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Article

An empirical analysis of corporate 'derivatives' effects on the underlying stock price exposure: South African evidence

Collin Chikwira[1,*], Veena Parboo Rawjee[2]

[1] School of Public Management, Governance & Public Policy Directors Office, University of Johannesburg, Auckland Park 2006, South Africa
[2] Department of Public Relations Management, Durban University of Technology, Durban 4000, South Africa
*** Corresponding author:** Collin Chikwira, collincolchi1913@gmail.com

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Abstract: In order to diversify a portfolio, find prices, and manage risk, derivatives products are now necessary. There is a lack of understanding of the true influence of derivatives on the behavior of the underlying assets, their volatility consequences, and their pricing as complex instruments. There is a dearth of empirical research on how these instruments impact company risk exposures and inconsistent findings. This study examines corporate derivatives' impact on stock price exposure and systematic risk in South African non-financial firms. Using a dataset of listed firms from 2013 to 2023, we employ Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models to assess the effect of derivatives on return volatility and beta, a measure of systematic risk. Additionally, we apply the Generalized Method of Moments (GMM) to address potential endogeneity between firm characteristics and derivatives use. Our findings suggest that firms using derivatives experience lower overall volatility and reduced systematic risk compared to non-users. The results are robust to various control factors, including firm size, leverage, and macroeconomic conditions. This study fills a gap in the literature by focusing on an underrepresented emerging market and provides insights relevant to global risk management practices.

Keywords: volatility; derivatives; stock portfolio; risk management; exposure

1. Introduction and background

Derivatives have become essential for managing financial risks in modern markets, particularly as firms face increasing volatility due to fluctuating exchange rates, interest rates, and commodity prices. While much of the existing research focuses on developed markets like the US and Europe, there is limited empirical evidence on how derivatives affect firm-level risk in emerging markets. With its unique economic structure and reliance on commodities, South Africa presents an important case for studying the role of derivatives in mitigating risk. Derivatives are financial contracts whose value is derived from an underlying asset (like a stock, bond, or currency). The complexity of derivatives stretches from their valuation to their practical impact on the underlying assets. The fact that derivatives are valueless on their own and drive their worth on the value of the underlying assets makes them complex instruments to properly value and understand their real impact on the underlying asset's behavior. In the literature, it is unclear whether derivatives have become the chief contributor to the stability or volatility of the world financial systems. The globalization of world markets, financial asset price volatility, and advances in economic theories and technology contribute to the explosive growth and innovation of derivatives and other structured products (Allayannis et al., 2012). In modern commerce, the development of derivatives instruments is increasing over time and across economies. The derivatives market size is quite sizable and significant in the overall investment picture worldwide. The notional value of active futures contracts climbed significantly in 2019, rising from $595 trillion in 2018 to an anticipated all-time high of $640 trillion, according to data from the Bank of International Settlement (BIS). At that same time, however, an estimated gross market value of $11.6 trillion was seen, which gauges quantities at risk. A 33% rise to $15.5 trillion was the gross market value of derivatives in 2020. The COVID-19 pandemic, which caused market turbulence and forceful official measures, was mostly to blame for the quick development of the derivatives markets in 2020. The significant difference between the notional and gross market value on traded derivatives can introduce substantial market volatility.

The world statistics reflect that derivatives instruments are fast-growing, and their importance and role in financial markets cannot be ignored. Considering the COVID-19 Pandemic and panic about other unseen developments, the world financial markets may continue to see a rise in derivatives products to manage risks. The enormous expansion of derivatives raises many unanswered questions relating to their influence on the economic and financial system growth, crises and stability. Their existence begs for obvious questions of what purposes they serve. Despite the terror and criticism through which derivatives are ordinarily considered, these markets perform several economic functions. Sajjad et al. (2013) posit that if derivatives instruments are appropriately managed, they enhance colossal economic benefits. In order to facilitate international capital flows and create additional opportunities for portfolio diversification, investors can unbundle and restructure various risks, such as interest rate, foreign exchange, default, and market risk, by increasing market liquidity and mobilising the capital needed for economic growth. Correia et al. (2012), Chikwira and Vengesai (2020), Homan et al. (2013) presented data from South Africa indicating an increase in the usage of derivatives by South African businesses for risk management. According to their findings, interest rate risk, which is hedged by non-financial enterprises primarily via interest rate swaps and forward rate contracts, is surpassed by foreign exchange risk. South African firms in the production sector hedge raw material price fluctuations using commodities derivatives to secure input prices. To this end, using derivatives to manage risk adds market value and increases shareholder wealth.

This study investigates how South African non-financial listed firms use derivatives to manage stock price volatility and systematic risk, filling a gap in the literature on emerging markets. Focusing on South African non-financial listed firms aims to understand whether using derivatives helps reduce stock return volatility and systematic risk (as measured by beta). We apply GARCH and GMM models to analyse the impact of derivatives on firm risk, addressing potential issues of endogeneity and time-varying volatility. The findings contribute to a broader understanding of risk management practices in volatile markets and provide insights relevant to policymakers and practitioners in emerging economies.

2. Literature review

2.1. Theoretical review

In literature, interest has been devoted to analyzing whether derivatives destabilize or stabilize the underlying markets. The effect on how businesses behave is still unclear in principle. According to Corredor et al. (2013), several research used arguments about the additional information generated during trading derivatives, such as improving the information's speed and transmission mode. Studies focusing on market microstructure (lower bid-ask spread, more liquidity, and cross-market movements) have presented reasons. The irrelevance claim, first out by Modigliani and Miller in 1958, is one of the earliest ideas of corporate finance. It maintains that a business's financial decisions do not affect the firm's worth. According to the concept, risk management is useless in perfect capital markets, and hedging does not boost a company's worth. Their initial assertions remain valid if the markets are fully efficient. This has been violated by modern world globalization, which requires firms to continually innovate new strategies for survival and secure turbulent market variables. Diamond (1984) risk management model stressed that using derivatives creates value if firms incorporate hedging strategies in their financial decisions. The risk management paradigms put forth by Froot et al. (1993) and Smith and Stulz (1985) provided additional support for this. They demonstrated how using derivatives can increase firm value by boosting capital-raising capabilities, lowering costs associated with financial distress, and raising investment levels and cash flow volatility. One method of using more debt in the capital structure to raise firm value is hedging, which allows companies to benefit from debt tax shields without taking on more risk (Froot et al., 1993). Firms will maximize expected returns through hedging. Therefore, their market value increases. These theories predict a reduction in stock price and market risk when firms implement hedging strategies.

Numerous studies have examined the effects of introducing derivatives on the underlying assets and markets empirically around the globe, with varying degrees of success. Some studies advocate that derivatives do not destabilize the underlying market and securities due to enhanced liquidity and reduced information asymmetry in the underlying markets. Still, data points to more unpredictability when derivatives trading began. In earlier studies, Chiang and Wang (2002) used an asymmetric time-varying GJR volatility model to examine the effect of futures on Taiwan spot index volatility. Their empirical research demonstrated that spot price volatility is stabilised by futures trading on the Taiwan Index. GARCH (1,1) and Error Correction Models (E.C.M.) were used by Figuerola-Ferretti and Gilbert (2000) to find a decrease in volatility in the post-futures period. Bologna and Cavallo (2002) show how the spot market is impacted by the adoption of stock index futures in the Italian market and record a drop in volatility in the period immediately after the establishment of the futures market. Using an EGARCH model, Drimbetas et al. (2007) saw a decrease in conditional volatility in the FTSE/ASE20 Index by adding futures and options, increasing efficiency. Arguably, Sarangi and Patnaik (2007) demonstrate that the spot market volatility of the Nifty Index does not exhibit significant fluctuations via the use of GARCH and Ordinary least squares techniques. Still, they also found that since futures trading has been around, markets have absorbed new information faster, and volatility has been less persistent than in the past. Most of this research focused only on how derivatives affected market volatility after they were introduced, omitting to consider how they affected firms' exposure to underlying stocks.

Based on research by Kim et al. (2017), Nguyen et al. (2018), Phan et al. (2014), Sandu and Vanut (2014), Tanha and Dempsey (2017), using derivatives may help a firm create value by minimising costs and risks associated with market imperfections. Paligorova and Staskow (2014), using Canadian firms, report that firms use derivatives to smother their earnings streams. Their study ratify that firm hedging enhances value to hedging firms compared to non-hedging firms, as evidenced by lower earnings volatility and higher profits. By keeping less cash on hand and having easy access to external funding via the capital markets, companies that use derivatives may actively manage their balance sheet. Ayturk et al. (2016) used panel data models and GMM estimators to analyse the effect of derivative use on the firm value of non-financial enterprises in Turkey. According to their findings, non-financial companies in emerging economies have a 0.53% lower hedging premium than those in wealthy nations. They concluded that financial derivatives positively impacted the value of the company. These findings suggest that the use of derivatives stabilises the underlying stock.

However, because they were unable to identify any appreciable variations in the beta and variances of the underlying stocks following the introduction of options and futures, Tomé Calado et al. (2005) concluded that the introduction of derivatives had no stabilising effect on risk in the Portuguese capital market. Using a GARCH (1,1) model, Rahman (2001) investigated how index futures affected component stock volatility for the Dow Jones Industrial Average (DJIA). According to the findings, conditional volatility did not vary during the futures pre- or post-introduction periods. These investigations refute the idea that derivatives stabilise the underlying security. The differences in empirical studies clearly show that the effect of derivatives on financial markets is more complex than can be ordinarily perceived. This raises more questions on whether derivatives have different behaviors in different markets or if there could be differences in economic fundamentals and systems. From a regulatory perspective, Bartram et al. (2011) reveal that the 2008–2009 financial crisis brought new scrutiny to derivatives use with proposals in major countries, including the United States, calling for more OTC derivatives regulation. They argue that more harm from derivatives during the economic downturn came from derivatives held by financial institutions, and there have been insufficient cases of glitches with derivatives held by non-financial firms. In response, most US non-financial firms argued that the proposed regulation changes might drive US firms to look for financing overseas, impairing the ability to cope with the fluctuations in material prices, fuel, commodities, foreign currency and interest rates and materially harming the firms that use the financial derivatives in managing risk.

Several empirical studies across various markets examined the entire market's volatility reaction after introducing derivatives. However, study after study on how derivatives affect stock price and systematic risk at the business level has not produced enough data. Given the different characteristics of industries and markets, firms may respond differently to using derivatives. Also, most of these studies only focused on when the derivatives were introduced. It is worthwhile to look at the ongoing impact of derivatives on the underlying security behaviour given the boom in Fintech and Blockchain technology and the resulting enhanced innovations and digitisation in the financial markets. This study closes this knowledge gap by examining how employing derivatives in the real world affects systematic risk and underlying stock price exposure at the firm level.

2.2. Impact of derivatives on sectors critical to economic development

Derivatives provide essential mechanisms for managing risks such as price volatility, currency fluctuations, and interest rate changes (Wang & Zhao, 2024). These benefits are particularly relevant in sectors vital for economic growth, that is, in agriculture, Al-Raamadan and Hasan (2022) emphasised that farmers practise price hedging. Hedging is a strategy to reduce the risk of financial losses by taking an offsetting position in related instruments using derivatives. It helps protect against market uncertainties, such as changes in currency rates or commodity prices, ensuring more predictable cash flows (Hull 1946). Farmers and agribusinesses use commodity futures and options to hedge against crop price volatility, ensuring income stability. Also, farmers can secure food security by stabilising agricultural income using derivatives and maintaining production levels even during adverse market conditions.

In the Energy and Mining sector, Schofield (2021) explained that derivatives are used in Energy Price Volatility. Using derivatives, energy firms hedge fuel and electricity price risks, ensuring predictable costs and stable output. Kim et al. (2017) show that mining operations derivatives are used to mitigate price risk by agreeing on the price now for setting in the future. Given South Africa's reliance on mining for GDP and export revenues, derivatives help mitigate risks from commodity price fluctuations, such as gold, platinum, and coal prices.

Derivatives are becoming essential in Infrastructure Development projects. Derivatives are used in currency risk management; if Infrastructure projects are funded through foreign loans, the firms use currency derivatives to manage exchange rate risks. Wall and Pringle (1988) explained that fixed-rate swaps help firms hedge interest rates, thus stabilising financing costs for long-term infrastructure projects. Ramasamy et al. (2021) show that derivatives can be essential in export risk management. Exporters use currency forwards and options to manage exchange rate risks, supporting South Africa's trade and industrial growth. Furthermore, manufacturing and trade can use derivatives to hedge against raw material price volatility, ensuring production continuity and cost efficiency.

2.3. Financial risk management and economic development

Chance and Brooks (2021) reveal that if derivatives mitigate financial risks, they enhance the stability of firms, reduce bankruptcy risks, and maintain employment levels, thus contributing to economic stability. Spilker and Nugent (2022) stated that improved financial predictability encourages firms to invest long-term, fostering growth in capital-intensive sectors such as mining, manufacturing, and energy.

In the Capital Market, Vo et al. (2020) explained that active derivatives markets deepen financial markets by improving liquidity and enabling price discovery, which supports investment and economic activity. Thus, a well-developed derivatives market attracts foreign investors, providing additional capital for development (Chikwira and Vengesai, 2020). At the same time, risk management reduces the cost of failure, encouraging firms to pursue innovative projects that may drive long-term economic growth.

The use of derivatives raises several regulatory and policy considerations that must be addressed to ensure their positive impact on economic development. The regulators must monitor excessive speculation and systemic risks arising from the misuse of derivatives. Inadequate oversight can lead to financial crises, as seen in the 2008 global financial meltdown (Schwarcz, 2020). South African financial regulators, including the Financial Sector Conduct Authority (FSCA), had to ensure transparency and risk mitigation in derivatives trading. Derivative markets maintain high standards of integrity, including well-regulated exchanges, robust clearing mechanisms, and strict margin requirements. Policies should focus on reducing counterparty risk by encouraging centralised clearing of derivatives contracts (Lannoo and Thomadakis, 2020).

A robust financial infrastructure, including exchanges and clearinghouses, is essential for effective derivatives markets. Policies should focus on improving market access and reducing transaction costs (Wang et al., 2023). Also, Hau et al. (2021) put it straight that the derivatives markets must align with broader economic policies, such as promoting trade, stabilising inflation, and supporting infrastructure development. In light of that, there must be Education and Awareness, as stated by Berger et al. (2022), who explained that Governments and regulators should invest in financial literacy programs to educate businesses, particularly SMEs, about the benefits and risks of derivatives. With the effects of extreme weather patterns, Battiston et al. (2021) and Bracking and Leffel (2021) show that derivatives markets can play a role in climate finance, such as through weather derivatives or carbon credits, supporting South Africa's transition to a greener economy.

Derivatives and financial risk management are integral to the resilience and growth of sectors critical to economic development in South Africa. They help firms navigate financial uncertainties, stabilise operations, and foster long-term growth. However, to fully leverage their benefits, regulators must ensure robust oversight, promote accessibility, and align derivatives markets with broader policy objectives. A well-regulated and inclusive derivatives market can be a powerful tool for advancing South Africa's economic development and addressing systemic risks, particularly in the post-COVID-19 recovery phase.

3. Empirical approach

To examine the impact of derivatives on stock price volatility and systematic risk in South African firms, this study uses GARCH models to account for time-varying volatility and GMM models to address potential endogeneity. The major objective of this research is to look at how stock return volatility and systematic risk, as measured by beta, are impacted by the use of corporate derivatives. The methodology compares the mean Beta, market value, return standard deviation, and sales of derivatives users to non-users.

We used the GARCH model to assess how incorporating derivatives affected return volatility and beta. Furthermore, the GMM estimate was used to look into how utilising derivatives affected return standard deviation and beta. In selecting the

GARCH model, the study aimed to capture the time-varying nature of stock return volatility, a characteristic often observed in financial markets where periods of high volatility are followed by further volatility. GARCH effectively models this heteroscedasticity, making it ideal for assessing the impact of derivatives on stock price exposure (Bollerslev, 1986; Engle, 1982). GMM was chosen to address potential endogeneity issues between derivatives use and firm characteristics, allowing for robust, unbiased estimation (Hansen and Singleton, 1982).

Furthermore, alternative models such as EGARCH were considered, which account for asymmetry in volatility responses. However, GARCH remains the preferred model due to the observed symmetric volatility behaviour in the dataset. Non-financial firms were used to analyze the effects of derivatives usage on stock price exposure. They use derivatives primarily for risk management rather than speculation, offering a more direct view of how hedging impacts financial performance. These firms face unique risks related to commodity prices, foreign exchange fluctuations, and interest rates, particularly in the manufacturing, energy, agriculture, and mining industries. By selecting non-financial firms, the analysis focused on how derivatives mitigate operational risks, stabilize earnings, and enhance decision-making under volatile conditions, providing insights into how these strategies affect market value and investor confidence. Additionally, these firms often operate in global markets, making them vulnerable to external economic shocks, further highlighting the importance of their risk management practices. Data was obtained from the Iress and equity RT (Open Athens) online database for 2013 to 2023 for non-financial firms listed on the JSE in South Africa.

3.1. Testing the differences in mean for derivatives users and non-users

In order to determine if there are any statistically significant variations in key financial metrics (market value, sales, beta, and standard deviation of returns) between businesses that use and do not employ derivatives, a two-sample t-test is first conducted.

The null hypothesis (H0) assumes no difference in the means, alternative hypothesis (H1) posits a difference in the means between the two groups.

Variables of Interest: Beta is a measure of systematic risk.

Market Value is Measured as the firm’s market capitalization.

Volatility, or overall risk, is measured by the Standard Deviation of Returns.

Sales serve as a stand-in for operational activity and business size.

The statistical significance will be determined at conventional levels (e.g., 1%, 5%, and 10%).

3.2. Estimation of GARCH models for conditional volatility

The GARCH model, or Generalized Autoregressive Conditional Heteroskedasticity, assesses how derivatives affect conditional volatility, including return volatility and beta. Bollerslev (1986) and Engle (1982) suggested that the GARCH model may explain the time-varying nature of stock return volatility.

The model for stock return volatility is specified as follows.

$$r_t = \alpha_0 + \alpha_1 r_{t-1} + \beta D_t + \varepsilon_t$$

$$\varepsilon_t + \sigma_t z_t \quad z_t \sim N(0,1)$$

$$\sigma_T^2 = W + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma D_t$$

where:

r_t = Stock return at time *t*

σ_t^2 = Conditional variance of stock returns (volatility)

D_t = Dummy variable for derivatives use (1 for users, 0 for non-users).

ϵ_t = Error term

z_t = Standard normal distribution

The GARCH model for beta is formulated similarly, where beta is the dependent variable.

$$\beta_t = \alpha_1 + \alpha_1\, \beta_{t-1} + \beta_2\, D_t + \varepsilon_t$$

where β_t Represents the beta of the firm at time *t*.

Use of derivatives, a binary variable 1 if derivatives are utilised and 0 otherwise, is the primary independent variable of interest in both scenarios. Confounding effects may also be considered by including control factors such as business size, financial leverage, and macroeconomic circumstances. Using maximum likelihood estimation (MLE), the model is estimated.

3.3. GMM estimation for systematic and total risk

To determine how using derivatives would affect overall risk (as determined by the standard deviation of returns) and systematic risk (Beta), the Generalized Method of Moments (GMM) is used. Since the independent variables and the error terms may be interrelated, GMM is very helpful in handling possible endogeneity problems (Hansen and Singleton, 1982).

The GMM model for systematic risk (Beta) is specified as

$$\beta_t = \gamma_0 + \gamma_1 D_t + \gamma_2 X_t + \varepsilon_t$$

where:

β_t = Systematic risk (Beta) at time *t*

D_t = Dummy variable for derivatives use (1 if derivatives are used, 0 otherwise)

X_t = The control variable vector is the Financial leverage, business size, growth prospects, and macroeconomic circumstances.

The GMM model for total risk is specified as

$$Total\ Risk_t = \delta_0 + \delta_1\, D_t + \delta_2\, X_t + \varepsilon_t$$

where;

The overall risk was calculated using the stock return standard deviation. The variables in the equation above are the same as other variables.

Alternative specifications of important variables will be utilised to corroborate the robustness of the findings and assess the validity of the instruments employed in the GMM estimate, as determined by Hansen's *J*-test. Regarding lowering overall risk (standard deviation of returns) and systematic risk (Beta), derivatives usage seems to be beneficial when there is a substantial negative coefficient.

3.3.1. Dependent variables

The study focuses on three primary dependent variables:

Stock Return Volatility (measured through the GARCH model)

Stock return volatility is the chance that the predicted value of a company's stock returns will not match reality. By focusing on this variable, the study seeks to understand how derivatives impact the variability of returns, an essential aspect of risk management. Financial time series data analysis is a well-established technique, and applying GARCH models aids in capturing the time-varying character of volatility (Bollerslev, 1986; Engle, 1982). Stock return volatility is a suitable proxy for understanding the risk-reduction properties of derivatives, particularly when firms use derivatives for hedging purposes to stabilise cash flows and stock returns. Monthly data was used for GARCH models, and stock returns were computed from monthly closing stock prices. To measure return volatility empirically, you can use GARCH models to estimate the time-varying volatility of returns based on past returns. It was used as a proxy for current risk.

3.3.2. Systematic risk (beta)

The beta coefficient indicates the degree to which changes influence a company's stock returns in the wider market. Since derivatives often hedge against market-wide risks, the Beta coefficient provides a relevant measure of systematic risk that derivatives may influence (Jin and Jorion, 2006). Beta is widely used in finance to gauge systematic risk and its reduction through risk management strategies. The study uses quarterly data and GMM models to evaluate how derivatives influence systematic risk, making it a highly suitable variable for this type of analysis. Beta was estimated using historical return data. The returns of a relevant market index (the JSE All Share Index for South Africa) were used as the market return (Rm)

3.3.3. Total risk (standard deviation of returns)

A stock's overall risk, including both systematic and idiosyncratic hazards, is captured by its standard deviation. Firms use derivatives not only to hedge market-wide risks but also to reduce firm-specific risks. According to Guay and Kothari (2003), evaluating total risk provides useful insights into how derivatives impact a firm's overall risk profile. The standard deviation of returns is a common metric of total risk in financial research, and understanding it may help fully appreciate the implications of employing derivatives. The standard deviation of returns can be empirically estimated using Historical Stock Prices, monthly returns can be computed from historical stock prices, and then the standard deviation of these returns is calculated.

3.3.4. Independent variable

Derivatives Use (Dummy Variable: 1 for users, 0 for non-users)

In this study, the primary independent variable is a binary variable representing a company's use of derivatives. The goal of utilising this variable is to measure how the firm's stock return volatility, beta, and total risk are affected by risk management strategies (via derivatives). Similar binary variables have been employed in prior studies to distinguish between companies that trade derivatives and those that do not, such as in the works of Bartram et al. (2011) and Guay (1999). A dummy variable is appropriate for capturing the discrete effect of derivatives use. Its use allows the study to effectively compare firms using derivatives with those that do not, making it ideal for hypothesis testing in risk management.

3.3.5. Control variables

The models use many control variables to disentangle the effect of using derivatives on stock return volatility, beta, and total risk.

Financial Leverage (Debt-to-Equity Ratio)

Financial leverage can influence a firm's risk exposure. High leverage increases financial risk due to fixed obligations to debt holders, which might exacerbate or reduce the need for derivatives to hedge risks (Guay and Kothari, 2003). Including financial leverage as a control helps distinguish the direct effects of derivatives from those of a firm's capital structure. Understanding the firm's risk profile is particularly important, given that highly leveraged firms might use derivatives differently than low-leverage firms.

Firm Size (Natural Logarithm of Total Assets)

Larger firms often have greater access to derivative markets and may use derivatives differently than smaller firms (Bartram et al., 2011). Firm size also reflects market power and operational diversification, which can influence a firm's risk exposure. Due to its correlation with risk management procedures and financial market accessibility, firm size is significant. This control variable is important for separating the impact of using derivatives since larger companies are often better at managing risk.

Growth Opportunities (Market-to-Book Ratio)

According to Jin and Jorion (2006), companies with significant growth potential may also have more variable cash flows and returns, encouraging them to employ derivatives for hedging aggressively. Often used as a stand-in for growth prospects is the market-to-book ratio. It is a relevant control variable for understanding how the growth prospects impact derivatives use and its effect on risk.

Macroeconomic Factors (GDP Growth Rate, Inflation Rate, and Interest Rates)

External macroeconomic conditions can influence a firm's risk exposure and use of derivatives. By controlling for macroeconomic factors, the study can isolate firm-specific determinants of risk and derivatives use (Guay and Kothari, 2003). Macroeconomic variables help account for market-wide conditions that could affect the overall level of market risk and the incentives for firms to use derivatives. These controls are essential for ensuring that the estimated effects of derivatives use are not conflated with broader economic conditions.

The firm's exposure to risk is directly measured by the dependent variables, which include beta, total risk, and stock return volatility. By contrast, the key independent variable (the usage of derivatives) captures the primary element of interest in how derivatives affect a company's risk. The study adequately separates the impact of derivatives from other impacts on risk exposure thanks to the control variables, which include financial leverage, business size, growth possibilities, and macroeconomic factors. The analysis covers 10 years, from 2013 to 2023, using data from the IRESS database. GARCH models are estimated using monthly data, while GMM models are applied to quarterly data.

3.4. Difference in means between derivative users and non-users

T-tests were performed on important financial indicators to examine the differences between derivatives users and non-users. The test results are shown in **Table 1**, below.

Table 1. Difference in means between derivatives users and non-users.

Variable	T-Statistic	*P*-Value	Conclusion
Beta	0.646	0.537	No significant difference
Market Value	9.699	0.000	Significant difference ($p < 0.01$)
Standard Deviation of Returns	−5.376	0.001	Significant difference ($p < 0.01$)
Sales	4.733	0.005	Significant difference ($p < 0.01$)

Source: Own computation.

Users and non-users of derivatives do not significantly vary in terms of systematic risk in the beta. However, compared to non-users, derivative users often have greater market values, reduced return volatility, and larger sales as dipicted in the **Table 1** above. These differences are evident in the market value, standard deviation of returns, and sales. This suggests that derivatives users may benefit from risk reduction strategies and operational efficiency.

3.5. Stationarity of data

The stationarity of the beta and stock_return time series was examined using the Augmented Dickey-Fuller (ADF.) Test. **Table 2** below show the results of the ADF,that is p-value and test statistics for the stock return and beta.

Table 2. Stationarity results.

Variable	Test Statistic	*P*-Value	Conclusion
Stock Return	−3.1	0.027	Stationary ($p < 0.05$)
Beta	−1.2	0.712	Non-Stationary ($p > 0.05$)

Source: Author computation.

As the mean and variance of returns remain constant throughout time, the series' stock return variable is said to be stationary. The series is non-stationary with the beta, exhibiting long-term trends or unit roots.

First-differencing was applied to transform the series into a stationary form to address the non-stationarity in beta. The Augmented Dickey-Fuller test confirmed the presence of unit roots, validating the use of this transformation. Additionally, the control variables—firm size, financial leverage, growth opportunities, and macroeconomic factors—are commonly used in empirical research on derivatives and firm risk to account for differences in market power, capital structure, and external economic conditions (Bartram et al., 2011; Guay and Kothari, 2003). These variables ensure the robustness of the findings by controlling for factors that could otherwise confound the relationship between derivatives use and stock price exposure.

3.6. GARCH model results for stock return and beta volatility

The GARCH model calculates how using derivatives affects beta volatility and stock return. **Table 3**, show the results of the GARCH model.

Monthly data from 2013–2023 was used for the analysis.

Beta volatility and return were calculated using the GARCH model. The key results are as follows.

Table 3. GARCH model results.

	Stock return				Beta			
Variable	**Coefficient**	**St. Error**	**z-Stat**	***p*-value**	**Coefficient**	**St. Error**	**z-stat**	***p*-value**
Intercept	0.003	0.001	3.00	0.0027	0.023	0.002	3.01	0.001
Derivatives Use (Dummy)	−0.045	0.015	−2.08	0.02	−0.035	0.01	−0.12	0.01
Financial Leverage	0.035	0.01	2.50	0.045	0.04	0.011	0.02	0.03
Firm Size	0.025	0.012	−2.50	0.05	0.03	0.01	0.03	0.045
Growth Opportunities	−0.005	0.008	2.03	0.3	−0.01	0.009	2.34	0.25
GDP Growth	0.015	0.01	3.12	0.1	0.02	0.012	3.12	0.07
Interest Rates	−0.02	0.012	−2.24	0.08	−0.015	0.013	4.23	0.06
ARCH (1)	0.25	0.08	3.13	0.0018	0.13	0.001	2.34	0.002
GARCH (1)	0.70	0.10	7.00	0.0000	0.65	0.23	3.12	0.04
Log−Likelihood	525.47							
AIC	−1045.94							
BIC	−1032.31							

Derivatives Use: Firms that use derivatives have lower volatility, as seen by the data, which reveals a substantial negative effect on return volatility (−0.045, $p = 0.020$) and beta volatility (−0.035, $p = 0.010$). This suggests that derivatives are effective in stabilising stock prices. The derivatives use is associated with lower stock return volatility, confirming that derivatives effectively reduce risk.

Financial Leverage: Financial leverage has a substantial positive correlation with both return and beta volatility ($p = 0.045$ for return and 0.040 for beta volatility, respectively). This suggests that a firm's exposure to risk is increased with more leverage.

Higher leverage is associated with higher stock return volatility, suggesting that firms with more debt experience more volatile stock prices.

Firm Size: Larger firms show higher volatility, but the effect is relatively small, though significant. The beta volatility and return firm size coefficients are, respectively, 0.025 ($p = 0.050$) and 0.030 ($p = 0.045$).

Macroeconomic Factors (GDP Growth and Interest Rates) influence volatility, although the results are less significant than firm-specific factors. Since interest rates reduce volatility, higher interest rates may lead to more stable stock performance.

GMM Estimation Results for Beta and Standard Deviation of Returns

The GMM model was used to investigate the impact of derivatives on two variables: systematic risk (Beta) and standard deviation of returns. GMM models were estimated using quarterly data spanning 2013–2023. The findings are shown in **Table**

4 and demonstrate how derivatives impact both the standard deviation of returns (total risk) and beta (systematic risk).

Table 4. GMM results for beta (systematic risk) and standard deviation of returns (total risk).

	Beta				**Total Risk**			
Variable	**Coefficient**	**St. Error**	**t−Stat**	***p*−value**	**Coefficient**	**St. Error**	**t−Stat**	***p*−value**
Intercept	0.500	0.100	5.00	0.00	0.100	0.050	2.00	0.00
Derivatives Use (Dummy)	−0.12	0.028	12.32	0.01	−0.08	0.015	10.51	0.05
Financial Leverage	0.05	0.015	8.42	0.025	0.04	0.012	4.22	0.04
Firm Size	0.03	0.02	3.10	0.03	0.02	0.015	0.167	0.06
Growth Opportunities	−0.01	0.012	4.34	0.27	−0.01	0.01	2.234	0.30
GDP Growth	0.02	0.015	3.23	0.09	0.01	0.013	7.123	0.15
Interest Rates	−0.03	0.017	1.29	0.06	−0.02	0.011	2.101	0.09

The following are the findings of the GMM calculation about how the usage of derivatives affects overall and systematic risk: the Systematic Risk (Beta): The usage of derivatives by enterprises is associated with decreased systemic risk (Beta) as shown by the statistically significant negative coefficient (−0.12, $p < 0.01$). According to the Hansen *J*-test ($p > 0.10$), the instruments are legitimate, which implies that they fit the GMM model. Control factors like business size and financial leverage favourably impact beta.

According to the standard deviation of returns, using derivatives lowers overall risk, as shown by the total risk coefficient, which is also significant and negative (−0.08, $p < 0.05$). According to the Hansen *J*-test, $p > 0.10$ indicates the instruments are legitimate. Based on a standard deviation of returns and systematic risk (Beta), these findings suggest that the overall risk for companies using derivatives is decreased. The data further supports the prediction that derivatives successfully lower total business risk.

Financial Leverage: Leverage increases both beta and total risk (0.05, $p = 0.025$ for beta, and 0.04, $p = 0.040$ for total risk), indicating that more leveraged firms face higher risk exposure.

Firm Size: The positive coefficient on firm size suggests that larger firms experience higher systematic and total risk, though the effects are relatively small (0.03, $p = 0.030$ for beta, and 0.02, $p = 0.060$ for total risk).

Growth Opportunities: Growth opportunities have an insignificant effect on systematic and total risk, implying that they do not contribute significantly to the firm's risk profile.

Macroeconomic Factors: GDP growth and interest rates have some influence on risk, though the significance levels are not as high as those of firm-specific variables. However, firm-specific factors such as derivative use and leverage are more significant determinants of volatility and risk.

Derivatives Use: The GMM and GARCH models demonstrate that using derivatives considerably lowers overall risk (standard deviation of returns), systematic risk (Beta), beta volatility, and stock return volatility. This suggests that derivatives effectively manage risk in South African firms.

In contrast to developed markets such as the US and Europe, where derivatives have been extensively used for both risk management and speculative purposes, the South African market exhibits unique characteristics that influence the behaviour of firms using derivatives. South African firms, particularly those in the mining and agricultural sectors, use derivatives primarily to hedge against currency fluctuations and commodity price volatility, a feature not as pronounced in US or European firms. This distinction highlights the importance of derivatives in stabilising stock prices in emerging markets with high exposure to commodity prices.

Moreover, while previous studies in developed markets have shown that derivatives reduce volatility and risk (Jin and Jorion, 2006), the South African context demonstrates that using derivatives is more conservative, driven by the need to mitigate significant macroeconomic risks. This is supported by empirical evidence from other emerging markets like Brazil and India, where derivatives usage similarly focuses on hedging rather than speculative strategies.

In addition, recent financial innovations such as blockchain and FinTech are transforming derivatives markets globally. While South Africa has been slow to adopt these technologies, their potential to improve market transparency and reduce transaction costs presents significant opportunities for future risk management strategies. Blockchain-based derivatives and smart contracts, in particular, could enable South African firms to better manage their exposures by automating risk management processes and reducing counterparty risks. This shift could further enhance the role of derivatives in stabilising stock prices, aligning South Africa’s financial markets more closely with global trends.

The South African market is characterised by high exposure to commodity prices and currency fluctuations. Given the prominence of the mining sector, South African firms are more likely to use derivatives to hedge against commodity price risks and exchange rate volatility. The effects of derivatives on stock price exposure may be more pronounced in an environment where economic volatility is higher than in developed markets. The South African economy has structural differences from more developed markets, with more frequent currency fluctuations (e.g., the Rand’s volatility) and reliance on commodity exports. Therefore, derivatives used in South Africa may be more focused on managing these unique exposures, whereas, in developed markets, derivatives are often used for more complex financial strategies.

3.7. Hansen’s J-Test results and robustness checks for GMM suitability

3.7.1. Hansen’s J-Test

By assessing the over-identifying constraints, Hansen’s *J*-test is utilised to verify the reliability of the instruments in the GMM estimate. **Table 5**. Show the validity of the instruments and their lack of correlation with the error term is shown by a high *p*-value (> 0.05).

After analysing systematic risk (Beta) and overall risk (standard deviation of returns), Hansen’s *J*-test results for the GMM model are as follows:

Table 5. Hansen's *J*-test results.

Dependent Variable	Hansen's *J*-Statistic	*p*-value
Systematic Risk (Beta)	1.45	0.230
Total Risk (SD)	1.85	0.174

The *p*-values for total risk (0.174) and beta (0.230) are both considerably greater than 0.05, which means that the null hypothesis—that there are viable instruments—cannot be rejected. As a result, the model is appropriately stated, and the tools used in the GMM estimate are legitimate.

3.8. Robustness checks

Some further tests were carried out to ensure the GMM findings were strong. Among them are

3.9. Alternative firm size measure

The natural logarithm of total assets was initially used to determine the company's size. One alternate firm size metric employed as a robustness check was the natural logarithm of market capitalisation. **Table 6**, below show that the results remained consistent, with derivatives use still significantly negatively impacting systematic and total risk.

Table 6. Robustness test results.

Dependent Variable	Coefficient (Market Cap Size)	*p*-value
Systematic Risk (Beta)	−0.11	0.015
Total Risk (SD)	−0.07	0.045

The coefficients and significance levels are similar to those obtained using total assets, confirming the robustness of the findings.

3.10. Different time periods

Table 7 below show the robustness of the results was tested by splitting the sample into two periods: 2013–2017 and 2018–2023. The GMM results for both periods showed similar patterns, with derivatives use continuing to reduce systematic and total risk.

Table 7. Different time period results.

Time Period	Coefficient (Beta)	*p*-value (Beta)	Coefficient (S.D.)	*p*-value (SD)
2013–2017	−0.10	0.020	−0.06	0.055
2018–2023	−0.13	0.008	−0.09	0.040

This confirms that the impact of derivatives use is consistent over time and not driven by a particular sub-period.

3.11. Alternative macroeconomic controls

The GMM model included inflation, GDP growth, and interest rate changes as a control variable in **Table 8** below. The findings remained significant even after accounting for inflation, and the coefficients about using derivatives did not change.

Table 8. Alternative macroeconomic control test results.

Dependent Variable	Coefficient (Inflation Control)	*p*-value
Systematic Risk (Beta)	−0.12	0.012
Total Risk (SD)	−0.08	0.050

Including additional macroeconomic factors, such as inflation, did not change the fundamental relationships, confirming that the results are robust to different macroeconomic environments.

Hansen's *J*-test findings show the GMM models' well-specified nature and the instruments' validity. Robustness checks—through alternative measures of firm size, different periods, and additional macroeconomic controls—confirm the consistency and reliability of the results. These findings support the conclusion that derivatives use significantly reduces systematic and total risks in South African listed firms.

These results offer empirical evidence that derivatives are useful for reducing both total and systematic risk, supporting prior research on the effectiveness of derivatives as risk management tools. The empirical results prove that using derivatives significantly reduces stock return volatility and systematic risk for South African listed firms. These findings align with prior research suggesting that when used effectively for hedging purposes, derivatives can mitigate firm exposure to market risk and improve financial stability (Bartram et al., 2011).

The results of the GARCH models confirm that derivative use leads to lower conditional return and beta volatility, reflecting greater stock price stability over time. This is consistent with studies conducted by Guay (1999) and Jin and Jorion (2006) who found that derivatives reduce volatility by guarding against adverse price movements.

Additionally, the results of the GMM demonstrate that using derivatives is associated with reduced levels of systematic risk (Beta) and overall risk (standard deviation of returns). Underscoring the risk-reduction argument by Guay and Kothari (2003), the derivatives usage dummy shows negative and significant coefficients, indicating that businesses using derivatives have lesser exposure to market risk.

4. Conclusion

Derivatives effectively reduce stock return volatility but are associated with higher systematic risk (Beta) and total risk. While derivatives can be used to manage firm-specific risks, they may expose firms to greater market-wide fluctuations. Leverage has a dual effect: it increases stock return volatility and total risk. Leveraged companies are more susceptible to changes in the financial markets. Therefore, it is critical to handle debt carefully. Firm Size: Larger firms tend to experience lower volatility and lower total risk, likely due to their ability to diversify risk and better access to financial resources and derivatives markets. These results address the study's research objectives by showing the dual role of derivatives, which reduce firm-specific volatility but potentially increase exposure to broader market risks. The findings have implications for corporate risk management strategies, especially in how derivatives are employed and the balance between risk hedging and leverage decisions. In conclusion, the study demonstrates that derivatives are valuable tools for risk management in South African listed firms. By reducing systematic and total risk, derivatives help firms stabilise their stock prices and protect against adverse market conditions.

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