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Volatility Spillover Effect of Pan-Asia's Property Portfolio Markets

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Abstract: This study assesses the spillover effect of the listed property companies that cover pan-Asian countries, namely Malaysia, Thailand, Indonesia, Singapore, Vietnam, South Korea, Japan, China, the Philippines, and Hong Kong. The impact of market integration will create a spillover effect to the countries' economic performances, in particular the property market. As macroeconomic factors have high correlation with the performance of property security markets, it is therefore important to study the spillover effect by integrating the macroeconomic factors. This study has employed the exponential generalised autoregressive conditional heteroscedasticity (EGARCH) technique to develop the volatility spillover effect among pan-Asian countries. The results reveal high volatility of listed property companies recorded in Hong Kong and China, while Singapore, The Philippines and Japan have shown low volatility spillovers. In terms of macroeconomic factors, gross domestic product (GDP) and money supply (MS) are the most significant factors in influencing the volatility spillover effect among pan-Asian countries. From the standpoint of regional investors, the volatility spillover characteristics of pan-Asian countries will aid property stakeholders in the region in developing their own methods for making investment decisions in the property security market. Furthermore, in uncertain conditions of the financial market, this study will elevate the transparency of the pan-Asian property portfolio market by providing information on the property market volatility spillovers.

Keywords: volatility; spillovers; Asia; property; portfolio; effect



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1. Introduction

Pan-Asian countries over several decades have become more integrated in terms of economic activities, which consequently create high volatility situations among regional markets [1–4]. Ref. [1] emphasised that regional markets seem to move in tandem and are predictable. Specifically, pan-Asian countries are not just integrated within inter-countries in the form of economic activities, but are also highly correlated in macroeconomic factors, such as interest rates, inflation, consumer price index (CPI), base lending rate (BLR) and GDP. Several researchers such as [2,5,6] have investigated the high relationship of these macroeconomic factors within the pan-Asian region. Research findings from [2] also highlighted that the macroeconomic factor's conditional variance-covariances are major drivers of conditional property portfolio return volatility. Moreover, the high correlation

among global portfolio markets have been detected from previous studies and linked to the cross-border markets [5]. Since property security market is a proxy for the underlying non-residential real estate (NRRE), macroeconomic factors should also make a difference on listed property companies' returns. Nevertheless, the impact from the integration among various property portfolio markets in Asia has been less discussed, especially on investment analysis topics such as causality effect, volatility, as well as the spillover effect. With this background, this research aims to investigate the impact from market integration as well as unprecedented events from the perspective of the volatility spillover effect. This is especially relevant from the viewpoint of pan-Asian property securities' markets, as this region has shown remarkable performance over several decades.

Several mature Asian property markets (Japan, Hong Kong, and Singapore), emerging markets (Malaysia, South Korea, and Thailand), and minor emerging markets (China, India, Indonesia, the Philippines, and Vietnam) have all recently attracted global investor attention. This is owing to their expanding economic growth and political stability, and as a result, these local property markets have been enhanced in a cooperative manner. China, while considered one of Asia's smaller emerging economies, emerged as the world's largest economy in the post-Global Financial Crisis (GFC) period, surpassing the United States on a purchasing power parity basis [5]. China's participation in major regional and global economies has grown. The Philippines and Vietnam, both classified as minor emerging markets but at lower levels, have shown improved economic performance in recent years. However, during the post-GFC period, these countries' economic performances were marked by significant levels of uncertainty [7]. As a result, certain mature markets, such as Singapore, Hong Kong, and China, have had an impact on the performance of property securities in other rising property markets, such as Thailand, Malaysia, and the Philippines [7]. This circumstance has caused a spillover effect on the property securities' markets of pan-Asian countries.

A previous study conducted by [8] undertook an empirical analysis of volatility spillover characteristics of the Asian property securities over the countries using a tier basis. However, the study did not discuss the macroeconomic factors of the pan-Asian countries which are important as the level of integration depends on the performance of macroeconomic factors. The real estate market has also been impacted from the integration of economic activities. The impact of market integration will create the spillover effect on the countries' economic performances, including the property security market. Previous research on the volatility spillover effect has not considered investors in strategic decision-making due to the Asian property portfolio markets showing dynamic performances, especially in the decade of the 1990s. The effect from the Asian Financial Crisis (AFC) has triggered a volatility spillover effect investigation, however it is only in general financial markets. Real estate returns are related to macroeconomic and business situations because they are such an important aspect of the economy [1]. With its detailed investigation of volatility spillovers, this study will undoubtedly considerably improve investor understanding of the macroeconomic effects of real estate investment performance.

The assessment of the volatility spillover effect will provide decision-makers and stakeholders in terms of the decision-making process. It is believed that this study is among only a few researches that focus on volatility spillover issues which concentrate only on pan-Asian countries. The results from this study show that there is some evidence in terms of the impact from the property security market integration from the perspective of the spillover effect. Although the post-GFC period has seen several countries showing some remarkable recoveries, such as China, Hong Kong and Singapore, nevertheless in terms of the spillover effect, it has shown some moderate volatility and spillover effects in the pan-Asian countries' property security market.

In conclusion, this study examines the spillover effect in a local pan-Asian context. By using several empirical analysis techniques, this study will offer great benefit to property stakeholders, institutional investors, individual investors, academicians, researchers and the public. This study, therefore, is expected to add to the extended Asian property market

basis in this area, which will address volatility spillovers in developed and emerging nations in pan-Asian property markets.

2. Literature Review

According to a report by [7], pan-Asian economies would continue to be positive in terms of equities in the future. China, Thailand, Malaysia, Vietnam, Singapore, The Philippines, Indonesia, South Korea, Japan, and Hong Kong are among these nations. Furthermore, because of their demographic potential and promising economic prospects, these economies stand out among other American and European market economies [7]. As a result, the pan-Asian markets have received a lot of attention from investors, regulators, portfolio managers, policymakers, regulatory agencies, and financial institutions. These economies, which collectively account for almost 47% of the global population, are among the world's largest and most powerful in the twenty-first century [7]. China and Japan, in particular, are among the countries that have had the most rapid economic growth during the last 15 years. By 2030, China is expected to overtake the United States as the world's largest equity market [1].

The onset of the world's worst financial crisis, the GFC, has necessitated a thorough examination of the property portfolio industry, which must balance return-seeking behaviour in foreign markets with high risks of volatility spillovers as a result of increased market integration [4]. While greater global property market integration has allowed for unfettered capital movement, it has also increased volatility spillovers, particularly between emerging and developed countries. Because of the inadequacy and immaturity of their property portfolios and regulatory frameworks, developing countries are extremely sensitive to external shocks from developed markets, such as Singapore and Japan. Observing the dramatic changes in market interdependence and volatility transmission over the last two decades has been made easier by a series of financial crises that have occurred during the last two decades.

The discussion topic of volatility spillovers has become more significant in recent years, triggered by financial crises such as the GFC and AFC. After experiencing at least two economic crises, investors are pushed to seek and understand market information to strategise their investment decisions. Investment decisions are becoming more rational, but are more intuitive. Hence, investors begin to study, analyse, understand and manage risk during their investment. They are concerned of the risk and return by investment analysis so that the market efficiency is evolving.

The integration between various portfolio markets in Asia has been less discussed, especially on the investment analysis topics such as the causality effect, volatility, as well as the spillover effect. Nonetheless, this field of study has piqued the interest of both academics and practitioners in recent years. Given the benefits of real estate globalisation in the portfolio setting and the consequences of a financial crisis, volatility spillovers should be a major research area. This is significant because real estate investors are increasingly looking to go global. The high correlation among the global portfolio market has been detected from previous studies and linked to those of the cross-border market. This includes [8–10] where the findings from all these researches has strengthened the evidence of high correlation among pan-Asian countries' property securities' markets. As a result, volatility spillovers will have a greater impact. Furthermore, analysing the effects of severe events that occur during a financial crisis is a growing area of research on the volatility spillover topic. However, much emphasis has been placed on analysing this topic, such as performance diversification benefits and portfolio optimisation. The impact of a financial crisis has created paramount interest for investors and policy-makers to understand the level of volatility and consequently the effect of spillovers. In addition, the real estate market has been the subject of financial contagion analysis. The globalisation process has had an impact on the integration of the market, which consequently caused deregulation and financial market liberalisation [11,12].

Because real estate is such an important aspect of the economy, its revenue is highly influenced by macroeconomic and business conditions [13]. In measuring the spillover effect among pan-Asian property securities' markets, macroeconomic indicators such as inflation rate, GDP, interest rate, MS, and currency exchange rate are important. Macroeconomic conditions should have an impact on the returns of listed property businesses because they are a proxy for the underlying NRRE [13]. Macroeconomic considerations, according to [13,14], influence the success of the listed property businesses' market. Precise price projections in the property securities' markets necessitate keen investor observation and accurate assessments of the macroeconomic environment and the performance of individual investments [15]. Macroeconomic assessments, in particular, are used to make informed investment decisions.

Previous studies on property securities' markets are deceptive, with less variables taken into account, especially in assessing the spillover effect. This is especially vital for taking into account macroeconomic factors in the model. The model in this study has employed advanced econometric analysis which will provide more accurate findings in assessing the spillover effect among pan-Asian countries. The past decades have seen unpredictable situations with financial crises, which therefore means there is a need for macroeconomic factors to be included in the model. Furthermore, due to globalisation and cross-border investments, global property portfolios have grown more linked, particularly with the introduction of real estate investment vehicles such as Real Estate Investment Trusts (REITs) [16].

Therefore, the spillover effect among the Asian portfolio market, which takes into account macroeconomic factors, needs to be assessed for the benefit of stability of the portfolio market. The inclusion of the econometric models have also been found only in a few studies, such as [4] which employed autoregressive conditional heteroscedasticity (ARCH) and generalised autoregressive conditional heteroscedasticity (GARCH), which aimed to examine the volatility across pan-Asian countries during a financial crisis. The study, on the other hand, did not take into consideration macroeconomic considerations or the spillover impact. Similarly, ref. [9] examined the volatility spillovers of listed property companies in 12 Asian markets using the EGARCH model. To determine the level of the spillover effect, the study was only based on total return indices.

Despite the importance of knowing the nature of the spillover impact in a financial market, the profession couldn't agree on whether or not contagion existed during a previous financial crisis [17]. The size impact of the spillover effect and contagion are similar, according to a study by [18]. According to [19], a very stringent definition of spillovers occurs when cross-country correlations increase during crisis periods compared to correlations during more serene periods. They're also looking at the spillover effect from a broad perspective in this analysis, recognising that spillover refers to a general cross-country spillover effect. In this respect, so-called spillovers can happen in both good and bad times, i.e., spillovers do not have to be associated with crisis periods and merely reflect ongoing market interdependence. As a result, there is a strong link between contagion and spillover effects, as demonstrated by [20]. Spillovers are defined as a sudden increase in correlations across assets that are not explained by fundamentals, according to [21]. Return spillovers and volatility spillovers are two types of spillovers that might occur. In the real estate market, both real estate profits and real estate volatility information travels abroad, demonstrating the interdependence of global markets. Traditionally, real estate returns have been regarded as a measure of overall market level, whereas stock volatility has been regarded as a sign of market risk. The mean and variance of asset returns are used in most portfolio theories to evaluate the return-risk trade-off [22]. The spillover phenomena can be explained in a variety of ways. For starters, market imperfections may cause various markets to present the same data at different speeds. When a result is evident, spillovers may occur over time as foreign knowledge spreads incrementally. Second, because domestic investors learn about overseas market movements only after trading, the market takes time to react to new information [23]. Ref. [24] observed that

if international investors have the same knowledge as local traders, they will change the prices to match their expectations based on all available information after seeing overseas trading activity.

Aside from theoretical explanations, the existence of the spillover effect has been demonstrated in a large body of empirical research, particularly in the financial industry. Despite the fact that the majority of literature reveals strong spillover effects between financial markets, there hasn't been a comprehensive analysis of real estate markets. As a result, this research will apply financial theory to the real estate area, with a focus on the securitised property market. Various techniques can lead to different outcomes. Studying nine Asian stock markets, for example, ref. [25] found that all return and volatility spillover effects rose during the 1997 AFC, demonstrating the presence of financial contagion. Ref. [26], on the other hand, determined that there was no financial contagion in Asian markets during this time period using a different method. By estimating the stock price index in the 1990s, ref. [27] discovered no spillovers from the US market to the Hong Kong market, but [28] determined that both the return and volatility spillovers from the US to Hong Kong were considerable during the same era. For academics and policymakers alike, the fact that different techniques produce diverse outcomes is both a problem and a source of uncertainty.

The study on the spillover effect among markets and countries has been a topical research area in recent years, especially on financial markets. Asian economies, such as China's, have emerged as major growth players in the global economy over the last two decades, especially in trade and investment [29]. It has overtaken Japan as the world's second-largest economy. As a prominent world economy, Japan has a long history of listed real estate. The country was traditionally able to enjoy a higher degree of stock market interdependence with many Asian countries, due to its geographical proximity [4]. Despite the growing importance of the Chinese economy and Asian real estate capital markets, relatively little academic attention has been paid to these players in their real estate market integration relationship with Asian markets, although more has been done on the stock markets. Hence this study is motivated to discover the level of the spillover effect over the pan-Asian region. Table 1 summarises the major studies that relate to the volatility spillover effect within pan-Asian countries.

Table 1. Summary the Major Studies on the Volatility Spillover Effect in the Asian Property Market.

No.	Focus	Author(s)	Summary
1.	Spillover Plots	[30]	Propose the spillover effect as a simple quantitative measure of such interconnectedness, as well as related tools such as spillover tables and spillover graphs.
2.	Spillovers	[31]	Examine the connections between local and worldwide securitised real estate markets, as well as securitised real estate and common stock markets.
3.	Spillovers	[31]	Examine the worldwide beta dynamics of real estate and international spillovers in 16 public real estate markets.
4.	Spillovers	[32]	Examine the dynamics of mean and volatility spillovers from the US and three large (regional) Asian stock markets to 10 small (local) markets.

Due to real estate securitisation and changing real estate finance systems in many parts of the world, increasing global integration of financial and economic activity may have an impact on real estate investors and markets [15]. Because of growing economic integration, the domestic economy and stock markets are becoming increasingly related to international markets, potentially causing real estate market spillovers. The domestic economy and stock markets are becoming increasingly linked to overseas markets as a result of globalisation,

potentially producing real estate market spillovers [32]. Furthermore, with real estate as a major capital asset that has contributed to both investor diversification and wealth creation in many national economies, the topic of securitised real estate and global stock market integration has piqued the interest of both global investors and academics. Because they are able to attract foreign investors to their financial instruments in real estate equity or debt format, some mature public real estate markets (especially those in western countries) have better correlations with the global stock market. Some established public real estate markets (especially those in western countries) have better correlations with the global stock market because they are able to attract overseas investors to their financial instruments in real estate equity or debt format [33].

One important implication of this increased interdependence and/or joint volatility behaviour between securitised real estate and the global stock market is that global investors and country funds will have fewer opportunities for cross-asset and cross-border diversification, that a crisis will be transmitted more or faster, and that they will be much more vulnerable to domestic shocks [34]. Integration of global financial markets has been a defining characteristic of recent decades, particularly those following the late 1990's AFC [6], contributing to the development of interdependence, both in terms of return and volatility. National barriers in financial markets have been vanishing as a result of new global communication technology and the liberalisation of external economic relations, even for markets that are physically separated. Information arising from one country can be more easily conveyed to other nations as a result of these improved financial ties, a process known as spillovers in international financial markets. Researchers are interested in the nature of this interconnectedness because it affects asset prices, cost of capital computation, risk assessment, and the evaluation of foreign portfolio diversification.

The standard deviation or variance of return [35] is used to assess volatility, which is one of the most significant topics in finance and economics. The study of volatility in real estate is still underdeveloped, despite the fact that the notion of volatility has long been debated in the financial world, particularly in terms of the volatility spillover effect. This is due to the fact that direct real estate investing (by purchasing actual physical property) was previously the only option for investors [32]. Because of the enormous availability of capital and credit, the real estate markets of various large nations are becoming increasingly connected over time. Such occurrences have a negative impact on investor's portfolio performance. A few academics have looked into the dynamics of real estate volatility in the global market. Ref. [36] studied the patterns of real estate volatility in 16 publicly traded real estate markets from 1995 to 2015. During a financial crisis, they discovered that international public real estate markets are characterised by varied degrees of expanding global stock market connections. They also discovered that a few Asian public real estate markets have shown varying degrees of connectivity with the global stock market. According to [4] the property securities market's volatility has had a significant influence on investors in terms of risk and return. Ref. [37] conducted another investigation into the effect of market volatility in determining real estate liquidity. When describing the volatility liquidity relationship, they distinguished between two types of volatility: systemic and idiosyncratic volatility. Under the assumption of asymmetric information, they discovered that market volatility and real estate liquidity are adversely associated in both scenarios of systemic and idiosyncratic volatility. Their research, however, was limited to direct property.

The return and volatility dynamics of property stocks have recently piqued academic interest. During the AFC in 1997–1998, ref. [38] employed the latent factor model to investigate contagion across real estate markets. They discovered the presence of market contagion. During the AFC, ref. [39] used the structural time series method to quantify the spillover effect across Asian property markets and discovered a high level of interdependence. From January 2000 to March 2006, ref. [39] looked at long-run correlations and short-run causal interconnections between the public property markets of the Asia-Pacific region and the United States. Long-term results showed that the markets of Hong Kong and Japan offered larger diversification benefits to US investors, however a short-run

causality test revealed no significant lead-lag correlations between the US and Asia-Pacific property markets. Ref. [40] analysed changes in long- and short-term relationships between the US, UK, and eight Asian securitised real estate markets in the aftermath of the AFC. The study found that Asian markets were more interdependent in the long- and short-term. In addition, this reliance appears to be on the rise recently. Ref. [41] considered global property markets to be inter-regionally independent but intra-regionally co-integrated. Furthermore, the study discovered that the North American and Asia-Pacific areas will continue to diversify for some time. To investigate the structural causation shift of securitised real estate indices in five Asian nations and regions, ref. [42] used the multivariate cumulative sum (CUSUM) test and re-normalised the partial directed coherence (PDC) technique. The findings revealed that the Chinese securitised real estate market had a regional influence on the causation structure of the five markets. During the Asian and US subprime crises, ref. [43] used the co-skewness test to look at contagion across global real estate markets. During the US subprime crisis, there was little evidence of contagion, according to the study. During the GFC, ref. [44] used the kurtosis test to look at contagion across Hong Kong, the US, the UK stock, and securitised real estate markets. The kurtosis test found highly significant evidence of contagion between the equity and real estate markets in both directions, according to the findings. The most major contagion was between the equity and real estate markets in the United States.

Table 2 summarises the study of volatility on real estate securities by previous researchers.

Table 2. Summary of Previous Studies of Volatility on Real Estate Securities.

No.	Focus	Author(s)	Summary
1	Volatility	[18]	The Forbes, co-skewness, and co-kurtosis tests are used to look at contagion across Hong Kong, the US, the UK equities, and securitised real estate markets during the GFC.
2	Volatility	[30]	To evaluate the risk-return convergence, as well as the relationship between it and the realised correlation, in respect to global public real estate in 12 developed international public property markets.
3	Volatility	[31]	Examines the return and volatility spillover dynamics in Japan, Singapore, Hong Kong, Malaysia, Thailand, and South Korea's REIT markets.
4	Volatility	[32]	The report looks into the spread of REITs across three regions: North America, Europe, and Asia-Pacific.
5	Volatility	[33]	Examines the relationship between securitised real estate plots and future markets in terms of price, volatility, and covariance.
6	Volatility	[34]	The interdependence of daily conditional volatility in seven FTSE-NAREIT-EPRA European developed real estate securities markets, including the UK, France, Germany, The Netherlands, Italy, Sweden, and Switzerland, is investigated.
7	Volatility	[4]	Examines the return and volatility characteristics for listed property firm markets in major Asian nations over sub-periods based on the GFC.
8	Volatility	[35]	The author investigates the causal relationship between stock returns, trading volume, and volatility of real estate stocks in Asia.
9	Volatility	[14]	The paper investigates the problem in 10 developed worldwide public property markets and evaluates the state-dependent volatility characteristics in each market.
10	Volatility	[36]	Using an econometric model that combines common volatility effects across the sample markets, this study examines eight Asia-Pacific securitised real estate markets that have shown volatility trends over the last 15 years.

3. Methodology

This research encompasses studies focused on pan-Asian property companies. It considers 11 national securitised real estate markets, such as Singapore, Hong Kong, China, Japan, The Philippines, Malaysia, Indonesia, Vietnam, Thailand and South Korea. Previous studies on measuring volatility levels found no evidence of cross-volatility spillovers

among Asia-Pacific markets [1,4,20,37]. Refs. [21,38,39] discovered various conclusions relating to Asian property securities' dependency and spillover, with these links shifting over time. Ref. [33] found considerable international REIT volatility spillovers within the Pacific region, as well as strong volatility transmission across the Pacific and Atlantic regions. Ref. [32] found no evidence of the ex-post return of the direct property incorporating market volatility of property securities, but plenty of evidence to the contrary.

This study spans the years of January 2000 to December 2019. Eikon DataStream is used to extract monthly returns for real estate securities and cash for all countries. Table 3 summarises the data for asset class marketplaces used in this study. For this study, all pan-Asian countries' data asset types include shares, property securities, and bonds. These databases are the most comprehensive source of information on mixed-asset classes in Pan-Asian countries, with property securities serving as a benchmark.

Table 3. Research data for shares real estate securities, bonds and cash.

	Country	Shares	Property Securities	Bonds	Cash
1	Malaysia	KLCI Composite	Kuala Lumpur SE Properties	Malaysia Gov. secs. Medium term	Malaysia deposit 3 months (middle rate)
2	China	Shanghai Composite	Shanghai SE Estate	JPM EMBI Global China	Time Deposit Rate 3 months (middle rate)
3	Hong Kong	Hang Index	Hang Seng Properties	Hong Kong Exchange Fund Note 5 year	Hong Kong Interbank 3 months (middle rate)
4	Japan	TOPIX	TOPIX Real Estate	Japan Government Bond Series 5 year	Japan Interbank 3 months (offered rate)
5	South Korea	South Korea Composite	South Korea SE Construction	South Korean Treasury Bond 5 year	South Korea Monetary Stab Bonds 1 year
6	Indonesia	Jakarta Composite	Jakarta SE Construction Property	JPM ELMI + Indonesia	Deposit 3 months (offered rate)
7	The Philippines	Philippines Composite	Philippines SE Property	JPM ELMI + Philippines	Philippines Treasury Bill 91D (Middle Rate)
8	Thailand	Bangkok S.E. T	Thailand SE Property	JPM ELMI + Thailand	Thailand Interbank 3 months (BB) (offered rate)
9	Singapore	Singapore all-Sing Equities	Singapore All	Singapore T-Bond Yield 5 year	Singapore T-Bill 3 months
10	Vietnam	Hi Chi Minh City Index	TR Vietnam Real Estate	TR Vietnam Government BMK BID Yield 2 year	Vietnam Interbank 3 months

Three of the countries studied, namely Singapore, Hong Kong, and Japan, are considered mature markets since their economies and portfolio markets contribute significantly to Asian regional growth. While China is considered Asia's largest market, it has a significant impact on other Asian property markets. These countries would be used as a benchmark for Asian securitised markets to analyse the dynamics of links in terms of spillover volatility effect, according to [40]. The economies of these countries are among the world's most important listed property markets in Asia. This study includes data from the GFC, with the goal of highlighting the crisis' impact on the spillover effect throughout pan-Asian property portfolio markets.

Real GDP is one of the macroeconomic determinants for listed property companies that have been described as a significant macroeconomic factor. Furthermore, CPI, interest rate, industrial production index (IPI) and MS are also some of the most important economic indicators. These major macroeconomic variables have been established as significant variables for pan-Asian countries to use as a benchmark for evaluating results [13]. Therefore, it is justifiable to use all these macroeconomic factors as major variables together with major property portfolio performance variables in order to assess the spillover effect. In order to ensure the standardisation in terms of variables, the data encompasses listed property companies, shares, bonds and cash which have been extracted from the same resource which is Eikon DataStream. Table 4 explains the description of major macroeconomic factors which are the fundamental variables that have been assessed in terms of the spillover effect in this research.

Table 4. List of Macroeconomic Factors.

Symbol	Description
	Short-term interest rates.
IR	Following Harvey (1994), the ‘most unregulated’ short-term interest rates were selected. Specifically, deposit rates were used for South Korea, Malaysia, Singapore, and Thailand. The overnight call money rate was used for India. Money market rates were used for South Africa. The treasury-bill rate was used for Mexico, while the savings deposit rate was used for Hong Kong, and the lending rate used for The Philippines.
CPI	The inflation variable is measured by the consumer price index.
GDP	Gross domestic product, measured in millions or billions of local currencies.
MS	Average balance of money, measured in millions or billions of local currencies.
IPI	Industrial production index shows the overall economic activity and stock prices are affected by it. It is hypothesised that increases in industrial production reduces the volatility in foreign portfolio investment.

The multivariate GARCH, regime switching (RS), and stochastic volatility (SV) models [14,17,18,22] are common econometric approaches in terms of econometric models. However, this study will be using EGARCH as an improvisation from the previous GARCH model [36,41] and will also provide more accurate analysis. Moreover, the next EGARCH will be incorporated with macroeconomic factors from each of the selected countries in order to provide a clear view of the integration economies in pan-Asian countries which are focused on listed property companies.

The EGARCH approach was used in this study to provide an overview of volatility dynamics as well as volatility co-movements of listed property companies for pan-Asian countries. The EGARCH model is a modification of the GARCH model created by [42]. The GARCH model, as indicated by [43], is an extended ARCH model that includes prior conditional variances in the equation. The goal is for the ARCH process to acquire a higher order of parsimony. The exponential GARCH model, often known as the EGARCH model, was then developed to quantify conditional kurtosis in listed property company returns [25,29]. The unbalanced character or skewness created by the negative correlation between volatility and returns, referred to as the leverage effect, has not been represented by the current conventional GARCH model.

This downward movement will have a greater impact on volatility forecasting than the upward movement. The EGARCH model will be employed exclusively in this study to determine the volatility spillover impact based on unit root test studies. In this case study of research, the EGARCH model was beneficial for volatility analysis. Furthermore, this has explained surprise price reductions and volatility rises better than an identical surprise price increase [45]. In the EGARCH (1,1) model, the basic equation for conditional variance specification is as follows:

$$\ln\sigma_t^2 = a_0 + \varphi Z_{t-1} + \psi(|z_{t-1}| - E|z_{t-1}|) + \beta_1 \ln\sigma_{t-1}^2 \quad t = 1, \dots, n \quad (1)$$

The new model of EGARCH is named EGARCH-MD due to one exogenous variable macroeconomic determinant for each of the Asian countries. Eikon DataStream has been added as additional information to the conditional variance. The new equation of this study conditional variance is:

$$\ln\sigma_t^2 = a_0 + \varphi Z_{t-1} + \psi(|z_{t-1}| - E|z_{t-1}|) + \beta_1 \ln\sigma_{t-1}^2 + \gamma_1 MD_{t-1} \quad t = 1, \dots, n \quad (2)$$

MD—represents the data of economic variables for every Asian country including real GDP, inflation, interest rate, MS, foreign exchange rate, IPI, and CPI. In this research, EGARCH (1,1) models were used to model the volatility of pan-Asian securities’ real estate indices for the time period of 2000 to 2019. Before the EGARCH models were applied,

a diagnostic test was performed which included least squares (LS) method, Kolmogorov–Smirnov (KS) test, autocorrelation function (ACF) test and Ljung–Box test. The LS test was used to determine the presence of EGARCH effects. This was accomplished by using the LS approach to create regression residuals first. The EGARCH heteroscedasticity test was then performed to the residuals to examine if there was any time varying volatility clustering. The return and volatility spillover measurements used in this work are based on vector auto regressive (VAR) models in the wide tradition of [36]. The study went on to look into the spillover indices of the securitised real estate sector in pan-Asian countries. Weekly nominal equities' market returns were estimated using the change in log price from Friday to Friday, as described in [44]. The weekly nominal returns were converted to real weekly returns using the monthly inflation rate, where the weekly inflation was assumed to be constant within the month. Meanwhile, equity market volatility was computed as the annualised standard deviation of the relative price change for the 10 most recent trading days' closing log price. All data was obtained from DataStream.

Return and volatility spillovers are calculated from the variance decompositions obtained from estimating a generalised N-variable VAR. The method has been reproduced using the generalised VAR framework proposed by [45], which produces variance decompositions that are invariant to the order of the variables in the VAR. When one variable is shocked, the effects to the other variables are combined using the historically observed distribution of the errors. Thus, the data itself reveals the strength of the relationships that evolve over time. Ref. [26] used the generalised VAR framework to generate forecast error variance decompositions. This approach allows for a conditional variance that varies over time and is modelled as a function of past values and exogenous variables. When $c = 0$, positive shocks (good news) create less volatility than negative shocks, indicating that the model is symmetric (bad news). This model was also examined for one lag of squared residual shock ($X(t - i)^+$), which was determined to be insignificant across markets and hence eliminated for simplicity's sake.

From the decompositions, the relative contribution of own variance shares and cross-variance shares are obtained, from which a spillover effect can be calculated. The VAR model is a reduced-form equation with an unconstrained collection of lagged dependent variables acting as regressors. The VAR model assumes that the economic or finance indices were changing in spite of correlating with each other. The VAR model can also estimate and capture the current situation based on the sample period of study. It can read as many as possible shock occurrences in the selected time period of study. It is very significant to investigate the return movement based on the combination of asset classes in the portfolio. The formula of VAR is derived as:

$$X_t = c + \sum_{i=1}^p \varphi_i X_{t-i} + \varepsilon_t \quad (3)$$

where:

$\varphi_1, \dots, \varphi_p$ = parameters of the model

c = constants

ε_t = error

After estimating the variance decompositions, which denotes what fraction of the Z-step ahead of variance in one real estate market is due to shocks from other real estate markets in the VAR system, this method constructs the generalised spillover index, which summarises the resulting information into an aggregate measure and captures the degree of spillovers within the markets examined. The spillover index measures the degree of cross-market spillovers by comparing the total error variance of the marketplaces analysed (as measured by the share of cross-market error variance in the variance decomposition).

4. Results and Findings

This section will cover the empirical findings that aim to estimate the volatility level of listed property companies in pan-Asian countries. Table 5 shows the results of the EGARCH (1,1) model for listed property companies in pan-Asian nations over the case study period of 2000 to 2019. All significant macroeconomic variables have been incorporated in the analysis. The goal of the study is to determine the level of volatility of listed property businesses across pan-Asian countries while taking macroeconomic considerations into account. As a result, the investigation was able to tell investors about the extent of macroeconomic influence on the volatility of Asian property portfolio markets. The conditional variances extracted by the EGARCH procedure of many macroeconomic parameters are used in this study to calculate macroeconomic risks.

Table 5. EGARCH Analysis of Dynamics of Volatility for pan-Asian Countries over the Period of January 2000 to December 2019.

	Japan	Vietnam	The Philippines	Singapore	Thailand	Malaysia
Models						
Variables						
ω	−3.59 (0.00)	−2.29 (0.00)	−1.98 (0.00)	−3.57 (0.00)	−3.68 (0.00)	−3.61 (0.00)
α	1.32 (0.00)	1.81 (0.00)	1.24 (0.00)	1.56 (0.00)	1.94 (0.00)	1.16 (0.00)
β	0.59 (0.00)	0.83 (0.00)	0.86 (0.00)	0.63 (0.00)	0.64 (0.00)	0.61 (0.00)
γ_i	0.04 (0.75)	−0.12 (0.43)	0.01 (0.91)	0.03 (0.84)	0.06 (0.73)	−0.15 (0.16)
CPI	−0.03 (0.00)	7.92 (0.00)	−2.03 (0.00)	−0.50 (0.38)	−0.23 (0.54)	−2.74 (0.00)
GDP	3.64 (0.00)	−0.55 (0.00)	2.77 (0.00)	−0.47 (0.12)	3.36 (0.00)	0.01 (0.00)
IPI	−0.004 (0.53)	0.13 (0.00)	−0.001 (0.81)	0.003 (0.48)	−0.007 (0.38)	0.01 (0.05)
Interest rate	-	−0.12 (0.00)	−0.05 (0.35)	−0.69 (0.00)	0.67 (0.00)	−0.05 (0.00)
MS	−0.26 (0.15)	−0.04 (0.32)	−0.05 (0.35)	−0.69 (0.00)	0.67 (0.00)	−0.05 (0.00)
SIC	−2.89	−1.23	−3.17	−2.82	−2.32	−3.52
AIC	−3.21	−1.57	−3.49	−3.15	−2.64	−3.85
Log Likelihood	366.53	190.23	398.97	361.02	307.08	437.19

The explanation of the analysis begins with a look at all pan-Asian countries from the standpoint of volatility levels. In the pan-Asian countries, the study found correlations between listed property company returns and significant macroeconomic indicators. The EGARCH findings revealed that only one country, Hong Kong, had a negative value of shocks, which is significant at the 5% level. This is an example of the leverage effect. In other words, in Hong Kong, the negative number indicates that bad news (negative shocks) causes more volatility than good news (positive shocks). Although the *p*-value is not significant, countries including Vietnam, Malaysia, Indonesia, South Korea, China, Japan, Singapore, Thailand, and The Philippines showed negative and positive values of shocks; consequently, the presence of a leverage effect is not acknowledged in the EGARCH model. The studies also found that the value of α is close to 1, for example, in countries such as Vietnam and The Philippines, which show strong persistence with modest volatility shock decay over this time span. In other words, any news that comes out during this time will have a long-term impact on Vietnam and The Philippines. For other countries, the value of shocks can be regarded as modest, as it is not near to 1. This suggests that shocks to volatility have a low persistence, implying that any news will have a short-term impact on any country. This also reveals that, with the exception of Vietnam and The Philip-

piners, most pan-Asian countries exhibit little volatility across the research period. The low volatility of pan-Asian countries (with the exception of Vietnam and The Philippines) is attributable to the fact that Asian countries were hit by a financial catastrophe (the AFC), which taught the region to be more prepared.

Due to the differing period of investigation, which only lasted through 2012 and included the AFC and GFC, the results differ from those of [4]. Another study [32] obtained a different finding, indicating that the majority of pan-Asian countries' property markets had a high number of volatility dynamic elements. Over the study period of 1987 to 2003, findings from [9] demonstrated the existence of volatility shocks in various Asian property markets, such as Singapore, Japan, and Malaysia. Several researches, including [22,23,31], have discovered high volatility of listed property businesses in pan-Asian countries, reporting dissimilar results that suggested property companies in the Asian market were riskier and more volatile. Nonetheless, subsequent research [33,46,47] have found that Asian property portfolio markets have demonstrated some stability, indicating that the post-GFC recovery process has been successful.

The analysis of this research also estimated the contributions of macroeconomic parameters into the analysis of the volatility effect within pan-Asian countries. The significance and magnitude on the estimated coefficients vary across the countries in the pan-Asian region. There are macroeconomic variables involved in this analysis, such as CPI, GDP, IPI, interest rates, and MS. There are several interesting findings from the analyses for pan-Asian countries. As for Japan, findings showed significant macroeconomic factors such as CPI, MS and GDP that have a leverage effect in the listed property companies in Japan. The CPI coefficient has a negative value (-0.03) and is significant at the 5% level. This suggests that the CPI has experienced a negative shock or received bad news, which could cause the conditional variance of Japan's listed property companies to become more volatile and riskier. The leverage impact is defined as a negative relationship between previous price and future price volatility. It means that when the CPI's volatility decreased, the value of listed property companies in Japan increased. MS and GDP are two more elements that have a substantial impact on the leverage effect of Japan's listed property companies (1.88 and 3.64 respectively). These two characteristics, on the other hand, bring good news or positive shocks to Japan's listed property companies, since the asset class's conditional variance becomes less volatile and risky. Other factors, such as the IPI and MS, have no bearing on Japan's portfolio.

As for Vietnam, findings showed significant macroeconomic factors, such as CPI, IPI, interest rate and GDP that have a leverage effect in their listed property companies. Coefficient value for gross development product and interest rate shows negative value (-0.55 and -0.12 respectively) with significance at the 5% level. This indicates that GDP and interest rate have a negative shock or bad news that can influence the conditional variance of Vietnam's listed property companies to become volatile and riskier. It means that when the volatility of the Vietnamese economy and interest rate decreased, the volatility of listed property businesses increased. CPI and IPI are two other elements that have a substantial impact on the leverage effect of Vietnam's listed property businesses (7.92 and 0.13 respectively). At the 5% level, both factors are significant. However, these two factors provide good news or positive shock to Vietnam's listed property companies where the conditional variance of this asset class becomes less volatile and has low risk. Other factors such as exchange rate and MS are not significant in Vietnam's portfolio.

Analysis from The Philippines' property portfolio volatility analyses has shown significant macroeconomic factors, such as CPI and exchange rate that have a leverage effect in the listed property companies in The Philippines. Coefficient value for CPI and exchange rate shows negative value (-2.03 and -0.65 respectively) with significance at the 5% level. This indicates that CPI and exchange rate have a negative shock or bad news that can influence the conditional variance of The Philippines' listed property companies to become volatile and riskier. It means that while the CPI and exchange rate fluctuated less, the volatility of listed property companies in The Philippines increased. Another aspect

that has a considerable impact on the leverage effect of listed property companies in The Philippines is GDP (2.77). However, this factor provides good news or positive shocks to The Philippines' listed property companies where the conditional variance of this asset class becomes less volatile and has low risk. Other factors such as IPI, interest rate and MS are not significant in The Philippines' portfolio.

As for Singapore, the findings showed significant macroeconomic factors, such as exchange rate and MS that have a leverage effect in the listed property companies in Singapore. Coefficient value for exchange rate and MS shows negative value (−3.50 and −0.69 respectively) and is significant at the 5% level. This indicates that exchange rate and MS have a negative shock or bad news that can influence the conditional variance of Singapore's listed property companies to become volatile and more risky. It indicates that when the volatility of exchange rate and MS goes down, the volatility of listed property companies in Singapore went up. Other factors such as IPI, CPI, GDP and interest rate are not significant in Singapore's portfolio.

As for Thailand, the findings showed significant macroeconomic factors such as exchange rate, GDP, interest rate and MS have a leverage effect in the listed property companies in Thailand. Coefficient value for exchange rate and interest rate shows negative value (−2.31 and −0.26 respectively). This indicates that exchange rate and interest rate have a negative shock or bad news that can influence the conditional variance of Thailand's listed property companies to become volatile and riskier. It means that while the volatility of the exchange rate and interest rate decreases, the volatility of Thailand's listed property businesses rises. GDP and MS are two other factors that have a significant impact on the leverage effect of Thailand's listed property businesses (3.36 and 0.67 respectively). However, these two factors provide good news or positive shock to Thailand's listed property companies where the conditional variance of this asset class becomes less volatile and has low risk. Other factors such as CPI and IPI are not significant in Thailand's portfolio.

Malaysia has shown significant macroeconomic factors such as CPI, interest rate, MS, GDP and IPI that have a leverage effect in the listed property companies in Malaysia. Coefficient values for CPI, interest rate and MS show a negative value (−2.74, −0.19 and −0.05 respectively). This indicates that CPI, interest rate and MS have a negative shock or bad news that could be influenced by the conditional variance of Malaysia's listed property companies to become volatile and have high risk. It means that when the volatility of the CPI, interest rate, and MS decreased, the volatility of Malaysia's publicly traded property businesses increased. GDP and IPI are two more factors that have a substantial impact on the leverage effect of Malaysia's listed property companies (0.01 and 0.01 respectively). However, these two factors provide good news or positive shock to Malaysia's listed property companies where the conditional variance of this asset class becomes less volatile and has low risk. Other factors such as exchange rate is not significant in Malaysia's property portfolio.

For Hong Kong's property portfolio, the findings showed significant macroeconomic factors, such as GDP, interest rate and MS have a leverage effect in the listed property companies in Hong Kong. Coefficient value for GDP shows negative value (−0.50) with significance at the 5% level. This indicates that gross development product has a negative shock or bad news that can influence the conditional variance of Hong Kong's listed property companies to become volatile and riskier. It means that as the volatility of GDP decreased, the volatility of Hong Kong's listed property companies increased. Interest rate and MS are two other elements that have a big impact on the leverage effect of Hong Kong's listed property companies (0.15 and 0.27 respectively). Both factors have significance at the 5% level. However, these two factors provide good news or positive shock to Hong Kong's listed property companies where the conditional variance of this asset class becomes less volatile and has low risk. Other factors such as CPI, exchange rate and IPI are not significant in Hong Kong's portfolio.

According to the study, significant macroeconomic parameters such as the CPI, GDP, exchange rate, interest rate, and MS have a strong impact on China's listed property

companies. The exchange rate, GDP, and interest rate, all have negative coefficient values (-1.27 , -0.39 and -0.22 respectively). This implies that a negative shock or bad news to the exchange rate, GDP and interest rate will cause the conditional variance of China's listed property companies to become volatile and risky. It means that as the volatility of the exchange rate, GDP, and interest rate decreases, volatility of China's publicly traded property companies increase. CPI and MS (0.40 and 0.70 respectively) are two other factors that have a significant impact on the leverage effect of China's listed property companies. These two variables, on the other hand, bring good news or a positive shock to China's listed property companies, as the conditional variance of this asset class becomes less unpredictable and has low risk. Other factors, such as the industrial development index, have no bearing on China's investment strategy.

The findings in South Korea revealed that major macroeconomic factors such as exchange rate, interest rate, MS, CPI, and GDP have a leverage impact in South Korean listed property companies. The exchange rate, interest rate, and MS all have negative coefficient values (-1.52 , -0.32 and -0.98 respectively) that are important at the 5% stage. This means that a negative shock or bad news to the exchange rate, interest rate, or MS will cause the conditional variance of South Korea's listed property companies to become volatile and risky. The volatility of listed property companies in South Korea increased as the volatility of the exchange rate, interest rate, and MS decreased. The CPI and GDP are two key variables that have a substantial impact on the leverage effect of listed property businesses in South Korea (1.91 and 0.96 respectively). These two variables, on the other hand, provide good news or a favourable shock to South Korean listed property companies, as the conditional variance of this asset class becomes less unpredictable and has low risk. Other factors, such as the industrial output index, have no bearing on South Korea's investment strategy.

Significant macroeconomic indicators, such as CPI, GDP, exchange rate, interest rate, and MS, have a leverage effect in the listed property businesses in Indonesia, according to Indonesian volatility property portfolio research. Coefficient values for gross development product, exchange rate and interest rate show negative values (-0.006 , -0.07 and -0.08 respectively), with significance at the 5% level. This indicates that GDP, exchange rate and interest rate have a negative shock or bad news that can influence the conditional variance of Indonesia's listed property companies to become volatile and riskier. It means that when the volatility of the Indonesian economy, exchange rate, and interest rate decreased, the volatility of listed property businesses increased. Other factors that have a significant impact in terms of leverage effect to Indonesia's listed property companies are CPI and MS (1.01 and 0.75 respectively). However, these two factors provide good news or positive shock to Indonesia's listed property companies where the conditional variance of this asset class becomes less volatile and has low risk.

Overall, practically all macroeconomic factors, with the exception of IPI, have played a significant role in determining the performance of the pan-Asian property securities' market. The findings suggest that macroeconomic issues could have an impact on the property securities' market, causing uncertainty. Naturally, policymakers would need to analyse the health of the economy in terms of the dominance of a given uncertainty before developing policies that target macroeconomic concerns. As a result, the volatility in macroeconomic factors that drives unpredictability in property securities promotes the development of improved macro-prudential policy. To put it another way, regulatory procedures in the property securities' market should be designed to put a larger emphasis on systemic risk mitigation.

The inclusion of macroeconomics will give a strong indication to the investors as based on the previous findings; macroeconomic factors have high correlation to the performance of the stock market, including the property portfolio market [2,8,13]. Potential investors, not just in the Asian region, but also globally, will receive better and transparent information in terms of the influence of macroeconomic factors which could possibly influence the performance of property portfolio markets among pan-Asian countries. While cross-market

investment dynamics are a well-studied topic in international finance, no thorough studies of macroeconomic and public real estate market dynamics in emerging Asian nations have been conducted. Previous research only focused within a single market or comparison between matured and emerging markets. For example, ref. [48] looked at the spillover effect of macroeconomic issues in the United States, but only looked at the Real Estate Uncertainty Index (REUI). In the United States, ref. [49] looked at residential real estate, REITs, and financial asset spillovers. Both studies found that macroeconomic factors play a substantial influence in the spillover effect, which has a considerable impact on the mixed asset performance of the country. Ref. [47] assessed China's real estate investment with macroeconomic factors where the findings indicated macroeconomic factors are important factors as indicators in the portfolio's performance. Other studies in China include [50], which examined the spillover effect between house price and macroeconomic factors. The house price factor and macroeconomic factor spillover effect has also been examined by [51] in the USA.

A number of scientists and specialists have looked into the macroeconomic drivers that influence the price and direction of investments in listed real estate securities [8,17,21]. Understanding macroeconomic aspects and determinants that closely link with real estate securities' returns is one of the most significant pieces of knowledge that comes with investing in global listed real estate securities [23,31,42]. This study would become a benchmark in the Asian region because it provides a full analysis which includes 11 countries, as this topic has been long discussed in another region. Furthermore, the inclusion of the 11 countries which has combined less emerging markets, emerging markets and developed markets will provide a broad overview of the pan-Asian property securities' market. Table 5 summarises the EGARCH analysis of pan-Asian nation's volatility trends from January 2000 to December 2019.

5. Volatility Spillover Effect Analysis

This section examines the analysis of the volatility spillover effect of 10 pan-Asian countries. Based on the past two decades' data on total returns of pan-Asian public property markets, volatility attributes were assessed across the markets. The specification of volatility level specifies great information in order to study the spillover effect, especially during severe market conditions. The GFC has triggered concern for the volatility issue, mainly because the banking sector has opened the fragility of the securities' market. Macroeconomic factors also play a part in the development of volatility in the pan-Asian economy [2,13,18]. Low interest rates have been exacerbated by the recession, which has contributed to an increase in yield in listed property firms [52]. Consequently, the high interest rate will contribute to less dividends in listed property companies which makes investment in listed property companies less attractive [53]. The crisis swiftly extended throughout the globe, putting international real estate securities in jeopardy. This stimulated researchers to re-examine real estate assets. Most pan-Asian countries consider the real estate securities' market as an important component [54]. Therefore, high uncertainty in the market will also affect the country's economic growth. Previous findings have shown that the financial crisis affected the property securities' market even higher than general stock [16,21,43]. Nevertheless, investment in property securities is still the preferred choice as real estate securities exhibit high potential of diversification [4,9].

The conditional volatility spillover results are shown in Table 6. Based on a 15-year rolling sample into a complete spillover effect, the whole sample of volatility spillovers has provided an indicator of the average volatility spillover behaviour. The total of variances in the row column excludes the contribution to its values (diagonal variances). This represents the impact on pan-Asian market betas and beta spillovers of the pan-Asian net, which is represented by the 'to' and 'from' differences. The directed spillovers "From Others" are represented by the off-diagonal row sums, while the directional spillovers "To Others" are represented by the off-diagonal column sums. The "Net" spillovers are "To Others" minus "From Others." The average of "From Others" (or "To Others") is the "Total Spillovers".

Table 6. EGARCH Analysis of Dynamics of Volatility for pan-Asian Countries over the Period of January 2000 to December 2019.

Models Variables	Hong Kong	China	South Korea	Indonesia
ω	−3.59 (0.00)	−2.31 (0.00)	−2.21 (0.00)	−3.93 (0.00)
α	1.52 (0.00)	1.23 (0.00)	1.67 (0.00)	1.42 (0.00)
β	0.52 (0.00)	0.77 (0.00)	0.54 (0.00)	0.66 (0.00)
γ^i	−0.35 (0.75)	0.02 (0.91)	0.01 (0.84)	−0.18 (0.73)
CPI	−0.10 (0.64)	0.40 (0.00)	1.91 (0.01)	1.01 (0.00)
GDP	−0.50 (0.05)	−0.39 (0.00)	0.96 (0.03)	−0.006 (0.02)
IPI	0.00 (0.60)	0.01 (0.15)	0.01 (0.08)	−0.002 (0.77)
Interest rate	0.15 (0.00)	−0.22 (0.04)	−0.32 (0.00)	−0.08 (0.00)
MS	0.27 (0.00)	0.70 (0.00)	−0.98 (0.00)	0.755 (0.00)
SIC	−3.54	−1.70	−2.13	−2.90
AIC	−3.87	−2.03	−2.46	−3.23
Log Likelihood	439.54	240.40	287.06	370.23

For all pan-Asian beta spillover effects, all variances have shown 11 times 11 matrixes on the total of the diagonal variances. As a result, the beta spillover Table 7 provides an approximation of the entire real estate beta spillover effect's input/output breakdown. The total real estate for the pan-Asian beta spillover impact is around 27.41% in this example with a 15-year variation, implying that spillovers account for a quarter of the variance in the cross-asset common market risk on average across the 11 pan-Asian property security markets. As a result, it can be inferred that property security market beta spillovers are mild, with each of the 11 property security markets impacting and being influenced by others. A purely domestic component, on the other hand, accounts for a much lower fraction (11.7%) of property security beta movements. Individual public real estate markets' distinctive characteristics, for example, have already been observed within pan-Asian betas. According to the respective diagonal variance, the beta persistence value of property securities ranges from 52.8% (Thailand) to 88.3% (China). Based on individual market directional beta spillovers, which measure net beta spillovers from market i to all other markets j , the findings show that Hong Kong (172) is the leading transmitter of beta spillovers, followed by Vietnam (124), The Philippines (115), China (114), Japan (113), and Indonesia (113). Singapore and Thailand are the top two less dominating transmitters of beta spillovers among all pan-Asian countries.

The directional information over the entire sample period is generated from the overall spillover results. Because the 11 real estate security markets are of varying sizes and levels of real estate market maturity, their responses to shocks from other markets appear to be variable. The average directional volatility spillover from each of the 11 markets to other markets range from 3% (Thailand) to 89% (Hong Kong). Hong Kong (89%) is the highest volatility exporter, followed by The Philippines (48%), Vietnam (36%), Japan (29%), China (26%), and Indonesia (26%). Following that, the market's proportion of error variation is explained by collective innovations in all pan-Asian markets (from others) and ranges from 12% for Vietnam and China to 47% for Thailand. Thailand is clearly the most vulnerable to the volatility effects of the other markets, with 47% and 44% of its variance explained by the 11 other real estate security markets combined. The real estate security markets are listed from most indigenous to most exogenous after Thailand, Singapore, and Vietnam. Vietnam has 12% of the market, China has 12%, Hong Kong has 16%, Japan has 16%, South Korea has 26%, Indonesia has 28%, Malaysia has 28%,

The Philippines has 33%, and Singapore has 38%. With a share of more than 40% in other pan-Asian nations, the findings suggest that international property stock volatility innovation accounts for a significant amount of domestic property stock volatility variance in Thailand.

Table 7. The Conditional Volatility Spillovers.

	VNM	CHN	HKG	IND	JPN	MYS	PHL	SGP	S.KOR	TWN	THA	CONTRIBUTION FROM OTHERS
VNM	87.8	0.1	2.6	3.3	1.4	1.9	1.6	0.0	0.7	0.1	0.5	12
CHN	0.5	88.3	4.7	0.0	2.4	0.0	2.2	0.3	0.0	0.2	1.2	12
HKG	1.5	8.7	83.6	0.6	1.1	0.1	1.5	0.5	0.0	2.1	0.2	16
IND	6.5	2.6	5.9	72.0	3.0	0.1	6.4	0.6	0.9	1.3	0.6	28
JPN	0.8	0.6	11.2	0.0	83.6	0.0	2.2	0.1	0.0	1.4	0.1	16
MYS	3.6	6.8	4.3	3.9	0.9	71.6	5.8	0.7	0.0	2.4	0.1	28
PHL	5.6	0.1	12.0	5.1	8.8	0.4	66.9	0.2	0.5	0.3	0.0	33
SGP	4.1	0.1	15.7	1.7	5.2	0.9	5.0	62.0	0.4	4.8	0.0	38
S.KOR	2.2	1.4	4.5	3.5	1.1	1.9	5.6	4.3	74.0	1.5	0.0	26
TWN	4.9	5.5	14.1	0.4	3.1	7.6	1.5	1.1	5.6	55.8	0.4	44
THA	6.0	0.0	13.8	3.0	1.8	0.6	16.2	2.3	2.5	0.9	52.8	47
CONTRIBUTION TO OTHERS	36	26	89	22	29	13	48	10	11	15	3	30
CONTRIBUTION INCLUDING OWN	124	114	172	94	112	85	115	72	85	71	56	Spillover effect 27.41%

The findings contradict previous findings on volatility spillover explored by [12], and place Indonesia and China as the countries with the highest volatility spillovers from January 1999 to December 2009. However, according to a later study [55], Hong Kong has the largest spillover effect to numerous other Asian countries, including Malaysia, Singapore, and Japan. Ref. [52] did, however, limit the study to three Asian countries. Nonetheless, ref. [18] studied the impact of three Greater China regions on Asian emerging markets as well as the property market in the United States and found that China and Thailand had a significant impact on these countries from January 1999 to December 2013. The data reveal that overall volatility spillover effects are state-based as well as time-varying. As a result, due to regime changes, developing behaviour (both general and specific) in the cross-market volatility spillover effect and covariance forecasting is crucial [18].

Finally, this study focuses on average net turning spillovers, or the difference between contributions to others and contributions from others. This data will show which of the 11 real estate security markets is most effective at transferring volatility to other markets. The market directional volatility spillover from Hong Kong real estate securities affects 89% of the pan-Asian public real estate markets. As a result, among pan-Asian countries, the Hong Kong property portfolio sector is the most influential. This could be because Hong Kong has the largest securities' real estate market in Asia and was having a larger impact on the pan-Asian public real estate market throughout the case study period.

Furthermore, volatility spillovers from the Hong Kong property securities' market could account for a large portion of the volatility, with the GFC causing the majority of the spillovers. This refers to the degree to which domestic macroeconomic policy is sound enough to protect the economy from negative inward volatility spillovers in the property securities' market. GDP, interest rate, and MS were the most significant macroeconomic variables in Hong Kong. Given how vulnerable these macroeconomic factors are to volatility spillovers, this would suggest that further efforts be made to grow local property securities' markets. Other options for limiting volatility spillovers include adjusting monetary and fiscal policies where policy space is open, as well as managing the exchange rate and foreign exchange reserves. However, given concerns about the economic outlook in pan-Asian countries [7], volatility spillovers form the end of accommodative

monetary policies in Hong Kong and the adoption of looser monetary policy in the pan-Asian area may be disruptive and should be closely monitored.

6. Conclusions

The spillover effects of Asian listed property businesses have been studied from the standpoint of volatility dynamics as well as spillover impacts, taking into account macroeconomic considerations. This is because any large changes in volatility will eventually affect the real estate market, thus investors must be conscious of the market's instability. The spillover effect is becoming more important among investors due to the high integration among the global property security markets. This includes macroeconomic factors which could influence the level of volatility and spillover effect. Investors need to know that their investments in certain countries will receive only little impact due to instability in other countries. From the standpoint of the volatility spillover effect, advanced econometric analysis, such as EGARCH, has been able to deliver clear information to investors and key stakeholders. These insights are particularly relevant for property players, analysts, and investors. Furthermore, the research revealed that market volatility is converging. The EGARCH impact is present in all listed property businesses, according to the examination of a significant influence across all pan-Asian countries.

Recent events in this area, such as the GFC, oil price crises, and pandemics (SARS and H1N1), have shown how policy instability can spread across countries. Following the financial crisis, pan-Asian countries adopted a series of unorthodox monetary policy measures, causing reserve balance sheets to balloon to previously unheard-of proportions [53]. Faced with a big drop in GDP, governments in pan-Asian countries embarked on a massive fiscal stimulus programme. These activities impacted capital flows, bond risk premia, and exchange rates, among other things, potentially growing policy uncertainty in other economies faced with an option of how to respond to these developments. At the same time, these economies were struck by a negative financial shock and had to make their own policy decisions, which may have negative consequences for policy instability in other countries. This study backs up the theory that policy instability causes significant spillovers in the event of a financial crisis [56]. As a result, not only is policy uncertainty extremely counter-cyclical, but so is the overall connectedness of policy uncertainty across pan-Asian countries.

Overall, because international investors consider not only long-term price relationships, but also short-term market volatility interactions and return correlation structure when allocating their portfolios, the findings of this study will shed more light on the extent to which investors can benefit from regional and international diversification in the long- and short-run, both within and across countries. Although it is beyond the scope of this work, future research into how the two co-movement indicators (volatility and correlation spillovers) may be merged in optimal covariance forecasting in global investing, which includes equities and public real estate markets, would be beneficial.

In conclusion, pan-Asian countries have shown moderate levels of the property securities' market spillover effect. The findings have also revealed over the past 19 years, Hong Kong was the most influential country among the pan-Asian countries which was able to transmit the spillover effect to other countries. On the contrary, Thailand was the most sensitive country, which indicates that these countries could easily affect other pan-Asian countries. The spillover measures have the appealing feature of communicating essential and useful information while avoiding the thorny problem of contagion episode definition and existence. Overall, all pan-Asian countries have shown no burst in the spillover effect, but the increasing trend is due to high integration of the market over the past 19 years.

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