International Journal of Innovative Mathematics, Statistics & Energy Policies
14(4):15-24, Oct-Dec., 2026

© SEAHI PUBLICATIONS, 2026 **www.seahipublications.org** **ISSN: 2467-852X**

DOI:10.5281/zenodo.23218535

A Two Correlated Assets with Pricing Level of Exponential Growth: Regime-Switching Analysis

[1]Amadi, Innocent Uchenna ,[2]Odu-Ndom Nkemdinim Kaydee and [3]Onyegbuchulem, Chialuka

[1, 2]Department of Mathematics/ Statistics
Captain Elechi Amadi polytechnic, Rumuola Port Harcourt, Nigeria
Email: innocent.amadi@portharcourtpoly.edu.ng

[3]Department of Statistics,
Alvan Ikoku Federal University of Education, Owerri,Imo State, Nigeria,
Email: chialuka.onyegbuchulem@alvanikoku.edu.ng.

ABSTRACT
This study used Systems of Stochastic models to understand Access Bank and First Bank share prices during the recapitalization period. The problem was analytically solved for Access and First Banks by the method of Ito's. Hence, the impression of the graphical solution explicitly shows as follows: (i) both banks showed short-term independence but long-term joint growth.(ii) volatility drives price more than growth rate. (iii) both banks grow exponentially but with a clear gap between them, meaning one bank has permanent structural advantage over the other. (iv) when correlation is negative -0.5 it shows negative relationship, when zero it shows no relationship, and when 0.8 it shows strong positive relationship, meaning the relationship between the banks changes with market policy. To this end, Access Bank behaves as volatile growth and First Bank as stable growth, so for decision making investors can buy Access for growth when volatility is high and correlation is high; buy First Bank for safety when correlation is negative.
Keywords: GBM, Correlation, Share Price, Coupled Systems, Access Bank and First Bank

1.1. INTRODUCTION

Financial markets play a crucial role in the economic development of nations by facilitating capital mobilization, efficient allocation of resources, and risk management. Stock markets in particular provide a platform where investors buy and sell ownership shares of publicly traded companies, thereby enabling firms to raise long-term capital for expansion and development. The behaviour of stock prices in financial markets has been a subject of extensive research among statisticians, economists, and financial analysts due to its complex and dynamic nature. Stock price movements are influenced by numerous factors including macroeconomic conditions, investor expectations, government policies, and global financial events. As a result, modeling stock market behaviour has become an important field within statistical and financial research.

Though, stock market prices have been examined in a wide manner by many scholars. For instance, [1] studied the stochastic analysis of stock market price model, and result showed that the proposed model is efficient for the production of stock prices. In a similar manner [2] studied the stochastic analysis of stock market expected returns. Their results of comparing the variances of four different stocks indicated that stock1 is the best among the stocks of diverse companies, which is consistent with the work of [3]. Also, [4] considered a stochastic analysis of stock market expected returns and growth-rates. In trying to stochastic model [5] considered the stability analysis of stochastic model for stock market prices and did

analysis of the unstable nature of stock market forces applying a new differential equation model that can impact the expected returns of investors. While [6] suggested in their study, some analytical solutions of stochastic differential equations with respect to Martingale processes and discovered that the solutions of some SDEs are related to other stochastic equations with diffusion part. On the other hand, [7] looked at the numerical techniques of solving stochastic differential equations. Their results showed that if the discretization value N is increasing, the Euler-Maruyama and Milstein techniques were closed to exact solution. Also, [8] worked on the stability of both analytical and numerical solutions for non-linear stochastic delay differential equations with jumps and they observed that the compensated stochastic methods inherit stability property of the correct solution. [9] studied the solution of differential equations and stochastic differential equations of time varying investment returns and obtained precise conditions governing asset price returns. The proposed model showed an efficient and reliable multiplicative inverse trend series. As if that is not enough, [10] studied stochastic model of the fluctuations of stock market price and obtained precise conditions for determining the equilibrium price. On the other hand [11] examined the stability behaviors of stochastic differential equations (SDEs) driven by time changed Brownian motions. In another dimension [12] studied stochastic methods in practical delineation of financial models and suggested useful delineation of asset stock price and volatility.

The problem is that portfolio diversification benefits are overestimated when two correlated assets grow exponentially without considering regime switches. If both assets are in a high-growth regime, correlation increases, reducing diversification. Standard Markowitz models fail during these periods. This was evident during the 2024 Nigerian banking boom where recapitalization news caused all bank stocks to grow together, increasing systemic risk.

The aim of this study is to model two corrected assets whose pricing level follows exponential growth regime switching, estimating joint growth rates and regime-dependent correlations. The gap is that literature focuses heavily on decay and crash regimes [18]. There is limited research on synchronized exponential growth with regime switching, particularly for two corrected assets. This study extends regime-switching theory to growth phases and provides a tool for bubble detection and profit optimization. This paper is a counterpart of exponential growth. During economic expansion, driven by Gross Demonstic Product (GDP) growth and low interest rates as documented by [19] and [20], correlated assets such as banking and industrial stocks often grow exponentially. However, this growth is not stable; it switches between low-growth and high-growth regimes due to monetary policy uncertainty.

This paper is prescribed as follows: Section 2.1 presents the mathematical preliminaries, Results and discussion are seen in Section 3.1 and paper is concluded in Section 4.1.

2.1: Mathematical Preliminaries

At this juncture we present few basic definitions as touching this dynamic area of study, hence we have as follows:

Definition 1: Probability space: This is a triple $(\Omega, \mathrm{F}, \tilde{A})$ where Ω represents a set of sample space, F represents a collection of subsets of Ω, while $\wp$ is the probability measure defined on each event $\mathrm{A} \in \mathrm{F}$. The collection F is a σ -algebra or σ -field such as $\Omega \in \mathrm{F}$ and F is closed under the arbitrary unions and finite intersections. Hence it is called probability measure when the following condition holds.

(i) $$P(A) \geq 0 \ \textit{for all} \ A \subset \Omega$$

(ii) $$P(\Omega) = 1$$

(iii) $$A, B \subset \Omega, \ A \cap B = \phi \ \textit{then} \ P(A \cup B) = P(A) + P(B)$$

Definition 2: A σ -algebra is a set F of subsets of Ω with the following axioms:

(i) $$\phi, \Omega \in \mathrm{F}$$

(ii) $$\text{If} \quad A \in \mathrm{F}, \textit{then} \ A^c \in \mathrm{F}$$

(iii) If $A_1, A_2, \ldots, \in \mathrm{F}, then \bigcup_{k=1}^{\infty} \quad \bigcap_{k=1}^{\infty}$ F

Clearly $A^c := \Omega - A$ is the complement of A.

Definition 3. Stochastic process: A stochastic process $X(t)$ is a relations of random variables $\{X_t(\gamma), t \in T, \gamma \in \Omega\}$, i.e, for each t in the index set $T, X(t)$ is a random variable. Now we understand t as time and call $X(t)$ the state of the procedure at time t. In view of the fact that a stochastic process is a relation of random variables, its requirement is similar to that for random vectors.

Definition 4. Random Walk: There are different methods to which we can state a stochastic process. Then relating the process in terms of movement of a particle which moves in discrete steps with probabilities from a point $x = a$ to a point $x = b$. A random walk is a stochastic sequence $\{S_n\}$ with $S_0 = 0$, defined by

$$S_n = \sum_{k-1}^{n} X_k$$

where X_k are independent and identically distributed random variables

Theorem 1.1: (Ito's formula) Let $(\Omega, \beta, \mu, \mathrm{F}(\beta)$ represents a filtered probability space $X = \{X, t \geq 0\}$ and an adaptive stochastic process on $(\Omega, \beta, \alpha, \mathrm{F}(\beta)$ having a quadratic variation (X) with SDE defined as follows:

$$dX(t) = g(t, X(t))dt + f(t, X(t))dW(t)$$

$t \in \Re$ and for $u = u(t, X(t) \in C^{1\times 2}(\Pi \times$ ` ,

$$du(t, X(t)) = \left\{\frac{\partial u}{\partial t} + g\frac{\partial u}{\partial x} + \frac{1}{2}f^2\frac{\partial^2 u}{\partial x^2}\right\}d\tau + f\frac{\partial u}{\partial x}dW(t)$$

Applying theorem 1.1 solves the SDE with the following solution below:

$$S(t) = S_0 \ \exp\left\{\sigma dW(t) + \left(\alpha - \frac{1}{2}\sigma^2\right)t\right\}, \forall t \in [0,1]$$

2.1.1 Problem Formulation

Here, we consider a short and long trading period where so many decisions will be faced by investors on how to minimize loss and maximize profit. So, at every time intervals investors receives wages and fully characterized by fluctuations due to the hazards of the environments. Investors' anticipations regarding stock returns and asset valuations will adhere to certain metrics. Hence, we have two-asset correlated constant Geometric Brownian Motion model,the joint dynamics of Access Bank and First Bank market efficiency with initial prices.

$$dS_t^{(1)} = \mu_1 S^{(1)}{}_t dt + \sigma_1 S^{(1)}{}_t dW_t^{(1)} \tag{1.1}$$

$$dS_t^{(2)} = \mu_2 S_t^{(2)} dt + \sigma_2 S_t^{(2)} dW_t^{(2)} \left(\rho dW_T^{(1)} + \sqrt{1-\rho^2}\, dW_t^{(2)}\right) \tag{1.2}$$

$$S_0^{(1)} = S'_{BASE}e^{kt}, S_0^{(2)} = S''_{BASE}e^{kt} \tag{1.3}$$

where $S_0^{(1)}, S_0^{(2)}$ represents independent initial prices of Access and First , μ_1 represents drift coefficient of Access Bank, σ_1 represents volatility coefficient of Access Bank , μ_2 represents drift coefficient of First Bank, σ_2 represents volatility coefficient of First Bank, ρ represents correlation, k represent growth rate , S_{BASE} is the base price level, $W_t^{(1)}, W_t^{(2)}$ represents independent Brownian Motions and t represents time.

2.1.2 Method of Solution

The investment equation consist of a system of variable coefficient problem whose solutions are not trivial. We apply Theorem 1.1 in solving from (1.1), let $f\left(S_t^{(1)}, t\right) = \ln S_t^{(1)}$ and taking the partial derivatives yields:

$$\left.\frac{\partial f}{\partial S_t^{(1)}} = \frac{1}{S_t^{(1)}}, \frac{\partial^2 f}{\partial S_t^{(1)2}} = -\frac{1}{S_t^{(1)2}}, \frac{\partial f}{\partial t} = 0\right\} \tag{1.4}$$

According to Ito's theorem gives:

$$df\left(S_t^{(1)}, t\right) = \sigma_1 S_t^{(1)} \frac{\partial f}{\partial S_t^{(1)}} dW_t^{(1)} + \left(\mu_1 S_t^{(1)} \frac{\partial f}{\partial S_t^{(1)}} + \frac{1}{2}\sigma^2 S_t^{(1)2} \frac{\partial f}{\partial t}\right) dt \tag{1.5}$$

Substituting (1.4) into (1.5) gives the following:

$$df\left(S_t^{(1)}, t\right) = \sigma_1 S_t^{(1)} \frac{1}{S_t} dW_t^{(1)} + \left(\mu_1 S_t^{(1)} \frac{1}{S_t^{(1)}} + \frac{1}{2}\sigma_1^2 S_t^{(1)2}\left(-\frac{1}{S_t^{(1)2}}\right) + 0\right) dt \tag{1.6}$$

simplifying gives

$$= \sigma_1 S_t^{(1)} \frac{S_t^{(1)}}{S_t^{(1)}} dW_t^{(1)} + \left(\mu_t \frac{S_t^{(1)}}{S_t^{(1)}} - \frac{1}{2}\sigma_1^2 \frac{S_t^{(1)2}}{S_{t\ t}^{(1)2}}\right) dt \tag{1.7}$$

$$= \sigma_1 S_t^{(1)} dW_1^{(1)} + \left(\mu_1 - \frac{1}{2}\sigma_1^2\right) dt$$

$$df\left(S_t^{(1)}, t\right) = \left(\mu_1 - \frac{1}{2}\sigma_1^2\right) dt + \sigma_1 dW_t^{(1)} \tag{1.8}$$

Integrating (1.8) from 0 *to* t gives

$$\int_0^t d\ln S_t^{(1)} = \int_0^t df\left(S_t u, u\right) = \int_0^t \left(\mu_1 - \frac{1}{2}\sigma_1^2\right)du + \int_0^t \sigma_1 dW_t^{(1)} du \tag{1.9}$$

$$\ln S_t^{(1)} - \ln S_t^{(1)} = \left(\mu_1 u - \frac{1}{2}\sigma_1^2 u\right)_0^t + \left(\sigma_1 dW_t^{(1)} u\right)_0^t$$

$$\ln\left(\frac{S_t^{(1)}}{S_0^{(1)}}\right) = \left(\mu_1 - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 dW_t^{(1)}$$

Taking the ln of the both sides gives

$$S_t^{(1)} = S_0^{(1)} \exp\left(\mu_1 - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 dW_t^{(1)} \tag{1.10}$$

This gives the general solution of the SDE. To find the particular solution

$$S_0^{(1)}\left(t\right) = S'_{BASE}e^{kt} \ ,\Rightarrow S_0^{(1)} \exp\left(\mu_1 - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 dW_t^{(1)} = S'_{BASE}e^{kt}$$

$$S_0^{(1)} = S'_{BASE}e^{kt}$$

$$S_0^{(1)}\left(t\right) = S'_{BASE}e^{kt} \exp\left(\left(\mu_1 - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 dW_t^{(1)}\right) \tag{1.11}$$

From(1.2), let $f\left(S_t^{(2)}, t\right) = \ln S_t^{(2)}$ and taking the partial derivatives yields:

$$\left.\frac{\partial f}{\partial S_t^{(2)}} = \frac{1}{S_t^{(2)}}, \frac{\partial^2 f}{\partial S_t^{(2)2}} = -\frac{1}{S_t^{(2)2}}, \frac{\partial f}{\partial t} = 0\right\} \tag{1.12}$$

According to Ito's theorem gives:

$$df\left(S_t^{(2)}, t\right) = \sigma_2 S_t^{(2)} \frac{\partial f}{\partial S_t^{(2)}}\left(\rho dW_t^{(1)} + \sqrt{1-\rho^2}\, dW_t^{(2)}\right)dW_t \ + \left(\mu_2 S_t^{(2)} \frac{\partial f}{\partial S_t^{(2)}} + \frac{1}{2}\sigma_2^2 S_t^{(2)2} \frac{\partial f}{\partial t}\right)dt \tag{1.13}$$

Substituting (1.12) into (1.13) gives the following:

$$df\left(S_t^{(2)},t\right)=\sigma_2 S_t^{(2)}\frac{1}{S_t^{(2)}}\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)dW_t+\left(\mu_2 S_t^{(2)}\frac{1}{S_t^{(2)}}+\frac{1}{2}\sigma_2^2 S_t^{(2)2}\left(-\frac{1}{S_t^{(2)2}}\right)+0\right)dt \quad (1.14)$$

simplifying (1.14) gives

$$=\sigma_2 S_t^{(2)}\frac{S_t^{(2)}}{S_t^{(2)}}\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)dW_t+\left(\mu_2\frac{S_t^{(2)}}{S_t^{(2)}}-\frac{1}{2}\sigma_2^2\frac{S_t^{(2)2}}{S_t^{(2)2}_t}\right)dt \quad (1.15)$$

$$=\sigma_2 S_t^{(2)}\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)dW_t+\left(\mu_2-\frac{1}{2}\sigma_2^2\right)dt$$

$$df\left(S_t^{(2)},t\right)=\left(\mu_2-\frac{1}{2}\sigma_2^2\right)dt+\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)dW_t \quad (1.16)$$

Integrating (1.16) from 0 *to* t gives

$$\int_0^t d\ln S_t^{(2)}=\int_0^t df\left(S_t u,u\right)=\int_0^t\left(\mu_2-\frac{1}{2}\sigma_2^2\right)du+\int_0^t\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)du \quad (1.17)$$

$$\ln S_t^{(2)}-\ln S_t^{(2)}=\left(\mu_2 u-\frac{1}{2}\sigma_2^2 u\right)_0^t+\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}dWu\right)_0^t$$

$$\ln\left(\frac{S_t^{(2)}}{S_0^{(2)}}\right)=\left(\mu_2-\frac{1}{2}\sigma_2^2\right)t+\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)$$

Taking the ln of the both sides gives

$$S_t^{(2)}=S_0^{(2)}\exp\left(\mu_2-\frac{1}{2}\sigma_2^2\right)t+\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right) \quad (1.18)$$

This gives the general solution of the SDE. To find the particular solution

$$S_0^{(2)}\left(t\right)=S''_{BASE}e^{kt}\Rightarrow S_0^{(2)}\exp\left(\mu_2-\frac{1}{2}\sigma_2^2\right)t+\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right)=S''_{BASE}e^{kt}$$

$$S_0^{(2)}=S''_{BASE}e^{kt}$$

$$S_0^{(2)}\left(t\right)=S''_{BASE}e^{kt}\exp\left(\mu_2-\frac{1}{2}\sigma_2^2\right)t+\sigma_2\left(\rho dW_t^{(1)}+\sqrt{1-\rho^2}dW_t^{(2)}\right) \quad (1.19)$$

Combining (1.11) and (1.19) gives complete solution of the systems

$$S_0^{(1)}(t) = S'_{BASE} e^{kt} \exp\left(\left(\mu_1 - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 dW_t^{(1)}\right) \tag{1.20}$$

$$S_0^{(2)}(t) = S''_{BASE} e^{kt} \exp\left(\mu_2 - \frac{1}{2}\sigma_2^2\right)t + \sigma_2\left(\rho dW_t^{(1)} + \sqrt{1-\rho^2}\, dW_t^{(2)}\right) \tag{1.21}$$

The adjusted growth model becomes

$$S_0^{(1)}(t) = S'_{BASE} \exp\left(\left(\mu_1 + k - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 dW_t^{(1)}\right) \tag{1.22}$$

$$S_0^{(2)}(t) = S''_{BASE} \exp\left(\mu_2 + k - \frac{1}{2}\sigma_2^2\right)t + \sigma_2\left(\rho dW_t^{(1)} + \sqrt{1-\rho^2}\, dW_t^{(2)}\right) \tag{1.23}$$

3.1 RESULTS AND DISCUSSION

Two-Asset Correlation Constant Gbm Growth : Models Joint Movement Of Access And First Bank Under Market Efficiency with parameter values:

$$\begin{cases} S_t^{(1)} = S'_{BASE} \exp\left(\mu_1 + k - \frac{1}{2}\sigma_1^2\right)t + \sigma_1 W_t \\ S_t^{(2)} = S''_{BASE}(t)\left(\exp\left(\mu_2 + k - \frac{1}{2}\sigma_2^2\right)t + \sigma_2\left(\rho W_t^{(1)} + \sqrt{1-\rho^2} W_t^2\right)\right) \end{cases}$$

$S'_{BASE} = 18, S''_{BASE} = 27, \mathrm{k} = 0.08, \mu_1 = 0.15, \sigma_1 = 0.30, W_t^{(1)} = 1, t = 1$

$\mu_2 = 0.12, \sigma_2 = 0.25, W_t^{(2)} = W_t^{(1)} = 1, t = 1, \rho = 0.5$

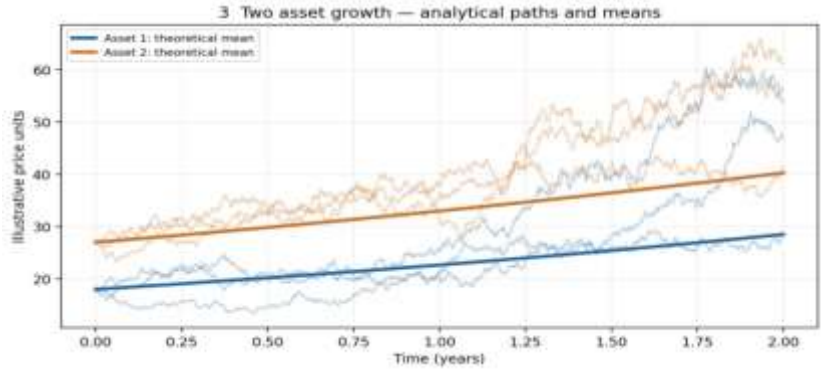

Figure 1: Model 3: three exact analytical paths per asset and theoretical expected means.

Figure 1 means you can diversify at the beginning when paths are separate, but later they will move together at the top. So buy both initially and take profit when they entangle at the peak.

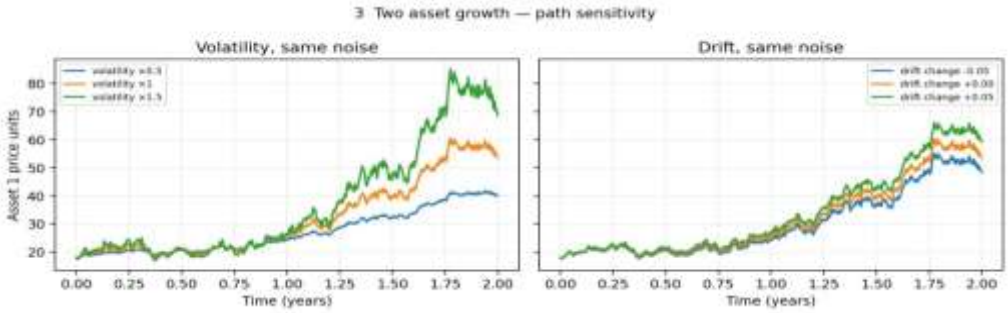

Figure 2: Asset 1 sensitivity using identical Brownian increments.

Figure 2 means volatility is more dangerous and more profitable than drift. The bank with wider gaps is high-risk high-return for speculation, while the bank with close lines is stable and predictable for long-term holding. Initial joint rise means recapitalization lifts all banks before they separate by fundamentals.

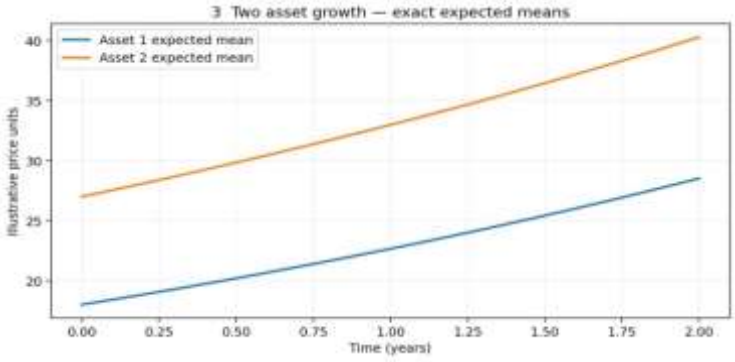

Figure 3: Theoretical expected means calculated directly from the exponential moments.

Figure 3 means the gap between expected growths will continue to widen and the upper bank will continue to dominate. So buy and overweight the upper bank and underweight the lower bank, because lower will not catch up.

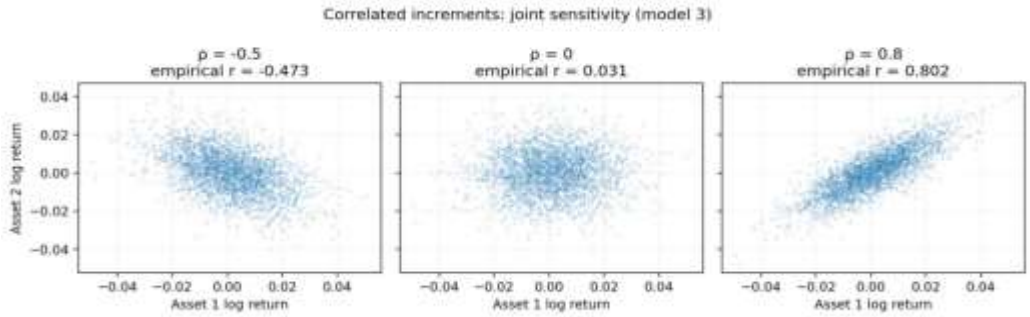

Figure 4: Correlation alters co-movement of pairwise increments while preserving marginal expected means.

Figure 4 means when correlation is negative, one bank hedges the other so hold both to reduce loss. When zero, they are independent so holding both gives good diversification. When correlation is 0.8 they move together strongly due to recapitalization news, so do not diversify within banks alone; buy both for momentum but hedge outside banking sector because if one crashes both will crash together. In general, Access Bank behaves as volatile growth and First Bank as stable growth. Buy Access for growth when volatility is high and correlation is high, buy First Bank for safety when correlation is negative.

4.1 CONCLUSION

The achievement of any investment depends mainly on the value of asset which impels the entire financial power of every company and differential equations are well known prevailing mathematical tool used for the prediction of stock prices. In particular, the problem was analytically solved for Access and First Banks by the method of Ito's. Hence, the impression of the graphical solution explicitly shows as follows: (i) both banks showed short-term independence but long-term joint growth.(ii) volatility drives price more than growth rate. (iii) both banks grow exponentially but with a clear gap between them, meaning one bank has permanent structural advantage over the other. (iv) when correlation is negative -0.5 it shows negative relationship, when zero it shows no relationship, and when 0.8 it shows strong positive relationship, meaning the relationship between the banks changes with market policy. In general, Access Bank behaves as volatile growth and First Bank as stable growth. Buy Access for growth when volatility is high and correlation is high; buy First Bank for safety when correlation is negative.

REFERENCES

[1] Adeosun,M.E, S.O and Ugbebor, O.O (2015). Stochastic Analysis of stock market price model; A case study of the Nigerian stock Exchange(NSE). WSEAS transactions on mathematics.

[2] Osu and Amadi(2022). A stochastic Analysis of stock market price fluctuations for capital market. Journal of Applied Mathematics and computation.6(1);85-95

[3] Ofomata,A.I.O; Inyama, S.C., Umana, R.A. and Omame,A.(2017). A stochastic model of the dynamic of stock price for forecasting. Journal of Advance in mathematics and computer science.25(6); 1-24, Articleno: JAMCS;38014,ISSN:2456-9965.

[4] Amadi, I.U; Igbudu, R. and Azor, P.A.(2022). Stochastic Analysis of the impact of Growth-Rates on stock market prices in Nigeria. Asian Journal of economics Business and Accounting 21(24):9-21

[5] Davis,I., Amadi, I.U. and Ndu, R.I. (2019). Stability Analysis of stochasdtic Model for stochastic Market prices international Journal of Mathematical and computational methods.VOL.4, ISSN:2367-895x

[6] Farnoosh, R, Razazadeh, H; Sobhani, A and Behboud, M. (2015). Analytical solutions for stochastic differential equations via Martingale processes. Math sci.9(2), 87-92.
[7] Bayram, M; partal, T. and Buyukoz, G.S.(2018). Numerical Methods for simulation of stochastic differential equations Advanced in difference equations a springerop journal.
[8] LI, Q. and GAN, S. (2012). Stability of Analytical and Numerical solutions for Nonlinear stochastic delay differential equations with jumps. Hindawi Publishing corporation abstract and applied analysis VOL.2012, Article ID:831082.
[9] Amadi, I.U. and Anthony, C. (2022). stochastic Analysis 0f Asset price Returns for capital market Domain international Journal of Mathematical and statistics studies,VOL.10.NO.3.PP.28-38.S
[10] Osu, B .O.(2010) . A stochastic Model of the variation of the capital market price international journal of trade, economics and finance, VOL .1 NO 3. 2010-023X.
[11] WU, Q.(2016). Stability of stochastic differential equation with respect to time-changed Brownian motions. Tufts university, department of mathematics,503 Boston Avenue, Medford,MA .02155,USA,
[12] Adewole, Y.O.(2016). A Stochastic formulation for asset stock delineation and interpretation viz Euler Maruyama method.Journal of multi displenary Engineering science and technology (JMEST). VOL, 3 ,issue7 ISSN:2458-9403.,
[13] Nwobi, F.N and Azor, P.A (2022).An Empirical Approach for the variation in Capital Market Price Changes. *International journal of Statistics and Mathematics*, Vol. 8(1), 164-172.
[14] Amadi, I.U and Okpoye , O.T (2022). Application of Stochastic Model in Estimation of Stock Return rates in Capital Market Investments. *International journal of Mathematical Analysis and Modelling,* Vol.5 issue 2, 1-14.
[15] Higham, D.J. (2004). *An introduction to financial option valuation:* Mathematics, Statistics and computation. Department of Mathematics, University of Strathclyde, Cambridge University Press.
[16] Wilmott, P., Howison, S. and Dewynne, .J.(2008*). Mathematics of Financial Derivatives*. Cambridge University press, New York.
[17] Hull, J. C. (2012). *Option, Futures and other Derivatives* (eighth Edition). Prentice Hall, Boston Columbus Indianapolis ,New York San Francisco.
[18]Wu, Q., & Cole, R. A. (2024). Macroeconomic conditions and bank failure. Journal of Forecasting, 43(5), 1212–1234. https://doi.org/10.1002/for.3066
[19]Ademola, O., Ogbebor, P., Ogunwale, O., & Ayanbadejo, K. (2024). Changes in macroeconomic variables and financial performance of Nigerian deposit money banks. *International Journal of Research and Innovation in Social Science*, 8(9), 269–285. https://doi.org/10.47772/IJRISS.2024.8090269
[20]Altine, U. M., Musa, T. B., & Zubairu, M. (2024). Assessing the impact of macroeconomic variables on the financial performance of commercial banks in Nigeria. *UMYU Journal of Accounting and Finance Research,* 6(1), 1–15. https://doi.org/10.61143/umyujafr.6(1)2024.001