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INVESTMENT RISK MANAGEMENT IN MAJOR STOCK EXCHANGES AND SME MARKETS OF EMERGING ECONOMIES

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Introduction. Small and medium enterprises (SMEs) are crucial in the economy by providing jobs, contributing to GDP, efficiently providing products and services where economies of scale are not needed and creating cash flows. However, SMEs encounter certain obstacles, with financial constraints being the major ones. SME markets have been perceived as another opportunity for SMEs to obtain external financing.

Aim and tasks. This study aims to analyse the interactions between major stock and SME markets in emerging economies, focusing on China, India, and Indonesia.

Results. The diagonal BEKK and DCC-GARCH models analyse the transitions between these stock markets. The study findings offer compelling evidence of dynamic conditional correlations across all markets and illustrate significant volatility spillovers among the SME markets. This correlation is evident both in the short and long periods. The evidence indicates that small- and medium-sized market volatility significantly affects larger markets. The findings reveal a substantial interplay between the major and SME stock markets in emerging economies, including China, India, and Indonesia. According to the diagonal BEKK and the DCC results, investors should not expect significant diversification benefits by including primary and SME market instruments in their portfolios. Investors should closely monitor the co-movements and transitions between these markets to optimise their portfolio diversification strategies.

Conclusions. Creating an environment and conditions that promote the growth of SMEs and improve resilience through specific fiscal alternatives, enhancing access to financing, and upgrading market infrastructure are essential. This study found substantial interplay between major and SME stock markets. Policymakers should be aware that SME market fluctuations influence larger stock exchanges and destabilise macroeconomic conditions, such as economic stability and growth. Therefore, regulatory actions that project the need and operational efficiency of stock market segments should be implemented to prevent adverse effects. For instance, transparency and risk management can stabilise SME stock markets to avoid volatility in larger markets.

Keywords: SME Stock Market, Emerging Economies, Volatility Spillover, GARCH model.

1. Introduction.

Small and medium-sized firms (SMEs) serve as accelerators of global development and retain their importance in economies. Following 1980, the extensive implementation of a free-market economy resulted in a swift escalation of global competition. The rapid reopening of economies and deregulation of borders for goods and services have facilitated this development. Consequently, consumer preferences diversified, shifting from an industrial to an information society. This societal change created significant obstacles for major organisations, while opportunities emerged for small enterprises, as they could adjust to changes more easily.

Thus, the worldwide shift in economic focus to specific businesses due to micro and small business employment, investments, and production achievements, as well as value creation and flexibility in emergencies and shifts, means that SMEs are now more crucial than ever. Concerning the country's development and growth strategies, SMEs have become increasingly important, and efforts have been made to increase the number of SMEs and support their financial systems. According to various SME research reports (Mortiz et al., 2016), SMEs have contributed significantly to GDP and employment. SMEs, as constituent elements of the economy, provide all types of support to the economy. The extensive number of SMEs relative to the global economic landscape provides a significant phenomenon for development and economic growth (El-Halaby et al., 2023; Ghalke et al., 2022).

SMEs are an important phenomenon relative to many socioeconomic efforts (regional development, output, investment, export, import, and employment), for which tremendous support is required. SME-specific advantages supplement these socioeconomic factors. From the perspective of regulation, during the founding period of an enterprise, fewer regulations limit SMEs. When factoring in the expenses of establishments, they are lower than those of large-scale enterprises. Mirze (2010) notes that the attributes that make SMEs better than larger entities include their flexibility to attain production and marketing structure adjustment.

This flexibility is due to their ability to respond to constantly changing demand, lower trading costs when economies of scale are not needed, and their built-in innovative potential. Variations in the definition and classification of SMEs hinder the interpretation of international statistics. However, the significance of the SME sector is acknowledged globally.

SMEs are essential to emerging and developed economies (Hasan et al., 2024; Keskin et al., 2010; Özkaya, 2021). The World Trade Organization states that 95% of all enterprises worldwide are SMEs. Such socioeconomic development patterns exist in both developed and developing nations (Zhang, 2021). For instance, over 99% of all enterprises in China, Germany, Japan, and the United States are SMEs. Thus, a significant portion of the population works in SME. For example, SMEs in the U.S. employ 53% of the U.S. labour force, SMEs in Germany employ 68% of Germany's labour pool, and SMEs in Japan employ 66% of Japan's workforce. In addition, SMEs account for much of the production; 55% of the added value comes from SMEs in Japan, 51% in the United States, and 45% in Germany (UK Essays, 2013). In the emerging markets of developing countries, SMEs can provide approximately 70% of formal employment and generate up to 40% of national income (GDP) (World Bank, 2023).

The economies of India and Indonesia rely heavily on small and medium enterprises. In India, SMEs are an important source of GDP, exports, and employment (Singh et al., 2010). In Indonesia, they account for almost all businesses and employ more than 90% of the population, including youth and women (Santia, 2020; Susanti et al., 2023).

When the numbers in different sectors are analysed, SMEs in Indonesia are mainly concentrated in the agriculture sector, followed by the trade and hospitality sectors. Despite their importance, SMEs' contribution to Indonesia's GDP fell from 54.8% in 2000 to 53.3% in 2006, a marginal decrease (Tambunan, 2009). This may be due to the considerable financial hardship SMEs face in Indonesia. A key factor contributing to the importance of SMEs in economies is their ability to achieve various socioeconomic goals.

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SMEs create job opportunities, stimulate economic growth through innovation, increase exports, and nurture entrepreneurship (Keskin et al., 2010; Li et al., 2024; Sri Artini & Sri Sandhi, 2021). They promote economic prosperity and stability (Fiseha & Oyelana, 2015). The World Bank (2023) has projected that approximately 600 million jobs will be required by 2030. Consequently, the employment-generating capacity of SMEs renders their advancement a paramount concern for governments worldwide. Moreover, SMEs contribute to regional development and sustainable production (Arakelyan, 2024).

1.1. SMEs in Emerging Economies and Market Dynamics.

Many severe global events occurred during this period, affecting SMEs, such as the COVID-19 pandemic and military conflict (European Union, 2023). Access to finance remains a key barrier to developing small and medium-sized enterprises (SMEs) (Shinozaki, 2014). Capital is needed for operating activities and launching new SME initiatives, which are often unavailable at the start-up stage. The primary forms of raising funds include equity financing (both internal and external) and debt financing from external sources. Due to limited resources at the start-up stage, enterprises are forced to turn to external capital to expand their operations.

However, most SMEs lack the organisational structure to issue shares or bonds, meaning they can only seek banks and financial intermediaries from which they require loans. The need for external funding is so severe that SMEs are seen as less stable than larger companies; as a result, interest rates are higher, and the company's survival is in balance. The disadvantages of SMEs include non-transparent financial information systems and high bankruptcy rates. Although using credit for money is less problematic in developed countries, it is a significant constraint on the growth of SMEs in developing or underdeveloped countries. As per Stein et al. (2013), the credit gap ratio compared to the volume of loans to SMEs will be significantly higher in the developing world than the developed one.

At the same time, approximately 5-6% in OECD countries, while in developing countries it is 26-32%. This is explained by such high rates in developing countries by the low level of collateral, low capacity for banks to lend, vulnerable SME banking environments, and a generally underdeveloped financial system in these regions. In developing economies, official external sources of capital financing are limited (Ghalke et al., 2022).

As previously stated, selling equity shares is an alternative financing solution for SMEs that cannot obtain low-cost and accessible loans. SMEs can obtain equity financing by selling shares to investors, such as angel investors and venture capitalists, without pursuing a public offering.

This approach is particularly advantageous for newly formed SMEs with significant development potential. In Turkey, in 2023, the total angel investment in startups and high-growth potential small enterprises reached roughly 901 million dollars (Startups Centrum, 2024). For SMEs that have attained a degree of institutionalisation adequate for a public offering, procuring requisite finance from the stock markets becomes more accessible and efficient. Public offerings allow SMEs to connect with a broad array of investors in the capital market, facilitating access to collateral-free long-term financing. They are devoid of repayment commitments that can disrupt cash flows.

1.2. SME (Stock) Markets.

The SME stock market, or SME market, is a specialised securities market that offers an alternate listing option for companies that fail to meet the requirements of major stock exchange markets. The primary objective is to create financial inclusivity for SMEs, provide a profitable introduction to the public market, and encourage expansion. SME stock exchanges demonstrate more malleable listing regulations and compliance obligations than major stock exchanges do. This is important because this market provides the mechanism for SMEs to fulfil the requirements to be listed on larger exchanges.

When SMEs transfer to larger markets, they find better liquidity, and the dynamism of the primary market benefits those (Harwood & Konidaris, 2015). A dedicated niche SME exchange or segment has been formed in many nations to meet the tailored needs of the SME business population. The inaugural SME stock exchange was the Alternative Investment Exchange (AIM), a subsidiary of the London Stock Exchange (LSE). In 1995, the AIM was created to help small firms' access money from the stock market. This enables firms to raise money by listing on the stock market with regulatory flexibility (London Stock Exchange, 2024). The existence of AIM has spawned like-minded SME markets internationally, which helps SME's access finance markets.

In 2012, the Bombay Stock Exchange launched a platform for small and medium enterprises (SMEs) to help them raise funds through initial public offerings (Arora & Singh, 2020). It then created an index to track the performance of these companies, making it easier for investors to track their performance (Artini & Sandy, 2021). On 19 November 2013, the Bombay Stock Exchange (BSE) registered 41 SMEs as issuers quickly after its inception (Shinozaki, 2014). With more than 400 companies listed, the Bombay Stock Exchange SME platform has expanded significantly.

It is important for small and medium enterprises to have access to financial markets, which will support the growth of BSE SME platform. As a reaction to the global financial crisis, China established the Chinex Market, a specialised platform for SMEs, in 2009.

The SME-ChiNext 100 Index was launched in February 2011. It has a high return on equity (ROE) and is frequently used as a relevant index for small businesses. SMEs in Indonesia do not have a dedicated platform. On 18 May 2009, the Indonesia Stock Exchange (BEI) and rating agency PT. Pemeringkat Efek Indonesia (PEFINDO) introduced the PEFINDO25 Index. The PEFINDO25 selection criteria and process consist of two stages. First, the criteria for identifying an eligible group include total assets of at least IDR 25 trillion, a beta close to 1, and regulatory requirements such as no Unusual Market Activity (UMA)or trading suspension in the past six months. The company must have been listed on the Indonesia Stock Exchange (IDX) for at least six months prior to the study. Second, constituent selection evaluates business metrics through the issuer's ROA and ROI indicators, with liquidity factors such as the number of trading days, trading volume, trading value, trading frequency, and free float (Pefindo, 2024). Table 1 shows cases of stock exchanges specifically designed to support SMEs.

Table 1. Global SME Stock Exchange Platforms.

SME Stock Market	Country	Market Opening
Australian Securities Exchange (ASX) Small and Mid-Cap Stocks	Australia	1987
TSX Venture Exchange (TSXV)	Canada	1999
ChiNext	China	2009
Nile Stock Exchange (NILEX)	Egypt	2007
Euronext Growth	Europe	2005
Growth Enterprise Market (GEM)	Hong Kong	1999
Bombay Stock Exchange (BSE) SME Exchange	India	2012
Indonesia Stock Exchange (IDX) Growth Board	Indonesia	2019
Market of the High-Growth and Emerging Stocks (Mothers)	Japan	1999
Moscow Exchange SME Sector	Russia	2012
Parallel Market (NOMU)	Saudi Arabia	2012
CATALIST	Singapore	2008
The Korean Securities Dealers Automated Quotations (KOSDAQ)	South Korea	1996
Mercado Alternativo Bursátil (MAB)	Spain	2006
BIST Emerging Companies	Türkiye	2009
Alternative Investment Market (AIM)	UK	1995

Source: based on the World Federation of Exchanges (2025).

However, companies listed on SME stock exchanges with significant growth potential are attractive to investors. Moreover, many stock exchanges impose reduced regulatory obligations to incentivise SMEs to go public and list. SME markets are anticipated to significantly impact growth and economic development (Nguyen et al., 2020a, 2020b). Forecasting the returns of one stock based on the lagged returns of another is impractical due to the absence of a time-varying risk premium in an efficient market. The implications of spillover effects on returns make for a sound trading strategy (Zhong & Liu, 2021). If such a strategy generates more profits than the cost of implementing the actions, then the market is inefficient. Therefore, investigating spillover channels and return spillover effects enables investors to make decisions on asset and stock selection and the application of appropriate portfolio management techniques.

Conversely, if the SME market is entirely connected to the significant market, volatility will diminish, resulting in investors benefiting from lower capital costs (Al-Nassar & Makram, 2022). Understanding volatility spillover effects is crucial for financial activities that rely on conditional volatility estimates, such as option pricing, hedging, and value-at-risk assessments. The importance of comprehending volatility spillovers for investors employing these financial strategies is evident (Harris & Pisedtasalasai, 2006).

This study explores the volatility spillover effects between the major stock markets and the SME market in China, India, and Indonesia, considering that SMEs are important for most emerging economies. Even amidst a global economic downturn, according to the International Monetary Fund's World Economic Outlook (2016), the average economic growth from 2009 to 2014 was highest for China, India, and Indonesia in the 5 years following the global financial crisis.

2. Literature Review.

Anyikwa & Phiri (2023), Aggarwal & Saradhi (2024), Belanes et al. (2024), and Yadav et al. (2023) state that the case of these shifts occurred in both developed and emerging stock markets.

Furthermore, Harris and Pisedtasalasai (2006) employed the AR_GJR GARCH_M model to examine the transmission of returns and volatility between securities traded in major securities exchange markets and the SME market in the UK. Large-to small-cap stocks did not have significant volatility transmission from the small to the large side. However, return and volatility spillovers were significant for large companies and small stocks. The findings suggest that larger stock returns and volatility transitions are a good tool for predicting future movements in smaller equities (Arouri et al., 2012; Kumar & Sahu, 2017; Tien & Hung, 2022; Xu et al., 2019).

Samitas et al. (2006) employed cointegration analysis to study the primary objective and examine the relationship between SME and the Athens Stock Exchange markets. The second objective is to ascertain fluctuations in SME stock values by comparing stock values in the Athens exchange and SME markets. The results indicate substantial unidirectional causality between the Athens Exchange and SME market indexes. This signifies and corroborates the presence of an information shift in the market. The study findings suggest that index prices in major securities exchange markets may provide valuable insights for investors regarding price fluctuations in SME stock markets. This may result from the infrequency of trade in the Athens stock market or the lack of weak-form market efficiency.

Hung and Lin (2013) analysed the information flows between large and small stocks on the Tokyo Stock Exchange. Using advanced volatility and correlation models (VC-GJR-GARCH and VAR), they found that the direct information flows between the Topix Small Cap index and the Topix Large 70/Core 30 index were weak. Koulakiotis et al. (2016) employed modified univariate and multivariate VAR-EGARCH models and utilised a Monte Carlo simulation for robustness testing. The FTSE/ASE-20 index represents the leading stock exchange of the Athens Stock Exchange, while the FTSE/ASE 40 and FTSE/ASE 80 indices represent small- and medium-sized enterprises. The study found significant differences between diversified and large-cap AP companies from 2001–2012.

Furthermore, the study revealed that the transition became less asymmetric following the 2008 global financial crisis. A similar model employed by Nguyen et al. (2020a) and the HKEX and GEM indices were chosen for data analysis, encompassing the period from 1 July 2009 to 30 December 2016. Six stock market indices were examined, encompassing SME market indices such as GEM in Hong Kong, CATALIST in Singapore, MAI in Thailand, and ACE in Malaysia.

Studies have shown no significant difference in returns between large-cap and small-cap equity markets in Malaysia, Thailand, and Singapore. Singh et al. (2010) studied the volatility between the Bombay Stock Exchange Small and Medium Enterprises Index (BSE SME Index) and the major index (SENSEX) in India using GARCH and BEKK-GARCH models during the period 2012- 2021. Sahoo and Kumar (2022) studied the relationship between the Nifty 100 and small-cap equity indices.

Jena et al. (2021) studied Indian markets using the VDC technique, which shows that these markets offer prospects for portfolio diversification in the medium to long term. Al-Nassar and Makram (2022) examined the differences in returns and volatility between major securities and SME markets in Egypt and Saudi Arabia. They employed asymmetric DCC-GARCH and BEKK-GARCH analyses.

The small and medium enterprise (SME) market needs to be further studied, especially compared to large enterprises, which usually attract analysts' attention to assess risks and react to economic and political changes. Since small businesses are often considered the driving force of the economy, especially in developing countries, this has led to a gap in understanding the development of this important sector.

3. Methodology.

This study explores the dynamic interplay between major stock and SME markets in China, India, and Indonesia. It used the diagonal BEKK model to examine how volatility changes between large and small markets and the DCC-GARCH model to examine how correlations and volatility change over time.

3.1 Diagonal BEKK GARCH Model.

The BEKK-GARCH analysis, promoted by Engle and Kroner (1995), is designed to incorporate dynamic linkages into the analysis. The primary BEKK GARCH formula, developed based on the GARCH (1,1) formulation, is as follows:

$$H_t = C'C + \sum_{j=1}^{q}\sum_{k=1}^{k}(\alpha'_{kj}\,\alpha_{kj}\varepsilon_{t-j}\varepsilon'_{t-j}) + \sum_{j=1}^{p}\sum_{k=1}^{k}(\beta'_{kj}h_{qk,t-j}\beta_{kj}) \quad (1)$$

where,

H_t – the $n\times n$ conditional covariance matrix;

C, α_{kj} and β_{kj} – $n\times n$ parameter matrix;

ε_{t-j} – the vector of residuals at lag i;

p and q – the lag orders.

The diagonal BEKK model, similar to the BEKK model, focuses on the diagonal elements of the covariance matrix. It captures different covariance matrix elements based on the past dependence levels between the variables. The number of dimensions to be estimated in both the BEKK and diagonal BEKK analyses is provided in Equations 2 and 3.

$$p + q = KN^2 + (N(N+1)/2 \quad (2)$$

$$p + q = KN + (N(N+1)/2 \quad (3)$$

Equation 3 demonstrates two-asset diagonal BEKK GARCH model:

$$H_t = C_0'C_0 + \begin{bmatrix}\alpha_{11} & \alpha_{12}\\ \alpha_{21} & \alpha_{22}\end{bmatrix}, \begin{pmatrix}\varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1}\\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon^2_{2,t-1}\end{pmatrix}\begin{bmatrix}\alpha_{11} & \alpha_{12}\\ \alpha_{21} & \alpha_{22}\end{bmatrix} + \begin{bmatrix}g^*_{11} & g^*_{12}\\ g^*_{21} & g^*_{21}\end{bmatrix}', H_{t-1}\begin{bmatrix}g^*_{11} & g^*_{12}\\ g^*_{21} & g^*_{22}\end{bmatrix} \quad (4)$$

Volatility analysis, propagation, and future price forecasting were conducted using the BEKK-GARCH models detailed in Equations 5-6 and 7.

$$h_{11} = c_{11} + a^{*2}_{11}\varepsilon^2_1 + 2a^*_{11}a^*_{21}\varepsilon_1\varepsilon_2 + a^{*2}_{21}\varepsilon^2_2 \quad (5)$$

$$h_{12} = c_{12} + a^*_{11}a^*_{12}\varepsilon^2_1 + (a^*_{21}a^*_{12} + a^*_{11}a^*_{12})\varepsilon_1\varepsilon_2 + a^*_{21}a^*_{22}\varepsilon^2_2 \quad (6)$$

$$h_{22} = c_{22} + a^{*2}_{12}\varepsilon^2_1 + 2a^*_{12}a^*_{22}\varepsilon_1\varepsilon_2 + a^{*2}_{22}\varepsilon^2_2 \quad (7)$$

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3.2 DCC-GARCH Model.

The DCC-GARCH model generated by Engle (2002), combines nonlinear univariate GARCH models with the Constant Conditional Correlation (CCC) model. The dynamic conditional correlation (DCC) model is represented as follows:

$$H_t = D_t R_t D_t \quad (8)$$

where:

H_t – the $n \times n$ conditional covariance matrix;

R_t – the conditional correlation matrix;

D_t – a diagonal matrix with time-varying standard deviations on the diagonal.

The DCC-GARCH model is implemented without the assumption that the conditional correlation is constant and time-invariant, unlike the GARCH and CCC GARCH models (Huang et al., 2010). Accordingly, the conditional variance Dt in Equation 8 differs from the conditional correlation Rt term in terms of allowing it to be time-varying.

$$R_t = diag\left(q_{11,t}^{\frac{1}{2}}, \ldots, q_{NN,t}^{\frac{1}{2}}\right) Q_t diag\left(q_{11,t}^{\frac{1}{2}}, \ldots, q_{NN,t}^{\frac{1}{2}}\right) \quad (9)$$

$$Q_t = q_{ii,t} = S(1-\alpha-\beta) + \alpha\varepsilon_{t-1}\varepsilon_{t-1}^{'} + \beta Q_{t-1} \quad (10)$$

where:

$\alpha>0$, $\beta>0$;

Q_t – N×N matrix;

S – the $n \times n$ unconditional variance matrix of ε_t.

For the DCC-GARCH model to be stationary, the condition $\alpha+\beta<1$ must be met.

The most important advantage of the DCC-GARCH analysis is that the number of calculated variables is less than that of the BEKK GARCH model. The DCC-GARCH model was implemented in two stages. The conditional variance is estimated in the first stage using the univariate GARCH model. In the second stage, the conditional correlation parameters are estimated by making the covariance matrix positive over time.

4. Empirical Results and Discussion.

4.1. Data and Preliminary Analysis.

This study is based on daily closing price data of stock indices from December 27, 2012, to July 12, 2024. A total of 2,512 observations were collected, and the time interval was determined based on the availability of information on the Investing.com platform.

Three major indices reflecting the performance of major Asian stock markets were selected for the analysis: the Shanghai Composite Index (SSE), the leading index of the Chinese stock market; the Bombay Stock Exchange Sensex 30 Index (SENSEX), one of the leading indices in India; and the Indonesia Stock Exchange Composite Index (IDX), a comprehensive index reflecting the Indonesian stock market.

The SME markets are represented by the SME-Chinext 100 Index (CHINEXT), S&P BSE SME IPO Index (BSE_SME), and IDX Pefindo-25 Index (PEFINDO25). Table 2 presents the data description.

Table 2. Description of Market Indices.

Country	Major Market Index	Major Market Acronym	SME Market Index	SME Market Acronym
China	SSE Composite	SSE	SME-Chinext 100	CHINEXT
India	BSE Sensex 30	SENSEX	S&P BSE SME IPO	BSE_SME
Indonesia	IDX Composite	IDX	IDX Pefindo-25	PEFINDO25

The daily returns of stock indexes are calculated using the following logarithmic formula:

$$R_t = 100 \times ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

where:

R_t – represents the percentage daily return;

$P_{i,t}$, $P_{i,t-1}$ – the closing index prices on day t and t-1, respectively.

Figure 1 plots the daily closing prices and returns of markets.

The volatility swings in SME markets are more pronounced than those in major markets, highlighting the influence of volatility on driving price fluctuations.

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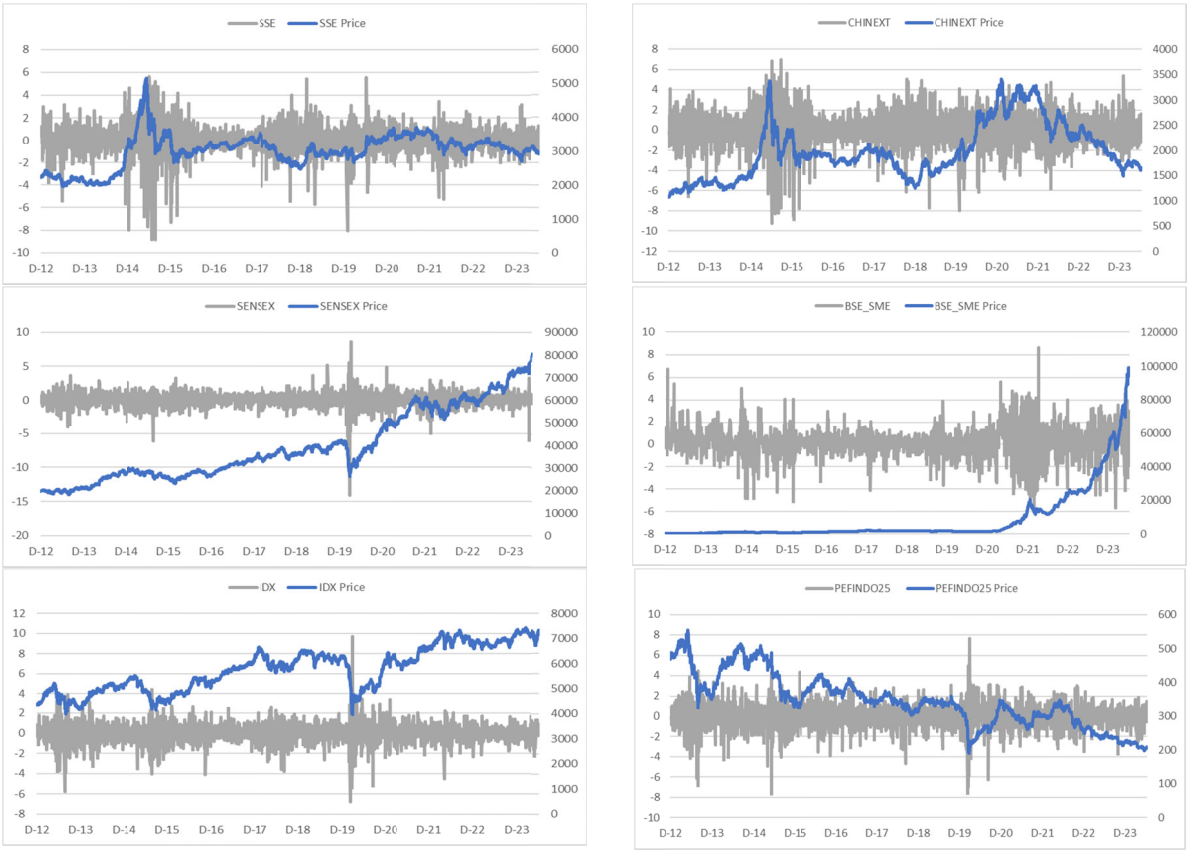

Fig. 1. Daily Closing Prices and Returns.

Table 3 presents the descriptive statistics for the major and SME market indices in China, India, and Indonesia. All markets, except China's major stock market and Indonesia's SME market experienced a positive mean. Except for Indian SMEs, returns in all markets are negatively skewed, indicating that losses are predominant.

A positive kurtosis greater than 3 indicates a kurtosis-kurtosis distribution. The Jarque-Bera test confirms non-normality at the 1% level. The ADF and PP tests confirm stationarity. The ARCH-LM test reveals heteroscedasticity, which justifies the use of the BEKK-GARCH and DCC-GARCH models.

Table 3. Descriptive Statistics.

	China		India		Indonesia	
	SSE	**CHINEXT**	**SENSEX**	**BSE_SME**	**IDX**	**PEFINDO25**
Mean	-0.0010	0.0121	0.0609	0.2263	0.0153	-0.0320
Max	5.6036	6.9463	8.5947	8.6142	9.7042	7.6936
Min	-8.8729	-9.2243	-14.1017	-5.6898	-6.8050	-7.6260
Std. Dev.	1.2908	1.6926	1.0565	1.3438	0.9906	1.2280
Skewness	-1.0514	-0.5799	-1.4111	0.0436	-0.3277	-0.5464
Kurtosis	10.7400	6.3320	23.3019	6.1759	10.8553	7.6077
Jarque-Bera	6733.0770	1302.8570	43973.8800	1056.4910	6503.4720	2347.1880
(Probability)	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*
ADF Test	-47.7513	-48.0762	-52.1317	-21.8666	-47.0768	-48.9529
(p-value)	(0.0001)*	(0.0001)*	(0.0001)*	(0.0000)*	(0.0001)*	(0.0001)*
PP Test	-47.7457	-48.1277	-52.1066	-42.4383	-47.0462	-49.0225
(p-value)	(0.0001)*	(0.0001)*	(0.0001)*	(0.0000)*	(0.0001)*	(0.0001)*
ARCH-LM (5)	130.0638	183.8757	157.5315	73.5724	119.6381	198.4445
(p-value)	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*
Observations	2512	2512	2512	2512	2512	2512

*Note: * denote 1% level of significance.*

4.2. Diagonal BEKK GARCH Results.

This study employs diagonal BEKK-GARCH analysis to explore the interlinkages of volatility between the returns of the major stock markets and SME markets in China, India, and Indonesia.

The model provides insights into the correlations between contingent volatility and covariance for investigating cross-market volatility transitions. The following summarises the results of the diagonal BEKK (1,1) model under the Student-t distribution (Table 4).

Table 4. Variance and Covariance Equations.

Variance and Covariance Equations
Panel A: China
GARCH1 = 0.0188170867311+0.0651942636469*RESID1(-1)^2+0.919246482029*GARCH1(-1)
GARCH2 = 0.0310713505029+0.0631747334048*RESID2(-1)^2+0.928643964198*GARCH2(-1)
COV1_2 = 0.0197751088173 + 0.0641765551071*RESID1(-1)*RESID2(-1) + 0.923933275268*COV1_2(-1)
Panel B: India
GARCH1 = 0.0193904856407+0.0605823209761*RESID1(-1)^2+0.912869750558*GARCH1(-1)
GARCH2 = 0.0489833726762+0.0518365836907*RESID2(-1)^2+0.909471998812*GARCH2(-1)
COV1_2 = 0.0187919637124 + 0.0560390984175*RESID1(-1)*RESID2(-1) + 0.911169290909*COV1_2(-1)
Panel C: Indonesia
GARCH1 = 0.0196693629508+0.0610466702415*RESID1(-1)^2+0.912456454132*GARCH1(-1)
GARCH2 = 0.0494108689658+0.0529259978914*RESID2(-1)^2+0.908407497232*GARCH2(-1)
COV1_2 = 0.0189337564119 + 0.0568414984011*RESID1(-1)*RESID2(-1) + 0.910429724817*COV1_2(-1)

The diagonal coefficients and spillover effects in Table 5 illustrate volatility transitions. The ARCH terms a_{11} and a_{22} represent endogenous shocks for the mean equation coefficients. Whereas the GARCH terms b_{11} and b_{22} represent endogenous volatility spillovers. The diagonal coefficients of a_{11} and a_{22} are positive for all markets and indicate higher volatility when the market movements are in the same direction.

Meanwhile, the correlation coefficient for the major market of China is 0.0652, for India it is 0.0606, and for Indonesia it is 0.0610. Of these markets, the Chinese market has the most significant impact on future changes. Similarly, the continuous coefficient for China SMEs is 0.0632, for the India core markets it is 0.0518, and for the Indonesia core markets it is 0.0529. The Chinese SME market had the most significant impact on future volatility. Moreover, in the major stock markets, past innovations significantly negatively impact future returns for all markets studied.

Short-run shocks originating from significant markets tend to amplify volatility in the SME market in the short term.

The own-volatility spillover coefficients are 0.9192 for the China major stock market, 0.9129 for the India primary stock market, and 0.9125 for the Indonesia major stock market, respectively. For the SME markets, the coefficients are 0.9286 for the Chinese SME market, 0.9095 for the Indian SME market, and 0.9084 for the Indonesian SME market.

Stock markets are highly dependent on the persistence of volatility, and the volatility between major markets and SME markets is 0.9239 for China, 0.9112 for India, and 0.9104 for Indonesia, indicating a strong persistence of cross-volatility between all major and SME markets. Overall, the diagonal BEKK analysis indicates that own-shocks and own-volatility spillovers are significant, suggesting that past volatility transitions impact present volatility, consistent with the literature (Al-Nassar & Makram, 2022). In addition, a bidirectional volatility transition exists between the significant and SME markets. The diagonal BEKK model's log likelihood is -6,776 for China, 6,885 for India, and 6,190 for Indonesia. These findings suggest that major markets significantly affect SME market volatility.

Table 5. Diagonal BEKK–GARCH Results.

Panel A: Diagonal BEKK–GARCH results between SSE and CHINEXT				
	Coefficient	Std.	T-Stat.	Prob.
c1	-0.0010	0.0164	-0.0606	0.9517
c2	0.0121	0.0237	0.5116	0.6089
w11	0.0137	0.0035	3.9055	0.0001
w12	0.0145	0.0039	3.7193	0.0002
w22	0.0226	0.0065	3.4717	0.0005
a11	0.3067	0.0143	21.5205	0.0000
a22	0.2530	0.0130	19.4576	0.0000
b11	0.9499	0.0041	233.6086	0.0000
b22	0.9638	0.0034	284.6336	0.0000
LL	-6776.6300			
AIC	5.4034			
SC	5.4266			
HQC	5.4118			
Panel B: Diagonal BEKK–GARCH results between SENSEX and BSE_SME				
	Coefficient	Std.	T-Stat.	Prob.
c1	0.0938	0.0158	5.9196	0.0000
c2	0.1264	0.0165	7.6517	0.0000
w11	0.0266	0.0064	4.1729	0.0000
w12	0.0101	0.0033	3.0968	0.0020
w22	0.0541	0.0093	5.7922	0.0000
a11	0.2437	0.0163	14.9405	0.0000
a22	0.4754	0.0239	19.8755	0.0000
b11	0.9562	0.0063	152.4099	0.0000
b22	0.8749	0.0104	84.0893	0.0000
LL	-6885.4930			
AIC	5.4900			
SC	5.5132			
HQC	5.4985			
Panel B: Diagonal BEKK–GARCH results between IDX and PEFINDO25				
	Coefficient	Std.	T-Stat.	Prob.
c1	0.0476	0.0149	3.1978	0.0014
c2	0.0052	0.0200	0.2582	0.7962
w11	0.0197	0.0041	4.7909	0.0000
w12	0.0189	0.0040	4.6816	0.0000
w22	0.0494	0.0111	4.4485	0.0000
a11	0.2471	0.0147	16.8098	0.0000
a22	0.2301	0.0147	15.6986	0.0000
b11	0.9552	0.0054	178.0378	0.0000
b22	0.9531	0.0069	138.9818	0.0000
LL	-6190.9360			
AIC	4.9371			
SC	4.9603			
HQC	4.9455			

4.3. DCC GARCH Results.

This study uses the DCC-GARCH (1,1) model to test the dynamic nature of the conditional correlations between the significant and SME markets. One of the benefits of the DCC-GARCH model is its ability to instantly display the variance and covariance. Another advantage is that the constrained correlation framework can change over time.

Table 6 presents the results of the DCC-GARCH model for the major and SME markets. In Table 6, μ denotes the population mean, and Ω denotes the free endpoint. The α value represents the ARCH effects, which reflect the influence of prior disturbances or errors on the mean. Similarly, the effect of past variation is denoted by beta, which is referred to as the GARCH effect.

Table 6. DCC Results.

	China		**India**		**Indonesia**
μ_{SSE}	0.0177	μ_{SENSEX}	0.0961	μ_{IDX}	0.0493
	(0.2900)		(0.0000)		(0.0010)
Ω_{SSE}	0.0201	Ω_{SENSEX}	0.0295	Ω_{IDX}	0.0269
	(0.0000)		(0.0000)		(0.0000)
α_{SSE}	0.0680	α_{SENSEX}	0.0901	α_{IDX}	0.0762
	(0.0000)		(0.0000)		(0.0000)
β_{SSE}	0.9157	β_{SENSEX}	0.8827	β_{IDX}	0.8872
	(0.0000)		(0.0000)		(0.0000)
$\mu_{CHINEXT}$	0.0282	$\mu_{\text{BSE\_SME}}$	0.1259	$\mu_{\text{PEFINDO25}}$	0.0049
	(0.2620)		(0.0000)		(0.8030)
$\Omega_{CHINEXT}$	0.0415	$\Omega_{\text{BSE\_SME}}$	0.0512	$\Omega_{\text{PEFINDO25}}$	0.0696
	(0.0000)		(0.0000)		(0.0000)
$\alpha_{CHINEXT}$	0.0764	$\alpha_{\text{BSE\_SME}}$	0.2461	$\alpha_{\text{PEFINDO25}}$	0.0667
	(0.0000)		(0.0000)		(0.0000)
β_{CHINEXT}	0.9129	$\beta_{\text{BSE\_SME}}$	0.7498	$\beta_{\text{PEFINDO25}}$	0.8785
	(0.0000)		(0.0000)		(0.0000)
DCC (θ_1)	0.0483	DCC (θ_1)	0.0500	DCC (θ_1)	0.0500
	(0.0000)		(0.0030)		(0.0030)
DCC (θ_2)	0.9390	DCC (θ_2)	0.8471	DCC (θ_2)	0.8471
	(0.0000)		(0.0000)		(0.0000)

Additionally, the short-term spillover impact is represented by DCC(θ_1), and the long-term spillover impact is represented by DCC (θ_2). The DCC-GARCH results also show that the sum of DCC(θ_1) and DCC(θ_2) values is less than 1 for all markets, indicating a mean-reverting conditional correlation process.

Therefore, the study suggests that the correlation returns to long-term unconditional correlation after shock events. Figure 2 indicates the conditional correlation plot of the series CHINEXTY, SENSEX-BSE_SME AND IDX-PEFINDO25, which the DCC_GARCH model calculated. The high persistence of conditional correlation findings is confirmed by Figure 2. Figure 2 shows that the correlation coefficient between the primary and SME stock markets has changed considerably over time.

This implies that investors significantly changed their portfolios traded in the market. The results indicate that investors should consider fluctuations in major markets when investing in small and medium-sized enterprise markets because of the integration and asymmetric effects between the markets in the short and long terms.

Regarding the diagonal BEKK and DCC results, investors are unlikely to achieve diversification benefits by including the principal and SME market instruments in their portfolios, as SME markets exhibit market efficiency.

Therefore, investors should closely monitor the co-movements and transitions between these markets to optimise their portfolio diversification strategies.

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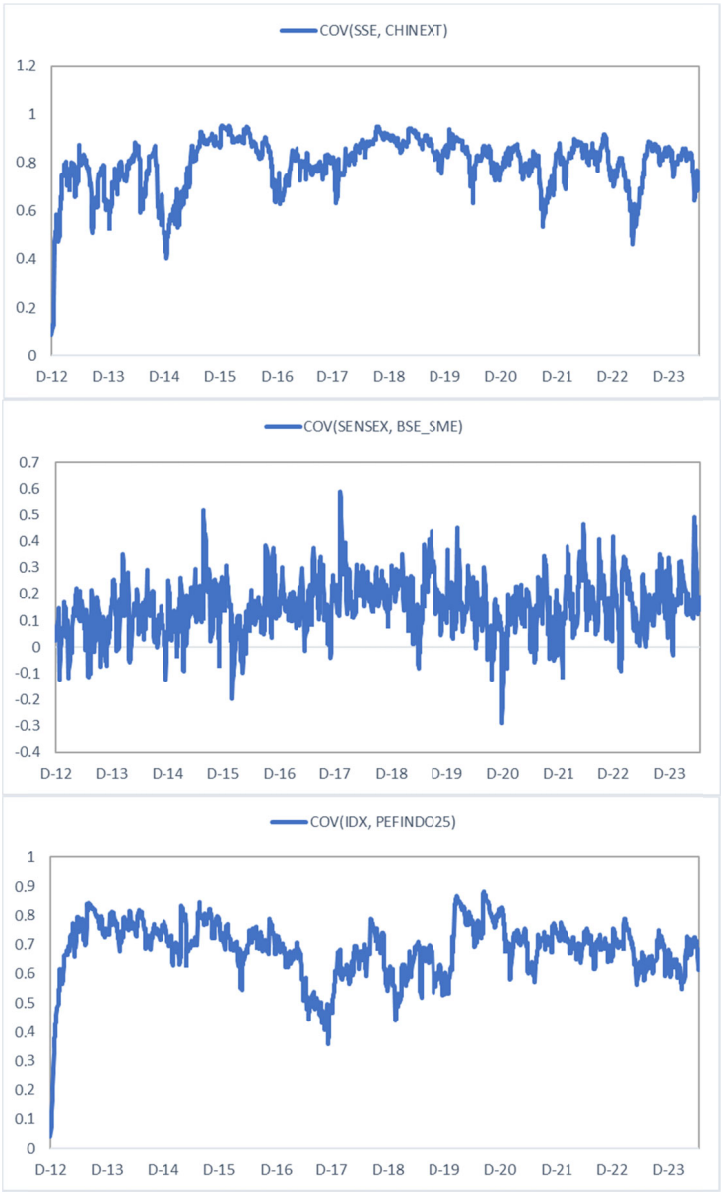

Fig. 2. The Conditional Correlation of the Series.

5. Conclusions.

This study examines the relationship dynamics between major stock markets and small and medium enterprises (SMEs), especially in emerging markets such as China, India and Indonesia. The BEKK-GARCH model is used to forecast the volatility of large and medium-sized enterprises from 27 December 2012 to 17 July 2024. Subsequently, the DCC-GARCH model is used to examine the interaction between these markets in the context of economic growth. The empirical results indicate a significant correlation between large- and small-cap stock indices. The results demonstrate significant conditional dynamic correlations across all markets. The BEKK-GARCH and DCC-GARCH models indicate the relative efficiency of the primary and secondary markets in China, India, and Indonesia. Consequently, investors who simultaneously hold products from these markets do not benefit from diversification.

Moreover, policymakers should recognise the significant impact of large markets on SMEs and consider this when developing economic policies to avoid negative consequences. SME research is currently lacking, particularly in China, India, and Indonesia.

This study fills this gap by providing a detailed analysis of volatility (i.e. price fluctuations) and changing conditions in SME markets in these countries. This confirms that SMEs are critical for risk management and prudent investment allocation. To make well-informed investment decisions, investors must understand how different stock markets interact and influence each other.

From an academic research perspective, to validate and expand the current study's conclusions, subsequent research should investigate the impact of volatility on both large and small stock markets over a broader spectrum of emerging economies. In particular, small and medium-sized enterprises (SMEs) play a key role in economic growth and comprise the majority of businesses worldwide.

It is necessary to analyse their financial indicators and understand the relationship dynamics between these stock markets. Despite the extensive financial literature on volatility spillovers among stock markets, relatively few studies have examined volatility spillovers between major and SME markets.

Therefore, regulatory actions that project the need and operationalisation of market segments should be taken to prevent such adverse effects. For instance, transparency and risk management can stabilise the SME market to prevent volatility in larger markets. Conversely, an SME marketplace should be relatively stable and offer hospitable fiscal incentives, enhanced access to financing, and persistent infrastructure, allowing for sustainable economic development and higher investor confidence.

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