Archives of Business Research – Vol. 13, No. 11
Publication Date: December 04, 2025
DOI:10.14738/abr.1311.19641.
Sen, B. R. & Minghui, J. (2025). Unraveling the Cascading Effects: Banking Frauds, Performance, and Exchange Rate Volatility Dynamics. *Archives of Business Research,* 13(11). 70-96.

SERVICES FOR SCIENCE AND EDUCATION

Unraveling the Cascading Effects: Banking Frauds, Performance, and Exchange Rate Volatility Dynamics

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ABSTRACT

The link between banking fraud, banking sector performance, and exchange rate fluctuations has significant implications worldwide, notably affecting countries like Bangladesh. Over the past two decades, Bangladesh has grappled with major banking frauds that have eroded trust and stability in its financial sector. This study explores the interconnectedness of banking fraud, banking performance, and exchange rate volatility in Bangladesh from 2000 to 2023. Utilizing Cressey's Fraud Triangle Theory and statistical models like GARCH and VECM, researchers found that the fraud cases and the personnel engaged in fraud negatively impact bank performance. Interestingly, the total monetary value of fraud cases had a positive influence. Furthermore, the study revealed that banking performance influenced Bangladesh's currency fluctuations against various trading partners positively, except for certain currencies like the Pound Sterling. The findings underscore the importance of enhancing internal controls to mitigate fraud, improve banking performance, and stabilize exchange rate dynamics in Bangladesh.

Keywords: Banking Fraud, Bank Performance, Exchange Rate Volatility, GARCH Model, Vector Error Correction Model (VECM).

JEL Classification: C32; E44; F31; G01; G15; N10.

BACKGROUND OF THE STUDY

As the foundation of the financial system, the banking industry is essential to a nation's economic growth. In the case of Bangladesh, the banking sector has witnessed significant growth and transformation since the 2000s, contributing to the country's industrialization and overall economic progress. However, the sector has also faced significant challenges in the form of financial crimes and malpractices, which have had far-reaching consequences on the stability and reliability of the Bangladeshi financial system [56]. Over the past two decades, from 2000 to 2023, the banking sector in Bangladesh has been marred by a series of high-profile fraud cases and scams that have shaken public confidence and raised concerns about the efficacy of the regulatory and supervisory frameworks governing the industry. One of the earliest and most prominent banking scandals in Bangladesh is the Hallmark Group Loan Scam, which

unfolded in 2012. The scam involved the illegal disbursement of over $300 million in loans by Sonali Bank to the Hallmark Group, a prominent business conglomerate, through the use of forged documents and the collusion of bank officials. This incident not only resulted in significant financial losses for the bank but also highlighted the need for stronger internal controls and risk management practices within the banking sector [25; 49].

Shortly after the Hallmark Group Loan Scam, the Bangladeshi banking sector was rocked by the Destiny Group Ponzi Scheme in 2011-2012. This multi-level marketing company managed to defraud thousands of investors of over $1 billion by operating an illegal Ponzi scheme, with the involvement of several banks, including Islami Bank Bangladesh Limited and AB Bank, in facilitating the fraudulent activities [51; 13]**.** The banking sector's woes continued in 2009-2013 with the Basic Bank Loan Scam, where over $450 million in loans were illegally disbursed through the use of forged documents and the collusion of bank officials **[50].** This incident once again underscored the need for robust internal controls and effective regulatory oversight to prevent such large-scale financial crimes from occurring.

Balu [9] and Mazumder & Sobhan [33] explore that in 2016, the Bangladeshi banking sector faced one of its most sophisticated and high-profile challenges – the Bangladesh Bank Cyber Heist. In this incident, cybercriminals were able to steal $81 million from the Bangladesh Central Bank's account at New York's Federal Reserve Bank by hacking into the bank's systems, exposing the vulnerabilities in the country's banking infrastructure and the need for enhanced cyber security measures. More recently, in 2017-2018, the Bangladeshi banking sector witnessed the collapse of the Farmers Bank, a private commercial bank, due to a loan scam where the bank's management had illegally disbursed loans worth hundreds of millions of dollars to various individuals and entities **[**52]. The significance of appropriate governance, risk management, and regulatory monitoring in the banking sector was brought to light by this tragedy. There are numerous reasons to determine the root causes of banking fraud in Bangladesh. In their investigation, Karim and Hossain [29] discovered that the financial statement components that can indicate possible fraud in Bangladesh's listed banks are the areas of repayment of loans, property, revenue spending on operations, and tax.

One of the critical aspects of the Bangladeshi banking sector's performance during this period has been its influence on the exchange rate fluctuation between the Bangladeshi Taka (BDT) and the currencies of its major trading partners, both in terms of exports and imports. On the export side, Bangladesh has had strong economic ties with countries like the United States, the United Kingdom, India, and Germany. The performance of the Bangladeshi banking sector, particularly its ability to facilitate trade and financial transactions, has been essential to the dynamics of exchange rates between the BDT and the currencies of these countries. Hossin and Mondol [23] discovered a weak negative correlation between exchange rate changes and bank performance in finance. Although annual inflation rates have been rising, return on assets has benefited from them. For instance, the Bangladeshi banking sector's involvement in the Hallmark Group Loan Scam in 2012 and the Basic Bank Loan Scam in 2013-2014 may have contributed to increased exchange rate fluctuation between the BDT and the currencies of these export destinations, as the loss of confidence in the Bangladeshi banking system could have affected the flow of trade and investment.

URL: http://doi.org/10.14738/abr.1311.19641

Similarly, on the import side, Bangladesh has had significant trade relationships with countries such as Singapore, Malaysia, China, and Indonesia. The performance of the Bangladeshi banking sector in facilitating import transactions and managing foreign exchange reserves has had a direct effect on the exchange rate fluctuation between the BDT and the currencies of these trading partners. The Bangladesh Bank Cyber Heist in 2016 may have also contributed to increased exchange rate volatility, as it undermined confidence in the Bangladeshi banking system's ability to manage its foreign exchange reserves and ensure the stability of the BDT. Furthermore, the collapse of the Farmers Bank in 2017-2018 due to a loan scam may have had ripple effects on the exchange rate dynamics, as the instability within the banking sector could have influenced the flow of trade and investment, leading to increased volatility in the BDT's value relative to the currencies of its major trading partners. These banking scams have had significant repercussions on the Bangladeshi economy, eroding public trust in the financial system, leading to financial losses, and undermining the overall stability and development of the banking sector. This extensive study focuses on the analysis of these incidents, their impact on bank performance, and their analysis of the dynamics of the Bangladeshi taka's exchange rate.

The principal aim of this research is to examine the impact of banking fraud on Bangladesh's banking industry from 2000 to 2023. Next, within the same period, this study looks at how banking performance affected the volatility of the exchange rate between the Bangladeshi Taka (BDT) and the currencies of its main export and import destinations. The goal of this study is to present a thorough knowledge of the connection between banking frauds, the performance of the banking industry, and Bangladesh's exchange rate dynamics. This analysis shed light on the broader implications of banking sector instability on the Bangladeshi economy, particularly in terms of trade, investment, and general economic growth. The findings of this study are invaluable for policymakers, regulators, and industry stakeholders in Bangladesh, as they work to strengthen the resilience and integrity of the banking sector, thereby promoting the long-term stability and growth of the Bangladeshi economy.

LITERATURE REVIEW

Using quarterly financial data, Muritala et al. [37] investigated the causal association between fraud and bank performance in Nigeria from 2000 to 2016. They used Granger Causality analysis using Vector Autoregressive (VAR) and Johansen's Multivariate Cointegration Model. The findings demonstrated a long-term correlation between fraud and bank performance indicators. The analysis revealed a two-way Granger causality between bank performance and fraud at a 10% significance level. In particular, the study discovered a direct causal association between rising fraud in the banking industry and falling bank performance. Fraud is a major problem for the bank, though the frauds are relatively unsophisticated and small in size [58]. This study also found that the fraud triangle model is effective in predicting fraud patterns, but does not fully capture the collusive and predatory nature of fraud in the Kenyan context. It looks into the issue of fraud in the financial industry, concentrating on Standard Chartered Bank, and surveyed 60 respondents across fraud, audit, security, and other management roles involved in fraud prevention. This research recommends policy changes and improvements for the bank, the legal system, and the banking industry in Kenya to better address the fraud problem. Based on the fraud triangle theory, Muritala et al. [36] investigate the effect of fraud on the performance of banks in the Nigerian banking sector using the Vector Error Correction Model.

The return on assets is positively impacted by the number of employees engaged in fraud. The performance of banks is negatively impacted by both the quantity and overall value of fraud. The VECM findings point to a short-term dynamic effect in which imbalances in the fraudulent banking environment are corrected by the variables adjusting.

The financial performance of deposit money banks in Nigeria was studied by Muoghalu et al. [35] concerning fraud involving electronic banking. The study examined how fraud affected bank performance metrics such as return on assets, return on equity, earnings from interest, and non-interest revenue as well as automated teller machines, mobile banking, point-of-sale devices, and online banking platforms. The study made use of four years' worth of fraud data from the Central Bank of Nigeria's various electronic banking channels. It used Granger causality analysis and ordinary least squares (OLS) regression to determine the effect of fraud on various digital platforms and the financial performance of banks. The main conclusion was that, whilst fraud on ATMs, mobile devices, and online banking had little effect on ROA, ROE, or non-interest revenue, it significantly reduced bank's earnings from interest when it occurred on POS terminals. The financial performance of Nigerian deposit money institutions was shown to be significantly impacted negatively by fraud via mobile banking, ATMs, as well as Internet banking methods, according to Jolaiya [28]. He concludes that there is a strong inverse association between the performance of banks and fraud via the Internet. In this case, the data is analyzed using the panel generalized method of moments. Moshirian and Wu [34] also employed this technique to look at the connection between the volatility of the banking sector and potential future growth in the economy. They discovered an adverse relationship between the instability of the banking sector and potential future economic expansion. Several factors, including government ownership of banks, the application of laws against insider trading, systemic financial crises, and bank accounting transparency standards, have a substantial impact on this unfavorable correlation.

Ogbeide [38] established that the adverse impacts of fraud on the financial performance of the Nigerian banking industry emphasize the necessity of strong internal controls and anti-fraud measures. Co-integration and error correction processes were used in this study's data analysis, which covered the years 1993 to 2016. According to Udeh and Ugwu [55], there is a slight but unfavorable correlation between fraud and bank profitability. They contend that although bank fraud rises in tandem with profits, the real quantity of money involved in the fraud has no bearing on the profitability of the bank. They employ an ex post facto study design, analyzing the data using OLS regression and data from the Nigeria Deposit Insurance Corporation (NDIC) annual reports for the years 2006–2015. Nigerian deposit money banks suffer greatly from fraud, thus it's critical to manage expenses, checks, account openings, and securities with caution to stop fraud [2]**.** This study arrived at this conclusion by looking at the relationships between fraud incidents, the reactions, and the functions of DMBs in Nigerian banks. Ogechukwu [39] examines how government initiatives, incentives, societal and environmental variables, and fund-looting affect bank fraud. He discovered that the most common type of bank fraud in Nigeria is the looting of funds by bank managers and directors; inadequate motivation is not a key contributing factor. He also found that government efforts have negatively impacted the fight against fraud and environmental and social factors harm bank fraud. Secondary data from the Nigeria Deposit Insurance Corporation (NDIC) and primary information from interviews are employed here.

URL: http://doi.org/10.14738/abr.1311.19641

In an effort to assess the many factors contributing to fraud, Khanna and Arora [31] looked into the problem of bank fraud. They aim to ascertain the degree to which bank workers adhere to the Reserve Bank of India's recommended fraud prevention procedures. They identified the primary causes of bank fraud, including inadequate employee training, overworked staff, competitiveness, and poor adherence to Reserve Bank of India fraud prevention rules. They found the primary causes of bank fraud, including inadequate employee training, overworked staff, competitiveness, and poor adherence to Reserve Bank of India fraud prevention rules. The nature, reasons, impacts, identification, and elimination of bank fraud in Nigeria were examined by Olatunji et al. [40]. They employed surveys for primary data collection; of the 100 they distributed to chosen bank employees, 92 were filled out and returned. Data on total fraud amounts; institutions with the highest fraud case counts, and categories of bank employees involved in fraud were also taken from NDIC annual reports and used in the study. To address the issue of bank fraud in Nigeria, the report emphasizes the necessity of strong internal controls, strong governance, and a society intolerance of fraud. Prompt investigation and punishment of offenders are also recommended as a key fraud prevention measure. Additionally, Owolabi [44] looks at several legislative initiatives that try to lower fraud and implement systems of control and reporting. He investigates different fraud theories and analyzes the causes, prevention, and control strategies for banking fraud. One of the main reasons why fraud occurs is greed, and bank employees are complicit in the planning, carrying out, and hiding of fraud [3]. According to this research, the two main effects of fraud are lost revenue and lost consumer confidence. Computer fraud is the most prevalent kind of fraud in the banking industry. He makes use of primary data gathered using a questionnaire survey administered to 200 employees of ten commercial banks located in Lagos. To stop and manage fraud in the Nigerian banking sector, this study advises putting in place a sufficient internal control mechanism.

According to a study conducted by Otusanya et al. [43]**,** bank directors and executives in Nigeria engage in corrupt activities that have detrimental effects. Based on available data, corporate executives appear to have created innovative methods to get around laws and regulations to increase their fortune. Nigeria's banking industry fraud has reached epidemic proportions, which has contributed to the economic downturn in the nation [4]**.** This study investigates the theory that weak corporate governance laws in the banking industry lead to chances for control fraud, in which executives of the organization take use of their positions to commit fraud. The hypothesis is supported by data gathered from five banks engaged in the 2008–2009 Nigerian banking crisis. The study evaluates the relationship between control fraud and corporate governance regulations using a socio-legal methodology. According to Park [45], cross-sectional regression analyses offer compelling proof of how corruption dramatically exacerbates the fraudulent loan issue facing the banking industry. The research also finds a novel way that corruption stunts growth in the economy: it skews bank funding distribution from worthwhile to unworthy endeavors, lowering the standard of private investment and slowing down GDP growth as a whole. Macroeconomic statistics from 76 nations between 2002 and 2004 were used by them. To determine which parts of financial statements in Bangladesh's banking industry are vulnerable to fraud, Karim and Hossain [29] looked at a study. The researchers analyzed financial data from 2006 to 2018 for 29 listed banks in Bangladesh. The dependent variable was banks identified by CPD as involved in fraud, scams, and robberies; the independent variables were financial data indicators recommended by ISA 240. The analytical

tool used in the study was a Multilayer Perceptron Network, a kind of feed-forward artificial neural network model. The main conclusions are that the financial statement components that can indicate possible fraud in Bangladesh's listed banks are the areas of loan distribution, assets, earnings, operational costs, and taxation.

From 2005 to 2014, Osundina et al. [42] looked at how exchange rate swings affected Nigerian banks' performance. The average yearly American dollar to Naira exchange rate was used to calculate fluctuations in the exchange rate. They discovered that changes in exchange rates had no bearing on the profitability of banks as determined by return on assets. However, the loans-to-deposits ratio indicated that exchange rate swings had a substantial negative impact on banks' liquidity. According to the findings, Nigerian banks' liquidity position would deteriorate if the Naira continued to weaken. The capital return ratio of banks is significantly and adversely affected by exchange rate fluctuation. Because it widens the financial gap and raises credit risk, it is also proven to be a factor in the rise in the lending to total bank deposit ratio [30]. To determine the volatility of the exchange rate, they employed the GARCH approach and panel data analysis with random effects estimation. The study gathers information from Fourteen Iranian banks and spans the years 2007 to 2017. There was a weak negative correlation between exchange rate fluctuations and financial performance [23]. Additionally, they discovered that while inflation rates have been rising yearly, ROA has benefited. They gathered secondary data from the World Bank database and bank financial statements.

According to Adebisi and Matthew's [1] research, there is no discernible correlation between banks' Return on Assets (ROA) and the amount of non-performing loans (NPLs), suggesting that the presence of NPLs does not affect asset prices. The correlation between non-performing loans (NPLs) and banks' return on equity (ROE) implies that the amount of NPLs affects shareholders' wealth. To examine the association between non-performing loans (NPLs) and bank profitability, the researchers applied regression analysis and secondary data from NDIC reports spanning seven years (2006–2012). According to research by Akter and Roy [5], NPLs represent a disproportionately large portion of total loans for banks that are listed on the Dhaka Stock Exchange (DSE)—more than 50% of all NPLs for the 30 listed banks between 2008 and 2013—for such banks. One of the main factors affecting bank profitability is non-performing loans (NPLs), which during the study period had a statistically significant negative influence on the net profit margin (NPM) of the listed banks. They looked at the growth, provisions, and link between non-performing loans (NPLs) and bank profitability using time series data.

The earlier studies have shed important light on the connections between exchange rate volatility, banking performance, and fraud in the banking industry. There is still a void in the literature, nevertheless, since no research has looked at how banking performance affects changes in exchange rates. This study seems to be the first to look into how fraud affects banks' performance and how banking performance affects exchange rate volatility. With a particular focus on Bangladesh, the researchers have accomplished their goal and concluded this extensive analysis. While existing research has elucidated various connections in this domain, this new study uniquely explores the previously unexamined effect of banking performance on exchange rate movements, providing a more complete picture of these dynamic relationships. The upcoming sections of the paper provide detailed information about the data sources and analytical methods used in the study. This gives a comprehensive overview of the data

URL: http://doi.org/10.14738/abr.1311.19641

collection and evaluation processes employed. The research findings then be thoroughly examined and discussed in a dedicated section, providing a comprehensive analysis of the results obtained. Finally, the paper summarizes the key insights gleaned from the study. It also suggests potential areas for future research and further exploration of this complex topic.

METHODOLOGY AND MODEL SPECIFICATION

Theoretical Framework

The fraud triangle theory, developed by Cressey [16], outlines three key factors that tend to contribute to the occurrence of fraud.

- The first element is the pressure or motive that can stem from financial troubles or needs.
- The second element is the perceived opportunity, which refers to weaknesses in the organization's monitoring and control systems that lead the perpetrator to believe their fraudulent actions can be committed without being detected.
- The final element is rationalization, where the person committing fraud convinces themselves that their actions are justified, such as believing they are saving their family that the organization needs the money less than they do, or simply not fully understanding the consequences of their criminal behavior.

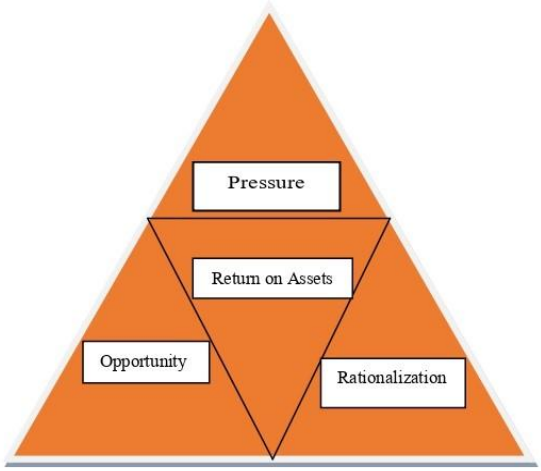

Figure 1: Fraud Triangle Model

In this study, the quantity of employees working on fraud cases is used as a proxy indicator for the pressure/motive element of the fraud triangle theory. This reveals whether there are any underlying problems or unmet needs that may be driving bank employees to commit fraud. The quantity of actual fraud cases committed is used as a proxy for the opportunity element. This sheds light on whether there are any issues with the bank's policies, monitoring of clients, or verification of legal documents that are creating vulnerabilities that perpetrators can exploit. The non-performing loan (NPL) is used as a proxy for the rationalization element. This provides insight into how banks' lax oversight of large loans and repayment issues may lead employees to convince themselves that fraudulent actions are justified or necessary. Finally, the analysis employs the bank's return on assets (***roa***) as a gauge of its general performance. This allows the researchers to conclude how the varying elements of the fraud triangle, as evidenced by the proxy measures, ultimately impact the bank's profitability and overall performance.

Data Collection and Sources

Data on reported fraud cases, non-performing loans, and banking employees engaged in fraud are gathered between 2000 and 2023 for the study; these variables are in line with the fraud triangle theory. These data are sourced from Bangladesh Bank Annual reports, government publications (Bangladesh Economic Review and Bangladesh Bureau of Statistics), newspapers (online portal of Dhaka Tribune, and The Daily Star), and research organizations like the Center for Policy Dialogue (CPD) to analyze their impact on banking performance.

This research investigation also looks at how banking performance affects the volatility of exchange rates between the Bangladeshi Taka and a few major exporting and importing nations' currencies. In the 2022-23 periods, the United States, Germany, the United Kingdom, and India were major export destinations, accounting for 16.30%, 11.35%, 8.59%, and 3.74% of Bangladesh's total exports, respectively. Meanwhile, China, Singapore, Indonesia, and Malaysia were major sources of imports for Bangladesh, making up 22.77%, 7.83%, 5.92%, and 3.69% of the country's total imports during the same time frame [48]. Given the significance of these countries in Bangladesh's international trade, this research has chosen to focus on the exchange rate dynamics between the Taka and the currencies of these major exporting and importing partners.

This research accessed the historical exchange rate data from the **fx-rate.net** website. The data covers the study period and includes the daily nominal exchange rates between the Bangladeshi Taka and the selected country's currencies. The researchers make use of the GARCH model to examine the volatility of these exchange rate fluctuations. This is a commonly used method that takes into consideration the fact that exchange rate volatility is time-varying. EViews 12 software is utilized here to estimate the conditional variance using the GARCH method. This makes it possible to spot trends and variations in the fluctuation of exchange rate swings. In interpreting the results, a negative value would indicate that the chosen currency has strengthened or appreciated against the Bangladeshi Taka. Conversely, a positive value would suggest that the currency has weakened or depreciated relative to the Bangladeshi Taka.

The interest rate (***ir***), the logarithmic representation of foreign currency reserves (***log_fcr***), and the logarithmic representation of the index for consumer prices (***log_cpi***) are the independent variables. Studies by Andersen et al. [6] and Fatum et al. [20] show that these particular variables affect a nation's financial market. The International Monetary Fund database is the source of the annual statistics for these variables. The dataset of this study is the time series data and **Table A1 in Appendix A** contains each variable's information. The researchers employ the CUSUM stability test to evaluate the model's stability. The analysis uses the Stata 12 software package, which provided the research outcomes.

Model for Estimating the Effect of Bank Scam on Banking Sector Performance

In their research, Chiezey and Onu [14] and Clementina and Isu [15] employed the following proxies: the total sum involved in the incidence of fraud (***tafc***) for noticed rationalizations, the number of employees working on fraud cases (***nstf***) for noticed pressure, and the number of fraud instances (***nfca***) for the noticed opportunity. As a stand-in variable to gauge banking performance, they employed the return on asset (***roa***) as the dependent variable. The model is given below:

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$$roa_t = \alpha + \beta_1 nstf_t + \beta_2 nfca_t + \beta_3 \ln tafc_t + \nu_t \quad \textbf{(1)}$$

Here, α is the intercept; β_1, β_2, β_3 are parameters of the independent variables respectively; ***roa*** = return on assets; ***nstf$_t$*** = The quantity of employees working on fraud cases; ***nfca$_t$*** = The quantity of fraud instances; ***lntafc$_t$*** = The total sum involved in fraud cases in log form; ν_t is the disturbance term.

Model for identifying the effect of bank performance on exchange rate volatility

This research modified the structure of the model which is followed by Osundina et al. [42] in their study. The present study takes the exchange rate volatility as the dependent variable and the return on assets as the independent variable. The model is given below:

$$vol_{ib} = \delta + \gamma_1 roa_b + \gamma_2 \log\_ fcr_b + \gamma_3 \log\_ cpi_b + \gamma_4 ir_b + u_b \quad \textbf{(2)}$$

Here, ***i*** for exporting and importing countries; ***b*** for Bangladesh; δ is the intercept; γ_1, γ_2, γ_3 and γ_4 are the parameters of the independent variables; ***vol*** = the exchange rate volatility; ***roa*** = the return of assets; ***log_fcr*** = the log form of foreign currency reserves; ***log_cpi*** = the log form of the index of consumer price; ***ir*** = the interest rate; u_b = the disturbance term.

GARCH Model

Previous research has used various models to assess exchange rate fluctuations and uncertainty:

a) The standard deviation of the logarithmic exchange rate's first difference was used by Dell'ariccia [17] and Devereux & Lane [18] to quantify exchange rate uncertainty.
b) Klaassen [32] computed volatility using the log form of the real exchange rate's moving average.
c) The GARCH model was used by Asteriou et al. [7] and Bahmani-Oskooee & Aftab [8] to examine changes in exchange rates.

The first two methods may suffer from measurement errors, leading to biased results. In contrast, the GARCH model is considered a more suitable and effective approach for reducing risks and achieving stability in exchange rate analysis. The algorithm for determining exchange rate volatility is as follows:

$$y_t = \sigma_0 + \sigma_1 y_{t-1} + \ldots\ldots\ldots\ldots\ldots + \sigma_n y_{t-n} + \varepsilon_t \quad \textbf{(3)}$$

$$\nu_t | I_{t-1} N(0, q_t) \quad \textbf{(4)}$$

$$q_t = \alpha_0 + \alpha_1 \nu_{t-1}^2 + \ldots\ldots\ldots\ldots + \sigma_n \nu_{t-n}^2 + \beta_1 q_{t-1} + \ldots\ldots\ldots + \beta_m q_{t-m} \quad \textbf{(5)}$$

where q_t is the conditional volatility; α_0 is the intercept term; v_{t-1} is the ARCH term; q_{t-1} is the GARCH term; α_1 is the coefficient of ARCH term; β_1 is the parameter reflects the persistence of conditional volatility;

Here, v_t is the ARIMA model's representing variable for the error term, which is provided below:

$$\Delta^c \ln exr_t = \beta_0 + \sum_{i=1}^{d} \beta_i \Delta^c \ln exr_{t-i} + \sum_{i=1}^{e} \delta_i \varepsilon_{t-i} + \varepsilon_t \quad \textbf{(6)}$$

Here, ***lnexr$_t$*** is the nominal exchange rate in log form.

Augmented Dickey-Fuller Test (ADF)

The analysis faces the common issue of unit root problems when dealing with time series data. The non-stationary nature of time series data might result in spurious regression issues since the data is frequently non-stationary. To address this, the researchers have thought of determining whether the data is non-stationary using the Augmented Dickey-Fuller (ADF) test. One popular technique for determining if unit roots exist in time series datasets is the ADF test. Null hypothesis: $H_o : \Omega = 0$

Alternative hypothesis: $H_1 : \Omega < 0$

The ADF test's regression formula is as follows:

$$\Delta y_t = \mu + \Omega y_{t-1} + \sum_{m=1}^{p} \Omega_m \Delta y_{t-m} + \nu_t \quad \textbf{(7)}$$

Here Δ indicates the variable's first difference and ν_t is the disturbance term and ***p*** shows the variables' lagged level.

The ADF test regression equation with a trend is:

$$\Delta y_t = \mu + \lambda_t + \Omega y_{t-1} + \sum_{m=1}^{p} \Omega_m \Delta y_{t-m} + \nu_t \quad \textbf{(8)}$$

Test of Cointegration

Granger [21] first proposed the idea of cointegration, which Engle and Granger [19] expanded upon. Cointegration is the study of the long-term relationship between non-stationary time series variables. If a linear combination of non-stationary variables is stationary, the variables are called cointegrated, and the vector that describes the stationary linear combination is called the cointegrating vector. To test for cointegration in this work, the researchers employ the Johansen Full Information Maximum Likelihood Method [26; 27]. The Johansen test employs two likelihood ratio (LR) tests to determine whether there is a single cointegrating vector.

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a) The trace test statistic, which is formulated as

$$\lambda_{trace} = -2\ln Q = -T\sum_{i=n+1}^{q}\ln\left(1-\lambda_i\right) \tag{9}$$

The alternative hypothesis, "*m* cointegrating relations," where n = 0, 1,..., n-1, is tested against the null hypothesis, "there are at most *n* cointegrating relations," using the trace test statistic.

b) The max-eigenvalue test, which is formulated as

$$\lambda_{\max} = -2\ln\left(Q : n/n+1\right) = -T\ln\left(1-\lambda_{n+1}\right) \tag{10}$$

Using the max-eigenvalue test statistic, the alternative that there are "*n+1* cointegrating relations" is compared against the null hypothesis that there are "*n* cointegrating relations." Johansen [26] and Osterwald-Lenum [41] summarized the critical values for these trace and max-eigenvalue tests, which were obtained by Monte Carlo simulations.

Vector Error Correction Model

Sargan [46] was the first to suggest the error-correcting system, and then Engle and Granger [19] popularized it. The VECM is the suitable estimation technique when the Johansen cointegration test finds one or more cointegrating vectors among the variables. The VECM can be used to represent deviations from the long-term equilibrium as well as short-term changes in the variables. The time series variables that are discovered to be cointegrated can have their short- and long-term dynamics examined using the VECM.

$$\begin{aligned}\Delta\ln vol_{i,t} &= \beta_0 + \sum_{j=1}^{\rho}\beta_1\Delta\ln vol_{i,-j} + \beta_2\Delta\ln roa_{i,-j} + \beta_3\Delta\ln\ fcr_{i,-j} + \beta_4\Delta\ln cpi_{i,t-j} \\ &+ \beta_5\Delta ir_{i,t-j} + \lambda\left[\ln vol_{i,t-1} - \hat{\alpha}_0 - \hat{\alpha}_1\ln roa_{i,t-1} - \hat{\alpha}_2\ln\ fcr_{i,t-1} - \hat{\alpha}_3\ln cpi_{i,t-1} - \hat{\alpha}_4 ir_{i,t-1}\right] + \nu_{i,t}\end{aligned} \tag{11}$$

The VECM model includes a lag structure $\boldsymbol{\rho}$, where $\boldsymbol{\Delta}$ represents the first difference of the variables. The parameter $\boldsymbol{\lambda}$ presents the speed of adjustment from any disequilibrium in the long-run relationship. The term $\nu_{i,t}$ indicates the white noise error term in the model.

RESULTS AND DISCUSSION

Effect of Fraud Cases on Banking Performance

Descriptive Analysis:

Figure 2 presents the trend of two variables from 2000 to 2023 in the Bangladesh banking sector - the number of employees working on fraud cases (***nstf***) and the number of fraud instances (***nfca***). The graph shows a generally positive trend relationship between these two variables, indicating that as the number of fraud cases has increased over time, the number of employees dedicated to handling these fraud cases has also risen. However, the data also exhibits significant variability and the presence of outliers, suggesting that the relationship between these two variables is not perfectly linear and may be influenced by other factors as well.

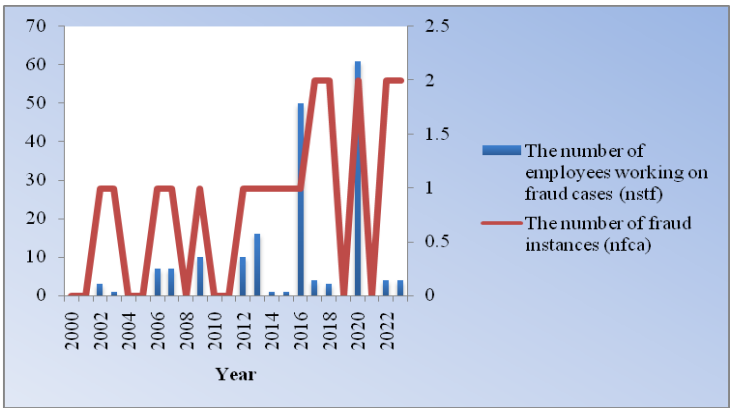

Figure 2: The number of employees working on fraud cases and the number of fraud instances in Bangladesh's banking sector from 2000 to 2023

The summary statistics presented in **Table 1** provide an overview of the key variables such as return on assets (***roa***), the number of employees working on fraud cases (***nstf***), the number of fraud instances (***nfca***), and the total sum involved in the incidence of fraud (***lntafc***). The average ***roa*** is a relatively high 71.08%, but with substantial variation as indicated by the high standard deviation of 0.42. On average there is around 8 staff members dedicated to fraud cases, but the range varies widely from 0 to 61, with a high standard deviation of 15.41 pointing to large differences in the number of employees working on fraud cases (***nstf***). On average there are approximately 0.83 fraud cases, with a standard deviation of 0.7614 suggesting moderate variability in the number of fraud incidents (***nfca***). The average value of the total sum involved in fraud incidents (***lntafc***) is 1.7074, with a moderate standard deviation of 0.5658, indicating some variability in the total assets and compliance measures across the sample.

Table 1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
roa	24	0.7108	0.4203	0	1.8
nstf	24	7.5833	15.41	0	61
nfca	24	0.8333	0.7614	0	2
lntafc	24	1.7074	0.5658	1.00	2.69

Unit Root Test:

To confirm the stationary qualities of the variables, **Table 2** below displays the unit root test results for the whole study period, from 2000 to 2023.

Table 2: Augmented-Dickey Fuller test

Variables	Level				1st Difference			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status
roa	-2.37		-2.67		-5.97*	I(1)	-5.88*	I(1)
nstf	-0.38		-2.30		-12.29*	I(1)	-11.90*	I(1)
nfca	-4.33*	I(0)	-5.93*	I(0)				
lntafc	0.58		-2.22		-4.38*	I(1)	-5.06*	I(1)
Note: * indicate statistical significance at 1%								
Source: Calculated by the author using Eviews								

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The Fisher-type ADF test is used to ascertain the integrated order of the variables. According to the results, only ***nfca*** is stationary at levels, or I(0) in both the intercept and trend and intercept terms, whereas ***nstf***, ***roa***, and ***lntafc*** are stationary at the first difference, or I(1) in both the intercept and trend and intercept terms.

Explanation of the Results:

To examine how bank fraud affects banking performance, this study first determines the ideal lag duration based on several factors listed in **Table 3**. According to the lag selection criteria, which include HQIC, AIC, FPE, SBIC, and LR, the ideal lag duration is 1. In particular, the AIC (Akaike Information Criterion) is used in the study to establish the proper lag duration for the vector error correction model (VECM) analysis that comes next.

Table 3: Lag selection

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-3.51914				0.124868	0.751914	0.79079	0.951061
1	0.225176	**7.4886***	1	0.006	0.006	**0.09541***	**0.526077***	**0.726415***
2	0.227405	0.00446	1	0.947	0.947	0.106291	0.635573	0.875979
3	0.381643	0.30848	1	0.579	0.579	0.11705	0.729868	1.01034
4	0.409305	0.05532	1	0.814	0.814	0.131137	0.83682	1.15736
Source: Calculated by the author using STATA 12								

The results of the Johansen test of cointegration, as shown in **Table 4** confirm that at least two variables in the model are cointegrated. Specifically, in the case of max rank 2, the values of the trace statistics and Max-Eigen statistics are lower than the 5% level of critical value. This indicates that there are at least two variables in the model that move together in the long run.

Table 4: Trace and Max-Eigen statistics

Maximum rank	Eigen statistics	Trace statistic	5% critical value	Eigen statistics	Max-Eigen statistic	5% critical value	Decision
0		89.1634	47.21		55.2722	27.07	None
1	0.92807	33.8912	29.68	0.92807	23.9937	20.97	At most 1
2	0.68100	**9.8975***	15.41	0.68100	**8.4913***	14.07	**At most 2***
3	0.33259	1.4062	3.76	0.33259	1.4062	3.76	At most 3
4	0.06477			0.06477			At most 4
Source: Calculated by the author using STATA 12							

Tables 5 and 6 display the outcomes of the VECM examination for both short-term and long-term speed of adjustment. In **Table 5**, at the 5% level, it is clear that every coefficient is statistically significant.

Table 5: Calculating the long-term relationship through VECM estimation
Dependent Variable: Return on Assets (*roa*)

Variable	Coef.	Std. Err.	Z	$P > z$
nstf	1.243462	0.31003	4.01	0.000
nfca	40.91692	7.42662	5.51	0.000
lntafc	-31.85097	7.86497	-4.05	0.000
constant	146.4417			
Source: Calculated by the author using STATA 12				

Note: In the long run, the signs of the coefficients are opposite

The final equation is as follows:

$$roa_t = -146.4417 - 1.243462 nstf_t - 40.91692 nfca_t + 31.85097 \ln tafc_t$$

In the given equation, the coefficient for ***nstf*** is -1.243462, suggesting that over the long term, a one-unit rise in the number of staff working on fraud cases leads to a decrease of 1.243462 units in return on assets (***roa***), with all other factors held constant. The coefficient for ***nfca*** is -40.91692, meaning that a one-unit rise in ***nfca*** causes the return on assets to drop by 40.91692 units. Conversely, a 1 unit rise in ***lntafc*** is associated with a 31.85097 unit increase in return on assets, as indicated by the positive coefficient for ***lntafc***.

Table 6: Determining the short-term relationship through VECM estimation
Dependent Variable: Return on Assets (*roa*)

Variable	Coef.	Std. Err.	Z	$P > \|z\|$
D_roa				
L1.	0.001	0.002	0.34	0.736
cons	0.019	0.07	0.27	0.787
D_nstf				
L1.	-0.492	0.098	-5.03	0.000
cons	-0.003	3.45	-0.00	0.999
D_nfca				
L1.	-0.022	0.004	-5.16	0.000
cons	0.079	0.148	0.54	0.592
D_lntafc				
L1.	0.0001	0.001	0.06	0.952
cons	0.084	0.035	2.38	0.018
Source: Calculated by the author using STATA 12				

Table 6's short-term VECM analysis indicates that while ***roa*** and ***lntafc*** do not exhibit statistical significance, previous changes in ***nstf*** and ***nfca*** have a statistically significant positive impact on ***roa***. Although not statistically significant, the error correction terms are positive, indicating that there is no clear indication of a short-term shift toward equilibrium.

The Relationship Between the Performance of Banks and Fluctuations in Exchange Rates
This study examines how the performance of the banking industry of Bangladesh impacts the volatility of exchange rates in key exporting and importing countries, including India, the USA, the United Kingdom, Germany, China, Singapore, Malaysia, and Indonesia. The research findings, including the results of the ADF test, criteria of lag selection, and test of Johansen cointegration, can be found in Table A2, Table A3 and Table A4 in Appendix A. Specifically, based on the AIC criteria, lag 2, 0, 4, 0, 0, 2, 4, and 5 are determined for India, China, Singapore, Malaysia, Indonesia, the United Kingdom, Germany, and the USA, respectively, as shown in Table A3 of Appendix A. The Johansen cointegration test is performed as described in Table A4 in Appendix A after the proper lag duration has been determined. The unrestricted cointegration test (Maximum Eigenvalue test) and the unrestricted cointegration rank test (Trace test) make up this test. At a significance level of five percent, the null hypothesis is

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rejected. The results from both the Trace statistics and Max-Eigen statistics indicate that in the long run, at least three variables for India, two variables for China, Singapore, and Indonesia, as well as one variable for Malaysia, the United Kingdom, Germany, and the USA, are involved in the model. Using the error correction model, it is possible to determine the short- and long-term impacts of variables (***roa***, ***log_fcr***, ***log_cpi***, and ***ir***) on the exchange rate volatility of selected exporting and importing nations relative to Bangladesh. The findings are outlined in the tables provided as **Table 7 and Table 8**.

Table 7: Analyzing the long-term relationship using VECM estimation

Country	Variable	Coefficient	Std. Err.	Z	$P>\|z\|$
India	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with Indian Rupee (vol_{IB})				
	Independent variable				
	roa	-0.906	0.103	-8.77	0.000
	log_fcr	-0.544	0.187	-2.91	0.004
	log_cpi	1.176	0.504	2.33	0.020
	ir	-0.117	0.101	-1.16	0.246
	constant	0.432			
	Equation				
	$vol_{IB} = -0.432 + 0.906roa + 0.544\log\_\ fcr - 1.176\log\_\ cpi + 0.117ir$				
China	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with Chinese Yuan (vol_{CB})				
	Independent variable				
	roa	-0.65	0.191	-3.41	0.001
	log_fcr	1.513	0.314	4.81	0.000
	log_cpi	-3.649	0.847	-4.31	0.000
	ir	0.17	0.183	0.93	0.353
	constant	3.034			
	Equation				
	$vol_{CB} = -3.034 + 0.65roa - 1.513\log\_\ fcr + 3.649\log\_\ cpi - 0.17ir$				
Singapore	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with Singapore Dollar (vol_{SB})				
	Independent variable				
	roa	-0.001	0.001	-1.88	0.060
	log_fcr	-0.008	0.002	-5.46	0.000
	log_cpi	0.019	0.004	4.57	0.000
	ir	0.002	0.001	2.37	0.018
	constant	-0.025			
	Equation				
	$vol_{SB} = 0.025 + 0.001roa + 0.008\log\_\ fcr - 0.019\log\_\ cpi - 0.002ir$				
Malaysia	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with Malaysian Ringgit (vol_{MB})				
	Independent variable				
	roa	-0.001	0.007	-0.12	0.905
	log_fcr	-0.05	0.011	-4.32	0.000
	log_cpi	0.136	0.031	4.36	0.000
	ir	0.024	0.006	3.89	0.000
	constant	-0.31			

	Equation				
	$vol_{MB} = 0.31 + 0.001roa + 0.05\log\_ fcr - 0.136\log\_ cpi - 0.024ir$				
Indonesia	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with Indonesian Rupiah (vol_{ISB})				
	Independent variable				
	roa	-0.002	0.001	-2.38	0.017
	log_fcr	-0.01	0.002	-6.03	0.000
	log_cpi	0.032	0.004	7.08	0.000
	ir	0.007	0.001	8.30	0.000
	constant	-0.091			
	Equation				
	$vol_{ISB} = 0.091 + 0.002roa + 0.01\log\_ fcr - 0.032\log\_ cpi - 0.007ir$				
United Kingdom	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with The Pound Sterling (vol_{UKB})				
	Independent variable				
	roa	0.002	0.0003	4.90	0.000
	log_fcr	-0.02	0.001	-23.22	0.000
	log_cpi	0.053	0.002	22.80	0.000
	ir	0.011	0.001	21.64	0.000
	constant	-0.125			
	Equation				
	$vol_{UKB} = 0.125 - 0.002roa + 0.02\log\_ fcr - 0.053\log\_ cpi - 0.011ir$				
Germany	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with Germany Euro (vol_{GB})				
	Independent variable				
	roa	-0.027	0.002	-13.70	0.000
	log_fcr	-0.072	0.005	-15.31	0.000
	log_cpi	0.129	0.013	10.11	0.000
	ir	-0.075	0.003	-26.54	0.000
	constant	0.486			
	Equation				
	$vol_{GB} = -0.486 + 0.027roa + 0.072\log\_ fcr - 0.129\log\_ cpi + 0.075ir$				
USA	Dependent variable				
	Exchange rate volatility of Bangladeshi Taka with US Dollar (vol_{USB})				
	Independent variable				
	roa	0.002	0.001	1.53	0.126
	log_fcr	0.009	0.002	3.84	0.000
	log_cpi	-0.026	0.006	-4.08	0.000
	ir	-0.004	0.001	-3.51	0.000
	constant	0.059			
	Equation				
	$vol_{USB} = -0.059 - 0.002roa - 0.009\log\_ fcr + 0.026\log\_ cpi + 0.004ir$				
Source: Calculated by the author using STATA 12 Note: The coefficients' signs are opposite over the long term.					

Table 7 displays the outcomes of the analysis on the sustained connection between the exchange rate volatility of Bangladesh and various countries such as India (***volIB***), China (***volCB***), Singapore (***volSB***), Malaysia (***volMB***), Indonesia (***volISB***), United Kingdom (***volUKB***), Germany

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(***vol$_{GB}$***), the USA (***vol$_{USB}$***). The variables examined include return on assets (***roa***), logarithmic representations of foreign currency reserves (***log_fcr***), consumer price index (***log_cpi***), and interest rates (***ir***). ***roa*** shows a positive and notable relation with ***vol$_{IB}$, vol$_{CB}$, vol$_{SB}$, vol$_{ISB}$ and vol$_{GB}$***. As per Wang's [56] Portfolio Balance Approach in **2020**, investors aim to diversify their investments for higher returns with lower risks. A stronger ***roa*** in Bangladesh's banking industry might attract foreign investors seeking lucrative opportunities. This increased foreign investment could result in a higher demand for the Bangladeshi Taka, leading to its appreciation against the Indian Rupee, Chinese Yuan, Singapore Dollar, Indonesian Rupiah, and German Euro. This capital inflow could contribute to exchange rate fluctuations across these nations.

The relation between return on assets (***roa)*** and ***vol$_{UKB}$*** is negative and significant. According to the Financial Market Integration Theory by Stavárek et al. [54], when financial markets of different countries integrate, it can lead to more synchronized movements in exchange rates and asset prices. If the ***roa*** of Bangladesh's banking sector reflects the country's financial health and performance, a negative ***roa*** could indicate lower investment returns, making Bangladeshi assets less appealing to investors in the United Kingdom. This situation may lead to decreased capital inflows and reduced demand for the Bangladeshi Taka in comparison to the British Pound, potentially lowering exchange rate volatility. Additionally, the relationship between ***roa*** and ***vol$_{MB}$***, as well as ***vol$_{USB}$***, is not statistically significant.

The logarithm of foreign currency reserves (***log_fcr***) has a positive and significant impact on the fluctuation of the Bangladeshi currency's exchange rate with India, Singapore, Malaysia, Indonesia, the United Kingdom, and Germany. This indicates that when Bangladesh holds more foreign currency reserves, it may not be able to effectively handle external shocks. Conversely, maintaining higher foreign currency reserves appears to decrease exchange rate volatility with the Chinese Yuan and the US Dollar. The negative coefficient implies that increasing reserves in Bangladesh act as a buffer against external shocks, thus reducing exchange rate fluctuations. Accumulating reserves helps Bangladesh manage external imbalances and reduce susceptibility to currency crises, especially with China and the USA, aligning with the findings of Hvidin et al. [24].

The impact of the consumer price index (***log_cpi***) on the exchange rate fluctuation of the Bangladeshi Taka is consistently positive with the Chinese Yuan and the US Dollar, signaling that higher ***log_cpi*** values tend to indicate inflationary pressures, potentially leading to increased exchange rate volatility. Conversely, ***log_cpi*** has a negative and significant effect on ***vol$_{IB}$***, ***vol$_{SB}$***, ***vol$_{MB}$***, ***vol$_{ISB}$***, ***vol$_{UKB}$*** and ***vol$_{GB}$***. This suggests that inflation may erode the purchasing power of a currency, contributing to market turbulence and uncertainty. Interest rates (***ir***) have a negative influence on the exchange rate volatility of the Bangladeshi Taka concerning Singapore, Malaysia, Indonesia, and the United Kingdom, while showing a positive relationship with Germany and the USA. Higher interest rates can attract foreign investment to countries, thereby stabilizing the foreign exchange market and reducing exchange rate volatility. These findings are in line with Schadler [47], Hakkio [22]**,** and Tafa [49]. Conversely, higher interest rates in Bangladesh lead to increased exchange rate volatility with the German Euro and the US dollar, possibly due to capital outflows, heightened borrowing costs, and economic instability.

Interest rates do not show a significant impact on the exchange rate volatility of the Indian Rupee and the Chinese Yuan.

The error correction results presented in **Table 8**, derived from the estimation process following the Vector Error Correction Model (VECM) approach, indicate the speed at which deviations from the equilibrium of the dependent variable are corrected. These discrepancies from the equilibrium state can arise due to various factors, whether included or omitted in the Vector Autoregression (VAR) model. The findings reveal adjustment values of approximately 1.01, 1.35, 0.69, and 0.641 for India, China, Indonesia, and the USA, respectively. These values, which are negative and statistically significant, denote how quickly departures from equilibrium are rectified. Conversely, for Singapore, Malaysia, the United Kingdom, and Germany, the adjustment values are deemed insignificant. This implies that in the short term, variables tend to deviate further from the equilibrium level and may not immediately revert.

Table 8: Analyzing the short-term relationship through VECM estimation

D_vol						D_vol					
Country	**Variable**	**Coef.**	**Std. Err.**	**Z**	$P>\|z\|$	**Country**	**Variable**	**Coef.**	**Std. Err.**	**Z**	$P>\|z\|$
India	L1.	-1.01	0.61	-1.64	0.101	China	L1.	-1.35	0.28	-4.76	0.000
	vol LD.	0.12	0.39	0.31	0.753		vol LD.	-0.09	0.16	-0.53	0.598
	ROA LD.	-0.15	0.45	-0.34	0.735		ROA LD.	-1.44	0.51	-2.83	0.005
	log_fcr LD.	-0.65	0.69	-0.94	0.349		log_fcr LD.	0.23	0.68	0.34	0.735
	log_cpi LD.	-0.61	10.4	-0.06	0.953		log_cpi LD.	9.37	7.61	1.23	0.219
	ir LD.	-0.31	0.47	-0.65	0.513		ir LD.	-0.28	0.38	-0.74	0.458
	_cons	-0.13	0.66	-0.20	0.842		_cons	-0.13	0.55	-0.24	0.808
Singapore	L1.	-229.9	214.3	-1.07	0.283	Malaysia	L1.	-1.58	9.66	-0.16	0.870
	vol LD.	96.8	309.8	0.31	0.755		vol LD.	18.47	58.34	0.32	0.752
	ROA LD.	-0.02	1.03	-0.02	0.984		ROA LD.	0.09	0.34	0.26	0.794
	log_fcr LD.	-3.81	1.71	-2.24	0.025		log_fcr LD.	-0.97	0.58	-1.68	0.092
	log_cpi LD.	2.83	19.71	0.14	0.886		log_cpi LD.	0.24	6.78	0.04	0.971
	ir LD.	0.11	1.03	0.11	0.915		ir LD.	0.09	0.34	0.27	0.783
	cons	0.25	1.41	0.18	0.859		_cons	0.21	0.48	0.45	0.654
Indonesia	L1.	-0.69	0.34	-2.06	0.040	United Kingdom	L1.	-0.003	0.27	-0.01	0.993
	vol LD.	0.007	0.24	0.03	0.978		vol LD. L2D.	-0.198 -0.470	0.332 0.307	-0.60 -1.53	0.551 0.126
	ROA LD.	0.001	0.002	0.37	0.709		ROA LD. L2D.	-0.006 0.002	0.004 0.003	-1.24 0.61	0.213 0.545
	log_fcr LD.	-0.004	0.004	-0.88	0.379		log_fcr LD. L2D.	0.007 -0.004	0.006 0.008	1.10 -0.55	0.273 0.582
	log_cpi LD.	-0.089	0.041	-2.17	0.030		log_cpi LD. L2D.	0.030 -0.169	0.118 0.110	0.26 -1.54	0.797 0.123
	ir LD.	0.004	0.002	1.67	0.095		ir LD. L2D.	0.002 -0.001	0.006 0.004	0.35 -0.22	0.726 0.828
	_cons	0.011	0.003	3.22	0.001		_cons	0.009	0.007	1.30	0.192
Germany	L1.	0.039	0.073	0.53	0.597	USA	L1.	-0.641	0.217	-2.96	0.003
	vol LD. L2D.	-0.558 -0.516	0.307 0.348	-1.82 -1.48	0.069 0.138		vol LD.	-0.171	0.207	-0.83	0.407
	ROA LD. L2D.	-0.002 0.0002	0.007 0.005	-0.24 0.03	0.809 0.977		ROA LD.	0.002	0.001	1.13	0.257

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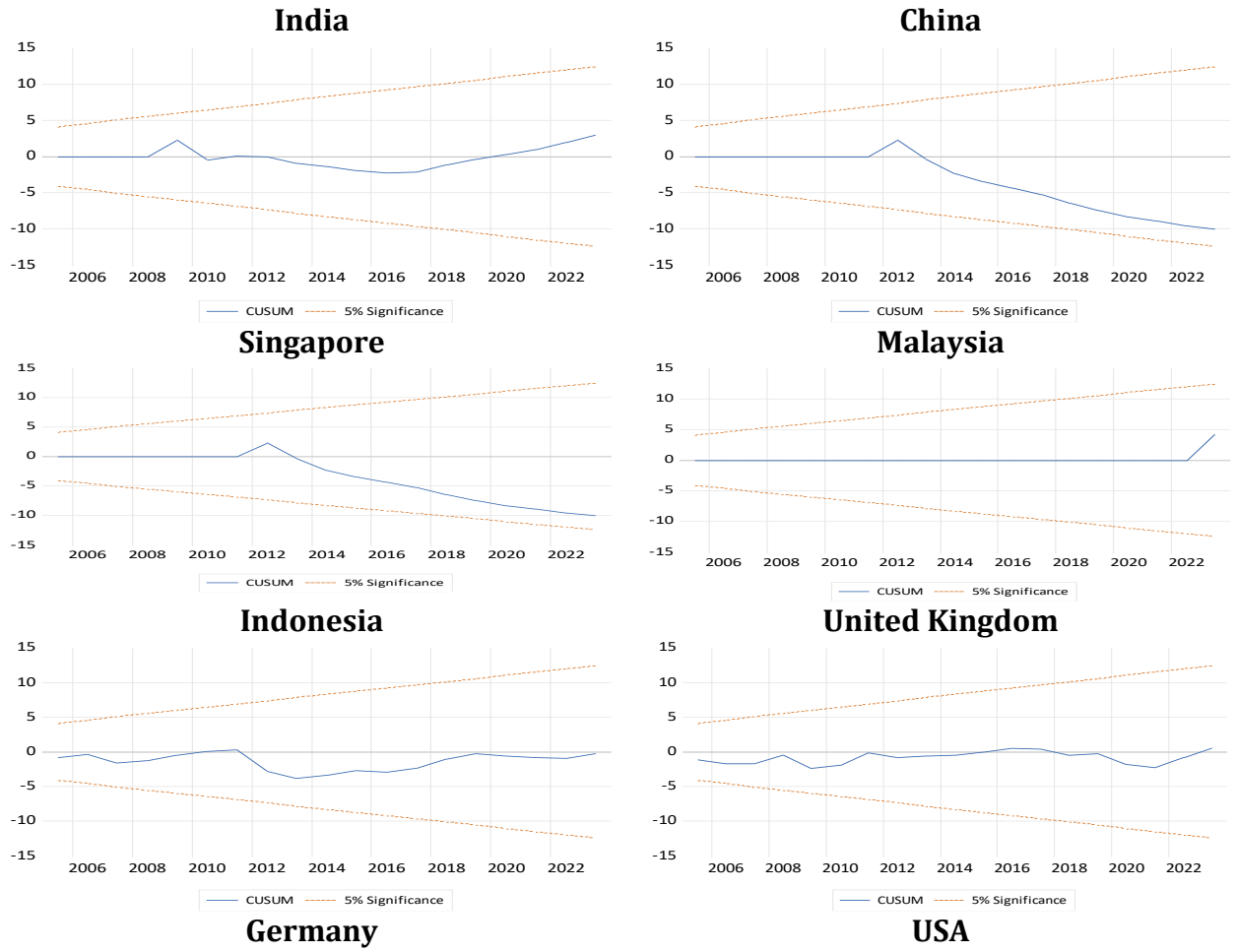
	log_fcr						log_fcr				
	LD.	0.011	0.011	0.98	0.325		LD.	0.005	0.003	1.67	0.095
	L2D.	0.009	0.010	0.88	0.380						
	log_cpi						log_cpi				
	LD.	0.023	0.127	0.18	0.860		LD.	0.07	0.032	2.16	0.031
	L2D.	0.060	0.136	0.44	0.659						
	ir						ir				
	LD.	-0.002	0.009	-0.18	0.856		LD.	-0.0002	0.001	-0.18	0.859
	L2D.	-0.003	0.006	-0.48	0.628						
	_cons	-0.010	0.008	-1.18	0.238		_cons	-0.004	0.002	-1.74	0.082
Source: Author's computation made with STATA 12											

CUSUM Stability Test

CUSUM tests are employed in this work to confirm the calculated model's stability. The results show that, at a significance level of 5%, the "CUSUM" plots are within the critical bounds, indicating model stability.



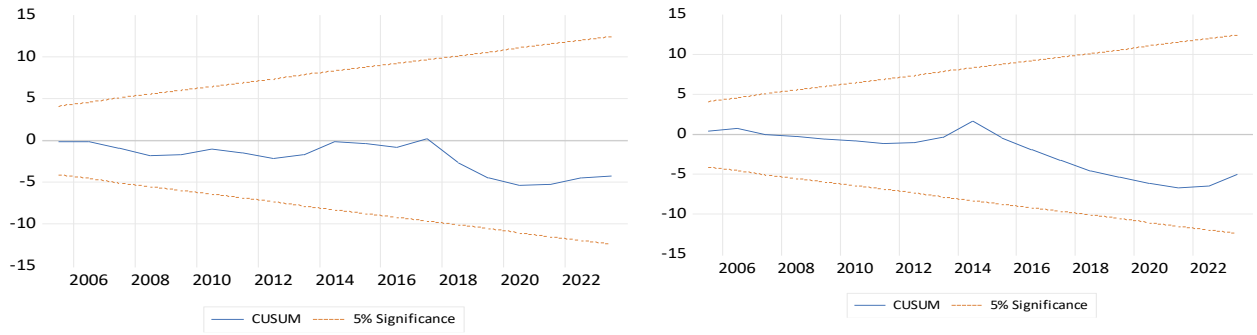


Figure 3: Plot of Cumulative Sum of Recursive Residuals (CUSUM)
Source: Eviews software

CONCLUSION AND RECOMMENDATION

This study explores how banking fraud affects bank's performance and finds that while there is no discernible short-term association, there is a long-term relationship between the factors. The study concludes that factors related to fraud such as the number of fraud instances (***nfca***) and the number of employees handling fraud cases (***nstf***) have a detrimental effect on return on assets (***roa***). The findings suggest that instances of fraud in banks lead to a decline in the proxy variable for bank performance, ***roa***, likely due to factors such as loss of trust, increased operational expenses, credit risks, loan losses, market perception, investor response, and regulatory implications. Interestingly, the total sum involved in fraud incidents (***lntafc***) shows a positive impact on ***roa***, possibly influenced by interest income effects and the banks' cost management systems. It is the reverse situation of the study conducted by Muritala et al. [36]**.** When it comes to fraud incidences, Bangladesh's banking industry seems to handle asset quality and credit risks well enough to maintain a stable and long-term financial performance. This study also explores how banking performance impacts the exchange rate fluctuations of the Bangladeshi currency concerning major trading partners. It reveals that the return on assets, a proxy for banking performance, positively influences the fluctuation of Bangladesh's currency against the Indian Rupee, Chinese Yuan, Singapore Dollar, Malaysian Ringgit, Indonesian Rupiah, and German Euro. However, it has a negative association with the Pound Sterling and shows insignificant effects on the American dollar. The fluctuation of the exchange rate of the Bangladeshi Taka with the Chinese Yuan and the US dollar is adversely affected by foreign currency reserves but positively influenced by the consumer price index. On the other hand, the Indian Rupee, Singapore Dollar, Malaysian Ringgit, Indonesian Rupiah, Pound Sterling, and German Euro are positively impacted by foreign currency reserves and negatively affected by the consumer price index. Interest rates have a negative association with the BDT's exchange rate volatility vs. the US dollar and the German euro, but a positive relationship with the Singapore dollar, Malaysian ringgit, Indonesian rupiah, and the pound sterling. The Indian rupee and Chinese Yuan exhibit insignificant associations with interest rates.

This inquiry offers distinct viewpoints. It recommends that to discourage and prevent fraud and safeguards the nation's assets, the government and the Bangladesh Bank authorities should improve their internal control systems. Additionally, regulatory and supervisory bodies in the banking sector should enhance their oversight by utilizing all available tools to effectively detect and mitigate instances of fraud. It is recommended that the government prioritize enhancing banking performance through the reduction of fraud to better manage exchange rate

URL: http://doi.org/10.14738/abr.1311.19641

volatility with trading partners. The present study is limited to analyzing the impact of the performance of Bangladeshi banks on the exchange rate fluctuations of the Bangladeshi Taka relative to the currencies of eight main trading partners. By examining the connection between the banking performance of Bangladeshi and the exchange rates with a wider range of Bangladesh's trade counterparts; future researchers could broaden the scope of this examination. Comparing the results across different trading partner countries would provide a more comprehensive understanding of these dynamics.

Declarations

Acknowledgments

The authors are grateful to the editor of this journal for their productive and supportive clarification.

Financial support

We do not get any economic support from any authorized, and all expenditures related to developing the article abide by authors only.

Accessibility of data and materials

We are at this moment assured that all relevant information will be disclosed for later use upon future demand.

Author's contribution

All authors have an equal contribution to the survey concept and design of this research work.

Challenging interests

The authors confirm that they are not interested in any competition.

Appendix A

Table A1: All variable's symbols, names, scales, and sources of data collection

SL. No.	Symbol of variables	Variable names	Scale	Source
1	***roa***	Return on Assets	Percentage	Bangladesh Bank Annual Report (2000-20230
2	***nstf***	The number of employees working on fraud cases	Number	Dhaka Tribune; The Daily Star
3	***nfca***	The number of fraud instances	Number	Dhaka Tribune; The Daily Star
4	***lntafc***	The total sum involved in the incidence of fraud (in log form)	Billion Dollar	Bangladesh Bank Annual Report (2000-2023)
5	***exr***	Exchange rate (daily nominal exchange rate)	BDT per currency of selected countries	https://fx-rate.net/historical
6	***ir***	Interest rate (Central Bank Policy Rate)	Percent per Annum	International Monetary Fund
7	***log_fcr***	Foreign currency reserves (in log 8 form)	USD	International Monetary Fund
8	***log_cpi***	Consumer price index (in log form)	Percentage change	International Monetary Fund

9	vol_{IB}	Exchange rate volatility of BDT with Indian Rupee	Unit	Own calculation
10	vol_{CB}	Exchange rate volatility of BDT with Chinese Yuan	„	„
11	vol_{SB}	Exchange rate volatility of BDT with Singapore Dollar	„	„
12	vol_{MB}	Exchange rate volatility of BDT with Malaysian Ringgit	„	„
13	vol_{ISB}	Exchange rate volatility of BDT with Indonesian Rupiah	„	„
14	vol_{UKB}	Exchange rate volatility of BDT with The Pound Sterling	„	„
15	vol_{GB}	Exchange rate volatility of BDT with the German Euro	„	„
16	vol_{USB}	Exchange rate volatility of BDT with US Dollar	„	„

Table A2: Augmented-Dickey Fuller test

Variables	Level				1st Difference				2nd Difference	
	Intercept		Trend and Intercept		Intercept		Trend and Intercept		Intercept	
	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status	ADF-Fisher Chi-square	Status
vol_{IB}	-4.80*	I(0)	-4.75*	I(0)						
vol_{CB}	-4.80*	I(0)	-4.68*	I(0)						
vol_{SB}	-1.09		-2.78		-2.34*	I(1)	0.56	I(1)		
vol_{MB}	-0.56		-0.47		0.25*	I(1)	6.09*	I(1)		
vol_{ISB}	-2.60		-2.61		-5.56*	I(1)	-5.48*	I(1)		
vol_{UKB}	-3.02*	I(0)	-3.23***	I(0)						
vol_{GB}	-2.52		-2.39		-4.75*	I(1)	-5.00*	I(1)		
vol_{USB}	-3.54*	I(0)	-3.52*	I(0)						
roa	-2.37		-2.67		-5.97*	I(1)	-5.88*	I(1)		
ir	-3.38*	I(0)	-3.80*	I(0)						
log_cpi	0.84		-2.65		-3.21*	I(1)	-3.11		-4.97*	I(2)
log_fcr	-1.76		2.51		0.42		-3.68*	I(1)	-3.10*	I(2)
Note: *, **, and *** indicate statistical significance at 1%. 5% and 10%										
Source: Calculated by the author using Eviews										

Table A3: Lag selection from VAR

Country	lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
India	0	-12.86				0.353	1.79	1.83	2.04
	1	-10.96	3.81	1	0.051	0.325	1.69	1.75	1.99
	2	-8.94	**4.03***	1	0.045	**0.297***	**1.59***	**1.66***	**1.94***
	3	-8.91	0.07	1	0.795	0.333	1.69	1.77	2.09
	4	-8.24	1.33	1	0.249	0.352	1.72	1.81	2.17
China	0	-21.93				**0.875***	**2.69***	**2.74***	**2.94***
	1	-21.9	0.07	1	0.794	0.971	2.79	2.85	3.09
	2	-21.82	0.16	1	0.690	1.08	2.88	2.95	3.23
	3	-21.75	0.13	1	0.719	1.20	2.98	3.05	3.37
	4	-21.63	0.24	1	0.623	1.34	3.06	3.15	3.51
Singapore	0	-23.89				1.06	2.89	2.94	**3.14***

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	1	-23.28	1.21	1	0.271	1.12	2.93	2.99	3.23
	2	-21.66	3.25	1	0.071	1.06	2.87	2.93	3.21
	3	-20.98	1.36	1	0.243	1.11	2.90	2.98	3.30
	4	-19.08	3.79	1	0.052	**1.04***	**2.80***	**2.90***	3.26
Malaysia	0	-1.66				**0.115***	**0.666***	**0.714***	**0.92***
	1	-1.6	0.11	1	0.740	0.128	0.76	0.819	1.06
	2	-1.6	0.01	1	0.931	0.143	0.859	0.928	1.21
	3	-1.57	0.06	1	0.807	0.159	0.957	1.03	1.36
	4	-1.36	0.41	1	0.521	0.177	1.04	1.12	1.48
Indonesia	0	97.27				**5.8e-06***	**-9.23***	**-9.18***	**-8.98***
	1	97.32	0.1	1	0.752	6.5e-06	-9.13	-9.07	-8.83
	2	99.27	**3.90***	1	0.048	5.9e-06	-9.23	-9.16	-8.88
	3	99.59	0.63	1	0.427	6.5e-06	-9.159	-9.08	-8.76
	4	100.91	2.65	1	0.104	6.4e-06	-9.19	-9.10	-8.74
United Kingdom	0	89.28				0.000013	-8.43	-8.38	-8.18
	1	91.02	3.49	1	0.062	0.000012	-8.50	-8.44	-8.20
	2	95.77	**9.5***	1	0.002	**8.4e-06***	**-8.88***	**-8.81***	**-8.53***
	3	96.16	0.78	1	0.378	9.1e-06	-8.82	-8.74	-8.42
	4	97.3	2.27	1	0.132	9.2e-06	-8.83	-8.74	-8.38
Germany	0	81.62				0.00003	-7.66	-7.61	-7.41
	1	82.3	1.35	1	0.245	0.00003	-7.63	-7.57	-7.33
	2	83.31	2.03	1	0.155	0.00003	-7.63	-7.56	-7.28
	3	83.4	0.18	1	0.674	0.00003	-7.54	-7.46	-7.14
	4	87.84	**8.87***	1	0.003	**0.00002***	**-7.88***	**-7.80***	**-7.44***
USA	0	92.74				5.8e-06	-9.24	-9.19	-8.99
	1	93.17	0.86	1	0.353	6.2e-06	-9.18	-9.13	-8.88
	2	93.18	0.02	1	0.902	7.0e-06	-9.07	-9.01	-8.72
	3	93.91	1.47	1	0.226	7.3e-06	-9.04	-8.98	-8.65
	4	94.56	1.3	1	0.255	7.8e-06	-9.01	-8.93	-8.56
	5	101.15	**13.19***	1	0.000	**4.5e-06***	**-9.59***	**-9.51***	**-9.10***

Source: Calculated by the author using STATA 12

Table A4: Trace and Max-Eigen statistics

Country	Maximum rank	Eigen statistics	Trace statistic	5% critical value	Eigen statistics	Max-Eigen statistic	5% critical value	Decision
India	0		99.06	68.52		42.03	33.46	None
	1	0.852	57.02	47.21	0.852	25.78	27.07	At most 1
	2	0.69	31.24	29.68	0.69	16.58	20.97	At most 2
	3	0.529	**14.66***	15.41	0.529	**9.92***	14.07	**At most 3***
	4	0.363	4.75	3.76	0.363	4.75	3.76	At most 4
	5	0.194			0.194			At most 5
China	0		97.63	68.52		43.34	33.46	None
	1	0.861	54.3	47.21	0.861	27.28	27.07	At most 1
	2	0.711	**27.02***	29.68	0.711	**13.34***	20.97	**At most 2***
	3	0.455	13.68	15.41	0.455	10.17	14.07	At most 3
	4	0.37	3.51	3.76	0.37	3.51	3.76	At most 4
	5	0.147			0.147			At most 5
Singapore	0		83.03	68.52		32.99	33.46	None
	1	0.777	50.04	47.21	0.777	27.28	27.07	At most 1
	2	0.711	**22.76***	29.68	0.711	**15.41***	20.97	**At most 2***
	3	0.504	7.35	15.41	0.504	6.37	14.07	At most 3
	4	0.252	0.97	3.76	0.252	0.97	3.76	At most 4
	5	0.043			0.043			At most 5
Malaysia	0		75.44	68.52		29.96	33.46	None

	1	0.744	**45.48***	47.21	0.744	**17.95***	27.07	**At most 1***
	2	0.558	27.53	29.68	0.558	15.48	20.97	At most 2
	3	0.505	12.05	15.41	0.505	8.32	14.07	At most 3
	4	0.315	3.73	3.76	0.315	3.73	3.76	At most 4
	5	0.156			0.156			At most 5
Indonesia	0		91.04	68.52		40	33.46	None
	1	0.838	51.03	47.21	0.838	28.91	27.07	At most 1
	2	0.731	**22.12***	29.68	0.731	**11.84***	20.97	**At most 2***
	3	0.416	10.29	15.41	0.416	7.36	14.07	At most 3
	4	0.284	2.93	3.76	0.284	2.93	3.76	At most 4
	5	0.125			0.125			At most 5
United Kingdom	0		75.45	68.52		33.84	33.46	None
	1	0.785	**41.62***	47.21	0.785	**23.77***	27.07	**At most 1***
	2	0.66	17.85	29.68	0.66	9.84	20.97	At most 2
	3	0.361	8.01	15.41	0.361	7.17	14.07	At most 3
	4	0.278	0.84	3.76	0.278	0.84	3.76	At most 4
	5	0.037			0.037			At most 5
Germany	0		89.46	68.52		36.46	33.46	None
	1	0.809	53.01	47.21	0.809	30.79	27.07	At most 1
	2	0.753	**22.22***	29.68	0.753	**15.78***	20.97	**At most 2***
	3	0.512	6.44	15.41	0.512	5.61	14.07	At most 3
	4	0.225	0.83	3.76	0.225	0.83	3.76	At most 4
	5	0.037			0.037			At most 5
USA	0		77.83	68.52		46.67	33.46	None
	1	0.869	**31.16***	47.21	0.869	**18.9***	27.07	**At most 1***
	2	0.56	12.26	29.68	0.56	7.4	20.97	At most 2
	3	0.275	4.86	15.41	0.275	4.81	14.07	At most 3
	4	0.189	0.04	3.76	0.189	0.04	3.76	At most 4
	5	0.002			0.002			At most 5

Source: Calculated by the author using STATA 12

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