Impact of Derivative Trading on Stock Market Volatility: Empirical Evidence from Emerging Markets

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Abstract

This study investigated the impact of derivative trading on stock market volatility in emerging markets. We analyzed data from 10 emerging markets over 15 years (2005-2020) using a panel data approach. The research employed GARCH(1,1) models to estimate volatility and conducted difference-in-differences (DiD) analysis to assess the effect of derivative introduction. Additionally, we used Granger causality tests to examine the directional relationship between derivative trading and volatility. Results indicated that introducing derivatives significantly reduced stock market volatility ($\beta = -0.0023, p < 0.01$). This effect was more pronounced in markets with higher liquidity (interaction $\beta = -0.0012, p < 0.05$) and better regulatory frameworks (interaction $\beta = -0.0015, p < 0.05$). Granger causality tests suggested a unidirectional relationship, with derivative trading Granger-causing reduced volatility ($F = 7.234, p = 0.002$). Furthermore, GARCH persistence analysis revealed decreased volatility persistence post-derivative introduction across all sample markets. These findings contribute to the ongoing debate on the role of derivatives in financial markets and have important implications for policymakers and market regulators in emerging economies.

Keywords: Derivative Trading, Stock Market Volatility, Emerging Markets, GARCH Models

Introduction

The impact of derivative trading on stock market volatility has been intensely debated among academics, policymakers, and market participants. While derivatives are often viewed as tools for risk management and price discovery, concerns have been raised about their potential to amplify market volatility, especially in emerging markets where regulatory frameworks may be less developed (Bae et al., 2004; Kumar & Pandey, 2010).

Emerging markets have experienced significant growth in derivative trading over the past two decades, with many countries introducing derivative products as part of broader financial market reforms. This trend has sparked interest in understanding how these financial instruments affect market dynamics in developing economies. While extensive research has been conducted on developed markets, the evidence from emerging markets needs to be more comprehensive and conclusive (Gulen & Mayhew, 2000; Malik & Shah, 2017).

This study aims to address this gap by providing a comprehensive analysis of the impact of derivative trading on stock market volatility in emerging markets. By focusing on a diverse set

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of emerging economies and employing robust econometric techniques, we seek to contribute to the existing literature and offer insights to inform policy decisions in these rapidly evolving financial markets.

Literature Review

The finance literature has extensively studied the relationship between derivative trading and stock market volatility, with mixed findings. Early theoretical work by Ross (1976) suggested that derivatives could enhance market efficiency by improving information flow and price discovery. This view was supported by empirical studies such as Conrad (1989), who found that introducing options led to decreased stock price volatility.

However, other researchers have argued that derivatives may increase market volatility due to speculative trading and leverage effects. For instance, Stein (1987) developed a theoretical model showing how speculative trading in futures markets could destabilize spot prices. Studies like Bae et al. (2004) provided empirical support for this view, finding increased volatility following the introduction of index futures in Korea.

The evidence is particularly mixed in the context of emerging markets. Gulen and Mayhew (2000) examined 25 countries and found that futures trading was associated with increased volatility in the U.S. and Japan but decreased volatility in most other markets. Kumar and Pandey (2010) studied the Indian market and concluded that introducing derivatives stabilized the underlying stock market.

More recent studies have attempted to reconcile these conflicting findings by considering market-specific factors. For example, Malik and Shah (2017) found that the impact of derivatives on volatility in Pakistan depended on market conditions and regulatory measures. Similarly, Jiang et al. (2019) showed that the effect of derivatives on Chinese stock market volatility varied over time and was influenced by market reforms.

Despite these contributions, there remains a need for a comprehensive, multi-country analysis of derivative trading's impact on stock market volatility in emerging markets, which this study aims to address.

The impact of derivative trading on stock market volatility in emerging markets has continued to be a topic of interest in recent years. Several studies have contributed new insights to this area of research.

Deng et al. (2020) examined the effect of stock index futures trading on the volatility of the Chinese stock market. Their study found that introducing stock index futures significantly dampened market volatility, particularly during periods of market stress. This finding supports the notion that derivatives can serve as a stabilizing force in emerging markets.

In a comprehensive study of 32 emerging markets, Jain and Xue (2021) investigated how introducing various derivative products affected stock market efficiency and volatility. They found that while the initial introduction of derivatives was associated with increased volatility in some markets, this effect diminished over time. Moreover, they observed that markets with more sophisticated derivative products exhibited lower volatility in the long run.

Focusing on the COVID-19 pandemic period, Chauhan et al. (2022) analyzed the role of derivatives in managing stock market volatility across several emerging economies. Their results indicated that markets with well-established derivative trading systems showed greater resilience and lower volatility spikes during the crisis than those with less developed derivative infrastructure.

Lee and Kim (2023) took a novel approach, using machine learning techniques to assess the non-linear relationships between derivative trading activity and stock market volatility in emerging Asian markets. Their findings revealed complex interactions, suggesting that the impact of derivatives on volatility can vary depending on market conditions and the level of derivative market development.

These recent studies underscore the evolving nature of derivative markets in emerging economies and highlight the need for continued research to understand their impact on market dynamics.

Research Objectives

1. Examine the impact of introducing derivative trading on stock market volatility in emerging markets.
2. To investigate whether the effect of derivative trading on volatility differs across emerging markets with varying levels of market development and regulatory frameworks.
3. Analyze how the relationship between derivative trading and stock market volatility evolves in emerging markets.
4. To identify the key factors that influence the impact of derivative trading on stock market volatility in emerging economies.

Conceptual Framework

The conceptual framework for this study integrates several key components:

1. *Derivative Trading Introduction*: The primary independent variable representing introducing derivative instruments in each market.
2. *Stock Market Volatility*: The dependent variable, measured using GARCH models.
3. *Market Characteristics*: Moderating variables include market liquidity, size, and trading volume.
4. *Regulatory Environment*: Another moderating variable, capturing the strength and effectiveness of financial market regulations.
5. *Time*: A dimension that allows for analyzing how the relationship between derivative trading and volatility evolves over the study period.

This framework posits that introducing derivative trading affects stock market volatility, but market characteristics and the regulatory environment moderate this relationship. Furthermore, the impact may change over time as markets develop and adapt to the presence of derivatives.

Research Methodology

Data Collection and Sample

This study analyzed data from 10 emerging markets over 15 years, from 2005 to 2020. The countries included in the sample were Brazil, China, India, Indonesia, Malaysia, Mexico, Russia, South Africa, Thailand, and Turkey. These markets were selected based on their size, economic significance, and the timing of derivative introduction during the study period.

Daily stock market index data for each country were collected from Thomson Reuters Datastream. Additional market-level data, including trading volume, market capitalization, and regulatory quality indices, were obtained from the World Bank's World Development Indicators and the World Bank's Worldwide Governance Indicators.

Variables and Measurement

Dependent Variable

This study used the GARCH(1,1) model to estimate volatility, calculated for each market's daily returns. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, introduced by Bollerslev (1986), is widely used in financial econometrics to model volatility clustering.

The GARCH(1,1) model specifies the conditional variance ($\sigma^2 t$) as:

$\sigma^2 t = \omega + \alpha 1 \varepsilon^2 t\text{-}1 + \beta 1 \sigma^2 t\text{-}1$

Where $\omega > 0$, $\alpha 1 \geq 0$, $\beta 1 \geq 0$, and $\alpha 1 + \beta 1 < 1$.

The sum of $\alpha 1$ and $\beta 1$ represents volatility persistence. Our analysis (table 6) observed a decrease in this sum after introducing derivatives, indicating reduced volatility persistence. While GARCH(1,1) is often sufficient, other GARCH variants could be considered for future research:

- *EGARCH (Nelson, 1991):* Captures asymmetric effects of positive and negative shocks.
- *GJR-GARCH (Glosten et al., 1993):* Another model for asymmetric volatility.
- *FIGARCH (Baillie et al., 1996):* Accounts for long memory in volatility.

Independent Variable

A dummy variable indicated the presence of derivative trading, taking the value of 1 for periods after the introduction of derivatives and 0 otherwise.

Control Variables

Market capitalization (log-transformed), trading volume (log-transformed), and a regulatory quality index were included as control variables.

Empirical Model and Estimation

The study employed a difference-in-differences (DiD) approach to estimate the impact of derivative introduction on stock market volatility. The basic model specification was:

$$Volatility\_it = \beta 0 + \beta 1 DerivativeDummy\_it + \beta 2 MarketCap\_it + \beta 3 Volume\_it + \beta 4 RegQuality\_it + \alpha\_i + \delta\_t + \varepsilon\_it$$

Where i denotes the country and t denotes time. α_i and δ_t represent country and time-fixed effects, respectively.

The base model was modified by adding interaction terms to test the hypotheses related to market characteristics and the regulatory environment.

Results and Analysis

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Volatility	0.0152	0.0089	0.0032	0.0573
Derivative Dummy	0.6833	0.4652	0	1
Market Cap (log)	11.872	1.4563	8.9245	15.321
Volume (log)	9.6541	1.2387	6.7832	13.254
Regulatory Quality	0.3265	0.5978	-0.952	1.5463

Table 1 presents the descriptive statistics for the key variables. The mean volatility across all markets and periods was 0.0152, with substantial variation as indicated by the standard deviation and range.

Table 2: DiD Estimation Results

Variable	Model 1	Model 2	Model 3
Derivative Dummy	-0.0023**	-0.0031**	-0.0028**
	(0.0009)	(0.0011)	(0.0010)
Market Cap (log)	-0.0015*	-0.0014*	-0.0016*
	(0.0007)	(0.0007)	(0.0007)
Volume (log)	0.0009	0.0008	0.0009
	(0.0006)	(0.0006)	(0.0006)
Regulatory Quality	-0.0018*	-0.0017*	-0.0019*
	(0.0008)	(0.0008)	(0.0008)
Derivative * Market Cap		-0.0012*	
		(0.0005)	
Derivative * Reg Quality			-0.0015*
			(0.0007)
Constant	0.0387***	0.0392***	0.0389***
	(0.0052)	(0.0053)	(0.0052)
Observations	39,150	39,150	39,150
R-squared	0.2873	0.2889	0.2885

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

Table 2 presents the main results from the DiD estimation. Model 1 shows the base specification, while models 2 and 3 include interaction terms to test hypotheses related to market characteristics and regulatory environment.

The coefficient on the derivative dummy is negative and statistically significant across all models, indicating that the introduction of derivative trading is associated with a reduction in stock market volatility. This supports hypothesis 1.

The interaction term between the derivative dummy and market cap (log) in model 2 is negative and significant, suggesting that the volatility-reducing effect of derivatives is more pronounced in larger, more liquid markets. This provides support for hypothesis 2.

Similarly, the interaction between the derivative dummy and regulatory quality in model 3 is negative and significant, indicating that markets with stronger regulatory frameworks experience a greater reduction in volatility following derivative introduction, supporting hypothesis 3.

To test hypothesis 4, we conducted a rolling window analysis, estimating the model over 3-year windows throughout the sample period. The results (not shown in the table) indicated that the magnitude of the derivative effect decreased over time, providing support for hypothesis 4.

Table 3: Impact of Derivative Introduction on Volatility by Market Size

Market Size	Pre-Derivative Volatility	Post-Derivative Volatility	Change in Volatility
Small	0.0189	0.0172	-8.99%
Medium	0.0166	0.0143	-13.86%
Large	0.0147	0.0118	-19.73%

Interpretation of table 3: This table illustrates the impact of derivative introduction on stock market volatility, segmented by market size. The results suggest that the volatility-reducing effect of derivatives is more pronounced in larger markets. Small markets experienced an 8.99% reduction in volatility after the introduction of derivatives, while medium and large markets saw reductions of 13.86% and 19.73%, respectively. This supports our earlier finding that market size and liquidity play a role in determining the effectiveness of derivatives in reducing volatility.

Table 4: Regression Results - Impact of Derivative Trading Volume on Volatility

Variable	Coefficient	Std. Error	t-statistic
Intercept	0.0183***	0.0012	15.25
Derivative Trading Volume	-0.0024**	0.0008	-3.00
Market Cap (log)	-0.0011*	0.0005	-2.20
Regulatory Quality	-0.0016*	0.0007	-2.29
Interest Rate	0.0005	0.0003	1.67
GDP Growth	-0.0002	0.0001	-2.00

Note: *** p<0.001, ** p<0.01, * p<0.05

Table 4 examines the relationship between derivative trading volume and stock market volatility, controlling for various factors. The results show a significant negative relationship between derivative trading volume and volatility (coefficient = -0.0024, p < 0.01). This suggests that as derivative trading volume increases, market volatility tends to decrease. Market capitalization and regulatory quality also show significant negative relationships with volatility, consistent with our earlier findings. Interestingly, while GDP growth shows a marginally significant negative relationship with volatility, the interest rate does not have a significant impact in this model.

Table 5: Granger Causality Test Results

Null Hypothesis	F-Statistic	p-value
Derivative trading does not Granger-cause market volatility	7.234	0.002
Market volatility does not Granger-cause derivative trading	1.876	0.159

Table 5 provide insights into the directional relationship between derivative trading and market volatility. The first null hypothesis, that derivative trading does not Granger-cause market volatility, is rejected at the 1% significance level (p = 0.002). This suggests that past values of derivative trading have predictive power for future market volatility. Conversely, we fail to reject the second null hypothesis (p = 0.159), indicating that past market volatility does not significantly predict future derivative trading. These results support the notion that derivative trading has a causal impact on market volatility, rather than the other way around.

Table 6: Volatility Persistence Before and After Derivative Introduction

Market	GARCH(1,1) Persistence (Pre-Derivatives)	GARCH(1,1) Persistence (Post-Derivatives)
A	0.947	0.912
B	0.962	0.933
C	0.953	0.921
D	0.939	0.908
E	0.958	0.929

Table 6 presents the volatility persistence, as measured by the sum of ARCH and GARCH coefficients in a GARCH(1,1) model, before and after the introduction of derivatives in five sample markets. A value closer to 1 indicates higher volatility persistence. Across all markets, we observe a decrease in volatility persistence following the introduction of derivatives. For example, in market A, the persistence decreased from 0.947 to 0.912. This suggests that the introduction of derivatives not only reduces overall volatility but also makes it less persistent, potentially indicating improved market efficiency and faster incorporation of new information into prices.

Volatility-Reducing Effect of Derivatives

The volatility-reducing effect of derivatives can be theoretically explained through several mechanisms:

a) Improved Price Discovery: As posited by Ross (1976), derivatives can enhance market efficiency by improving information flow. Our Granger causality results (Table 5) support this theory, showing that derivative trading Granger-causes reduced volatility.

b) Risk Transfer: Derivatives allow for more efficient risk transfer among market participants. This can lead to more stable markets, as evidenced by the reduced GARCH persistence post-derivative introduction (table 6).

c) Market Completion: The introduction of derivatives completes the market by offering new instruments for hedging and speculation. This can lead to more efficient risk allocation and reduced volatility, as suggested by our main DiD results (table 2).

Summary of Key Themes

Volatility Reduction Effect of Derivatives

Our difference-in-differences (DiD) analysis revealed a significant negative relationship between the introduction of derivatives and stock market volatility ($\beta = -0.0023$, $p < 0.01$). This finding suggest that derivative instruments are associated with a reduction in market volatility in emerging economies.

This result aligns with several recent studies in the literature. Kumar and Pandey (2010) reported a stabilizing effect of derivatives in the Indian market. Similarly, Deng et al. (2020) found that the introduction of stock index futures dampened volatility in the Chinese stock market, with a reported decrease in volatility of approximately 8% following futures introduction.

Our Granger causality tests further supported this theme, indicating that derivative trading Granger causes reduced volatility ($F = 7.234$, $p = 0.002$), while the reverse relationship was insignificant. This unidirectional causality supports the notion that derivatives are causal in reducing market volatility.

Market Characteristics as Moderators

The interaction between derivative introduction and market capitalization in our model was significant ($\beta = -0.0012$, $p < 0.05$), suggesting that the volatility-reducing effect of derivatives is more pronounced in larger, more liquid markets. This was further supported by our analysis of volatility changes across market sizes (table 3), which showed larger reductions in volatility for bigger markets (-19.73% for large markets vs. -8.99% for small markets).

These findings are consistent with Jain and Xue (2021), who observed in their study of 32 emerging markets that those with more sophisticated derivative products tended to exhibit lower volatility in the long run. They reported that markets in the top quartile of derivative sophistication experienced, on average, 15% lower volatility than those in the bottom quartile.

Importance of Regulatory Environment

Our analysis revealed a significant interaction between derivative introduction and regulatory quality ($\beta = -0.0015$, $p < 0.05$), highlighting the crucial role of strong regulatory frameworks in maximizing the benefits of derivative trading.

This result is supported by recent literature, including Chauhan et al. (2022), who noted that emerging markets with well-established derivative trading systems showed greater resilience during the COVID-19 crisis. They found that markets in the top tercile of regulatory quality experienced, on average, 22% less volatility during the crisis than those in the bottom tercile.

Reduction in Volatility Persistence

Our GARCH persistence analysis (table 6) showed a consistent decrease in volatility persistence across all sample markets after introducing derivatives. For instance, in market A, persistence decreased from 0.947 to 0.912.

This finding aligns with Lee and Kim (2023), who used machine learning techniques to assess non-linear relationships between derivative trading activity and stock market volatility in emerging Asian markets. They reported an average decrease in volatility persistence of 0.037 across their sample markets following derivative introduction.

Conclusion

This study provides empirical evidence that introducing derivative trading is associated with reduced stock market volatility in emerging markets. The findings suggest that derivatives can stabilize these markets, potentially by improving price discovery and risk management capabilities.

The results also highlight the importance of market characteristics and regulatory environment in shaping the impact of derivatives. Larger, more liquid markets and those with stronger regulatory frameworks benefit more from introducing derivatives, experiencing greater reductions in volatility.

These findings have important implications for policymakers and regulators in emerging markets. The eloping derivative markets, when accompanied by appropriate regulatory measures, can contribute to more stable and efficient stock markets. However, the diminishing effect over time indicates that the benefits may be most pronounced in the initial years following introduction, emphasizing the need for ongoing market development and regulatory adaptation.

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