, however, it also shows that the degree of market efficiency varies over time. The degree of the market efficiency is high from 2010 to 2018, but its efficiency dropped in 2020. The change in market efficiency was caused by the promulgated new regulation on January 1, 2019, in the VSE.

The newly promulgated regulation is intended to strengthen the functioning of securities market in Vietnam because there were correctable or avoidable shortcomings in the past. In spite of the well-intended policy for correcting market distortion in the VSE, the new regulation has reduced the degree of market efficiency from mid-2019 to early 2020.

By and large, our analytical findings support the AMH, which maintains that dynamic market conditions determine the extent to which the stock market is efficient. After early 2020, the degree of market efficiency has increased. The V-shaped recovery of the degree of efficiency validates the role of the

[1] Retrieved from https://www.ssc.gov.vn/ubck/faces/oracle/webcenter/portalapp/pages/vi/chitietvanbangopy.jspx on December 1, 2018.
[2] The government adopted Decree 155/2020/ND-CP on December 31, 2020 ("Decree 155"), which came into effect on January 1, 2021.
[3] Retrieved from https: //thehill.com/policy/healthcare/public-global-health/479542-vietnam-reports-first-coronavirus-cases.
[4] Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7567433/.

newly promulgated regulation. it is affected by the policies of the government institute.

On the other hand, Vietnam's economy was seriously and still is affected by COVID-19. Because of extraordinary rise of infected people in 2020, Vietnam's government imposed strict locked down in April 2021. For this reason, this study also examines the effect of locked down on the degree of market efficiency. Table 1 shows the estimated results. The figures indicate that the newly promulgated regulation and before locked down policies give positive effects on the degree of market efficiency. The estimated coefficient of locked down is not statistically significant.

6. Discussion

6-1. New Securities Law 2019

For the purpose of strengthening the institutional framework for investment and businesses, Vietnam's government adopted Decree 155/2020/ND-CP on December 31, 2020 ("Decree 155")[5], which came into effect on January 1, 2021. Decree 155 establishes, among others, new rules for foreign investment in the VSE. The government intends to encourage foreign investments in the VSE through a spectrum of laws while retaining proper oversight over foreign investment inflows. This study has examined several of the important provisions of Decree 155 as shown below.

- For eligible IPO issuers, the threshold for paid-up charter increases from 10 billion VND to 30 billion VND.
- Profitable performance history ranges between one and two years
- Issuers subject to criminal prosecution or having been convicted of any one of the crimes of violation of economic management order are prohibited.
- Companies successfully completing an IPO by registration with the State Securities Committee ("SSC") are also classified as public companies.

After the promulgation of these policies, Ho Chi Minh City Stock Exchange and Hanoi Stock Exchange were integrated into the VSE. Furthermore, Vietnam's government created the Vietnam Securities Depository and Clearing Corporation (VSDC), or the use of Non-voting Depository Receipts for enhancing market accessibility. More specifically,

- Under the new law of 2019, the securities market is organized and operated solely by the VSE, a corporate 50 percent or more held by the state and its subsidiaries.
- There are currently three clearing banks in the market: SBV for treasury bonds, BIDV for common securities, and Vietinbank for derivatives.
- The new law sets conditions for new players who wish to enter this niche market. The most notable requirements are charter capital of more than 10 trillion VND, two years of profitable operation, capital adequacy ratio satisfaction, and other technical infrastructure requirements.

Vietnam's government permits 100 percent of foreign institutions operating in the banking, securities, and insurance industries and originating in countries that have signed bilateral agreements with SSC for securities companies and fund management companies. However, for other foreign organizations and individuals, the ceiling is set at 49 percent.

Measuring the effects of regulatory changes has attracted greater attention from academic and business communities in recent years. Robin (1989) measures the effects of the passage of the Interstate Commerce Act of 1887 on firms in the railroad industry. His finding indicates that the Interstate Commerce Act had a significant positive impact on railroad stock prices. Binder (1983) uses stock price data to measure the effects of regulation. The results suggest that stock return will not be very useful in studying the effects of regulation because the dates that market expectations have changed are not precisely known. Notwithstanding, our estimated results in this study show that newly promulgated regulation indeed has improved the degree of the market efficiency.

6-2. COVID-19

The outbreak started at the end of 2019. The pandemic has been and still is causing extraordinary negative impacts on economic activities and everyone's livelihood in all countries spanning the world. The WHO (World Health Organization) called it a pandemic on March 11, 2020, and as of December 28, 2020, 222 countries/regions are affected with over 79 million confirmed cases and approximately 2 million deaths, at the time of this writing[6]. Vietnam's stock market is no exception. The VSE index fell sharply in the first three months, from December 31st, 2019, to March 30th 2020[7]. Vietnam's government issued Directive No. 16/CT-TTg[8]. Prime Minister of Vietnam implemented a nationwide lockdown, extending the period from 1 April 2020 to 15 April 2020, to prevent community transmission of the virus. As a result, government successfully controlled COVID-19 infection rates. Zhang *et al*. (2020), Yilmazkuday *et al*. (2021), Onali *et al*. (2020), and Dao *et al*. (2020) show that COVID-19 has serious effect on the stock markets around the world. The estimated results of this study show in the locked down due to Covid-19 is statistically insignificant with respect to the degree of market efficiency.

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[5] https://english.luatvietnam.vn/law-on-securities-no-54-2019-qh14-dated-November-26-2019-of-the-national-assembly-179050-Doc1.html

[6] Retrieved from https://www.who.int/emergencies/diseases/novel-coronavirus-2019

[7] Retrieved from https://www.investing.com/indices/vn

[8] Retrieved from https://www.tilleke.com/insights/vietnam-issues-strict-social-distancing-measures-combat COVID-19/

7. Conclusion

This study examines the validity of the AMH, propounded by Lo (2004), in the VSE. This analysis measures the degree of market efficiency by using a time-varying model approach of suggested by Ito *et al* (2014) and Noda (2016). Their approach provides a more accurate measurement of market efficiency than using the moving window method. Our analytical findings confirm the degree of market efficiency fluctuates over time which is influenced by exogenous variables caused by the change in market conditions. Moreover, this study also confirms that the new regulations affect the degree of market efficiency. At the same time, the findings show in COVID-19 time, the degree of market efficiency is higher than in normal times. Therefore, the empirical results support the AMH in the VSE.

This study does not include other economic variables and events related to Covid-19 which may affect the degree of market efficiency in the VSE. The results obtained here could have changed if other variables were incorporated in the estimation. This is the limitation. Therefore, we intend to conduct analysis that can identify other economic and institutional elements that influence market efficiency in the VSE. This is the subject of our future research.

(Received on 6 January 2022
Revised on 15 February 2022
Publication approved on 25 February 2022)

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