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BANKING & FINANCE | RESEARCH ARTICLE

Minimum variance portfolio in ASEAN-6 stock markets diversification: A Vietnamese perspective

Tri M Hoang^{1,2}*

Abstract: Using daily and monthly MSCI index returns of Association of Southeast Asian Nations (ASEAN) markets for the period 2007 and 2021, this study aims to examine if there are any advantages to diversification in ASEAN markets for Vietnamese investors and if those perks have altered between pre and post 2008 financial crisis (period 1) and pre and during the Covid-19 pandemic (period 2). Correlations are evaluated pre and post crises using both an 86-month correlation window for the whole period and a 12-month rolling correlation window. To assess the benefits of diversification, several portfolios are built employing the Markowitz Portfolio Optimizer using a minimum-variance (MV) reference. Correlations between ASEAN emerging markets have risen between before and after crises. Diversification advantages are available to Vietnamese investors, although benefits have declined during crises, and they seem to be stronger in emerging markets than in Singapore (a developed market). As a result, this paper suggests that Vietnamese investors should look other alternative approaches than the MV portfolio method to minimize investment risks during crises. Vietnamese investors also need to prepare different investment strategies for each period as the perks of ASEAN diversification in periods 1 and 2 are not the same.

ABOUT THE AUTHOR

Tri M. Hoang is a Ph.D. student at the University of Economics Ho Chi Minh City (UEH) in Vietnam, working under the guidance of Prof. Su Dinh Thanh. His thesis examines the diversification of asset returns in portfolio management for investors from emerging markets. This article is based on a section of his doctoral thesis. Behavioral finance and markets, as well as empirical asset pricing, are among his research interests.

PUBLIC INTEREST STATEMENT

As the members of ASEAN (Association of Southeast Asian Nations) grow more legally and economically interconnected, Vietnamese investors may diversify their investments overseas. More significantly, the opportunity to make international gains and minimize investment risks become attractive for Vietnamese investors when effects of crises such as the 2008 financial crisis and the ongoing Covid-19 pandemic enhance the difficulties of investors' portfolio diversification. This study responds to the question of whether the ASEAN diversified portfolios help Vietnamese investors reach their goals using a risk-based approach. A significant conclusion is that diversification benefits are attainable to Vietnamese investors, although at a reduced level during crises, and seem to be greater in emerging countries. Additionally, Vietnamese investors should develop distinct investment strategies for each time, since the benefits of ASEAN diversification vary according to the period.

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Subjects: Statistics; Statistics for Business, Finance & Economics; Finance; Investment & Securities

Keywords: ASEAN Equity Markets; Asset Correlations; International Diversification; Portfolio Diversification Benefits JEL Classifications: G11; G15; C14.

1. Introduction

Over the last two decades, the transaction fees of international acquisitions have significantly declined due to the rise of the internet. The internet's prevalence has also aided in the removal of other obstacles to foreign investment, such as the circulation of and availability of information, as well as the general convenience of executing trades. That, along with the movement of accounting principles to a more standardized universal norm, has made it easier for investors to diversify globally (Levy & Levy, 2014).

According to Demirci et al. (2021), diversifying globally has historically been and continues to be a useful approach to lowering risk in an investment portfolio. Diversification is the process through which an investor attempts to lessen country-specific risks by investing in several different nations. A trader has traditionally been able to achieve a higher risk-adjusted return by distributing his or her assets across other stock markets that have low correlations to the domestic market and have diverse macroeconomic features than if he or she had just put money in their home country (Bermejo et al., 2020).

According to Hunter and Coggin (1990), there are no advantages to diversifying globally if correlations are perfect or equal to 1, and if correlations are zero, portfolio risk is decreased in proportion to each overseas asset introduced to the portfolio. If correlations were less than zero, the portfolio risk would be reduced even further for each additional foreign asset. Previous research finds that the worldwide diversification of stocks produces significant benefits. According to Solnik (1974), a globally diversified portfolio is just half as risky as a diverse U.S. investment portfolio, and German and Swiss investors would benefit much more from foreign diversification During the 1980s and 1990s, Odier and Solnik (1993) discover that US equities have an average correlation of roughly 0.50 with 16 other markets; an ideal international investment portfolio with the same risk generates better annual returns of 19.0 percent compared to 13.3 percent for the US portfolio.

Since the global economy has grown more international, the bulk of published evidence has shown that the correlations of several global financial markets have risen significantly during the last twenty years. This implies that prominent equity markets, such as those in the United States, Germany, and the United Kingdom, fluctuate with higher covariance. As a result, a rise in the top American stock markets over a particular period would almost certainly result in an equally substantial increase in the major exchanges in Germany and the United Kingdom (Bodie et al., 2018).

Because a comparatively low correlation is among the major motivations to rebalance globally and has largely been among the principal factors, if global stock market correlations are improving and have achieved high levels, the issue is whether the advantages of global diversification have declined in recent years and whether the reduction has indeed been substantial (Mukherji & Jeong, 2020). The study on the subject yields contradictory results, with some stating that advantages may still be obtained by global diversification and others suggesting the contrary.

The contradictory results of some of the existing studies serve as the initial impetus for additional investigation on the subject. Furthermore, the great bulk of past research has been undertaken from the standpoint of an investor in advanced countries or major emerging nations, with hardly any studies undertaken from the perspective of small emerging nations with frontier domestic stock markets. To add to the latter viewpoint, this research will look at whether there are any international diversification gains available to Vietnamese investors that use a risk-based approach.

The purpose of this study is to investigate if the Vietnamese stock market's return correlations have risen versus other stock markets and if there are any achievable benefits for Vietnamese investors from foreign diversification. It also examines the benefits of international diversification and how they have evolved over periods.

To assess whether Vietnamese investors gain from international diversification, a Vietnam-only portfolio will be evaluated against portfolios with varied allocations to ASEAN-6 markets, by using minimum variance portfolios, based on a modern portfolio framework and the capital asset pricing model. The Sharpe ratio, Sortino ratio, value at risk (VaR), and Jensen's alpha will be explored to differentiate between the portfolios and determine whether the portfolio distribution is preferable from the other. All indicators are affected by portfolio volatility, which is impacted by the portfolio variance and the correlation between the assets (Scherer, 2010). Hence, minimizing portfolio variance improves these measurements and diversification benefits.

To see how the financial crisis in 2007/2008 and the Covid-19 pandemic has impacted international diversification benefits for Vietnamese investors, there is a comparison of the benefits from before and after the 2008 global financial crisis and the ongoing Covid-19 outbreak. This is accomplished by employing two periods, the first of which is the period preceding the financial crisis until the revival of Vietnamese markets, and the second of which is an equally long time following the recovery of global markets following the financial crisis until the present Covid-19 epidemic. Period 1 begins in January 2007 and ends in February 2014, whereas Period 2 begins in March 2014 and ends in April 2021.

With international stock markets becoming more available, Vietnamese investors must understand if diversifying into ASEAN-6 markets is valuable in terms of risk mitigation and return. As ASEAN markets are net recipients and transmitters of volatility spillovers from other regions in the 2008 financial crisis (Kang et al., 2019), a priority for investors is to minimum-variance diversify their portfolio to other markets. Comparing diversification gains between two periods helps better comprehend how the global financial crisis and Covid-19 pandemic affects ASEAN-6 markets and their covariance.

2. Overview of the research context

2.1. ASEAN Exchanges

ASEAN Exchanges is a partnership of exchanges from Malaysia, Vietnam (2 exchanges), Indonesia, the Philippines, Thailand, and Singapore to encourage ASEAN financial market development by delivering more ASEAN investment options to more market participants. The ASEAN Exchanges partnership established the ASEAN Trading Link on 18 September 2012, as a channel for securities brokers to provide investors with faster access to linked exchanges. The first two markets to join the connection on the inauguration day were Bursa Malaysia and Singapore Exchange, while The Stock Market of Thailand joined on 15 October 2012, establishing a virtual market of over 2,200 listed businesses with a total market value of US\$1.4 trillion (ASEAN Exchanges, 2012).

2.2. The Covid-19 pandemic

Since the World Health Organization (WHO) declared the new coronavirus (COVID-19) a worldwide pandemic on 11 March 2020, the virus has affected 23.3 million individuals and killed 741,000 across 210 nations. In Southeast Asia, 17 ASEAN member nations confirmed at least 869,515 cases and 21,076 fatalities in October, albeit this figure is certainly much higher due to the vast number of undocumented or misdiagnosed cases, particularly in underdeveloped nations with shaky healthcare systems. Indonesia has the greatest mortality rate as a proportion of its

population (4.56) as of August 2020, whereas Singapore has the lowest mortality rate in the area (0.05; Djalante et al., 2020).

3. Literature review

3.1. Theoretical perspectives

The first formal study of the risk-return relationship or the modern portfolio theory (MPT) by H. Markowitz (1952) considers the relationship between beliefs and portfolio choices, according to the "expected return-variance of returns". Empirical results confirm the strong relationship between risk and returns and the importance of diversification in investment. Roy (1952) examines the risk-return relationship by exploring the effects of upper-bound minimization of a chance of a reluctant event when the available information of a probability distribution is restricted to the first and second moments. This is the commencement of the portfolio theory. H. M. Markowitz (1959, p. 22) defines an efficient portfolio as a portfolio whose average returns cannot increase without incurring greater standard deviations. Since then, based on diversification, academics have put effort to devise several selection rules (Alexander & Baptista, 2002; Cumova & Nawrocki, 2014; Elton et al., 1976; Holthausen, 1981; H. M. Markowitz, 1959) and asset pricing theories such as capital asset pricing model (CAPM) proposed by Sharpe (1964) and Ross (1976).

The goal of MPT is to build a portfolio with the best potential return given the degree of risk, a portfolio known as the optimal portfolio in the theory. To do this, the model focuses on three components: Capital allocation between the portfolio and the risk-free asset, capital allocation across asset classes, and selection of assets. The ideal allocation to obtain the optimal portfolio is thus defined by the investor's risk aversion and the risk-return trade-off. When developing the optimal portfolio, picking assets is based on the covariance between the assets rather than the individual attributes of the assets. This indicates that even if one asset's risk and return profile is optimal, a strong correlation to another asset in the portfolio may prevent it from being included in the optimal portfolio (Bodie et al., 2018).

Another key portfolio aspect is the correlation, which is derived from the covariance between the corresponding assets. The covariance between two assets is the expected value of the product of two variances of their respective returns (Blume & Friend, 1974). The covariance matrix is the intended method to measure the covariance between assets. However, this matrix does not explain the matrix diagonal. The solution is to scale the covariance by the product of standard deviations of respective asset returns, or the asset correlations, to determine the coefficient correlations. The resulting correlation coefficient matrix in which each value runs from -1 to +1. The correlation between assets is the primary driver of the size of the gain from diversification (H. Markowitz, 1952). If all individual assets had a perfect positive correlation would be equivalent to the weighted average standard deviation of the assets. As a result, any less-than-perfect correlation between risky assets would result in a diversification benefit, and the lower the correlation, the greater the diversification advantage. Given the amount of risk and the fact that correlation would be less than perfect, this implies that a combination of assets will indeed surpass the assets on their own (Cronqvist & Siegel, 2014).

When a combination of securities is set up, the established portfolio risk-return properties are a function of the underlying portfolio holdings' features and the correlation between the assets. Investors generate an investment opportunity set of multiple portfolio configurations by altering the proportion to the underlying assets (Bodnar et al., 2018). This is composed of various pairings of risky assets that result in a given portfolio risk-return profile.

A risk-averse investor will choose the portfolio with the lowest risk for every rate of return. This reduction in risk for each level of return results in the formation of a minimum-variance frontier, which is a compilation of all minimum-variance (minimum-standard deviation) portfolios (Kempf &

Memmel, 2006). A minimum-variance portfolio with the maximum returns per unit of risk occurs at a position along this minimum-variance frontier curve. The leftmost position along the minimumvariance frontier is a portfolio with the lowest variance when matched to all potential portfolios of risky assets. This is referred to as a global minimum-variance portfolio (Golosnoy et al., 2021). The Markowitz efficient frontier is the section of the minimum-variance curve that sits above and to the right of the global minimum variance portfolio and comprises portfolios that rational and riskaverse investors would pick (Dos Santos & Brandi, 2017). The slope of the efficient frontier represents the change in units of return per unit of risk. The amount of risk increases, the rise in return begins to decline. The slope begins to level off. This does not imply that we may attain everincreasing profits as we take on more risk; rather, the contrary is true. As portfolio risk is raised, investors' potential profits decline. H. Markowitz (1952) denote elements of MPT, including the expected rate of return of a portfolio ($E(r_p)$), the correlation coefficient (ρ_{ij}), the covariance (Cov(i,j)), and the portfolio volatility (σ_p) as follows:

$$E(r_{p}) = \sum_{i=1}^{n} E(r_{i}) * W_{i}$$
(1)

$$\rho_{i,j} = \frac{\mathsf{Cov}(i,j)}{\sigma_i \sigma_j} = \frac{\mathsf{E}\left[(\mathsf{X} - \mu_i)\left(\mathsf{Y} - \mu_j\right)\right]}{\sigma_i \sigma_j} \tag{2}$$

$$Cov(i,j) = \sigma_i \sigma_j \rho_{ij}$$
(3)

$$\sigma_{p} = \sqrt{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{i} w_{j} Cov(r_{i}, r_{j})}$$
(4)

Where: W_i is the weight of asset *i* in the portfolio, and σ_i is the standard deviation of asset *i*'s returns.

Treynor (1965), Sharpe (1964), and Lintner (1956) publish scholarly publications that establish and develop the CAPM. The model depicts the link between an asset's risk and its anticipated return. Because investors have reasonable beliefs, investors who aim to achieve the strategy with the highest Sharpe ratio, risk-adjusted return, will finish up with a profile that comprises certain assets as the market portfolio. This winds up in this situation because the market portfolio has the highest attainable Sharpe ratio. The CAPM is defined as follows:

$$ER_i = r_f + \beta_i (ER_m - r_f) \tag{5}$$

Where: ER_i is the asset expected return. r_f is denoted as the risk-free rate of return. ER_m is the market expected return. β_i is the beta value of the asset, measured by the covariance between R_i and R_m over the variance of R_m . $\beta_i(ER_m - r_f)$ is the market risk premium. The CAPM formula demonstrates how more risk equates to a greater expected return. The risk-free rate is frequently represented as a 10-year government bond. The beta of an asset indicates how volatile it is in comparison to the market overall. If an asset has a beta value of 1, it signifies that it has the same risk as the market, or that the asset risk is equivalent to the market risk. A beta number greater than one indicates that the asset is more volatile in nature (Berk & Demarzo, 2020).

3.2. International stock market co-movements

Goetzmann et al. (2005) examine equity market correlations over the last 150 years and find equity return correlations are not consistent. They form a 5-year rolling window and equally weighted portfolios to determine the stock market correlations. A clear pattern indicates that mean equity market correlations fluctuate widely over time, grow dramatically after the Second World War, and pick in 2000. Quinn and Voth (2008) use non-overlapping four-year intervals to evaluate correlations between 120 developed nation pairings. They discover a similar pattern of substantially changing yet rising connections as Goetzmann et al. (2005).

According to Amira et al. (2011), volatility has no causal association with correlations, but the market direction is the most important factor of equities market correlations. They also confirm an asymmetric causal relationship between returns and correlations. Because stock markets have traditionally had many more positive return periods than negative return periods, the asymmetric causal link between returns and correlations may be one explanation for why correlations across global equity markets have risen over time.

You and Daigler (2010) discover that correlations are stronger in down markets than in bull markets, while Longin and Solnik (1995) conclude that correlations are stronger during turbulent times. Mollah et al. (2016) analyse how correlations responded to the 2008 financial crisis and the Eurozone crisis in 2009. Contagion, defined as a rise in conditional correlation before the crisis to throughout the crisis, has been proven to become a key explanatory element as to why crises spread to a global scale, which illustrates why correlations grow in bearish and unstable markets.

Research work on ASEAN market integration, such as Arshanapalli et al. (1995), conducts a comovement analysis on the Asian market and discovers that the Asian market is less interconnected at the time. Similarly, Roca et al. (1998) study the long-runcorrelations of the five ASEAN markets using multivariate cointegration and find no indication of integration across countries. Azman-Saini et al. (2002), on the other hand, study the linkage among ASEAN stock markets and find that the ASEAN markets are strongly integrated. Click and Plummer (2005) investigates whether the ASEAN-5 markets are interconnected or fragmented by employing the time series methodology of cointegration to derive long-run relationships. According to the empirical findings, the ASEAN-5 equity markets are cointegrated and hence not separated by national borders. Nevertheless, apart from Indonesia, these markets have considerable short-run interconnections. According to Abd et al. (2008) and Oh et al. (2011), the ASEAN stock markets are becoming more integrated, particularly in the aftermath of the 1997 financial crisis. Furthermore, Mandigma (2014)employs the Granger causality test and Vector Error Correction (VEC) to demonstrate that the bond markets of the ASEAN 5 + 1 nations are correlated.

Thanh and Lan (2016) use EGARCH and VAR to examine the comovements of ASEAN-6 and major markets like Hong Kong, the United States, and Japan and show that a positive shock causes less volatility than a negative shock. According to Jiang et al. (2017), Vietnam has the least interconnectedness with other ASEAN exchange members, and the impact of creating ASEAN trading links on comovement is limited to less than 2 years.

3.3. Diversification Benefits Across Countries: The Perspectives of Developed-Country Investors

Levy and Sarnat (1970) use the Markowitz MPT framework to assess the advantages of worldwide diversification for an American investor by examining the average rates of return, correlations, and standard deviations of the major stock exchanges in 28 different nations. They discover that the American market is one of the best performers and has relatively low volatility throughout the studied period, 1951–1967, and that an American investor may profit from diversification. Between 1959 and 1973, Lessard (1976) research the benefits of diversification for an American investor. Lessard demonstrates that although investors in many economies would suffer returns of more than 3 percent if they solely invested locally, an American investor would only forfeit a return of 0.31 percent if they did not diversify globally. McDowell (2017) investigates how the impacts of allocation weight limits and ideal portfolios, both as implemented in the MPT framework, affect the potential advantages of foreign diversification for an American investor. From 1988 to 2014, the comparable MSCI is utilized for all of the listed nations, of which 21 are advanced and 13 are

emerging markets. He demonstrates that the globally diversified portfolio outperforms the domestic-only portfolio during certain cycles between 1988 and 2014, but not all.

3.4. Diversification benefits across countries: the perspectives of developing-country investors

Several studies have found that the advantages of international diversifications shift over time and among nations. Bekaert and Harvey (1995) demonstrate time-varying capital market convergence in many emerging economies. Driessen and Laeven (2007) prove, using monthly returns from 1985 to 2002 in 23 advanced and 29 emerging markets, that investors in developing economies, which have high country risk, derive larger global diversification benefits than investors in developed economies, and diversification advantages have lowered as country risk has enhanced.

However, small-country and institutional investors are frequently limited by their governments to investments mostly in assets traded in their native country (Black, 1974; Inderst, 2021; Stulz, 1981). A few governments have relaxed a substantial number of investment limits in recent years, promoting asset trade on a global scale (International Monetary Fund, 2020). Even though there are no formal limits, investors usually spend a considerable portion of their funds in domestic stocks. This popular "home bias" in financial assets is well known in the literature (French & Poterba, 1991; Riff & Yagil, 2021).

ASEAN research articles such as Sriboonchitta et al. (2014) calculate the value at risk and the predicted deficit employing Monte Carlo simulation with a copula-based GJR-GARCH model and validate the created portfolio between the Indonesian, Philippine, and Thai stock markets may potentially prevent risk in a major way. According to Jiang et al. (2017), diversified portfolios in ASEAN equity markets are not ideal owing to substantial long-term comovement. According to Kang et al. (2019), there is a positive equicorrelation between the ASEAN-5 and Global stock indexes, which is particularly prominent during the financial collapse. Particularly, during the 2007–2009 financial crisis and the 2010–2012 European debt crisis, ASEAN markets were net recipients and transmitters of volatility spillovers. As per Duong and Huynh (2020), diversification across these pairings of ASEAN-6 stock markets is still appropriate for foreign investors; however, it may cause contagion concerns.

3.5. Hypothesis development

The empirical fact that high-market-beta equities are not compensated with proportionately greater returns has long been a source of criticism for the CAPM, as stated by (Fama & French, 1992). However, Haugen and Baker (1991) discovered that investing in a stock portfolio designed to subject investors to the least amount of risk (as evaluated by variance) will beat the Wilshire 5000 index over time (as assessed by larger Sharpe ratio). Clarke et al. (2006) showed that the minimum variance portfolio (MVP) outperformed a capitalization-weighted benchmark in terms of both returns and actual risks in US markets. Frank and Raman (2008) and Poullaouec (2008) find essentially consistent outcomes for global stock markets. Moreover, Ang et al. (2006) have established a low-risk, high-return empirical anomaly associated with idiosyncratic volatility. Baker et al. (2011) show that low-volatility and low beta portfolios provide an exceptional mix of strong average returns and minimal drawdowns from 1968 to 2008. This result contradicts the fundamental assumption that a greater expected return compensates for risk. Bednarek and Patel (2018) confirm the outperformance of MVP against the market portfolio and the correlations between low beta and low-risk anomalies. Though there is considerable evidence for the MVP's market performance, there is a limited theoretical explanation, particularly for frontier markets with significant volatility. The MVP's performance cannot be explained by portfolio theory, which states that investors should maintain a portfolio with the highest Sharpe ratio possible (MSP). Using the MVP method, this study sheds light on the advantages of Vietnamese investors diversifying into ASEAN markets.

Initially, the return correlations between the Vietnamese market and the other ASEAN markets are analysed for both periods (period 1 and period 2). This is performed to see whether the correlations are changing and whether there are any noticeable patterns in the correlations. From a perspective of a Vietnamese investor, the following is the research hypothesis:

H1: The return correlations are not consistent and exhibit a distinct pattern when compared to other ASEAN markets.

If H1 is correct, there are concerns for a Vietnamese investor in respect of portfolio rebalancing and diversification. For instance, if there is an upward tendency in correlations, with period 2 having a larger average correlation than period 1, this might imply that the gains of diversification have reduced between the two phases. As a result, the next step is to examine the diversification advantages and see whether benefits have changed between the two periods:

H2: Vietnamese investors benefit from MVP diversification.

Diversification benefits are defined as the ability to attain the maximum return target with the least amount of variance, as measured mainly by the Sharpe ratio, followed by the Sortino ratio, and 5% VaR. Diversification gains are regarded as markets that provide Jensen's alpha in comparison to the Vietnamese market:

H3: For Vietnamese investors, the benefits of diversification are not the same across periods 1 and 2. In other words, markets with positive Jensen's alpha in period 2 are not the same as those with positive Jensen's alpha in period 1.

4. Data

4.1. Monthly returns

The sample data comprises MSCI national funds that are not proactively managed and are referred to as "index" funds. Data is gathered from the MSCI homepage, which is a significant source of exchange-traded funds (ETFs; MSCI, 2019).

Period 1 consists of 86 monthly returns from 31 January 2007, to 28 February 2014. This time frame was chosen since the bulk of the markets studied peaked at the end of 2007, plunged after 2008, and then rebounded until 2014. Specifically, the most market reached their bottom in February 2009 and have subsequently followed an upward-moving (bull) market. Additionally, this time frame was chosen to represent the various impact of the 2008 financial crisis on sampling markets from the beginning to the end of 2014. Furthermore, the Vietnamese Government Resolution No: 11/NQ-CP On Macroeconomic Stabilization is an important element for investors looking to diversify their portfolio overseas (Government, 2011).

The second period (Period 2) includes 86 observations from 31 March 2014, to 30 April 2021, representing the complete market recovery following the 2008 crisis and the economic depression caused by the Covid-19 epidemic, which exists in the first quarter of 2020. After a solid run since 2014, the majority of markets bottomed on 30 March 2021. The market returns have picked up in November 2020 and slowly recovered ever since.

4.2. Monthly correlations

I use the daily MSCI index returns, which run from 1 January 2007, to 30 April 2021, to construct monthly correlations. Because the correlation reflects the degree of a link between two variables,

a monthly return correlation (for example, the Vietnam-Thailand return correlation) is derived from two daily return variables (for example, the MSCI Vietnam return and MSCI Thailand return). The monthly correlations are then utilized to generate a 12-month rolling correlation.

5. Research methods

5.1. Significance test of the return correlations

The return correlations for the complete periods were computed first. This method was performed for both periods 1 and 2, yielding all of the relevant correlations between all of the examined nations. The following is the return correlation equation:

$$Correlation(X,Y) = \frac{\sum^{(x-\bar{x})} (y-\bar{y})}{\sqrt{\sum^{(x-\bar{x})^2} (y-\bar{y})^2}}$$
(6)

Where: X and Y represent the results for two different nations over either Period 1 or Period 2. \bar{x} and \bar{y} are the means value of returns.

I utilize an ordinary least squares (OLS) regression to examine the significance of correlation data, with the return of MSCI Vietnam indexes (Y_i) as the dependent variable and the return of another MSCI country index (X_i) as the independent variables. The Durbin-Watson (DW) statistic is also computed to test for autocorrelation. The model is stated as follows:

$Y_i = \alpha_0 + \beta X_i + \varepsilon_i \tag{7}$

5.2. Rolling 12-month correlations

The 12-month rolling correlations are performed to determine if correlations are constant, stationary, or moving in any direction over time. The 12-month rolling correlations are computed by utilizing a 12-month moving window, in which the correlations from the previous 12-months are shifted forward one month at a time across the whole period.

5.3. The Sharpe- and Sortino ratio

Sharpe (1964) created the Sharpe ratio (S_p) , which is a measure of risk-adjusted return. It is determined by dividing a portfolio's excess return $E(r_p)$ minus the risk-free rate (r_f) by the volatility of the portfolio, which is quantified by the standard deviation of the excess return, (σ_p) .

Sharperatio
$$(S_p) = \frac{E(r_p) - r_f}{\sigma_p}$$
 (8)

The higher the Sharpe ratio, the higher the portfolio's risk-adjusted return. As a result, if two portfolios are reviewed, the one with a higher Sharpe ratio would be chosen by an investor (Bodie et al., 2018). The Sortino ratio is a Sharpe ratio variant that distinguishes damaging volatility from actual total volatility by utilizing the asset's standard deviation of negative portfolio returns—the standard deviation of the lower percentile (also known as negative volatility or negative standard deviation)—rather than the total standard deviation of portfolio returns (Sortino & Price, 1994). The Sortino ratio (S_p) calculates the return on an asset or portfolio, $E(r_p)$, takes away the risk-free rate (r_f), and divides the result by the asset's downside deviation (σ_d).

Sortinoratio
$$(S_p) = \frac{E(r_p) - r_f}{\sigma_d}$$
 (9)

The Sortino ratio follows the same logic as the Sharpe ratio in that a greater Sortino is favoured over a lower. In general, the Sortino ratio generates a higher value than the Sharpe ratio for the identical asset. This is because asset values that have increased over time have fewer negative standard deviations than positive standard deviations (De Capitani, 2014).

5.4. Value-at-risk (VaR)

VaR calculates the risk of loss in a certain portfolio of assets in the worst-case scenario, under normal market circumstances and with a specified probability. The VaR was derived by ordering the reported historical returns of all assets from bottom to top and then obtaining the values at the 5th percentile. When determining the 5% VaR for a portfolio, the VaR for each nation included in the portfolio was multiplied by the weight of that nation. The products between VaR and asset weights were then added together, and this total equalled the portfolio's 5% VaR.

5.5. Minimum-variance portfolio with the Markowitz Portfolio Optimizer

The Markowitz Portfolio Optimizer (MPO) model is based on the Markowitz MPT framework (Bodie et al., 2018). It considers not just an asset's excess returns, but also the standard deviation and correlation between the assets. MPO is employed in the paper to develop and differentiate the asset allocations with minimum variance. The MPO is created in a series of phases. First, the return for each market is computed:

$$R_i = \frac{R_{i,t} - R_{i,t-1}}{R_{i,t-1}} \tag{10}$$

Where: R_i is the monthly return of asset *i*; $R_{i,t}$ is the closing price of asset *i* at time *t*; $R_{i,t-1}$ is the closing price of asset *i* at (*t*-1) time. The average monthly excess return (ER) is then computed by subtracting the return (R_i) from the risk-free (r_f) rate. Because a Vietnamese investor viewpoint is utilized, the risk-free rate employed was the monthly rate on 10-year Vietnamese government bonds (Ministry of Finance, 2021; Transport And Development Strategy Institue, 2021). The equation for ER is stated as follows:

$$Monthly Excess Return(ER) = R_i - r_f$$
(11)

AnnualExcessReturn(AER) = ER *
$$\sqrt{12}$$
 (12)

The following step is to compute the portfolio ER:

$$ER_{p} = \sum^{E} R_{i} * W_{i} \tag{13}$$

Where: ER_p is the excess return of the portfolio p; ER_i is the excess return of asset i; W_i is the asset weight. The standard deviation (σ) is then annualised as follows:

Annualised
$$\sigma = Monthly\sigma * \sqrt{12}$$
 (14)

After measuring the ER and σ , a correlation matrix is generated. Also, a formula is used to produce a covariance matrix:

$$Cov(i,j) = W_i * W_j * \sigma_i * \sigma_j * \rho_{i,j}$$
(15)

Where: $W_i or W_j$ is the weight of asset *i* or *j* in the portfolio, and $\sigma_i or \sigma_j$ is the standard deviation of asset *i*'s returns or asset *j*'s returns. After adding together all of the covariances between the various assets, the variance (σ_{ρ}^2) and standard deviation (σ_{ρ}) of the entire portfolio are obtained:

$$\sigma_{\rho}^{2} = W_{i} * W_{j} * \sigma_{i} * \sigma_{j} * \rho_{ij}$$
(16)

$$\sigma_{\rho} = \sqrt{W_i * W_j * \sigma_i * \sigma_j * \rho_{ij}}$$
(17)

At this point, the lowest variance is chosen, as well as the weights of contributing assets. Using Equations 8 and 9, the Sharpe ratio and the Sortino ratio are derived from the ER and σ_{ρ} .

Table 1. Summ	nary statistics of	MSCI country i	ndexes		
Country	Obs	Mean	Std. Dev.	Min	Max
Vietnam	173	0.0077	0.0991	-0.2380	0.4851
Thailand	173	0.0050	0.0612	-0.3065	0.2120
Indonesia	173	0.0076	0.0636	-0.3053	0.1964
Philippines	173	0.0051	0.0548	-0.2237	0.1617
Malaysia	173	0.0022	0.0358	-0.1506	0.1320
Singapore	173	0.0019	0.0552	-0.2650	0.2113
Risk-free rate	173	0.0010	0.0059	0.0001	0.0683

This table provides summary statistics of monthly returns of MSCI country indexes: Vietnam, Thailand, Indonesia, Philippines, Malaysia, Singapore, starting from 31 January 2007, to 30 April 2021. Risk-free-rate is the 10-year Vietnamese Government bond rate since the Vietnamese perspective is used. Presented statistics are mean, standard deviations, minimum value, and maximum value.

5.6. The Jensen's alpha

Jensen's alpha is used to examine and assess the behaviour of each of the markets under consideration, determining whether they produced positive or negative alpha. Because Vietnam is utilized as the home market, other nations' risk-adjusted returns are matched to those of the Vietnamese markets. If a market has created positive alpha, it means it has delivered a greater risk-return than the projected return, i.e. the Vietnamese market return. Jensen's alpha (α_i) is calculated as follows:

$$\alpha_i = R_i (r_f + \beta (R_m - r_f)) \tag{18}$$

Where: R_i is the return of asset *i*; β is the systematic risk; r_f is the risk-free rate; R_m is the expected market return (Bodie et al., 2018). The values of β are found by estimating Equation 7.

6. Results and discussion

6.1. Findings for the hypothesis 1

6.1.1. Correlations over the entire periods

Table 1 shows monthly return summary statistics. Thailand, Indonesia, and Singapore all have at least one month with a return reduction (Min) greater than 0.25, while Malaysia has a maximum return fall (Min) of 0.15. Malaysia and the Philippines are the least risky, while Vietnam is the riskiest, based on standard deviations.

As shown in Table 2, all of the results are significant at the 10% significance level. Furthermore, it is worth noting that correlations in all markets have risen from the first to the second period, and. The Thai stock market has witnessed the highest rises in correlation with the Vietnamese stock market while having the lowest correlations in period 1.

When examining Vietnamese return correlations with other countries, the Durbin Watson (DW) statistic indicates minimal to no autocorrelation with DW values ranging between 1.5 and 2.5. This is because a DW statistic has a value between 0 and 4 and a DW value of 2 means there is no autocorrelation found in the data. Between 1.5 and 2.5, the DW value is rather typical, indicating the lack of autocorrelation (Arjmand & Shafiei, 2018). During period 1, the greatest DW values were obtained in Indonesia and Thailand, both of which were close to 2.5. According to Pan (2010), some autocorrelation in stock market returns is to be anticipated, and autocorrelation in stock market returns over periods of 6 to 12 months is typically positive. Hong and Stein (1999) show that stock market returns in the short run frequently display positive autocorrelation, but stock returns in the long term are more likely to show negative autocorrelation.

Table 2. Signit	ficance test of	return correla	tion with Vietn	amese stock						
		Period 1: :	31/01/2007- 28	3/02/2014			Period 2:	31/03/2014-30	/04/2021	
	(1)	(2)	(3)	(†)	(5)	(1)	(2)	(3)	(†)	(2)
Thailand	0.344*					0.511***				
	(0.173)					(0.126)				
Indonesia		0.362**					0.414***			
		(0.162)					(0.128)			
Philippines			0.805***					0.591***		
			(0.184)					(0.129)		
Malaysia				0.953***					0.972***	
				(0.286)					(0.206)	
Singapore					0.754***					0.574***
					(0.184)					(0.127)
Constant	0.000	-0.001	-0.004	-0.003	0.002	0.006	0.006	0.006	0.009	0.006
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Correlation between dependent variable and independent variables	0.132	0.227	0.440	0.324	0.409	0.406	0.332	0.448	0.458	0.441
Durbin- Watson statistics	2.373	2.574	1.997	2.255	2.285	2.108	1.920	2.003	1.925	1.930
Observations	86	86	86	86	86	86	86	86	86	86
R-squared	0.045	0.056	0.186	0.117	0.167	0.164	0.110	0.201	0.210	0.195
This table provide The dependent va	s regression resultriable (Y_i) is the r	ts of the following onthly returns of t	model: $Y_i = lpha_0 + \epsilon$ the MSCI Vietnam i	$3X_i + \varepsilon_i$ index, while the in-	dependent variabl	$e(X_i)$ is one of the	following monthly	returns of MSCI co	untry indexes: Tha	iland, Indonesia,

Table 3. 12-m	onth rolling co	prrelations bet	ween Vietnam d 31/01/2007- 28	and other ASE/ 102/2014	AN stock mark	ets	Period 2:	31/03/2014-30	104/2021	
Corvelations	ohe	Mean	C+4 Dov	ai M	Ň	Ohe	acom	C+d Dev	Nin	₩2
Vietnam- Thailand	86	0.1940	0.3080	-0.4750	0.7450	86	0.2980	0.2510	-0.2670	0.8660
Vietnam- Indonesia	86	0.2040	0.2410	-0.2800	0.8120	86	0.2430	0.2620	-0.3140	0.8560
Vietnam- Philippines	86	0.3750	0.2150	-0.1260	0.7500	86	0.3110	0.3170	-0.4120	0.9130
Vietnam- Malaysia	86	0.2090	0.1950	-0.3640	0.6190	86	0.2950	0.2930	-0.3730	0.8760
Vietnam- Singapore	86	0.3950	0.1910	-0.1210	0.8070	86	0.2940	0.2920	-0.3950	0.7590
Average		0.2754		-0.2732	0.7466		0.2882		-0.3522	0.854
This table provide Malaysia, Philippin	s summary statisties, and Singapore	tics for 12-month 1 Reported figures	rolling return correl are observations, m	ations between the	he MSCI Vietnam ir viations (Std.Dev.), I	ndex and one of t	he following month aximum (Max). Ad	hly returns MSCI cc ditional statistics a	ountry indexes: Tho re reported in the A	iland, Indonesia, Appendix section.

Figure 1. The average of rolling 12-month return correlations between Vietnam and ASEAN markets (excluding Singapore).







Also, the R-square values are less than 0.5, which implies that country market movements are hard to predict. However, the independent variables are statistically significant that implies significant coefficients still indicate the mean change in the dependent variable when the independent variable is adjusted by one unit.

6.1.2 12-Month rolling return correlations

Table 3 displays rolling 12-month correlations, indicating that these correlations are calculated over rolling 12-month periods. For every nation, the mean of the 12-month rolling correlation is determined, and the minimum (Min) and maximum (Max) 12-month rolling correlations for each month are also displayed. Furthermore, an average (Avg) of all rolling 12-month mean-, min-, and max-correlations is calculated.

Table 3 shows that the average 12-month rolling correlations improve for Thailand, Indonesia, and Malaysia versus Vietnam but fall for the Philippines and Singapore between periods 1 and 2. The average rolling 12-month correlation rises from 0.2754 to 0.2882. Period 1 correlations have a wider gap between the least and greatest correlation than Period 2 correlations. Figure 1 and Figure 2 are

Table 4. Countries and	their weights in the mi	inimum variance portfol	io
	31/01/2007-30/04/ 2021	Period 1: 31/01/2007- 28/02/2014	Period 2: 31/03/2014- 30/04/2021
Country	Minimum Variance Portfolio	Minimum Variance Portfolio	Minimum Variance Portfolio
Vietnam		18.9936%	18.2727%
Thailand			4.1893%
Indonesia	100.0000%		
Philippines		3.9174%	1.9522%
Malaysia		70.0341%	62.9313%
Singapore		7.0549%	12.6545%

Table 5. Key	measures fo	r the Vietnam	-only and the	minimum va	riance portfol	ios
	31/01/2007	-30/04/2021	Period 1: 3 28/02	1/01/2007- /2014	Period 2: 31/ 04/2	03/2014-30/ 2021
Measures	Vietnam- only portfolio	Minimum Variance Portfolio	Vietnam- only portfolio	Minimum Variance Portfolio	Vietnam- only portfolio	Minimum Variance Portfolio
Excess return (ER)	-0.2306%	-0.1964%	-0.5144%	-0.5093%	0.0518%	-0.0506%
Standard deviation (o)	4.6857%	4.7745%	5.6947%	2.5236%	3.6815%	1.8503%
Sharpe	-0.0492	-0.0411	-0.0903	-0.2018	0.0141	-0.0274
Sortino	-0.0777	-0.0630	-0.1506	-0.3053	0.0206	-0.0419
5% VaR	-2.5157%	-2.4936%	-2.5157%	-1.6047%	-2.5351%	-1.6447%
The lowest required rate of return		-0.0567%		-0.1469%		-0.0146%

provided to show the correlations movements fluctuate through time. Because Singapore is a developed market and other ASEAN markets are emerging, a separate graph is needed.

To summarize, when examining the statistics from period 1 to period 2, figure 1 and figure 2, the correlations can be observed to fluctuate through time. This implies that correlations are not always the same. In respect of any trend in correlations, it can be shown that correlations have grown between the different periods, and correlations have not been consistently stronger in period 2 than in period 1 for any of the analysed returns of nation indices. The results demonstrate the same phenomenon, with significant p-values for all markets in period 1 and period 2 (see, Table 2). This suggests that correlations are not constant and have shown a propensity to move upward. Past studies indicate that stock market correlations have grown from the standpoint of an American and other developed-country investors, signifying that the findings are consistent with previous studies.

6.2 Findings for the hypothesis 2

Table 4 depicts a Vietnamese-only portfolio with a 100 percent weight in the Vietnamese market, as well as a portfolio with the standard deviation minimized without short-selling using the Markowitz portfolio optimizer. Table 4 shows the nations and related weights in the minimal variance portfolio. The main metrics for both the Vietnamese-only and minimal variance portfolios are shown in Table 5.

Table 6. Annual .	Jensen's Alpha					
Period 1: 01/ 2007- 02/2014	Std. Dev.	CORR	P-value	Beta	ER	Jensen's Alpha
Vietnam	5.6947%			1.0000	-0.5144%	
Thailand	5.1650%	0.1940	0.0500	0.3440	-0.4732%	-6.7413%
Indonesia	5.4770%	0.2040	0.0290	0.3620	-0.3977%	-6.7249%
Philippines	4.6042%	0.3750	0.0000	0.8050	-0.4491%	-6.6765%
Malaysia	2.6325%	0.2090	0.0010	0.9530	-0.5051%	-6.6581%
Singapore	3.9530%	0.3950	0.0000	0.7540	-0.5706%	-6.6920%
Period 2 : 03/2014-04/2021						
Vietnam	3.6815%			1.0000	0.0518%	
Thailand	3.1628%	0.2980	0.0000	0.5110	-0.0178%	-0.0112%
Indonesia	4.0754%	0.2430	0.0020	0.4140	0.0039%	-0.0080%
Philippines	3.7110%	0.3110	0.0000	0.5910	-0.0344%	-0.0128%
Malaysia	2.0866%	0.2950	0.0000	0.9720	-0.0858%	-0.0094%
Singapore	2.7047%	0.2940	0.0000	0.5740	-0.0365%	-0.0132%

This table provides figures of Jensen's alpha and alpha construction factors are provided in this table: the standard deviation (Std. Dev.) of MSCI index returns, mean return correlations (CORR) between MSCI Vietnam and other MSCI country indexes, P-value, and betas generated from regression findings in Table 2, and excess returns (ER). Thailand, Indonesia, Malaysia, the Philippines, and Singapore are among the MSCI country indexes that have been investigated.

During period 1, the lowest variance portfolio beat the Vietnamese-only portfolio, as shown in Table 4. The return on the minimum variance portfolio was -0.1964 percent, whereas the return on the Vietnamese-only portfolio is -0.2306 percent. The standard deviation of the lowest variance portfolio, on the other hand, is almost two times smaller than that of the Vietnamese-only portfolio.

The minimum variance portfolio consists of four nations, with 93 percent of the portfolio weighted in frontier and emerging markets and 7 percent in a developed market (Singapore). Table 5 shows that the minimum variance portfolio has substantially lower Sharpe- and Sortino ratios than the Vietnamese-only portfolio.

As shown in Table 5, the ER of the Vietnamese-only portfolio surpasses the minimal variance portfolio by two times during period 2. The minimal variance portfolio, on the other hand, has a considerably smaller standard deviation and a lower 5 percent VaR number, yet the Vietnamese-only portfolio has a higher Sharpe ratio and Sortino ratio than the minimum variance portfolio.

The conclusion for hypothesis 2 is that Vietnamese investors do not benefit from the MVP approach if they use the same MVP allocation for the period from 31 January 2007, to 30 April 2021. However, the asset allocation in period 1 allows Vietnamese investors to profit from the MVP approach because the minimum variance portfolio provides a higher return at a considerably lower risk (measured by the portfolio standard deviation) than the Vietnamese-only portfolio in period 1. In terms of minimising risks, Vietnamese investors gain from the MVP method in period 2 when portfolio indicators are considered. Specifically, the Vietnamese-only portfolio outperforms the minimum variance portfolio in terms of return, but with a larger standard deviation. Its Sharpe and Sortino ratios turn positive, suggesting a significant increase in ER and providing relevant risk indicators.

6.3. Findings for the hypothesis 3

Table 6 shows the markets that produced Jensen's alpha against the Vietnamese market (market return-risk-free rate) during periods 1 and 2. Jensen's alpha will be utilized to assess and analyze

the performance of each market under investigation. As seen in Table 6, all markets earned negative Jensen's alpha versus the Vietnamese market in period 1. In period 1, the Thai market, which has the lowest correlations to the Vietnamese market, is significant at the 10% level, but in period 2, all results are significant at the 5% level. Even though the markets with significance levels are excluded, there were much more markets in period 1 that generated significantly more negative Jensen's alpha than in period 2. As a result, the conclusion for hypothesis 3 is that the diversification benefits in periods 1 and 2 are not the same and that the diversification gains for Vietnamese investors have declined between the two periods.

7. Conclusion

This article examines the advantages of employing the MVP approach for Vietnamese investors from January 2007 to April 2021. Specifically, it examines if the correlations between the Vietnamese and ASEAN markets are evolving and whether any noticeable patterns exist in the correlations. Second, the study examines the benefits of MVP diversification for Vietnamese investors. Finally, this research examines whether the advantages of diversification are consistent over the first and second periods. Comparing diversification benefits over time enables a clearer understanding of how the global financial crisis and the Covid-19 pandemic have impacted the ASEAN-6 markets and their covariance.

The following research findings can be drawn from the empirical investigation. First, the Vietnamese stock market return correlations have increased almost unanimously against the majority of investigated markets when looking at the correlations over the entire period except for the cases of the Philippine and Singaporean markets. The rolling 12-month correlations demonstrate that correlations change markedly, but those correlations were usually higher in period 2. Furthermore, the correlations between the Vietnamese market and developing markets are consistently larger than those between the Vietnamese market and Singapore. Second, Vietnamese investors do not benefit from the MVP approach for the whole period. However, diversification favours a Vietnamese investor in period 1 since it allows for a minimum variance with higher returns by diversifying into ASEAN stock markets. In terms of minimizing risks based on the portfolio standard deviation, period 2 diversification advantages are substantial for Vietnamese investors when portfolio indicators are reviewed. Finally, diversification advantages in periods 1 and 2 are not identical, and Vietnamese investors' diversification gains have decreased between the two periods. For a Vietnamese investor, Thailand, Indonesia, and Malaysia (also known as emerging markets) are stronger providers of diversification advantages in period 1 than the Philippines (also an emerging market) and Singapore (a developed market). During period 2, all markets demonstrate relatively comparable diversification gains.

The findings of this article have significant implications for Vietnamese investors seeking to diversify their portfolios using the MVP method in ASEAN stock markets. In addition to the conclusions, this study makes the following recommendations. First, a Vietnamese investor may have achieved a lower variance and higher risk-adjusted return during period 2, but it would have needed a considerably more concentrated portfolio and hence much more risk-taking than during period 1. Second, if the findings of this study are any indicator, it has become more difficult for a Vietnamese investor to reap the benefits of foreign diversification. Furthermore, the Covid-19 pandemic has caused a significant drop in performance across all markets, limiting the diversification benefit from ASEAN diversification for Vietnamese investors. Finally, emerging economies, with their lower average correlation to the Vietnamese market, are expected to benefit Vietnamese investors. If correlations continue to grow, the advantages of international diversification may be diminished to the point that they are no longer worthwhile. Increased market interconnectedness may cause home bias, or an investor's tendency to hold an excessively large percentage of assets in their home market.

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Correction

This article has been corrected with minor changes. These changes do not impact the academic content of the article.

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Appendix

I produce Z-statistics to compare the distribution of a correlation sample with the distribution of another correlation sample from Table 3 to test whether they are from the same or different populations. Therefore, the goal of this test is to determine if two distributions are statistically different. The formula for the Z-statistics are shown as follows:

$$Z = \frac{(\overline{X_1} - \overline{X_2})}{\sqrt{\sigma_{X_1}^2 - \sigma_{X_2}^2}}$$
(19)

Where: X_1 is the mean value of the correlation sample 1

 X_2 is the mean value of the correlation sample 2

 σ_{x_1} is the standard deviation of the correlation sample 1 divided by the square root of the number of observations.

 σ_{x_2} is the standard deviation of the correlation sample 2 divided by the square root of the number of observations.

Table 1A. The tes	t of statistical diffe	rence of a correlat	ion sample in perio	ods 1 and 2
(1)	(2)	(3)	(4)	(5)
-22.5107	-9.4218	14.3695	-21.0139	24.8940

Table 1B. The	test of statistica	al difference bet	ween correlatio	n samples (Perio	od 1)
	(1)	(2)	(3)	(4)	(5)
(1)	N/A				
(2)	-2.1990	N/A			
(3)	-41.4410	-45.5344	N/A		
(4)	-3.5387	-2.3871	49.1837	N/A	
(5)	-47.6966	-53.4163	-5.9808	-58.6024	N/A

Table 1C. The t	test of statistica	al difference bet	ween correlatio	n samples (Peri	od 2)
	(1)	(2)	(3)	(4)	(5)
(1)	N/A				
(2)	13.0364	N/A			
(3)	-2.7650	-14.2198	N/A		
(4)	3.6872	-11.3775	3.1876	N/A	
(5)	2.8934	-11.1799	3.3922	2.0790	N/A

Note: (1) = Vietnam-Thailand; (2) = Vietnam-Indonesia; (3) = Vietnam-Philippines; (4) = Vietnam-Malaysia; (5) = Vietnam-Singapore; N/A = Not Available. This Table uses the Z-statistics to compare two correlation samples from Table 3 to check whether their distributions are the same or different. A Z-value that is greater than 2.0 or less than -2.0 indicates the correlation samples are statistically different.

Additionally, I used the Kolmogorov-Smirnov test on two samples (Chakravarti & Roy, 1967) to determine if the correlations between the data in Table 3 are statistically different. This test's H0 hypothesis is that the distributions of two correlation samples are identical. The Table indicates that all p-values are less than 1%, indicating that the H0 hypothesis is rejected. Correlations between samples are all statistically distinct.

Table 2A. The test	t of statistical diffe	rence of a correlat	ion sample in perio	ds 1 and 2
(1)	(2)	(3)	(4)	(5)
0.0950	0.0650	0.0050	0.0000	0.0140

Table 2B. The 1 2021)	test of statistica	al difference bet	ween correlatio	n samples (31/	/01/2007-30/04/
	(1)	(2)	(3)	(4)	(5)
(1)	N/A				
(2)	0.0750	N/A			
(3)	0.0020	0.0000	N/A		
(4)	0.0470	0.0110	0.0020	N/A	
(5)	0.0010	0.0000	0.0580	0.0300	N/A

Note: (1) = Vietnam-Thailand; (2) = Vietnam-Indonesia; (3) = Vietnam-Philippines; (4) = Vietnam-Malaysia; (5) = Vietnam-Singapore; N/A = Not Available. This table uses the Kolmogorov-Smirnov for the two-sample test to compare two correlation samples from Table 3 to check whether their distributions are the same or different. A P-value that is less than 10% indicates the correlation samples are statistically different.



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