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Analysis of Market Trend Models and Asset Valuation Under Inflationary Pressure

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ABSTRACT
This study considered the use of matrix algebra in modeling market trend functions. This trend functions were given in three distinct trend growths; firstly to established share price value through rate of change for each distinct trend functions; which have significant impacts on share prices of Fidelity during the periods of trading and investments. In the same vain, we developed and proved four theorems with respect to trend functions. These theorems demonstrate the physical properties of what they represent, providing new insights into the behavior of stock market trends. However, the impact of inflation on nominal asset prices of Fidelity Bank using three price matrices $C_1(t), C_2(t), C_3(t)$, different trend functions and three inflation scenarios: $\text{low}\,\pi = 0.2$, $\text{Moderate}\,\pi = 0.5$,and $\text{High}\,\pi = 0.9$. Nominal prices were deflated using real price formula to obtain real purchasing power. Results show that at 20%, 50%, and 90% respectively, independent of the price scale. The nominal drift rate $\mu_{nominal} = 0.15$ was adjusted to real drift rate μ_{real} using the Fisher relation, revealing that real expected returns become negative under moderate and high inflation. The findings indicate that failing to account for inflation leads to significant overestimation of real asset growth.
Keywords: Share price, Trends, Market, Inflation, assets value.

1.1 INTRODUCTION

Asset values lies at the core of financial economics, capital budgeting and investment management. It provides the framework for determining whether an asset retains its value relative to its fundamentals. The reliability of any asset value however is conditioned on the assumptions embedded in the trend model used to project price or cash flows through time. In stable, low inflation environments, the choice among linear, quadratic and cubic trend functions is often a matter of mathematical measures. The choice of this trend functions becomes a determinant of whether asset value reflects economic reality or monetary illusion. Therefore, inflation is the sustained rise in the general price level that reduces the purchasing power of money over time. Its key effects are the erosion of real returns on investments, distortion of financial decisions through nominal illusion, redistribution of wealth from savers to borrowers, and increased uncertainty that complicates long-term planning. At high levels transaction costs, and undermines stable economic planning; see [26] and [27] respectively.

However, heaps of scholars has written extensively on stock market prices using diverse methods in their individual research, for instance [1] worked on the share prices of Access and Fidelity banks , they applied stochastic model where the predicted share prices were presented and merged bank was found. In the same vain, [2] looked out a matrix application to Dangote stock market prices is considered where illustrations of the investments were given in different forms. In a simillar manner, [3] examined the problem of matrix differential calculus with stochastic term and measurable spaces for investment plans. In another dimension [4] examined stochastic system with changes to measure the value of wealth for each corporate investor through linear and quadratic returns. As if that was not enough, [5] Investigated system of stochastic differential equations with importance on variations of drift parameters. In [6] the stochastic analysis of two asset values was successfully analyzed. [7] Examined stability and controllability for stock exchange market were obtained; first by developing a vector valued stochastic differential system with control. [8] Looked at the applications of various stochastic volatility models in determining optimal investment strategies. Henceforth, [9] studied stochastic model of the fluctuation of stock market price. Consequently many scholars have systematically addressed the issues of stock prices in different forms such as [10 – 13].

This study is therefore motivated by the need to examine three distinct trend functions and how inflation distorts asset values over a particular trend functions with time and to establish basis for several methods relevant to inflationary markets.

The paper is set as follows: Section 2.1 is Material and methods, Section 3.1 presents results and discussion while the paper is concluded in Section 4.1.

2.1 Materials and Methods

In this Section, we present few intricate definitions as stirring this dynamic area of study, hence we have as follows:

2.2 Function: A relationship between stock price and a variable, stock prices (P) as a function of stock prices (D): $\mathrm{P} = \mathrm{f}(s)$.

For example:

$$P(t) = 50 \tag{1}$$

where $P(t)$ is a function of stock price.

Definition 2.1: Mathematically, a function is a relation in which no two distinct order pairs have the same element.

2.2.1 Linear Function : A linear function is a function whose graph is a straight line . It has the form:

$$f(x) = mx + c \tag{2}$$

where x represents input/independent variable, $f(x)$ is output/dependent variable , m is the slope or rate of change and c is the intercept which is the value of $f(x)$ when $x = 0$

2.2.2 Quadratic Trend Function: A parabolic relationship, for example, three Nigerian stock price over time (t) :

$$P(t) = at^2 + bt + c \tag{3}$$

This capture accelerating growth, where $P(t)$ is the stock price of three Nigerian cements at time, and $a, b,$ *and* c are constants.

2.2.3 Cubic Trend Function: This is a function that has a power of three. This is of the form:

$$P(t) = at^3 + bt + c + d \tag{4}$$

where $P(t)$ is the stock price of three Nigerian cements at time, and a, b, c *and* d are constants.

2.3 Matrix Algebra: This is set of rules for adding, multiplying, and manipulating matrices the same way we do with numbers, but with special twits. For example:

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{pmatrix} \tag{5}$$

That's a 2×3 matrix: 2 rows, 3 columns.
More so, matrices are machines that transform vectors. Example, rotating a point in 2D:

$$\begin{pmatrix} Cos\theta & -Sin\theta \\ Sin\theta & Cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \tag{6}$$

That matrix rotates (x, y) by angle θ

2.3.1 Portfolio Weights

3 NGX stocks, returns vector R weights W .

$$\text{Portfolio return} = W^T R \tag{7}$$

variance $= W^T \sum W$ where $\sum$ is covariance matrix. All matrix algebra.

2.3.2 Leontief Input-Output

Economy with sectors.

$$X = AX + d \tag{8}$$

where A represents input matrix. Solution: $X = (I - A)^{-1} d$. Used by Central Bank of Nigeria (CBN) to model how rate hikes hit sectors.
A matrix is defined as a system of number arranged in a rectangular array of rows and columns enclosed in parenthesis.

2.4 Rate of Change of Asset over time: This is derivative of price with respect to time, it tells you how fast the stock is moving right now. For an asset with price $S(t)$ at time t :

$$\text{Rate of change} = \frac{dS}{dt} = \lim_{\Delta t \to 0} \frac{S(t + \Delta t) - S(t)}{\Delta t}$$

Here we explore the application of matrix algebra with stochastic terms to model the share prices of Fidelity Bank; considering three distinct trends: Linear , Quadratic and Cubic.

Let $C_1(t), C_2(t)$ *and* $C_3(t)$ represents share prices of three different trends at time t ;

Matrix of Linear trend Function

$$C_1(t) = \begin{pmatrix} \mu_1 S'_{t011} t & \mu_1 S'_{t012} t & \mu_1 S'_{t013} t \\ \mu_1 S'_{t021} t & \mu_1 S'_{t022} t & \mu_1 S'_{t023} t \\ \mu_1 S'_{t031} t & \mu_1 S'_{t032} t & \mu_1 S'_{t033} t \end{pmatrix} \tag{9}$$

Matrix of Quadratic trend Function

$$C_2(t) = \begin{pmatrix} \mu_2 S''_{t011} t^2 & \mu_2 S''_{t012} t^2 & \mu_2 S''_{t013} t^2 \\ \mu_2 S''_{t021} t^2 & \mu_2 S''_{t022} t^2 & \mu_2 S''_{t023} t^2 \\ \mu_2 S''_{t031} t^2 & \mu_2 S''_{t032} t^2 & \mu_2 S''_{t033} t^2 \end{pmatrix} \tag{10}$$

- **Matrix of Cubic trend Function**

$$C_3(t) = \begin{pmatrix} \mu_3 S'''_{t011} t^3 & \mu_3 S'''_{t012} t^3 & \mu_3 S'''_{t013} t^3 \\ \mu_3 S'''_{t021} t^3 & \mu_3 S'''_{t022} t^3 & \mu_3 S'''_{t023} t^3 \\ \mu_3 S'''_{t031} t^3 & \mu_3 S'''_{t032} t^3 & \mu_3 S'''_{t033} t^3 \end{pmatrix} \tag{11}$$

where $C_1(t)$, $C_2(t)$ *and* $C_3(t)$ denotes three cement companies at time t under different trend functions , $S'_{t011} + \cdots$ $\cdots$ $\cdots$ represents monthly initial stock prices of the three cement companies at time t under different trend functions, and μ_1, μ_2 *and* μ_3 denotes expected instantaneous growth rate of the stock.

2.4.1 Method of Analysis

The method of rate of change : solving (9-11) according to their respective trend functions. The rate of change of an investment refers to how the value of the investment changes over time.

$$\frac{dC_1(t)}{dt} = \begin{pmatrix} \mu_1 S'_{t011} & \mu_1 S'_{t012} & \mu_1 S'_{t013} \\ \mu_1 S'_{t021} & \mu_1 S'_{t022} & \mu_1 S'_{t023} \\ \mu_1 S'_{t031} & \mu_1 S'_{t032} & \mu_1 S'_{t033} \end{pmatrix} \tag{12}$$

$$\frac{dC_2(t)}{dt} = \begin{pmatrix} 2\mu_2 S''_{011}t & 2\mu_2 S''_{012}t & 2\mu_2 S''_{013}t \\ 2\mu_2 S''_{021}t & 2\mu_2 S''_{022}t & 2\mu_2 S''_{023}t \\ 2\mu_2 S''_{031}t & 2\mu_2 S''_{032}t & 2\mu_2 S''_{033}t \end{pmatrix} \quad (13)$$

$$\frac{dC_3(t)}{dt} = \begin{pmatrix} 3\mu_3 S'''_{011}t^2 & 3\mu_3 S'''_{012}t^2 & 3\mu_3 S'''_{013}t^2 \\ 3\mu_3 S'''_{021}t^2 & 3\mu_3 S'''_{022}t^2 & 3\mu_3 S'''_{023}t^2 \\ 3\mu_3 S'''_{031}t^2 & 3\mu_3 S'''_{032}t^2 & 3\mu_3 S'''_{033}t^2 \end{pmatrix} \quad (14)$$

2.5 General Analysis of the Trend Functions

Based on the physical properties of the trend functions, we state and prove the following theorems:

Theorem 1 (General Polynomial Growth): Let $S(t) = S_0 + at + \sum_{k=1}^{n} a_k t^k$,where

$S_0, a_k \in$ □ □ $0.$ *Then* $\frac{dS}{dt} = \sum_{k=1}^{n} k a_k t^{k-1}$.

Proof: By induction on $n.$ Base case $n = 1n = 1 : S(t) = S_0 + a_1 t.$ By Theorem1, $\frac{dS}{dt} = a_1 = 1.a_1 t^0$ .Holds. Assume true for n . Let $S(t) = S_0 + \sum_{k=1}^{n+1} a_k t^k$. Then $\frac{dS}{dt} = \frac{d}{dt}\left(S_0 + \sum_{k=1}^{n} a_k t^k\right) + \frac{d}{dt}\left(a_{n+1}t^{n+1}\right)$ $= \sum_{k=1}^{n} k a_k t^{k-1} + a_{n+1}(n+1)t^n$ by hypothesis $= \sum_{k=1}^{n+1} k a_k t^{k-1}$. This true for $n+1$ .By induction, holds for all $n \in$ □ ,

$\frac{dS}{dt} = \frac{d}{dt}S_0 + \frac{d}{dt}(at) + \frac{d}{dt}(bt^2) = 0 + a.1 + b.2t^{2-1} = a + 2bt$ **.** Since S_0 is a constant**.**

Theorem 2 (Linear Growth): Let $S(t) = S_0 + mt$,where $S_0, m \in$ □ $0.$ *Then* $\frac{dS}{dt} = m$.

Proof: Using linearity of differentiation and the power rule $\frac{d}{dt}t^n = nt^{n-1}$,

$\frac{dS}{dt} = \frac{d}{dt}S_0 + \frac{d}{dt}(mt) = 0 + m.1 = m$ **.** Since S_0 is a constant**.**

Theorem 3 (Quadratic Growth): Let $S(t) = S_0 + at + bt^2$,where

$S_0, a, b \in$ □ $0.$ *Then* $\frac{dS}{dt} = a + 2bt$.

Proof: Applying linearity and the power rule termwise:

$\frac{dS}{dt}=\frac{d}{dt}S_0+\frac{d}{dt}(at)+\frac{d}{dt}(bt^2)=0+a.1+b.2t^{2-1}=a+2bt$. Since S_0 is a constant.

Theorem 4 (Cubic Growth): Let $S(t)=S_0+at+bt^2+ct^3$, ,where $S_0, \mathrm{a}, \mathrm{b}, \mathrm{c} \in$: 0. *Then* $\frac{dS}{dt}=a+2bt+3ct^2$.

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Proof: By linearity and the power rule,

$\frac{dS}{dt}=0+a.1+b.2t+c.3t^2=a+2bt+3ct^2$. Since S_0 is a constant.

2.6 Problem Formulation : Impact of Inflation on Fidelity Bank Asset Prices

Let the nominal asset of Fidelity Bank at three different trend functions or scenarios be represented by the matrices:

$$C_1=\begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{pmatrix}, C_2=2C_1, C_3=3C_1 \tag{15}$$

where each entry represents a nominal price in NGN.

2.6.1 Given Inflation Scenarios:

Three inflation rates are considered: Low inflation: π_L ,Moderate inflation: π_M and High inflation: π_H

2.6.2 Problem

Determine the impact of inflation on the real purchasing power of the given asset prices.:

1. Deflate each nominal matrix C_i to obtain the corresponding real price matrices under each inflation scenario using

$$\text{Real Price}=\frac{\text{Nominal Price}}{1+\pi} \tag{16}$$

2. Compute the percentage loss in real value relative to the nominal values for each inflation scenario.

3.Assess how inflation affects the drift $\mu_{nominal}$ to a real drift μ_{real} using

$$\mu_{real}=\frac{1+\mu_{nominal}}{1+\pi}-1 \tag{17}$$

This is to quantify the erosion of real value caused by inflation and to adjust the drift parameter in the analysis of Fidelity asset prices.

To compute the %loss in real value for each scenario versus the nominal matrix.

% loss

$$\% Loss = \frac{Nominal - Real}{Nominal} \times 100\% \tag{18}$$

Since we deflated with $\frac{S}{1+\pi}$,this simplifies to:

$$\% Loss = \left(1 - \frac{1}{1+\pi}\right) \times 100\% = \frac{\pi}{1+100}\% \tag{19}$$

$$Real\ \ Value = \frac{Nominal}{1+\pi} \tag{20}$$

The above ideas can be seen in the following works [23-25].

3.1 RESULTS AND DISCUSSION

The data for this paper is gotten from the work of [22].To demonstrates the closing share market price performances of Fidelity Bank. To perform this task the following parameter values were used $: \mu_1 = \mu_2 = \mu_3 = 0.8, t = 1.00$.

$$\frac{dC_1(t)}{dt} = \begin{pmatrix} 332 & 49.6 & 110.4 \\ 48.8 & 96.8 & 64.8 \\ 111.2 & 64 & 307.2 \end{pmatrix}, \frac{dC_2(t)}{dt} = \begin{pmatrix} 664 & 99.2 & 220.8 \\ 97.6 & 193.6 & 129.6 \\ 222.4 & 128 & 614.4 \end{pmatrix}, \frac{dC_3(t)}{dt} = \begin{pmatrix} 996 & 148.8 & 331.2 \\ 146.4 & 290.4 & 194.4 \\ 333.6 & 192 & 921.6 \end{pmatrix}$$

FOR C1 ROW 1: 332 tends to 49.6 tends to 110.4. A sharp 85% drop followed by a 123% recovery. For investment plans of Fidelity bank, this fits a recovery/ contrarian strategy. The management of Fidelity will allocate here only if they expect a rebound and can tolerate high drawdown risk. ROW2: 48.8 tends 96.8 tends 64.8. A 98% rally then a 33% pullback. This is a momentum/bull trap pattern. Investment plans using this asset need tight stop-loss rules, since gains reverse quickly. Row3: 111.2 tends to 64 tends to 307.2. A 42% dip then a 380% surge. The large upside at t2 makes it suitable for long-term capital appreciation goals. C1 shows that under baseline conditions, only Asset Row 3 delivers sustained growth by t2. The other two are volatile and unreliable for long-horizon plans.

In C2 : This is exactly double C1. For planning, it answers: What if the whole market doubles while keeping the same relative moves. This is so, because it is quadratic trend function. Row 1: ends at 220.8 versus 332 starting point . Even with 100% market growth, it’s still 33% below the initial level . Not suitable for conservative or income-focused plans. Row 2 peaks at 193.6 then falls to 129.6. The pattern remains unstable. Only short-term tactical plans would fit here. Row 3, ends at 614.4, a 452% gain from its t1 low. For future investment plans of Fidelity bank, this confirms Asset ROW 3 as the only one that creates substantial wealth in a doubling market. In all, Row 3 tells us that a 100% nominal market rally does not fix assets. Asset allocation still matters.

For C3: This is triple C1 because it grows on cubic trend functions. It tests plans under a strong bull market. Row 1: 996 at t2, but started at 332. A 200% gain looks good nominally, but the path has a 85% drawdown. Only high-risk, high-tolerance plans can use this. Row 2, 290.4 at t2, up from 48.8. The 495% total gain is attractive , but the mid-period reversal shows timing risk. Plans needs active management. Row 3, 921.6 at t2.This is 728% above its t1 low and 729% above its starting point. For future investment plans, this is the clear wealth-creation asset. In general, C3 shows that even in a 200% bull market, Assets Row 1 and 2 have large drawdowns that can derail retirement, education, or liability-matching plans. Asset Row 3 is the only one that supports long-term, low-maintenance investment goals.

Deflating Nominal Prices to Real Prices

Matrices:

$$C_1 = \begin{pmatrix} 332 & 49.6 & 110.4 \\ 48.8 & 96.8 & 64.8 \\ 111.2 & 64 & 307.2 \end{pmatrix}, C_2 = 2C_1, C_3 = 3C_1$$

So C_2 *and* C_3 are just $2\times$ and $3\times$ scaling of C_1 .

1. Low Inflation $= 0.2 \rightarrow$ divided by 1.2 .

$$\frac{C_1}{1.2} = \begin{pmatrix} 270.67 & 41.33 & 92.00 \\ 40.67 & 80.67 & 54.00 \\ 92.67 & 53.33 & 256.00 \end{pmatrix}, \frac{C_2}{1.2} = \begin{pmatrix} 553.33 & 82.67 & 184.00 \\ 81.33 & 161.33 & 108.00 \\ 185.33 & 106.67 & 512.00 \end{pmatrix}, \frac{C_3}{1.2} = \begin{pmatrix} 830.00 & 124.00 & 276.00 \\ 122.00 & 242.00 & 162.00 \\ 278.00 & 160.00 & 768.00 \end{pmatrix}$$

2. Moderate Inflation $= 0.5 \rightarrow$ divided by 1.5 .

$$\frac{C_1}{1.5} = \begin{pmatrix} 221.33 & 33.07 & 73.60 \\ 32.53 & 64.53 & 43.20 \\ 74.13 & 42.67 & 204.80 \end{pmatrix}, \frac{C_2}{1.2} = \begin{pmatrix} 442.67 & 66.13 & 147.20 \\ 65.07 & 129.07 & 86.40 \\ 148.27 & 85.33 & 409.00 \end{pmatrix}, \frac{C_3}{1.2} = \begin{pmatrix} 664.00 & 99.20 & 220.80 \\ 97.00 & 193.60 & 129.00 \\ 222.40 & 128.00 & 614.40 \end{pmatrix}$$

3. High Inflation $= 0.9 \rightarrow$ divided by 1.9 .

$$\frac{C_3}{1.9} = \begin{pmatrix} 174.74 & 26.11 & 58.11 \\ 25.68 & 50.95 & 34.11 \\ 58.53 & 33.68 & 161.68 \end{pmatrix}, \frac{C_3}{1.9} = \begin{pmatrix} 349.47 & 52.21 & 116.21 \\ 51.37 & 101.89 & 68.21 \\ 117.05 & 67.37 & 323.37 \end{pmatrix}, \frac{C_3}{1.9} = \begin{pmatrix} 524.21 & 78.32 & 174.32 \\ 77.05 & 152.84 & 102.32 \\ 175.58 & 101.05 & 485.05 \end{pmatrix}$$

At 90% inflation, the real purchasing power of C_1 drops to approximately 53% of its nominal value. The proportional relationship between C_1, C_2, C_3 is preserved under deflation. So if C_2 is 2 times Fidelity's price in one scenario, it stays 2 times in real terms. In general, higher inflation erodes real value fast. For long-dated options on Fidelity, one would want to use real prices or adjust the drift for expected inflation to avoid overestimating gains.

1. **Low inflation=0.2**

$$\%Loss = \frac{0.2}{1.2} \times 100\% = 16.67\%$$

2. **Moderate inflation=0.5**

$$\%Loss = \frac{0.5}{1.5} \times 100\% = 33.33\%$$

3. **High inflation=0.9**

$$\%Loss = \frac{0.9}{1.9} \times 100\% = 47.37\%$$

So the % loss is the same for every entry in a matrix, only depends on the inflation.

Table 3.1: Breakdown for C_1 as an example

Inflation	Real C_1	% Loss versus Nominal
0.2	$\begin{pmatrix} 276.67 & 41.33 & 92.00 \\ 40.67 & 80.67 & 54.00 \\ 92.67 & 53.33 & 256.00 \end{pmatrix}$	16.67% loss on every entry
0.5	$\begin{pmatrix} 221.33 & 33.07 & 73.60 \\ 32.53 & 64.53 & 43.20 \\ 74.13 & 42.67 & 204.80 \end{pmatrix}$	33.33% loss on every entry
0.9	$\begin{pmatrix} 174.74 & 26.11 & 58.11 \\ 25.68 & 50.95 & 34.11 \\ 58.53 & 33.68 & 161.68 \end{pmatrix}$	47.37% loss on every entry

Same % loss applies to C_2 and C_3 because they are just scaled version of C_1 .At 90% inflation, almost half the nominal gain is just inflation.

Table 3.2: Real Value After Inflation

Inflation	Real Value Kept	Interpretations
20% Low	83.3%	Most nominal gains survive. Asset Row 3's 380% move= 304% real.
50% Moderate	66.7%	Doubling nominal price just break even. Fidelity need>50% nominal returns to creat wealth.
90% High	52.6%	Fidelity need>90% nominal return to avoid losing purchasing power. Only asset Row 3 clears this.

If Fidelity's nominal drift is 15%, then at 90% inflation real drift $= \frac{1.15}{1.9} - 1 = -39.5\%$. Holding assets in nominal terms destroys real value.

4.1 CONCLUSION

This paper examined the use of matrix algebra in modeling market trend functions. This trend functions were given in three distinct trend growths; firstly to established share price value through rate of change for each distinct trend functions; which have significant impacts on share prices of Fidelity during the periods of trading and investments. In the same vain, we developed and proved four theorems with respect to trend functions. These theorems demonstrate the physical properties they represent, providing new insights into the behavior of stock market trends. However, the impact Inflation substantially erodes the real value of Fidelity Bank asset prices, with purchasing power losses of 16.67% at low inflation and 47.37% at high inflation. The proportional structure between matrices is preserved under deflation, confirming that inflation affects all price levels uniformly. Adjusting the nominal drift for inflation reveals negative real expected returns under moderate and high inflation scenarios, implying that sustained real growth is not supported.

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