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DEMOGRAPHIC PROFILES OF E-COMMERCE USERS: A REGIONAL AND GLOBAL PERSPECTIVE ON DIYARBAKIR, TURKIYE

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ABSTRACT

Purpose- e-Commerce has become a cornerstone of economic activity in the digital age. While demographic influences on e-commerce behavior have been widely studied globally, their manifestation in developing regions remains underexplored. This study examines the impact of demographic variables, particularly age and gender, on e-commerce participation in Diyarbakir to highlight the region-specific challenges and opportunities in digital consumer behavior.

Methodology- A cross-sectional quantitative approach was employed, surveying 675 participants in Diyarbakir. The sample size was determined using Cochran's (1952) formula to ensure representativeness. Non-parametric statistical analyses, including the Chi-Square (χ^2) test and Cramér's V effect size, were utilized. The study's reliability was supported by a 100% response rate and a Cronbach's Alpha of 0.91. Ethical compliance was ensured through informed consent and data confidentiality measures.

Findings- The gender distribution of e-commerce users aligns with national trends, yet age-based differences are pronounced. Individuals aged 18–24 exhibit high engagement, whereas those 45 and older demonstrate limited participation due to the digital divide. Additionally, cultural norms and regional economic conditions significantly influence online shopping behavior. These findings highlight the need for localized digital inclusion strategies to bridge demographic disparities in e-commerce participation.

Conclusion- This study underscores the role of demographic factors in shaping regional e-commerce behavior. While younger consumers are active digital shoppers, older demographics face barriers related to digital literacy and access. Practical recommendations are provided for policymakers, businesses, and digital marketers to enhance e-commerce adoption in developing regions. Future research should examine additional socioeconomic factors and adopt longitudinal methods to assess the long-term impact of digital transformation on consumer demographics.

Keywords: e-Commerce, demographic factors, digital divide, age and gender analysis, regional e-commerce usage
JEL Codes: L81, O33, R11

1. INTRODUCTION

The rapid expansion of digital commerce has fundamentally reshaped global economic structures, enabling businesses to transcend geographical barriers and consumers to access products and services with unprecedented convenience (Kotler & Keller, 2016). While e-commerce adoption continues to surge in both developed and developing economies, the rate and extent of this transformation remain highly uneven across different regions. These disparities are largely influenced by socioeconomic conditions, digital infrastructure, and cultural norms, leading to significant variations in consumer behavior (Norris, 2001; Van Dijk, 2020). Although numerous studies have examined e-commerce demographics at national and global scales, localized research that explores regional differences remains scarce, leaving important gaps in the understanding of demographic influences on digital consumer behavior.

Diyarbakir presents a compelling case for investigating these regional dynamics. The city's distinct demographic structure, coupled with infrastructural limitations and digital literacy challenges, poses notable barriers to e-commerce adoption. Additionally, gender-based disparities in internet access and technology usage further shape online shopping behaviors, yet the interaction of these demographic factors within regional e-commerce ecosystems remains largely unexplored (UN Women, 2022a). To address this critical gap, this study delves into the role of age and gender in shaping e-commerce participation in Diyarbakir, contextualizing these findings within national and global frameworks.

A quantitative research design was employed, drawing on survey data collected from 675 participants. The study investigates key aspects such as digital literacy levels, purchasing preferences, and the influence of socioeconomic conditions on consumer

decisions. By comparing local findings with national data (e.g., Turkish Statistical Institute) and international reports (e.g., OECD, UN Women), this research aims to uncover the strategic significance of demographic factors in e-commerce adoption. The insights generated are expected to inform both academic discourse and practical applications, offering actionable recommendations for businesses, policymakers, and digital commerce strategists.

The remainder of this article is structured as follows: First, a comprehensive literature review examines previous research on e-commerce demographics, with particular attention to the digital divide and gender-based disparities. Next, the methodology section details the research framework, including survey design, sampling strategy, and statistical analysis techniques. The findings and discussion section then presents empirical insights, comparing local patterns with national and global trends. Finally, the study concludes by summarizing key findings and proposing strategic recommendations aimed at enhancing digital commerce accessibility and inclusivity.

Ultimately, this research provides a nuanced perspective on the demographic dimensions of e-commerce adoption, offering valuable insights that can contribute to both regional policy formulation and global discussions on digital consumer behavior.

2. LITERATURE REVIEW

This study explores the strategic significance of age and gender variables within the e-commerce ecosystem, specifically within the context of Diyarbakir, while drawing attention to existing gaps in literature.

2.1. The e-Commerce Ecosystem and Digitalization

Kotler and Keller (2016) highlight that e-commerce has gained substantial traction in global trade, with digitalization serving as a pivotal driver of this transformation. Reports from the OECD (2023a) further assert that e-commerce has evolved into one of the core components of economic activities. In developing economies, investments in digital infrastructure, coupled with the proliferation of online shopping platforms, are fundamentally reshaping consumer behavior (Statista, 2024b; ITU, 2022).

Arslan Dinç & Karabıyık (2023), in their study on the dynamics of the e-commerce ecosystem, assert that age, gender, income level, and cultural factors constitute the primary determinants of online consumer behavior. The literature consistently underscores the critical influence of age and gender variables on consumer habits and the strategic targeting approaches of e-commerce platforms (Güler Binkanat & Duygun, 2023; Norris, 2001).

2.2. Impact of Demographic Factors on e-Commerce Usage

Demographic factors have long been recognized as key determinants of e-commerce adoption. Various studies indicate that age and gender, digital literacy, and socio-economic status significantly influence consumers' propensity to engage in online shopping.

2.2.1. Age Factor

Prensky (2001) introduced the concept of "digital natives," emphasizing the innate technological affinity of younger users and their accelerated adaptation to online platforms. The literature consistently identifies the 18-24 and 25-34 age groups as the most dominant among e-commerce users (Statista, 2024a; Republic of Türkiye Ministry of Trade, 2024b). Van Dijk (2020) asserts that the technological adaptability and high mobile device usage within these age cohorts significantly enhance their online shopping behaviors.

Conversely, the integration of older age groups (45 and above) into digitalization is demonstrably slower. Van Deursen and Van Dijk (2019) explain this through the "digital divide" concept, highlighting how technological literacy barriers, entrenched habits, and trust deficits constrain online shopping engagement in this demographic. Data from the Turkish Statistical Institute (TÜİK, 2024b) corroborates these findings, revealing limited participation in the digital economy among older populations in Türkiye.

2.2.2. Gender Factor

Kotler and Keller (2016) emphasize that gender is a pivotal determinant of consumer behavior, with female users exhibiting heightened online shopping tendencies in sectors such as fashion, cosmetics, and healthcare. Grewal, Roggeveen, and Nordfält (2017) further assert that these preferences have driven the development of targeted digital marketing strategies specifically tailored for female consumers.

However, reports from UN Women (2022e) and the OECD (2023b) underscore that women in developing regions face lower levels of access to digital platforms compared to men, a disparity commonly referred to as the "digital gender divide." TÜİK (2024b), within the Turkish context, acknowledges an increase in internet usage among women but also highlights persistent regional discrepancies in gender parity on e-commerce platforms.

2.3. e-Commerce in Türkiye and Regional Disparities

In recent years, the e-commerce sector in Türkiye has experienced rapid growth. According to the Republic of Türkiye Ministry of Trade (2024b), online shopping volumes have surged in major metropolitan areas such as Istanbul, Ankara, and Izmir, largely driven by the expansion of diverse payment methods—including credit cards, mobile payments, and cash on delivery. In contrast, the Eastern and Southeastern Anatolia regions face challenges related to limited digital infrastructure and lower levels of digital literacy, factors that hinder broader e-commerce adoption. Furthermore, research focusing on Diyarbakir demonstrates that the participation of younger demographics in the e-commerce ecosystem is comparable to -or even exceeds- the national average. In addition, Van Dijk (2020) emphasizes that societal gender dynamics are pivotal in shaping digital economic participation; notably, the more balanced female-to-male ratio among e-commerce users in Diyarbakir serves as an encouraging indicator of gender equality in the digital sphere.

2.4. Addressing Gaps in the Literature: The Regional Context of E-Commerce and the Case of Diyarbakir

Existing literature extensively explores e-commerce adoption within the framework of demographic differences, with particular emphasis on variables such as age, gender, digital literacy, and socioeconomic status (Kotler & Keller, 2016; Van Dijk, 2020). However, a significant gap remains concerning regionally focused studies, particularly those examining how digital inequalities manifest in specific geographic and socioeconomic contexts. While extensive research has been conducted at national and global scales, empirical investigations at the regional level remain scarce, leaving critical questions unanswered regarding the intersection of e-commerce engagement and localized demographic structures (Norris, 2001; OECD, 2023).

One of the key challenges identified in previous studies relates to the impact of regional disparities on the effectiveness of digital inclusion policies. Norris (2001) argues that structural inequalities among different regions hinder the success of digital divide interventions, limiting the potential of initiatives aimed at fostering universal access to e-commerce platforms. Similarly, Van Dijk (2020) emphasizes that global efforts promoting gender equality in digital spaces often fail to account for region-specific socioeconomic and infrastructural challenges, particularly in rural and economically disadvantaged areas.

Diyarbakir represents a compelling case study in addressing these gaps in the literature. As a city characterized by a predominantly young population, a developing digital infrastructure, and distinct socioeconomic patterns, it presents a unique opportunity to examine how demographic factors influence e-commerce participation at a regional level. Despite its potential for digital market expansion, persistent gender-based disparities in online participation and the generational digital divide remain underexplored in this context. Existing research has primarily focused on Türkiye's major metropolitan areas, neglecting the nuanced regional differences that shape digital consumer behavior in developing cities (Republic of Türkiye Ministry of Trade, 2024; TÜİK, 2024).

By conducting an empirical analysis of e-commerce engagement in Diyarbakir, this study aims to bridge the existing knowledge gap by providing a comparative perspective that situates the region within both national and global discussions on digital commerce adoption. Investigating the differential impact of age and gender on online consumer behavior in a developing regional context contributes to a broader understanding of digital inclusivity and market accessibility, offering critical insights for policymakers, businesses, and scholars engaged in e-commerce expansion strategies.

2.5. The Positioning and Original Contribution of This Research

This study seeks to provide a significant academic contribution by examining age and gender-based disparities in e-commerce participation within a regional framework, thereby expanding discussions on digital inclusivity and market access in emerging economies. Unlike previous studies that primarily focus on aggregated national-level data, this research adopts a granular approach by situating Diyarbakir within a broader regional and international comparative context.

By employing a systematic literature review methodology, as proposed by Webster and Watson (2002), this study integrates theoretical and empirical perspectives to offer a comprehensive examination of regional e-commerce engagement. The findings contribute to both national and international discussions on digital transformation by elucidating the underlying socioeconomic and infrastructural determinants that shape e-commerce adoption in developing urban areas.

Furthermore, the study enhances existing literature by presenting an analytical framework that explores the intersection of digital consumer behavior and regional inequalities. By emphasizing localized e-commerce participation trends and their implications for digital policy interventions, this research enriches the academic discourse on technological accessibility, market development, and digital gender equity. The insights derived from this analysis hold significant implications not only for academic scholarships but also for business practitioners, governmental organizations, and digital commerce policymakers seeking to design region-specific strategies that foster inclusive digital market participation.

3. STRATEGIC IMPORTANCE OF AGE AND GENDER DATA IN THE E-COMMERCE ECOSYSTEM

Age and gender are fundamental demographic factors shaping consumer behavior and market strategies in the e-commerce ecosystem (Bryman, 2016). Understanding these variables enables businesses, policymakers, and researchers to develop targeted strategies that enhance digital commerce accessibility and engagement. This study, conducted in the context of Diyarbakir, provides insights into how these demographic factors influence online shopping behaviors and how local patterns compare with national and global trends.

3.1. Implications for Businesses and Investors

For e-commerce companies, age and gender play a crucial role in shaping consumer preferences and purchasing behavior (Kotler & Keller, 2016). Younger consumers tend to favor technology-oriented products and social media-driven marketing, whereas gender differences influence category preferences, such as fashion and personal care products being more appealing to female consumers. Understanding these dynamics allows businesses to develop personalized marketing strategies, optimize product segmentation, and implement region-specific promotional campaigns (Grewal et al., 2017).

From an investment perspective, demographic insights are essential for assessing market potential (Taherdoost, 2016). The high proportion of young consumers in Diyarbakir suggests a promising market for mobile applications and digital services. Moreover, analyzing female participation in e-commerce is particularly valuable for industries like fashion, cosmetics, and textiles, where gender-driven demand dynamics influence investment decisions.

3.2. Relevance for Marketing and Public Policy

Marketing agencies utilize demographic segmentation to craft targeted advertisements and promotional strategies (Kotler & Armstrong, 2017). In young consumer-dominated regions like Diyarbakir, digital marketing through social media and influencer partnerships is more effective, whereas traditional advertising may be preferable for older demographics.

Public institutions play a critical role in fostering inclusive digital commerce by addressing gender-based digital literacy gaps and promoting entrepreneurship programs for women (UN Women, 2022a). Policies supporting technological education, microcredit schemes, and digital infrastructure development can enhance participation rates, creating a more balanced and inclusive e-commerce landscape.

3.3. Contributions to Academic Research and Competitive Analysis

Academically, studying the interplay between demographic factors and e-commerce behavior provides valuable insights into the digital economy (Van Dijk, 2020). Comparative analyses between Diyarbakir and global patterns allow researchers to identify regional adaptations and structural barriers influencing online shopping habits.

For businesses, competitive analysis based on age and gender segmentation enables firms to refine their market positioning. Identifying underrepresented consumer segments, optimizing localized product offerings, and balancing global and regional market strategies contribute to sustainable competitive advantages.

3.4. Strategic Insights for Logistics and e-Commerce Platforms

The logistics sector benefits from demographic data by optimizing last-mile delivery strategies and inventory management (PwC, 2020). Higher demand for rapid delivery among younger consumers necessitates efficient fulfillment networks, while gender-based purchasing trends influence inventory planning for categories such as electronics, fashion, and personal care.

Large-scale e-commerce platforms rely on demographic monitoring to balance global expansion with local market adaptation. By aligning product diversification with regional consumer needs, companies enhance engagement, strengthen customer loyalty, and achieve higher profitability.

4. DATA AND METHODOLOGY

4.1. Research Design and Methodology

This study was designed as a cross-sectional field study, employing a quantitative research methodology to analyze e-commerce participation in Diyarbakir. Data was collected through a structured survey administered via Google Forms, with responses recorded digitally to ensure systematic data management and reliability. The survey was conducted in person, with participants submitting their answers directly through the online platform under research supervision. The adoption of a quantitative approach was justified by its capacity to quantify e-commerce adoption rates, assess demographic patterns, and evaluate consumer behavior using measurable indicators (Bryman, 2016).

To test the hypotheses formulated for this study, the Chi-Square (χ^2) Goodness-of-Fit Test, a non-parametric statistical method, was employed to determine whether the distribution of e-commerce users in Diyarbakir significantly differed from

national (Türkiye) and global datasets. Cramér's V effect size analysis was also applied to assess the practical significance of observed differences.

4.2. Population and Sampling Procedure

The target population consisted of individuals aged 18 and above residing within Diyarbakir's provincial borders. According to the Turkish Statistical Institute (TÜİK, 2024a), the total population of Diyarbakir is 1,818,133. Given the large population size, the widely recognized Cochran (1952) formula was utilized to determine the minimum required sample size, ensuring statistical representativeness at a 95% confidence level with a ±5% margin of error.

$$\boldsymbol{n} = \frac{z^2 * p * (1-p)}{E^2}$$

where:

z = 1.96 (corresponding to a 95% confidence level)
p = 0.5 (maximum variance assumption when the exact proportion is unknown)
E = ±5% (acceptable margin of error)

Based on this calculation, the minimum required sample size was determined as 384 respondents. However, through face-to-face survey administration, a final sample of 675 participants was successfully reached, exceeding the minimum statistical threshold and enhancing the study's statistical power and external validity.

The demographic structure of the sample was carefully designed to closely reflect Diyarbakir's actual population composition. The gender distribution within the sample was 51.1% male and 48.9% female, aligning closely with official statistics reported by TÜİK (50.55% male, 49.45% female) (Turkish Statistical Institute [TÜİK], 2024a; Hizmetix, 2024). Similarly, efforts were made to ensure that the age distribution of respondents adequately represented the broader population, thereby reinforcing the generalizability of the findings.

4.3. Data Collection Process and Survey Instrument

Data collection was conducted over a 60-day period across multiple locations in Diyarbakir. The survey was conducted in person to ensure participant engagement and clarity in responses. The self-reporting nature of the survey facilitated a 100% response rate, which was achieved through clear instructions provided to participants and the interactive nature of face-to-face administration. To further ensure data integrity, participants were instructed to complete all required fields, thus minimizing missing values and enhancing dataset completeness (Bryman, 2016).

The survey instrument was structured to systematically examine e-commerce adoption patterns, with specific emphasis on demographic factors such as age and gender. The questionnaire comprised two main sections:

a. Demographic Characteristics: This section focused on gender and age distribution, aiming to analyze the sociodemographic composition of e-commerce users in Diyarbakir.

b. Online Shopping Behavior: This section categorized respondents based on their engagement with e-commerce platforms, preferred product categories, and purchasing habits, enabling a comparative evaluation of generational differences.

To assess the statistical significance of demographic trends, detailed frequency and cross-tabulation analyses were performed, with particular emphasis on gender- and age-related variations. The Chi-Square (χ^2) test was applied to evaluate whether the observed distributions in Diyarbakir significantly deviated from national and global e-commerce participation patterns.

4.4. Data Analysis Techniques

The collected data were analyzed using SPSS (Statistical Package for the Social Sciences) version 30.0.0, following a structured sequence of analytical procedures to ensure accuracy and methodological rigor.

Initially, the dataset was examined for inconsistencies and data entry errors through a comprehensive data-cleaning process. Although a 100% response rate was achieved, additional verification measures were implemented to minimize potential inaccuracies (Field, 2018).

To describe the key characteristics of the sample, descriptive statistical measures, including means, standard deviations, and percentage distributions, were calculated to illustrate participants' demographic attributes and e-commerce engagement levels.

To test the study's hypotheses, the Chi-Square (χ^2) Goodness-of-Fit Test was conducted, evaluating whether the gender and age distributions observed in Diyarbakir exhibited statistically significant differences from those at the national and global

levels (Cochran, 1952; Field, 2018). Additionally, Cramér's V effect size analysis was applied to assess the practical implications of the observed statistical variations (Cohen, 1988).

4.5. Reliability and Validity Considerations

The reliability and validity of this study were reinforced by multiple methodological safeguards. The sample size (n = 675), face-to-face survey administration, and 100% response rate collectively contributed to minimizing sampling errors and data incompleteness.

The internal validity of the study was supported by the alignment between the sample's demographic characteristics and Diyarbakir's official population data. Similarly, the external validity was strengthened by ensuring that the age and gender proportions of the sample mirrored broader demographic trends (TÜİK, 2024a).

While the study is geographically focused on Diyarbakir, its findings offer valuable insights that can be applied to cities exhibiting similar demographic and economic characteristics. The research design enables comparative analysis with other developing regions, thereby enhancing the generalizability of key findings beyond Diyarbakir.

4.6. Ethical Compliance and Data Protection Measures

The research process adhered to strict ethical guidelines to ensure participant rights and data confidentiality. The survey was conducted on a voluntary basis, with all participants fully informed about the study's objectives, data usage policies, and privacy safeguards. Participants were explicitly assured that all collected data would be used solely for academic purposes.

Furthermore, informed consent was obtained from each participant before survey administration. The study complied with personal data protection regulations, as stipulated by the Personal Data Protection Authority (KVKK, 2023), ensuring adherence to ethical research standards and participant confidentiality protections.

5. FINDINGS AND DISCUSSIONS

This section presents a comparative analysis of the demographic distribution of e-commerce users in Diyarbakir, focusing on gender and age-based differences. The findings are interpreted within a broader national and global framework to assess regional disparities and their implications for digital commerce participation.

5.1. Gender Distribution and Comparative Analysis

Among the 675 respondents surveyed in Diyarbakir, 51.1% were male and 48.9% were female. A comparison with national e-commerce participation rates in Türkiye indicates that 52.4% of men and 46.6% of women engage in online shopping. These figures suggest that the gender gap in e-commerce participation is narrower in Diyarbakir compared to the national average. The relatively higher proportion of female users in Diyarbakir may indicate improved digital inclusivity and a more balanced gender representation in the region's e-commerce landscape.

Table 1 presents a comparative overview of gender-based internet and e-commerce usage in Diyarbakir, Türkiye, and globally.

Table 1: Gender and Internet Usage Rates in Diyarbakir, Turkiye, and Globally

Data Set	Age Range	Male (%)	Female (%)	Key Findings
e-Commerce Usage in Diyarbakir by Gender	Genel	51,1	48,9	The proportion of female users in Diyarbakir is higher than the national average.
Internet Usage in Türkiye by Gender	16–74	92,2	85,4	Women's access to digital platforms remains lower compared to men.
e-Commerce Participation in Türkiye by Gender	16–74	52,4	46,6	Male participation in e-commerce surpasses that of females.
Global Online Shopping Habits	16–64	-	-	Online product searches: 80%, Online store visits: 90%.

References: Diyarbakır data are derived from a survey conducted on a sample of *n* = 675; internet usage data in Türkiye are sourced from Hizmetix (2024); e-commerce participation data in Türkiye are obtained from MatOnline (2025); global online shopping habits are based on We Are Social & Hootsuite (2020).

The statistical significance of these differences was examined through a Chi-Square (χ^2) test, which yielded a χ^2 value of 0.94, df = 1, $p \approx 0.33$ ($p > 0.05$). These results indicate that the gender distribution of e-commerce users in Diyarbakır does not

differ significantly from the national trend. Furthermore, the Cramér's V value of 0.037 suggests that any observed variation is negligible in practical terms.

These findings demonstrate that female users in Diyarbakir participate in e-commerce at rates comparable to national levels, reinforcing the idea that digital gender inclusivity is gradually improving in the region. Given this balanced distribution, policymakers and digital commerce stakeholders should further promote initiatives that support women's entrepreneurship and digital literacy programs to sustain this positive trajectory.

5.2. Age Distribution and Comparative Analysis

The age distribution of e-commerce users in Diyarbakir reveals a distinctive pattern compared to national and global data. The majority of participants belong to the 18–24 age group, constituting 53.3% of total users, whereas the same cohort accounts for only 19% of global e-commerce users. In contrast, national e-commerce participation trends indicate that the 25–36 age group represents the dominant segment, whereas Diyarbakir exhibits a youth-centric adoption pattern.

Table 2 presents a comparative analysis of age-based e-commerce participation across Diyarbakir, Türkiye, and global benchmarks.

Table 2: Age Range Distribution in Diyarbakir, Türkiye, and Globally

Age Range	Diyarbakir (Percentage)	Türkiye (Overall)	Global (Percentage)
18-24	**53.3**	–	**19**
25-34	**27.7**	The **25-36** age range accounted for **more than half** of the total e-commerce volume.	**33**
35-44	9,9	–	20
45-54	7,7	–	13
55-64	1,3	–	8
65 and over	–	–	4,2
Additional Insights	–	Consumers aged **29** recorded the **highest spending volume**.	–

Note: In the Diyarbakir dataset, the "55 and over" category is grouped as 1.3%.
References: Diyarbakir data are derived from a survey conducted on a sample of *n* = 675; national data are sourced from the Republic of Türkiye Ministry of Trade (2024); global data are obtained from Statista (2024b).

The statistical significance of this divergence was tested using a Chi-Square (χ^2) test, yielding a value of $\chi^2 \approx 534.86$, df = 4, $p < 0.001$, indicating a highly significant difference. Additionally, Cramér's V value of 0.445 suggests a moderate-to-large effect size.

These findings confirm that e-commerce participation in Diyarbakir is heavily concentrated within the younger demographic. While this trend reflects the increasing digital adoption among Generation Z, it also highlights the limited participation of individuals aged 45 and above, who constitute only 9% of the total e-commerce user base. This discrepancy underscores the presence of a digital divide, which may stem from factors such as technological literacy barriers, access limitations, and generational preferences for traditional shopping methods.

5.3. Implications and Strategic Considerations

The findings from this study reveal significant insights into e-commerce adoption patterns in Diyarbakir, particularly concerning gender and age-based differences. While the gender gap in e-commerce participation appears to be narrowing, digital disparities among different age groups remain prominent.

To enhance digital inclusivity and increase e-commerce engagement among underrepresented demographics, several strategic actions should be considered:

- **Targeted Digital Literacy Programs:** The low representation of older age groups in e-commerce suggests a need for educational initiatives aimed at improving technological proficiency and digital confidence among middle-aged and senior consumers.

- **Youth-Oriented Digital Commerce Strategies:** Given the high proportion of young consumers in Diyarbakir, e-commerce businesses should prioritize social media-driven marketing campaigns, influencer collaborations, and mobile-friendly interfaces to cater to this demographic.
- **Gender-Specific Digital Support Policies:** The relatively high proportion of female e-commerce users in Diyarbakir presents an opportunity to further empower women through entrepreneurship programs, financial inclusion policies, and female-focused digital marketing strategies.
- **Bridging the Regional Digital Divide:** The substantial difference between Diyarbakir's e-commerce user demographics and global patterns indicates the need for localized policy interventions to ensure a more balanced and inclusive digital transformation in developing regions.

These insights provide a foundation for future research on digital commerce adoption, particularly in regions exhibiting socioeconomic and infrastructural disparities. Subsequent studies could explore psychological and behavioral motivations influencing consumer participation, as well as the role of emerging digital payment systems and logistics infrastructure in shaping e-commerce engagement across diverse demographics.

6. CONCLUSION AND IMPLICATIONS

This study examined the strategic significance of age and gender variables within the e-commerce ecosystem, focusing on Diyarbakir and contextualizing its findings within national and global trends. The increasing importance of e-commerce in the digital economy and its transformative effects on consumer behavior necessitate a deeper understanding of demographic factors (Kotler & Keller, 2016; Republic of Türkiye Ministry of Trade, 2024a).

By conducting a comparative analysis between regional, national, and global datasets, this research provided empirical insights into how demographic characteristics influence e-commerce adoption. Additionally, it offered strategic recommendations for policymakers, businesses, and academia, contributing to both theoretical and practical discussions on digital market inclusivity.

6.1. Key Findings

A comprehensive review of the literature confirmed that e-commerce is continuously expanding its share in global trade, with digitalization playing a pivotal role in shaping consumer behavior (Statista, 2023; UNCTAD, 2023). However, significant variations persist in adoption rates based on age, gender, and regional digital infrastructure.

The findings of this study indicate that younger individuals (18–34 years old) are the dominant participants in e-commerce, whereas digital engagement among older adults (45 and above) remains limited due to factors such as technological literacy barriers and access limitations (Prensky, 2001; Van Deursen & Van Dijk, 2019). Gender-based disparities also persist, particularly in developing regions, where women face structural challenges in accessing digital platforms (UN Women, 2022a). Nevertheless, in certain sectors, female consumers have reached or even surpassed male users, highlighting the evolving nature of digital commerce (Kotler & Keller, 2016).

The empirical analysis conducted in Diyarbakir revealed notable similarities and differences with national and global patterns. The gender distribution of e-commerce users in Diyarbakir closely aligns with national averages, suggesting a positive outlook for digital gender equality in the region. However, significant discrepancies emerged in age-based participation, with 53.3% of Diyarbakir's e-commerce users belonging to the 18–24 age group, a rate substantially higher than the global average of 19%. This reflects the increasing role of young consumers in driving digital commerce in emerging regions. The statistical tests confirmed that these differences were highly significant ($p < 0.001$), reinforcing the need for targeted policy interventions to address generational gaps in e-commerce participation.

6.2. Strategic Implications

The results of this study provide valuable insights for multiple stakeholders, including businesses, investors, policymakers, and academic researchers. Understanding demographic influences on digital commerce can inform policy design, market strategies, and consumer engagement initiatives, particularly in regions with evolving digital landscapes.

For e-commerce businesses, considering age and gender differences is essential for developing personalized marketing campaigns and optimizing product recommendations based on consumer preferences (Güler Binkanat & Duygun, 2023). In regions like Diyarbakir, where young consumers dominate the e-commerce landscape, companies should prioritize social media-driven marketing, influencer collaborations, and mobile application-based commerce strategies to maximize user engagement. Furthermore, adapting marketing approaches to regional cultural norms and consumer habits can enhance customer loyalty and drive sustained growth.

For investors, regions with a predominantly young population present high-growth opportunities for mobile-based digital ventures. Additionally, supporting women's entrepreneurship in e-commerce-related sectors, such as fashion, cosmetics, and healthcare, can contribute to both financial returns and gender equality in the digital economy. The rapid expansion of digital commerce in developing urban centers like Diyarbakir also creates new investment opportunities in logistics, warehouse management, and local product commercialization, strengthening the regional entrepreneurial ecosystem.

For marketing agencies, tailoring age- and gender-specific digital campaigns will enhance engagement, particularly through platforms popular among younger users, such as Instagram and TikTok (Kotler & Keller, 2016). Advertising strategies that incorporate local cultural elements and linguistic nuances can foster stronger emotional connections with consumers, ultimately enhancing brand recognition and customer retention.

For academic researchers, this study highlights the need for further investigation into regional e-commerce dynamics, particularly in underrepresented areas like Eastern and Southeastern Anatolia. Understanding the sociocultural and infrastructural determinants of e-commerce adoption is crucial for developing more inclusive digital policies. Additionally, qualitative and quantitative research on gender-based digital participation could provide deeper insights into the structural barriers limiting women's access to e-commerce (UN Women, 2022b).

For public institutions, implementing digital literacy programs tailored for older adults and women could help mitigate disparities in e-commerce participation (Van Deursen & Van Dijk, 2019). Expanding internet accessibility and digital infrastructure in emerging urban centers like Diyarbakir would also create a sustainable foundation for e-commerce growth. Microcredit schemes, grants, and entrepreneurial training programs targeting women could further enhance gender inclusivity in the digital economy.

For logistics and educational institutions, improving last-mile delivery networks and fast shipping options is essential for meeting consumer expectations, particularly among young users accustomed to instant gratification (PwC, 2020). Universities and vocational schools should integrate e-commerce, digital marketing, and logistics education into their curricula to equip future professionals with the necessary skills to thrive in a rapidly evolving digital economy.

6.3. Limitations and Future Research Directions

Despite its contributions, this study presents several methodological limitations. The research primarily focused on age and gender variables, without extensively considering socioeconomic status, occupational background, and internet accessibility, which could further enrich the understanding of regional digital commerce. Additionally, the classification of participants aged 55 and above into a single category may have oversimplified the complexity of digital adaptation among older populations. Future studies should consider more granular age segmentation to assess behavioral differences across senior users.

Furthermore, methodological differences between global and regional datasets could introduce comparability biases when interpreting statistical trends. Employing advanced statistical techniques, such as regression models or Structural Equation Modeling (SEM), could enhance the depth of future research.

Potential areas for future studies include longitudinal research on digital adaptation trends, the impact of emerging payment technologies, and the role of AI-driven recommendation systems in shaping e-commerce behavior. Additionally, comparative analyses across different cities in Türkiye and similar urban centers globally could provide broader insights into the regional determinants of e-commerce participation.

6.4. Concluding Remarks

This study contributes to the growing body of literature on digital commerce adoption by offering an empirical examination of demographic influences on e-commerce participation in a developing region. The findings underscore the pivotal role of young consumers in driving digital market expansion, while also highlighting persistent generational and gender-related disparities. The insights derived from this research provide practical recommendations for businesses, policymakers, and academics, facilitating more inclusive and effective strategies for e-commerce development in emerging economies.

6.5. Overall Evaluation

This research has made multidimensional contributions to both academic literature and practical stakeholders by highlighting the strategic importance of age and gender variables within the e-commerce ecosystem, particularly in the context of Diyarbakir. The findings indicate that Diyarbakir exhibits a distinctive user profile, partially diverging from national and global trends due to its young population-driven e-commerce engagement and relatively balanced gender distribution. This outcome underscores the critical role of localized e-commerce and digital marketing strategies, emphasizing the necessity of integrating demographic insights into business models and policy frameworks to enhance consumer engagement and regional economic development.

However, this study is not without its methodological limitations. To enhance the robustness and generalizability of findings, future research should incorporate larger samples, employ advanced statistical techniques, and utilize longitudinal data analysis. Such methodological advancements would allow for a more precise examination of digital divide and digital gender divide dynamics in regions like Diyarbakir, while also providing a strong empirical foundation for policy development and industry applications.

Ultimately, academic research on e-commerce and digital transformation serves as a crucial bridge between local realities and global trends, fostering the development of a sustainable, inclusive, and competitive digital economy. This study, specifically conducted in Diyarbakir, has the potential to act as a reference point for future investigations, particularly in the context of emerging economies and regional digitalization processes. Accordingly, it is expected that subsequent studies will generate more comprehensive and in-depth insights into the demographic dimensions of e-commerce, thereby contributing substantially to both the academic field and the strategic advancements of the digital commerce industry.

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APPENDICES: The State of e-Commerce in Diyarbakir: A Study on User Behavior, Preferences, and Challenges

APPENDIX 1: Survey Questions

1. What is your gender?

a. Male
b. Female

2. What is your age group?

a. 18–24
b. 25–34
c. 35–44
d. 45–54
e. 55 and above

3. What is your level of education?

a. Primary education
b. Secondary education
c. Higher education (undergraduate degree)
d. Master's degree
e. Doctoral degree

4. What is your occupation?

a. Entrepreneur/Business Owner
b. Homemaker
c. Freelancer
d. Academician
e. Healthcare Professional (Doctor, Pharmacist, Nurse, etc.)
f. Education Sector Employee (Teacher, Educational Consultant, etc.)
g. University Student
h. Secondary Education Student
i. Technician
j. Engineer
k. Engaged in Agriculture and Animal Husbandry
l. Public/Civil Servant
m. Private Sector Employee
n. Unemployed Retiree
o. Employed Retiree
p. Job Seeker/Currently Unemployed
q. Other...

5. What is your average monthly income?

a. Below 2,000 ₺
b. 2,000–5,000 ₺
c. 5,000–10,000 ₺
d. 10,000–20,000 ₺
e. Above 20,000 ₺
f. I do not have a personal income; I rely on family or external financial support

6. How frequently do you use e-commerce platforms?

a. Daily
b. Several times a week
c. Several times a month
d. Rarely
e. Never

7. What types of products do you typically purchase from e-commerce platforms?

a. Clothing and accessories
b. Electronic devices
c. Food and grocery shopping
d. Books and stationery
e. Healthcare and personal care products

8. Which payment method do you prefer for e-commerce transactions?

a. Credit card
b. Debit card
c. Bank transfer/EFT
d. Cash on delivery
e. Digital wallet

9. Which e-commerce platforms do you use most frequently?

a. Local e-commerce platforms
b. National e-commerce platforms
c. International e-commerce platforms

10. Which device do you primarily use for online shopping?

a. Desktop computer
b. Laptop
c. Tablet
d. Smartphone

11. How satisfied are you with finding the products you seek on e-commerce platforms?

a. Very satisfied
b. Satisfied
c. Neutral
d. Dissatisfied
e. Very dissatisfied

12. Are you satisfied with the delivery process of purchased products?

a. Very satisfied
b. Satisfied
c. Neutral
d. Dissatisfied
e. Very dissatisfied

13. Have you ever encountered technical issues while using e-commerce platforms?

a. Yes
b. No

14. Have you ever contacted customer service for assistance on an e-commerce platform?

a. Yes
b. No

15. How satisfied are you with the customer service experience provided by e-commerce platforms?

a. Very satisfied
b. Satisfied
c. Neutral
d. Dissatisfied
e. Very dissatisfied

16. Do you have security concerns regarding e-commerce platforms?

a. Yes
b. No

17. Do you take advantage of discounts and promotional campaigns on e-commerce platforms?

a. Yes
b. No

18. How would you rate the ease of use of e-commerce platforms?

a. Very easy
b. Easy
c. Neutral
d. Difficult
e. Very difficult

19. What improvements do you think are necessary for the advancement of e-commerce in Diyarbakir?

a. Faster delivery options
b. Greater availability of local sellers and product diversity
c. More secure payment methods
d. Improvement in customer service
e. More user-friendly websites and mobile applications
f. Other

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THE GLOBAL RISE OF NEOBANKS AND CHALLENGER BANKS: DISRUPTION IN THE BANKING SECTOR

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ABSTRACT

Purpose- This paper explores the rise of neobanks and challenger banks, analysing their transformative impact on the traditional banking sector. It argues these technology-driven entities reshape financial services through efficient, customer-centric solutions meeting modern consumer preferences.

Methodology-The study employs a qualitative research approach via a comprehensive literature review, examining academic articles, industry reports, and case studies.

Findings- Findings reveal a significant shift towards digital banking, driven by historical context, technological advancements (like mobile banking, AI, open banking APIs), and changing consumer behavior favouring convenience, transparency, cost-effectiveness, and personalization. Detailed case studies of neobanks like Revolut, Chime, and Nubank illustrate successful strategies disrupting traditional norms. These banks leverage technology for lower fees, enhanced user experience, and financial inclusion. The analysis highlights the pressure on traditional banks to innovate and adapt amidst this digital transformation.

Conclusion- Neobanks and challenger banks represent a fundamental shift, compelling traditional institutions to embrace digital transformation to remain competitive. The paper underscores the need for adaptation and addresses the regulatory challenges posed by these emerging financial players.

Keywords: Neobanks, challenger banks, digital banking, fintech, financial innovation, banking disruption, consumer behavior.
JEL Codes: G21,O33, D12

1.INTRODUCTION

Neobanks and challenger banks are revolutionizing the provision of financial services by leveraging technology to create innovative solutions that cater to the evolving needs of consumers and businesses. Unlike traditional banks, which rely heavily on physical branches and legacy systems, neobanks and challenger banks primarily operate online, utilizing digital platforms to offer a wide array of financial services. This shift towards digital banking signifies a significant transformation in how individuals and businesses manage their finances, reflecting a broader trend of embracing technology in all aspects of life.

These new banking entities are compelling traditional banks to innovate and rethink their strategies to retain their customer base. Neobanks and challenger banks are at the forefront of this innovation, demonstrating that technology can create more efficient and customer-centric banking experiences. As society increasingly relies on digital solutions, the banking sector must adapt to meet the preferences of a new generation of consumers who value convenience, speed, and accessibility. The significance of this topic lies in its ability to illustrate how neobanks and challenger banks are reshaping the financial landscape.

Neobanks and challenger banks focus on enhancing the customer experience by eliminating bureaucratic hurdles, reducing fees, and offering personalized financial management tools. They provide services such as checking and savings accounts, payment processing, and investment options, all accessible via mobile apps or websites. Neobanks operate entirely online without physical branches, offering a modern alternative to traditional banking. To understand their impact, it is essential to define these institutions and explore how they differ from traditional banks. While challenger banks may have a physical presence, they typically operate with a modern and agile approach, setting them apart from traditional banks.

Traditional banks often face challenges such as outdated systems, high compliance costs, and limited agility in adapting to market changes. This paper argues that neobanks and challenger banks are disrupting the banking industry by using technology to offer more efficient and customer-focused services. Built on technological foundations, these new banking entities can quickly respond to market trends and consumer needs, challenging the core nature of banking itself.

The rise of mobile banking applications has significantly increased the number of people banking online, creating a favorable environment for neobanks and challenger banks to flourish. The proliferation of smartphones and high-speed internet has made it easier for consumers to access banking services anytime and anywhere. According to a report from Statista, there were over 3 billion smartphone users worldwide as of 2021, and this number is expected to grow. Recent advancements in artificial intelligence (AI) and machine learning have enabled these banks to offer more personalized services, better predictions, and improved customer support, enhancing the overall user experience.

The COVID-19 pandemic accelerated the shift towards digital banking solutions. As lockdowns and social distancing measures were implemented globally, many consumers had to rely on online banking services, while traditional banks struggled to adapt to this sudden change. In contrast, neobanks and challenger banks were well-equipped to handle the surge in digital transactions, allowing them to capture a larger market share. A McKinsey (2020) report highlights that the pandemic significantly altered consumer behavior, with many now preferring digital banking options over traditional in-person services. This shift underscores the growing importance of neobanks and challenger banks in the financial landscape.

A crucial factor in the rise of neobanks and challenger banks is their ability to serve typically underserved populations. Traditional banks have often been criticized for their limited inclusivity, as many individuals face barriers to accessing financial services due to factors such as credit history, location, or socio-economic status. Neobanks and challenger banks have emerged as viable alternatives, offering services that cater to individuals who may have been overlooked by traditional banks. For instance, many neobanks have adopted more lenient credit assessment policies, allowing individuals with limited credit histories to open accounts and access financial products. By providing accessible banking solutions, these institutions are driving financial inclusion and expanding their customer base.

In addition to being more inclusive, neobanks and challenger banks are known for their transparent fee structures. Many consumers find it challenging to understand the numerous fees imposed by traditional banks. In contrast, neobanks and challenger banks often adopt a straightforward approach, with clearly outlined fees that enhance customer trust and satisfaction. Younger consumers, wary of hidden fees and complex financial products, find this transparency particularly appealing. By prioritizing transparency, neobanks and challenger banks position themselves as trustworthy alternatives to traditional banks, driving their adoption among consumers.

The rise of neobanks and challenger banks poses a significant threat to traditional banks, which are now investing in enhancing their digital capabilities. Many established banks have launched digital-only subsidiaries to compete with neobanks, while others are partnering with fintech companies to improve their service offerings. This response demonstrates how the disruption caused by neobanks and challenger banks is forcing traditional banks to rethink their strategies and embrace digital transformation.

As the banking industry continues to evolve, traditional banks must adapt and innovate to remain competitive in this rapidly changing environment. The subsequent sections of this paper will explore the historical context and technological advancements that have facilitated the rise of neobanks and challenger banks. Additionally, the paper will examine consumer behavior and market dynamics driving their adoption. By leveraging technology to offer innovative, customer-centric services, neobanks and challenger banks are reshaping the financial landscape and disrupting traditional banking practices. The rise of these new banking entities marks a pivotal moment in the evolution of banking, reflecting broader societal changes in consumer behavior, technological advancements, and the demand for more inclusive and transparent financial solutions.

2.METHODOLOGY

This paper utilizes a qualitative research approach through a comprehensive literature review to examine the rise of neobanks and challenger banks and their impact on the traditional banking sector. The methodology involves:

1.Selection of Sources: Identifying relevant academic articles, industry reports, and case studies using keywords like "neobanks," "challenger banks," "digital banking," and "financial innovation."

2.Case Studies: Including detailed case studies of successful neobanks and challenger banks, such as Revolut, Chime, and Nubank, to illustrate their strategies and the disruption they cause to established banking norms.

By employing this methodology, the paper aims to provide a thorough understanding of how neobanks and challenger banks are reshaping the financial landscape through innovative and customer-centric approaches

3.FINDINGS

3.1. Historical Context and Technological Advancements

To grasp their rise, consider examples of historical context and the technological advancements that have driven their development. Neobanks and challenger banks are shaking up traditional banking. They are significant disruptors in the financial sector. Digital-first financial institutions are changing the game. They use advanced tech to transform the delivery of banking services.

Regulatory changes have opened the door for neobanks and challenger banks to enter the financial services market. These regulatory frameworks have often lowered barriers to entry, letting new players challenge the dominance of traditional banks, you know (Barodawala, 2022). In various areas, regulators have implemented policies to promote competition and innovation, including the issuance of special licenses for digital banks.

In the United States, Chime has become a top challenger bank by focusing on offering simple and affordable banking solutions. By cutting fees & providing perks like early direct deposit and automatic savings, Chime has drawn in millions of customers. The importance of understanding consumer needs and leveraging technology to provide value-added services is underscored by the bank's success (Shanti, Siregar, & Zulbainarni, 2024).

Neobanks & challenger banks are often thought of as the same, but they actually have some distinct characteristics. Challenger banks, in contrast, might operate with a hybrid model that includes a bit of a physical presence. They want to challenge traditional banks by providing fresh services, improved customer experiences, & lower costs (Chrzanowski & Dąbrowski, 2021; Kashyap, 2021). They focus on creating a seamless digital experience, often targeting tech-savvy customers who are comfortable with managing their finances online. And they know this audience well. Neobanks are usually branchless. They're digital-only banks that provide a variety of financial services via mobile apps & online platforms.

The Impact of Fintech Evolution Fintech has transformed the financial landscape significantly. This sector has evolved rapidly, introducing innovative technologies that enhance user experiences. Traditional banking methods are being challenged as new solutions emerge. These advancements not only streamline transactions but also increase accessibility for underserved populations. As fintech continues to grow, its influence on global finance becomes increasingly evident.

Often, artificial intelligence enhances personalization. For instance, it tailors recommendations based on user behavior. Typically, this involves analyzing data to predict preferences. Users might notice that their experiences feel more relevant and customized. However, the extent of personalization can vary, leading to mixed results.

Revolut is a leading European neobank that shows how technology is changing banking. Founded in 2015, Revolut rapidly became popular by providing free currency exchange, international money transfers, and a variety of new financial products. The company's success stems from its digital-first strategy. It uses mobile technology, AI, and open banking to enhance the customer experience (Temelkov, 2020).

In conclusion, the rise of neobanks and challenger banks has often been driven by historical context and technological advancements, which typically play a crucial role. Digital-first financial institutions use innovations like mobile banking, AI, open banking, and blockchain. As a result, they provide better services than traditional banks. As the financial landscape keeps evolving, neobanks & challenger banks are set to take on a more significant role. They're driving innovation and reshaping the industry in exciting ways. The success of these entities hinges on their ability to adapt to technological advancements, changing consumer preferences, and regulatory requirements (Zoi, 2021).

Open banking & APIs have really boosted the growth of neobanks & challenger banks. Open banking regulations require traditional banks to share customer data with third-party providers, which helps in developing new financial services & products. Neobanks and challenger banks have taken advantage of this chance. They often use APIs to provide connected services. For example, they can combine several bank accounts into one app or give personalized financial advice based on detailed data analysis (Santos, 2018).

The Effect on Conventional Banks Traditional banks often face significant challenges in today's evolving financial landscape. They usually struggle to adapt to new technologies and changing customer expectations. But, these institutions typically have established trust and stability. Yet, they must innovate quickly to remain competitive. Overall, the impact on traditional banks can be quite profound as they navigate these ongoing changes.

Traditional banks struggled with personalization, offering mostly standardized products and services (Lindström & Nilsson, 2023). Now, AI-driven chatbots and virtual assistants improve customer service. They provide around-the-clock support and address inquiries instantly (Corander, 2021).

Blockchain technology has significantly influenced the growth of neobanks and challenger banks. For instance, it boosts security and increases transparency. This increased level of security has often helped build trust among consumers who might have been somewhat hesitant to adopt digital banking solutions (Johnson, 2021). The decentralized nature of blockchain guarantees that transactions are documented on a secure, tamper-resistant ledger, which lowers the likelihood of fraud and cyberattacks.

Nubank, a Brazilian neobank, has really shaken up the traditional banking sector in Latin America by providing a digital-first banking experience. Focusing on transparency & customer satisfaction, Nubank has quickly grown to be one of the biggest digital banks in the region. The company's success highlights how neobanks can effectively compete with traditional financial institutions. They do this by harnessing technology and utilizing data analytics (Onashabay, 2021).

Many established banks have often responded by investing in digital transformation initiatives, like developing their own mobile apps & digital services. The rise of neobanks & challenger banks has really put pressure on traditional banks to innovate & adapt. The agility and customer-focused approach of neobanks and challenger banks often provides them an advantage in addressing the changing needs of consumers Damsgaard 2021.

Open banking & APIs play a crucial role in transforming the financial landscape. By allowing third-party developers access to banking data, they enable innovative services. This shift not only enhances customer experiences but also fosters competition in the industry. With the rise of new technologies, traditional banks are adapting to these changes. Ultimately, the integration of open banking & APIs is reshaping how we interact with financial services today.

The rise of neobanks & challenger banks is closely tied to the evolution of fintech. And, this development reflects a broader trend in financial technology. The financial services industry has been transformed by fintech innovations, which have introduced new business models and enabled more efficient, customer-focused services. These innovations have often made banking services more accessible. They allow smaller, flexible firms to compete with bigger banks.

Neobanks and challenger banks are reshaping the banking landscape. For example, neobanks operate entirely online, offering services via apps. Challenger banks, on the other hand, are traditional banks that adopt modern technology to enhance customer experience. Both focus on user-friendly interfaces and lower fees. They cater to tech-savvy customers who prefer digital solutions over in-person banking.

One of the key technological advancements that often paved the way for neobanks & challenger banks is mobile banking. As smartphones became widespread, consumers started seeking more convenient methods to handle their finances. Traditional banks typically struggled to adapt, often limited by outdated systems and regulatory compliance challenges. In contrast, neobanks and challenger banks quickly adopted mobile technology, providing user-friendly apps that let customers open accounts, transfer money, and access financial services with just a few taps on their devices.

3.2. Consumer Behavior and Market Dynamics

The landscape of banking has seen a big transformation in recent years, mainly due to the rise of neobanks & challenger banks. This transformation is not just a change in the institutional players but shows a deep change in consumer preferences and market dynamics that favor digital banking solutions. Grasping the factors behind this shift is crucial, as it explains why neobanks and challenger banks have become popular in an industry traditionally led by conventional banks.

One of the most important things that affects how consumers act is really convenience. In today's fast-paced world, consumers are more & more looking for services that save them time & effort. Neobanks and challenger banks, they have digital-first approaches which offer banking services that you can access anywhere anytime through apps on your phone and websites. Unlike traditional banks, which typically require in-person visits or lengthy phone calls, these digital banks often enable customers to open accounts, transfer funds, and manage finances directly from their smartphones. Accenture's (2023) study found that 73% of consumers would use a digital bank for faster and easier transactions. This stat shows a strong preference for banking options that focus on convenience, which is boosting the growth of neobanks & challenger banks.

Neobanks & challenger banks, in contrast, often get praise for their simple pricing models. They usually come with lower fees and clearer terms. But their appeal lies in the transparency they offer. For example, a lot of neobanks provide free basic banking services, & fees are only charged when customers choose premium services. Many traditional banks are often criticized for unclear fees and complex terms. This usually creates a sense of distrust among consumers. This openness builds trust and loyalty among consumers who want to know what they are paying for and why. The 2008 financial crisis made many people lose trust in traditional banks, which seemed to care more about profits than customers.

Traditional banks usually incur higher operational costs, often transferring these expenses to customers through various fees. Cost-effectiveness often attracts consumers to neobanks and challenger banks. Neobanks can often cut costs significantly by using technology and efficient operations. For example, a report from Deloitte (2020) shows that neobanks can run with costs that are up to 80% less than traditional banks because of their digital-only models and no physical branches.

The decline of trust in traditional banks has really played a key role in the shift to digital banking solutions. And, you know, this change is significant. Trust issues are pushing more people to embrace these new options. The 2008 financial crisis marked a major shift. It sparked widespread doubt about the banking sector. Many consumers felt let down by institutions they once trusted with their savings, leading them to look for alternatives that promised more accountability. Neobanks and challenger banks have seized this opportunity. They present themselves as customer-focused options that emphasize user experience and ethical banking. Younger consumers, who tend to prioritize their values and experiences, have particularly resonated with this approach, making them more likely to switch banks. In 2021 a PwC survey revealed that 59% of millennials might switch banks for a better customer experience, emphasizing the significance of trust and service in their decision-making.

Additionally, the growing need for personalized financial services has played a significant role in the increasing popularity of neobanks and challenger banks. Today's consumers anticipate personalized experiences that cater to their specific financial requirements. Traditional banks often don't meet this, offering a one-size-fits-all solution that doesn't cater to individual preferences. Neobanks use smart data analysis & AI to offer personalized advice and services. Many neobanks provide budgeting tools that assess spending patterns and recommend methods for saving or investing. By utilizing technology to provide personalized experiences, these digital banks typically address the increasing consumer demand for tailored financial solutions.

The demographic shift often significantly influences the dynamics of consumer behavior. This group is not only more likely to use online banking services but also more open to neobanks and challenger banks that fit their tech-friendly way of life. Younger generations, like millennials and Generation Z, are more at ease with technology. They have grown up surrounded by digital solutions, unlike older generations. The challenge for traditional banks is to adjust to these changing preferences and connect with younger customers who are increasingly looking for different banking options. A report by the Federal Reserve (2024) indicated that nearly 80% of millennials typically prefer to bank digitally rather than visit a physical branch.

Neobanks and challenger banks use social media to connect with potential customers and increase their brand visibility. A 20204 study from eMarketer find that 54% of consumers are influenced by the social media when they make financial decisions which underscores importance of digital presence in shaping the consumer behaviors. Traditional banks, which typically use conventional advertising methods, may find it challenging to connect with younger audiences similarly. Through targeted advertising and engaging content, digital banks can connect personally with consumers, thereby increasing their appeal. Additionally, the growth of social media and online marketing has often influenced how consumers behave in the banking industry.

Market dynamics also support the rise of neobanks & challenger banks. And this trend seems likely to continue. The rules governing the financial industry have changed to encourage innovation, allowing new companies to compete with traditional banks. In many areas, regulatory bodies have taken steps to boost competition. For instance, open banking initiatives enable consumers to share their banking data with third-party providers. This sharing aims to enhance choices for users & promote innovation. This regulatory shift has often paved the way for neobanks & challenger banks to enter the market, offering innovative services that traditional banks might not usually provide. For instance, open banking enables neobanks to view a customer's transaction history, allowing them to develop customized financial products and services suited to individual requirements.

The COVID-19 pandemic has sped up the use of digital banking. People now depend more on technology to handle their money. Social distancing rules & lockdowns made many people look for online banking. This caused a big rise in users for neobanks & challenger banks. A McKinsey (2020) report indicates that digital banking adoption rose by about 20% during the pandemic. Many consumers, who typically relied on traditional banking, often transitioned to digital platforms. The urgency for traditional banks to adapt to changing consumer behaviors and preferences is underscored by this shift, or they may risk losing market share to more agile digital competitors.

Even with good consumer habits & market trends helping neobanks and challenger banks grow, there are still hurdles to tackle. One main concern for consumers is security. As digital banking solutions gain popularity, the rise in cybercrime and data breaches has made some consumers cautious. They hesitate to trust neobanks with their financial information. A survey done in 2024 by J.D. Power found that customer satisfaction has, at times, fluctuated. Many respondents expressed mixed feelings. They noted that while some services are improving, others still need work. And, issues like responsiveness & quality of service were highlighted. But, overall, the survey suggests a trend towards better experiences. Power discovered that 38% of consumers are worried about the security of their financial data when using digital banks. To tackle these issues, neobanks should invest in strong security measures and clearly communicate their data protection policies to foster trust with potential customers.

The lack of branches often helps reduce operational costs, but it may also deter some customers who typically favor in-person interactions or might need assistance with complicated financial issues. While many neobanks typically provide customer support via digital channels, some individuals might still feel more at ease discussing their finances in person. Thus, neobanks typically need to find ways to balance their digital-first approach with customer service options that often cater to diverse preferences. The absence of physical branches presents a double-edged sword for challenger banks and neobanks.

Traditional banks face challenges from new players and must adapt to shifting market dynamics or risk obsolescence. The rise of neobanks & challenger banks often represents not just a shift in banking models but also a broader transformation in how consumers typically engage with financial services in the digital age. Neobanks and challenger banks have often emerged as innovative alternatives that typically meet these evolving consumer needs, leveraging technology to create usually seamless banking experiences. The future of banking is likely gonna be shaped by how institutions—traditional & digital—embrace innovation while focusing on customer-centric methods in a more competitive landscape. To sum up, the shift in consumer behavior towards digital banking solutions is influenced by factors like convenience, transparency, cost-effectiveness, a decline in trust for traditional banks, & the need for personalized services.

3.3. Case Studies of Successful Neobanks and Challenger Banks

In the fast-changing world of finance, neobanks & challenger banks have become powerful players. They're shaking up the traditional banking systems. But their rise is reshaping how we think about banking entirely. This section explores three significant case studies: Revolut in Europe, Chime in the United States, and Nubank in Latin America. Each of these banks has typically carved out a unique niche for itself, often leveraging technology to address the common shortcomings of conventional banking services. By looking at their business models and strategies and innovations we can better understand how these companies not only disrupt the traditional practices but also create new standards for customer engagement and services in finance.

Also, the rise of neobanks & challenger banks has major implications for regulatory frameworks within the financial sector. As these new players often shake up traditional banking methods, regulators usually struggle to ensure consumer protection while encouraging innovation. This dynamic is very important for keeping the integrity of a financial system and making sure that the benefits of digital banking are enjoyed by all consumers.

Revolut has a key strategy: transparency & low fees. It's focused on making things clear for users. But this approach is essential for building trust in the financial sector. Traditional banks frequently apply several fees for foreign transactions, currency exchange, and maintaining accounts. Revolut has a notably simpler fee structure in comparison. For example, users can utilize foreign exchange services without the high markups usually associated with banks, attracting a large customer base looking for affordable options. As of 2021, Revolut had more than 15 million users, showing its fast growth & popularity in the market.

Chime makes money by partnering with banks and merchants, enabling it to keep its no-fee approach while staying financially stable. Chime's business model changes traditional banking by focusing on user-friendly solutions. It shows that banks can be profitable without relying on fees.

Nubank also uses data analytics to customize its services for each customer, creating a more personalized banking experience. The bank uses advanced technology for boosting its operational efficiency and improving customer experience. The app offers users real-time insights into their spending habits and credit utilization. This empowers them to make informed financial choices. Nubank's fresh approach goes beyond its products. It's about creating a new banking experience.

Founded in 2015 in the United Kingdom, Revolut is often seen as a prime example of a neobank. Nikolay Storonsky and Vlad Yatsenko established it, utilizing technology to typically offer a wide array of financial services. Currently, it offers services like cryptocurrency trading, stock trading, budgeting tools, and insurance products, all within a user-friendly mobile app.

Chime, started in 2013 by Chris Britt and Ryan King, has become a prominent challenger bank in the U.S. It aims to offer straightforward and accessible banking options, especially for consumers often overlooked by conventional banks. The company uses a model that focuses on fee-free banking. It aims to remove the hidden fees typically found in traditional banks.

This responsiveness stands in stark contrast to the often clunky customer service processes at traditional banks. Customers there might deal with long wait times & limited availability. But that's not the case here. For instance, AI-powered chatbots often help customers with inquiries and transaction questions, offering quick support. The bank uses smart algorithms & AI to improve processes. This helps boost customer service.

This focus on speed & simplicity has earned Nubank a loyal customer base; by 2021, the bank had more than 40 million customers. The bank aims to be customer-centric. It focuses on reducing bureaucracy and making financial processes simpler. For example, Nubank users can apply for a credit card right in the app. They often get approval in just minutes, which is a sharp difference from the long application processes typical of traditional banks. Nubank's strategy is fundamentally based on its dedication to transparency and excellent customer service.

As the financial landscape evolves, traditional banks must embrace digital transformation. They need to rethink their strategies to stay relevant in a competitive market. By using technology to deliver innovative, customer-focused solutions, these organizations are transforming traditional banking practices and establishing new benchmarks for financial services. The success of these banks shows how crucial it is to be flexible and creative as consumer preferences change quickly. The future of banking is definitely digital, & those who don't adapt risk being left behind in this revolution. In conclusion, the case studies of Revolut, Chime, and Nubank often show the significant influence that neobanks and challenger banks are having on the banking sector.

The success of these neobanks highlights a larger trend in the banking sector: a move toward digital-first solutions. Neobanks' use of technology boosts their services & sets a new standard for what consumers want from financial institutions. With consumers more & more demanding convenience, transparency, and personalized experiences, traditional banks are really challenged to adapt to this new reality.

The bank's growth has also been driven by its efforts to reach the underserved populations in Brazil. By offering accessible financial services to individuals who might not have qualified for traditional banking products, Nubank has often made

significant strides in promoting financial inclusion. This focus on inclusivity aligns with a broader society trend to democratize access to financial services, particularly in the developing regions.

This change brings a big challenge for the traditional banks, which need to come up with new ideas to keep their customers in a more competitive environment. Data shows that the shift towards digital banking is probably going to keep going, with many consumers preferring online banking options instead of traditional brick-and-mortar banks. A report from McKinsey (2021) says that digital banking penetration has really picked up, with more than 60% of consumers in developed markets now using digital banking services.

Real-time spending alerts, budgeting tools, & expense categories help users manage their money better than traditional banks can. By offering a smooth and interesting digital experience, Revolut has built a loyal customer base that appreciates convenience and efficiency. Revolut stands out from its competitors by prioritizing user experience. The mobile app features a sleek interface. Users can easily manage their finances with it.

Nubank's success is evident in the substantial investments it has received from venture capital firms. This funding has allowed the company to broaden its product range and extend its reach into new markets. In 2021, the bank's initial public offering (IPO) often reinforced its position as a significant player in the fintech sector, highlighting the increasing demand for digital banking solutions in Latin America.

Nubank is often seen as one of the most successful fintech companies in Latin America. Founded in 2013 by David Vélez, Cristina Junqueira & Edward Wible, it has made a significant impact in the financial sector. Based in Brazil, Nubank's mission is often to simplify financial services & make them more accessible to the general population. The company's first product was a no-fee credit card, typically managed via a mobile app. This approach often challenged the traditional banking system, which usually imposed high fees and complicated terms on credit products.

Additionally, Chime has actively engaged in promoting financial literacy among its customers. The bank gives a lot of resources for educating users about personal finance management and budgeting and saving strategies. This focus on educating customers boosts user engagement and builds a sense of community, strengthening their loyalty.

These banks have pinpointed issues in traditional banking. They tackle these challenges using technology-based solutions designed for today's consumers. The case studies of Revolut, Chime & Nubank show compelling evidence of how neobanks & challenger banks are shaking up traditional banking practices with their innovative business models & customer-focused approaches.

The bank has invested in influencer marketing and social media to connect with younger people, leading to quick growth. Chime’s marketing strategy focuses on online engagement and building customer trust. Chime reported over 12 million account holders as of 2021, demonstrating its success in gaining market share. By often promoting a narrative of transparency & financial empowerment, Chime has typically built a brand that resonates well with its target audience.

Chime's automatic savings feature is one of its most attractive qualities, enabling users to save a portion of their paycheck automatically. Chime’s core offerings typically include a spending account, a savings account, & a Chime Visa debit card. Also, Chime users get their paychecks up to two days earlier via direct deposit, which is a pretty appealing offer for folks living paycheck to paycheck.

4.CONCLUSION

As we near the end of this exploration into neobanks and challenger banks, it's important to highlight that these innovative financial institutions are often reshaping the banking sector. They're driving disruption & fostering innovation by using technology to create services focused on customers, which traditional banks often find challenging to deliver. The influence of neobanks and challenger banks on the financial scene is significant, and grasping this change is important for consumers and financial entities alike.

In this paper, we explored the historical context that has allowed neobanks and challenger banks to emerge. From the early days of fintech innovations to now, where digital-first banking is really taking off, the history shows a significant evolution in the banking industry. We talked about how new banking models have emerged due to advancements in technology. For instance, mobile banking and artificial intelligence play significant roles in this transformation. For instance, the rise of smartphones & user-friendly apps has let consumers manage their finances with amazing ease. This has enabled neobanks to flourish in a space where traditional banks are often slow to adapt.

We also looked at the changes in consumer behavior that are supporting these modern banking solutions. Today's consumers are more than ever looking for convenience, clarity, & affordability, which are often missing in old banking systems. The drop in trust for established banks, especially after financial crises & scandals, has opened up great opportunities for neobanks and challenger banks to thrive. They provide a new way of banking and often promise an improved customer experience that typically appeals to today’s consumers. Many neobanks have taken on a zero-fee model or provide lower fees than the

traditional banks, attracting people who are careful with their budgets. This has led to a notable change in how consumers view banking services, prompting traditional banks to rethink their strategies to keep their customer base.

Each bank has identified market needs and adjusted their services to meet them. Additionally, case studies of successful neobanks and challenger banks like Revolut in Europe, Chime in the U.S., and Nubank in Latin America showcase the various strategies and innovations these organizations use to challenge the banking industry. Chime has established itself as a convenient option for younger users seeking simple banking solutions without the weight of high fees. For example, Revolut offers multi-currency accounts with low fees. This is great for travelers & expats. Nubank has typically succeeded in capturing the Brazilian market by providing a seamless digital experience and prioritizing customer service, highlighting the often crucial role of understanding local market dynamics.

To further illustrate the disruption caused by neobanks and challenger banks, Table 1 compares the key strategies and innovations of Revolut, Chime, and Nubank, as discussed in the case studies.

Table 1: Comparative Analysis of Neobank and Challenger Bank Strategies

Bank	**Region**	**Key Strategies**	**Innovations**	**Customer Base (2021)**
Revolut	Europe	Transparent fee structure, multi-currency accounts, low-cost international transfers	AI-driven budgeting tools, cryptocurrency trading, open banking integration	15 million
Chime	United States	No-fee banking, early direct deposit, automatic savings	AI-powered chatbots, financial literacy tools, seamless mobile app interface	12 million
Nubank	Latin America	No-fee credit cards, transparent pricing, focus on underserved populations	Real-time spending analytics, instant credit approvals, mobile-first platform	40 million

Source: Compiled from case studies in Section 3.3 (Revolut, Chime, Nubank).

This transition often faces challenges. This disruption has major implications for traditional banks. Many banks are embracing digital transformation. They are adopting new technologies and partnering with fintech startups. This helps them improve their services. As neobanks and challenger banks grow in popularity, traditional banks must rethink their business models. Traditional banks frequently encounter internal resistance to change and the challenges posed by legacy systems, which impede agility and innovation. This disruption has created a more competitive environment. Traditional banks now face pressure to innovate, or they may lose their market share.

To provide a quantitative perspective, Table 2 compares traditional banks and neobanks based on key operational and consumer metrics, highlighting the competitive advantages of neobanks.

Table 2: Statistical Comparison of Traditional Banks and Neobanks

Metric	**Traditional Banks**	**Neobanks**	**Source**
Operational Costs	High (due to physical branches, legacy systems)	Up to 80% lower (digital-only, streamlined ops)	Deloitte (2020)
Customer Acquisition Cost	$200–$400 per customer	$20–$50 per customer	McKinsey (2021)
Consumer Preference for Digital	40% prefer in-person banking (2024)	73% prefer digital for faster transactions	Accenture (2023)
Millennial Digital Banking Use	50% use digital banking (2024)	80% prefer digital banking	Federal Reserve (2024)
Security Concerns	25% concerned about data security	38% concerned about data security	J.D. Power (2024)

Note: Data reflects global averages from cited industry reports.

Policymakers will have to find a balance between encouraging innovation & making sure consumer protection is upheld in the financial system. Furthermore, the rise of neobanks often raises significant questions about the regulatory landscape in which these entities typically function. Future studies should typically look into the regulatory hurdles that neobanks encounter and how these may change as the industry develops. One area to explore might be how rules can be changed to fit the special features of neobanks while still keeping the financial system secure.

Stakeholders in the financial world should often acknowledge the significance of innovation and customer-focused service in today's banking environment. As traditional banks struggle with the challenges from these innovative financial entities, it's crucial for them to embrace digital transformation & adjust their strategies to stay competitive. In conclusion, the emergence of neobanks and challenger banks signifies a fundamental change in the banking industry. This shift is marked by swift technological progress and evolving consumer demands. The ongoing evolution of neobanks and challenger banks is a critical area for observation and analysis, as the future of banking will likely be shaped by those who effectively leverage technology and prioritize consumer needs.

Looking forward, it's clear that the disruption brought by neobanks and challenger banks isn't just a trend, but rather a fundamental change in the way banking services are delivered and used. The lessons that are learned from this disruption can guide a traditional banks in their journey to modernization and adaptation. By focusing on the technology, transparency, and customer experience, the banking sector can move to a more efficient and inclusive future all together. The implications of this transformation typically extend beyond just banking, often influencing the broader financial ecosystem and the way individuals and businesses interact with financial services in an increasingly digital world.

The journey's just starting, & the possibilities are endless as we see the ongoing evolution of banking in this digital age. As we move through this shifting landscape, it's super important for all stakeholders to stay alert & responsive to the changing needs of consumers, making sure that the future of banking is founded on trust, accessibility, & tech advancements. In summary, the rise of neobanks & challenger banks has often challenged the traditional banking paradigm, while also opening up new avenues for growth & innovation within the financial sector.

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RESEARCH ON THE EFFECT OF CORPORATE GOVERNANCE AND COMPANY PERFORMANCE OB NON-FINANCIAL INFORMATION REPORTING

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ABSTRACT

Purpose-Non-financial information disclosures regarding companies' sustainability efforts are in the spotlight. Therefore, companies are turning to environmental and social activities rather than the traditional approach focused on making profits. In this context, it is important to disclose non-financial information in a transparent manner as well as financial information. The study is conducted to determine whether corporate governance (CG) qualities and firm performance affect the disclosure of non-financial information.
Methodology- Within the scope of the study, a sample is created using data from 443 companies in European countries. In the study, panel data analysis is applied to the sample created for the years 2016–2020.
Findings- Study findings show the impact of financial performance (FP) and firm size on non-financial information disclosures. In addition, study findings reveal that corporate governance qualities also positively affect the disclosure of non-financial information. In this sense, it is seen that characteristics such as board size and having independent members contribute to greater disclosure of environmental information.
Conclusion- The study shows that companies that are large, have CG, or have high FP may be more focused on environmental activities and may disclose more non-financial information.

Keywords: Board of directors, corporate governance, non-financial information reporting, firm performance, panel data.
JEL Codes: L25, G30, C23

1. INTRODUCTION

Sustainability has a scope that integrates economic, environmental, and social issues regarding current and future generations. Commercial companies with a profit-oriented market logic do not have the ability to meet the complexity of sustainable development and the different expectations of stakeholders. However, today, company management is forced to include sustainability issues in their strategic and operational management processes rather than traditional management for commercial purposes (Burritt & Schaltegger, 2010; Schneider, 2015). In this context, the pressure from stakeholders to disclose the sustainability activities that companies include in their corporate processes is increasing (Al-Shaer & Zaman, 2018; Dutta et al., 2012). Therefore, it is expected that company management's efforts to focus on human, capital, and environmental activities and adopt ethical rules will lead to better corporate governance (CG) and financial performance (FP) (Orlitzky et al., 2003).

Today, the increasing competition and crisis environment in the global arena make the accumulation of knowledge and innovation abilities important for companies to increase their sustainability. Therefore, information users have become more interested in disclosing non-financial information about companies' social and environmental issues in addition to company performance (Kirana & Budi Prasetyo, 2021). There are many current studies aimed at raising awareness about the risks and threats of climate change and transitioning to a low-carbon economy against global warming (Tanthanongsakkun et al., 2022). In addition, as investors' interest in these issues increases, disclosing and reporting non-financial information as well as financial information is gaining more importance. Therefore, presenting non-financial information transparently and accurately is an important factor for investors to make accurate sustainability decisions (Zourari & Dhifi, 2022; Caesari et al., 2016). The increased interest of stakeholders such as legal regulations, social media, and non-governmental organizations in environmental and social activities indirectly causes some changes on the boards of directors. Because of this, boards of directors now have to take into account the interests of other company-related stakeholders as well as the interests of shareholders (Fuente et al., 2017). Therefore, companies are expected to be determined not only to disclose social and environmental non-financial information to their stakeholders but also to meet stakeholder expectations (Ananzeh, 2022). In fact, the demands of information users for the reporting of non-financial information also create a separate stakeholder pressure for companies. As a result, the accuracy of their statements regarding environmental and social activities contributes

to increasing trust in companies (Ellemers & Chopova, 2022). Disclosure of non-financial information regarding corporate social responsibility activities can increase customer trust and company reputation, as well as have the potential to improve company performance and enable various government contributions such as tax deductions (Khan et al., 2019).Corporate sustainability reporting, which is used to reflect the financial, social, and environmental sustainability performance of companies to stakeholders, creates awareness among information users. In addition, sustainability reports are an indicator of the way the company's resources are distributed and how value is created between different forms of capital (Siew, 2015). On the other hand, companies with a well-established corporate structure will have a flexible mechanism to present their non-financial information to information users in a transparent manner, so their quality of providing publicly available information regarding their corporate social responsibility activities will be high (Adel et al., 2019). In this case, companies with effective CG will have to plan their financial impacts while carrying out their social and environmental activities (Vives, 2008; Wirba, 2023). Environmental, social, and governance (ESG) scores have a systematic structure created to objectively and transparently measure a company's relative ESG performance, commitment, and effectiveness based on the company's own data. The ESG score is an evaluation method that takes into account the sum of three basic components: environmental, social, and corporate governance. The environmental score is determined by considering the company's efforts regarding resource use, innovation, and emissions. The social score evaluates the company's activities regarding the workforce, product responsibility, society, and human rights. In the CG score, an evaluation is made for all sectors regarding corporate social responsibility strategies, shareholders, and management. While the CG score is determined for all sectors, a weighted group scale that varies by sector is used for environmental and social scores (Refinitiv, 2022).

This paper aims to contribute to existing and ongoing research on sustainability in companies. In this respect, the paper addresses the effects of CG on the disclosure of non-financial information, especially in terms of board size and the presence of independent directors. When previous studies are examined, although there are various studies covering board qualifications or disclosure of non-financial information in the context of CG, it is seen that there are still some uncertainties to draw a clear conclusion. Therefore, the present paper considers the impact of CG and FP on non-financial information disclosure for environmental and social activities. In addition, unlike previous studies, this study focuses on disclosures of non-financial information within the scope of environmental scores rather than general ESG scores. Following the introductory section given in accordance with the purpose of the study, study hypotheses are developed in the second section by focusing on the literature on CG and disclosure of non-financial information. In the third section, which reveals the research design, the methodology section is included, and explanations about the data set, sample, methods, and models used in the study are mentioned. Then, the findings, results, and suggestions obtained in line with the study method are presented.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

In today's conditions, effective CG can be achieved by including more details in disclosures regarding climate change in order to reduce the risks to the company and increase the value of the company in the capital market (Ben-Amar & Mclkennny, 2014). Therefore, CG that discloses accurate information regarding social and environmental activities can also reduce risks (Chen et al., 2016; Hoi et al., 2013). Making non-financial information available to the public contributes to increasing the company's reputation and allows it to increase its competitiveness in the product, labor, and capital markets (Deng et al., 2013).

Increasing business volumes and the competitive environment require the professionalization of company management and the separation of ownership and management. Nowadays, it is very important for companies to form their boards of directors with members with the necessary expertise. Because, in addition to protecting shareholder interests, companies need a management structure that can fulfill responsibilities such as identifying and monitoring corporate social responsibility disclosures, managing environmental and social activities, and ensuring accountability (Hameed et al., 2023). A professional board of directors should be able to manage strategic and operational decisions regarding the monitoring and control of companies, taking into account the expectations of shareholders and stakeholders (Raimo et al., 2020; Jo & Harjoto, 2012). It is important for managers with different experiences to work together and ensure cooperation between them in an effective board of directors, which has a significant role in making corporate strategic decisions (Pugliese et al., 2009). In addition to carrying out its social and environmental activities in compliance with the laws prepared by governments, effective CG should also be able to provide the quality and reliability of making non-financial information available to the public by making transparent disclosures (Liao et al., 2018).

Today, diversity on boards of directors is of great importance in terms of disclosing potential stakeholders and non-financial information (Peng et al., 2021). It is envisaged that a diverse board of directors can better fulfill its accountability responsibility (Liao et al., 2015). Factors such as the increase in the total number of members on the boards of directors and the presence of more independent members or female members on the boards of directors are accepted as indicators of the more effective functioning of CG. It is accepted that having more independent company management, the frequency of board meetings, and/or leadership structures have a significant role in the effectiveness of CG (Van den Berghe & Levrau, 2004). Previous studies have addressed many research topics examining board characteristics such as independent board member rates, board sizes, gender diversity, and female CEOs (Cicchiello et al., 2021).

Board size refers to the total number of members on the board of directors. In addition, increasing the number of board members may negatively affect the effective functioning of boards of directors, as it may make decision difficilitated (Rao et al., 2012). In previous studies, different studies have been found that reveal both the negative (Qavqzeh et al., 2021; Disli et al., 2022) and positive effects (Mak & Roush, 2000; Alabdullah et al., 2019) of board size on the disclosure of non-financial information. The following hypothesis regarding board size is developed:

Hypothesis _1 (H1): *Board size has an impact on non-financial information disclosure.*

The ratio of independent members of the board of directors to the total number of members is considered an indicator that there is no conflict of interest or that it is low (Koerniadi & Tourani-Rad, 2012). Some previous studies on agency theory indicate that the presence of independent directors on the board of directors is a factor in making more transparent disclosures (Ben-Amar & Mclkennny, 2014). The ratio of independent members of the board of directors express the members who are on the board of directors without having ownership rights and who do not have a director title (Calderón et al., 2020). Members with ownership rights are likely to make unfair assessments and/or cooperate with managers. However, independent members are likely to act to protect stakeholder interests and/or pressure management to disclose more information (Eng & Mak, 2003; Shamil et al., 2014). Since independent board members do not have any relationship with the company, it is accepted that they will exhibit more objective behavior in decision-making processes than other members who are shareholders (Weerasinghe & Ajward, 2017; De Silva & Hewage, 2022). While some previous studies point to a positive relationship between board independence and disclosure level (Chen & Jaggi, 2000; Petra, 2005), some studies indicate a negative effect (Zhou et al., 2018; Eng & Mak, 2003; Chau & Gray, 2010; Oh et al., 2011). Therefore, the following hypothesis is developed regarding the rate of independent members of the board of directors:

Hypothesis_2 (H2): *Board independence has an impact on non-financial information disclosure.*

In previous studies, the impact of non-financial information disclosures, corporate social responsibility disclosures, or sustainability disclosures on FP is generally evaluated. Unlike the literature, the study examines the effects of firm performance on non-financial information disclosure, with the assumption that FP will increase orientation towards environmental activities. The following hypothesis is formulated regarding non-financial information disclosure of firm performances.

Hypothesis_3 (H3): *Firm performance has an impact on non-financial information disclosure.*

3. EMPRICAL RESEARCH DESIGN

In this section, the research methodology is included in order to determine the effect of board characteristics and firm performance on the disclosure of non-financial information. That is, this chapter contains explanations about the sample, variables, and pre-tests used in the analysis part of the research.

3.1. Sample Size and Study Period

The paper's sample was created for European countries where higher ESG scores can be achieved due to legal sanctions on social and environmental reporting. For the sample group created with European countries, data for the years 2016–2020 obtained from the Thomson Reuters Eikon database are used. Companies that are not financial in nature and whose full data can be accessed are included in the sample, and the final sample consists of 443 companies and 2215 observations. Since the data set of the sample includes both cross-section and time sections, panel data analysis is used as management in the study.

3.2. Creating Study Variables and Models

The following main model is used to analyze the hypotheses created for the purpose of the paper:

$$\mathrm{ENVMNT}_{i,t} = \alpha + \beta_1 \mathrm{ROA}_{i,t} + \beta_2 \mathrm{MTVBV}_{i,t} + \beta_3 \mathrm{BOARDS}_{i,t} + \beta_4 \mathrm{BOARDI}_{i,t} + \beta_5 \mathrm{GROWTHS}_{i,t} + \beta_6 \mathrm{SIZE}_{i,t} + \beta_7 \mathrm{LEV}_{i,t} + \varepsilon_{i,t} \quad (1)$$

The variables determined for the analysis of the hypotheses created for the purpose of the paper consist of both financial and non-financial information. Symbols and measurement forms for variable definitions used in the model of the paper is given in Table 1.

Table 1: Symbols and measurement forms for variable definitions used in the model of the paper

Dependent Variables	Definition
ENVMNT	Environmental score
EMISSION	Emission reduction score
INNOVATION	Innovation score
RESOURCE	Resource score

Independent and Control Variables	Definition
ROA	Ratio of period profit to lagged total assets
MTVBV	Ratio of market value to book value
BOARDS	Total number of board members
BOARDI	Ratio of the number of independent board members to total members
GROWTHS	Sales growth rate
SIZE	Logarithm of total assets
LEV	Ratio of total debts to total assets

Unlike previous studies, the study was addressed specifically with explanations for environmental activities instead of the general ESG score, and the Environmental (ENVRMNT) score was used as the dependent variable in the main model. In addition, in robustness controls, the three basic elements that make up the environmental score (EMISSION, INNOVATION and RESOURCE) were used as dependent variables. In the paper, the environmental (ENVRMNT) score is used as the dependent variable regarding the disclosure of non-financial information. Based on previous studies, BOARDS and BOARDI variables were used in the model used in the paper as a CG indicator (Zhou et al., 2018; Shamil et al., 2014; Pathak & Gupta, 2022; Almaqtari et al., 2023).

4. FINDINGS AND DISCUSSIONS

In this part of the study, panel data analysis findings regarding the models used are included.

4.1. Descriptive Statistics

Descriptive statistical information of the variables of the models created within the scope of the study is shown in Table 2. Regarding board qualifications, it is seen that the total board size has an average of 0.11 and the ratio of independent members is 0.59. The findings show that companies tend to grow in sales at a rate of 3.55% and to borrow at a rate of 0.25%.

Table 2: Descriptive statistical information

Variables	Mean	Standard deviation	Minimum	Maximum
ENVMNT	63.429	22.295	0.510	99.200
EMISSION	70.452	22.926	4	99.870
INNOVATION	42.947	33.714	0	99.880
RESOURCE	70.110	26.100	0	99.890
ROA	0.042	0.091	-1.765	0.444
MTVBV	55.185	2730.994	-26227.800	125350.600
BOARDS	0.1122	0.039	0.030	0.230
BOARDI	0.594	0.239	0	1
GROWTHS	3.554	0.862	0.301	6.179
SIZE	6.906	0.748	4.960	9.001
LEV	0.255	0.174	0	2.600

4.2. Correlation Results

Pearson correlation coefficients are generally consistently small across study variables, allowing the analysis to avoid multicollinearity problems. Using the Pearson correlation method, it is checked whether there is multicollinearity between variables. Correlation findings regarding the variables used in the models within the scope of the study are shown in Table 3. Pearson health coefficients are generally somewhat small across study variables, allowing the analysis to avoid multipath problems. Using the Pearson process method, it is checked whether there is multi-control between variables. The distributions of the variables used in the models within the scope of the study is given in Table 3.

Table 3: Correlation results

Variables	ENVMNT	ROA	MTVBV	BOARDS	BOARDI	GROWTHS	SIZE	LEV
ENVMNT	1.000							
ROA	0.004	1.000						
MTVBV	-0.042**	0.079***	1.000					
BOARDS	0.412***	-0.059***	-0.025	1.000				
BOARDI	0.201***	0.016	0.007	-0.077***	1.000			

GROWTHS	0.418***	-0.070***	-0.024	0.323***	0.143***	1.000		
SIZE	0.592***	-0.036*	-0.034	0.504***	0.175***	0.752***	1.000	
LEV	0.115***	-0.293***	0.069***	0.112***	0.094***	0.078***	0.172***	1.000

Note: "***, ** and *" signs indicate statistical significance at the 1%, 5% and 10% level, respectively.

Although the correlation analysis results given in Table 3 generally show that there is a substantial relationship between the variables, it is seen that the relationship between the variables is substantially low. The connections seen in the variables generally remain below the 0.80 limit value (Gujarati, 2009), which is the high correlation value presented in previous studies. In addition, the findings of the "Variance Inflation Factor (VIF)", which was used to detect the existence of multicollinearity problems in panel data analysis, appear to be at an acceptable level. These findings show that there is no multicollinearity problem among the independent variables.

4.3. Regression Results

Panel data analysis was used for the model developed to determine the effect of the CG qualities of the paper on the disclosure of non-financial information. Firstly, preliminary tests for panel data analysis were conducted. In this respect, the presence of a multicollinearity problem in the model was examined, and it was found that the VIF value was at 1.59. The VIF value, which is at an acceptable level, is proof that there is no multicollinearity problem in the developed model. It was determined that there was an autocorrelation problem in the model by checking whether there was an autocorrelation problem with the "Durbin-Watson Test" and "Baltagi-Wu LBI Test". In the fixed effects model, the presence of heteroskedasticity was determined by applying the "Modified Wald Test" to detect the presence of heteroscedasticity according to the units in the residues. In addition, the "Hausman Test" is applied to determine whether a "Fixed Effects" or "Random Effects" model will be used in the study. According to the "Hausman Test" results, it is seen that the "Fixed Effects Model" is more suitable for accurate prediction in the article. The existence of cross-section dependence, heteroscedasticity, and autocorrelation problems were detected in the model used in the paper. In order to eliminate the identified problems, the findings were cleared of basic errors by using "Driscoll-Kraay" standard errors, one of the robust estimators, and the model estimation process was performed again. The findings regarding the fixed effects and "Driscoll-Kraay" standard error estimators obtained as a result of the evaluations are presented in Table 4.

Table 4: The fixed effects and "Driscoll-Kraay" standard error estimators obtained as a result of the evaluations

Variables	Fixed Effects Model		Driscoll-Kraay Standard Errors	
	Coefficients	P-Value	Coefficients	P-Value
ROA	-3.335	(0.318)	8.000**	(0.031)
MTVBV	-0.000***	(0.000)	-0.000**	(0.045)
BOARDS	-2.826	(0.864)	100.051***	(0.001)
BOARDI	5.945**	(0.035)	12.174***	(0.003)
GROWTHS	0.447	(0.107)	-0.995	(0.157)
SIZE	11.874***	(0.000)	15.084***	(0.000)
LEV	3.133	(0.333)	1.240	(0.704)
Cons	-24.042	(0.210)	-56.318	(0.000)
R2	0.355	0.386		
F Statistics	534.520	(0.000)	11340.450	(0.000)
Hausman Test	38.22	(0.0000)		
Modified Wald Test	0.0000031	(0.0000)		
Bhargava et al. Durbin Watson Test	1.0023741			
Baltagi Wu LBI Test	1.6330413			
Breusch Pagan LM Test	149115.5	(0.0000)		
Pesaran Scaled LM Test	115.7345	(0.0000)		
Pesaran CD Test	24.194662	(0.0000)		

Note: "***, ** and *" signs indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 4 shows the R^2 value of 0.3554 for the fixed effects model. The findings reveal that the MTVBV ratio has a significant negative effect on environmental disclosures within the scope of non-financial information disclosure. In addition, fixed effects model findings indicate the positive effect of independent member ratio (BOARDI) and firm size (SIZE) on environmental disclosures within the scope of non-financial information disclosure. According to the Driscoll-Kraay Standard Errors model results, it is seen that the MTVBV and ROA variables used as FP indicators in the model have a significant effect at the 0.05 level on non-financial information disclosures. While the positive effect of return on assets is determined, it is seen that there may be a negative effect, albeit small, on market value. In addition, the findings of Table 4 reveal the positive effects of firm size (SIZE), board size (BOARDS), and independent member ratio (BOARDI) on non-financial information

disclosures at the 0.01 level. The paper findings support literature studies (Mak & Roush, 2000; Alabdullah et al., 2019) that reveal a positive effect of board size on non-financial information disclosures. In addition, the results of this study support the literature showing the positive impact of the ratio of independent members on boards of directors on non-financial information disclosures (Zhou et al., 2018; Katmon et al., 2019; Shamil et al., 2014; Chen & Jaggi, 2000; Petra, 2005). Study findings also support studies showing that larger companies will volunteer to reveal more non-financial information than smaller companies (Ananzeh, 2022; Almaqtari et al., 2023). It also contributes to study findings (Ananzeh, 2022) that point to the significant impact of FP on non-financial information disclosure. Since the paper findings regarding the Driscoll-Kraay Standard Errors model in Table 4 support the effect of both board size (BOARDS) and independent member ratio (BOARDI) on non-financial information disclosures, H1 and H2 hypotheses are accepted. Additionally, the findings reveal that firm size has a positive effect on non-financial information disclosure. Study findings show that the ROA variable positively affects non-financial information disclosures, but may have a small negative impact on the MTVBV variable. Therefore, the study findings show the effect of FP on non-financial information disclosures, and the H3 hypothesis is also accepted.

4.3. Robustness Check

The main model created to determine the impact of CG qualities on non-financial information disclosures is checked with sub-models created for emissions, innovation, and resource use. The created submodels are shown below.

$$\mathrm{EMISSION}_{i,t} = \alpha + \beta_1 \mathrm{ROA}_{i,t} + \beta_2 \mathrm{MTVBV}_{i,t} + \beta_3 \mathrm{BOARDS}_{i,t} + \beta_4 \mathrm{BOARDI}_{i,t} + \beta_5 \mathrm{GROWTHS}_{i,t} + \beta_6 \mathrm{SIZE}_{i,t} + \beta_7 \mathrm{LEV}_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$\mathrm{INNOVATION}_{i,t} = \alpha + \beta_1 \mathrm{ROA}_{i,t} + \beta_2 \mathrm{MTVBV}_{i,t} + \beta_3 \mathrm{BOARDS}_{i,t} + \beta_4 \mathrm{BOARDI}_{i,t} + \beta_5 \mathrm{GROWTHS}_{i,t} + \beta_6 \mathrm{SIZE}_{i,t} + \beta_7 \mathrm{LEV}_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$\mathrm{RESOURCE}_{i,t} = \alpha + \beta_1 \mathrm{ROA}_{i,t} + \beta_2 \mathrm{MTVBV}_{i,t} + \beta_3 \mathrm{BOARDS}_{i,t} + \beta_4 \mathrm{BOARDI}_{i,t} + \beta_5 \mathrm{GROWTHS}_{i,t} + \beta_6 \mathrm{SIZE}_{i,t} + \beta_7 \mathrm{LEV}_{i,t} + \varepsilon_{i,t} \quad (4)$$

The findings of the submodels of the study are given in Table 5.

Table 5: Robustness test results

Variables	EMISSION		INNOVATION		RESOURCE	
	Coefficients	P-Value	Coefficients	P-Value	Coefficients	P-Value
ROA	13.843***	(0.008)	-7.384	0.334	18.515***	(0.002)
MTVBV	-0.000**	(0.013)	-0.000	0.149	-0.000*	(0.064)
BOARDS	81.975***	(0.007)	148.962***	0.001	103.895***	(0.001)
BOARDI	11.138***	(0.003)	21.027***	0.001	9.413***	(0.005)
GROWTHS	-0.190	(0.817)	-0.619	0.519	-1.316*	(0.091)
SIZE	12.762***	(0.000)	13.736***	0.000	16.485***	(0.000)
LEV	1.609	(0.541)	-8.039**	0.021	-4.721	(0.411)
Cons	-33.819***	(0.001)	-76.555***	0.000	-55.890***	(0.006)
R2	0.280	0.198	0.308			
F Statistics	889.550	(0.000)	7655.880	(0.000)	442.340	(0.000)

Note: "***, ** and *" signs indicate statistical significance at the 1%, 5% and 10% level, respectively

The findings of the emission, innovation, and resource variables given in Table 5 generally support the findings of the main model. In particular, the findings regarding the emission and resource dependent variables also show a significant effect of FP and CG qualities on non-financial information disclosures. In addition, the findings support the significant effect of company size on non-financial information disclosures within the scope of emission, innovation, and resource dependent variables. However, the findings of Table 5 show that FP do not have any significant effect on non-financial information disclosures only in terms of the innovation dependent variable.

5. CONCLUSION AND IMPLICATIONS

Today, it is necessary to act with a more environmental and social business logic instead of the traditional approach focused on making profits. For this reason, it is important for companies to focus on environmental and social issues in addition to their commercial activities in order to maintain their sustainability in a competitive global environment. In this direction, company management acts more strategically and adds sustainability issues to their management plans. Another issue that needs to be managed is the reporting of company management's efforts to focus on human, capital, and environmental activities to information users. Disclosure of non-financial information as well as financial information is becoming a focus of attention for both stakeholders and other information users. Since the disclosure of non-financial information can lead to

benefits such as ensuring customer trust, increasing company reputation, benefiting from tax deductions or exemptions, and contributing to company performance, corporate management tries to use it correctly.

The study is conducted to determine whether CG qualities and firm performance affect the disclosure of non-financial information. Within the scope of the study, data on companies located in European countries, which have more legal sanctions regarding environmental activities, is used. The sample created with the data of 443 companies in European countries, whose environmental scores can be accessed, is examined with panel data analysis. In the study, panel data analysis was used for the sample with both horizontal and time-section data for the years 2016–2020. Environmental score (ENVMNT) is included as a dependent variable in the basic study model. In addition, emission reduction score, resource usage score, and innovation score variables were used as dependent variables in the submodels created for robustness checks. The independent variables of the study are the ratio of period profit to lagged total assets (ROA), ratio of market value to book value (MTVBV), total number of board members (BOARDS), and ratio of the number of independent board members to total members (BOARDI). Sales growth rate (GROWTHS), logarithm of total assets (SIZE), and ratio of total debts to total assets (LEV) variables are included as control variables in the model.

The necessary preliminary tests of the study models are carried out, and study findings are obtained using the Driscoll-Kraay Standard Errors Resistant Estimator. Study findings reveal that the ROA variable positively affects non-financial information disclosures but may have a small negative impact on the MTVBV variable. Therefore, the H3 hypothesis regarding the effect of FP on non-financial information disclosures is accepted. Hypotheses H1 and H2 are also accepted, as the study findings show that they support the effect of both board size (BOARDS) and independent member ratio (BOARDI) on non-financial information disclosures. In addition, the findings indicate that large companies view non-financial information disclosures more positively. The findings of the submodel, in which emission, innovation, and resource variables are used as dependent variables, generally support the findings of the main model. Robustness tests particularly show a significant effect of CG attributes on non-financial information disclosures.

The study shows that companies that are large, have CG, or have high FP may be more focused on environmental activities and may disclose more non-financial information. The study offers various insights for company boards, academics, or legal regulators. The study contributes to studies on sustainability and CG. The lack of sufficient regulations for the disclosure of non-financial information and the fact that company efforts and disclosures regarding environmental activities are still insufficient indicate the limitations of the study. In the future, examples from developing countries can contribute to the field.

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CRYPTO RESERVES AND MONETARY REVOLUTION: TRUMPISM'S BOLD BET ON DIGITAL ASSETS

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ABSTRACT

Purpose- This study examines the unprecedented proposal to establish a U.S. Crypto Strategic Reserve incorporating major cryptocurrencies (Bitcoin, Ethereum, Ripple, Solana, and Cardano) as national reserve assets. It investigates whether this initiative represents a prescient adaptation to evolving financial technologies or a speculative gamble with national financial resources while analyzing the theoretical foundations, practical implications, and strategic considerations of integrating digital assets into sovereign monetary frameworks.

Methodology- The research employs a comprehensive mixed-methods approach combining qualitative theoretical analysis with quantitative assessment of market and economic data. An integrated theoretical framework draws from four key domains: monetary theory, institutional economics, financial innovation diffusion, and international political economy. Data collection includes historical comparative analysis of past monetary transitions, technical assessment of major cryptocurrencies, systematic policy document analysis, and financial market data evaluation focusing on volatility, correlation with traditional assets, and portfolio optimization modeling. Multiple strategic implementation scenarios are developed and assessed, accompanied by comprehensive stakeholder analysis.

Findings- The study reveals that cryptocurrencies currently fall short of meeting traditional reserve asset requirements due to extreme price volatility, limited liquidity during market stress, and inadequate regulatory frameworks. However, their integration offers potential benefits, including hedging inflation, reduced reliance on fiat reserves, and strategic positioning in the evolving digital financial landscape. Implementation challenges include regulatory uncertainty, constitutional questions about authority mechanisms, custody security requirements, and potential conflicts with traditional monetary policy objectives. The analysis identifies the Treasury's Exchange Stabilization Fund as a potential implementation mechanism while acknowledging governance and operational complexities.

Conclusion- While current limitations preclude immediate widespread adoption of cryptocurrencies as major reserve assets, technological developments and institutional adaptation suggest digital assets may eventually play a meaningful role in reserve management strategies. The study recommends a measured, incremental approach balancing innovation with stability, accompanied by robust regulatory frameworks and specialized governance structures to navigate this unprecedented monetary evolution.

Keywords: Cryptocurrency reserves, digital monetary policy, financial sovereignty, institutional adoption, monetary evolution, reserve diversification, technological disruption.
JEL Codes: E42, E58, F33, G28, O33.

1. INTRODUCTION: THE DAWN OF A NEW MONETARY PARADIGM

The integration of digital assets into the national monetary policy has emerged as one of the most transformative developments in modern economics. President Donald J. Trump's proposal to establish a U.S. Crypto Strategic Reserve signals not merely an incremental policy shift but a fundamental reimagining of how nations might incorporate decentralized currencies into their financial infrastructure. This initiative represents a potential inflection point in the evolution of global monetary systems, one that challenges conventional understanding of reserve assets while simultaneously offering new possibilities for economic sovereignty in the digital age. As Prasad (2021) observes, digital technologies are reshaping money, finance, and even the structure of the international monetary system in ways that would have been unimaginable a decade ago. The implications of such a policy innovation extend far beyond immediate market reactions or political calculations; they touch upon foundational questions regarding the nature of money itself, the future of international financial architecture, and America's position within an increasingly digitized global economy.

The proposal to establish a crypto reserve comes at a pivotal moment in monetary history. Traditional financial systems face unprecedented challenges: persistent inflation pressures, declining trust in institutions, technological disruption, and shifting geopolitical alignments. Against this backdrop, cryptocurrencies have matured from speculative curiosities into an asset class commanding trillions in market capitalization. Burniske and Tatar (2018) argue that crypto assets are not merely a new asset

class but represent a new paradigm in value creation and transfer. The executive decision to incorporate these assets into national reserves therefore represents not merely an adaptation to technological change but a reconsideration of fundamental monetary principles that have governed economic policy for generations. By examining both the opportunities and challenges presented by this initiative, we can better understand whether it represents a prescient adaptation to changing technological realities or a speculative gamble with national financial resources. The complexity of this question requires careful consideration of historical precedents, technological realities, economic principles, and geopolitical dynamics.

2. LITERATURE REVIEW: CRYPTO RESERVES AND MONETARY REVOLUTION

The literature on cryptocurrency reserves and their implications for monetary policy is both rich and multifaceted, drawing from diverse fields including monetary theory, institutional economics, financial innovation, and international political economy. This review synthesizes key insights from these fields to provide a comprehensive foundation for analyzing the potential establishment of a U.S. Crypto Strategic Reserve.

2.1. Evolution of Monetary Theory

The study draws heavily on classical and contemporary monetary theories to contextualize cryptocurrency reserves within the broader evolution of money. Menger's (1892) conception of money as emerging spontaneously from market interactions provides a theoretical foundation for understanding how digital assets have gained value despite lacking centralized backing. This spontaneous order perspective is further developed through Hayek's (1976) arguments for the denationalization of money, which presciently anticipated some characteristics of decentralized cryptocurrencies. Hayek's observation that "private money has in history proved singularly successful, and public money has almost invariably been abused" frames the theoretical tension at the heart of incorporating private cryptocurrencies into public reserves.

The literature reveals a fundamental conceptual divide between the Chartalist perspective articulated by Knapp (1924) and developed by Modern Monetary Theorists like Wray (2015), which emphasizes the primacy of state power in establishing money's value, and the more market-oriented views represented by Selgin and White (1994), who argue that the forces of competition and entrepreneurship in the market for money can generate an efficient monetary order. The integration of cryptocurrencies into sovereign reserves represents a fascinating hybrid approach that challenges both perspectives.

Eichengreen's (2019) historical analysis of international monetary systems provides critical context for understanding transitional dynamics. He notes that "the history of the international monetary system is one of recurrent crises," suggesting that transitions between monetary regimes are inherently fraught with uncertainty and conflict. This historical lens helps frame the potential challenges in incorporating digital assets into established reserve frameworks.

2.2. Institutional Economics and Governance

The literature on institutional economics provides valuable frameworks for analyzing the governance challenges presented by cryptocurrency reserves. North's (1990) definition of institutions as "the rules of the game in a society" highlights the challenge of integrating decentralized cryptocurrencies within centralized institutional frameworks. The study effectively applies this perspective to analyze how formal rules, and informal constraints might evolve to accommodate cryptocurrency reserves within existing financial infrastructure.

Ostrom's (2015) work on governing common resources offers particularly relevant insights, demonstrating that "communities of individuals have relied on institutions resembling neither the state nor the market to govern some resource systems with reasonable degrees of success over extended periods of time." This perspective helps conceptualize how blockchain governance might complement or conflict with traditional monetary authorities, a critical consideration for managing hybrid reserve systems.

The literature on public choice theory, particularly Buchanan and Tullock's (1962) analysis of constitutional economics, provides a framework for understanding the governance challenges and potential principal-agent problems in managing a cryptographically secured reserve system. Their observation that "the relevant difference between markets and politics does not lie in the kinds of values/interests that people pursue, but in the conditions under which they pursue their various interests" illuminates the incentive alignment issues that would shape the institutional design of cryptocurrency reserves.

2.3. Financial Innovation and Technology Adoption

The study effectively synthesizes literature on innovation diffusion and technology adoption to analyze institutional cryptocurrency acceptance. Rogers' (2003) diffusion of innovations theory provides a conceptual framework for understanding how cryptocurrency adoption might progress from early adopters to mainstream implementation. His definition of diffusion as "the process by which an innovation is communicated through certain channels over time among

the members of a social system" helps predict the potential adoption pathway for cryptocurrency reserves across different institutional contexts.

Disruptive innovation theory positions cryptocurrencies as potentially transformative to existing monetary systems. As disruptive technologies introduce value propositions previously unavailable, this perspective effectively highlights the unique potential of programmable digital assets to fundamentally reshape reserve management practices.

The technology acceptance models developed by Davis (1989) and Venkatesh et al. (2003) provide empirical insights into factors influencing institutional adoption. Davis's finding that "perceived usefulness was 50 percent more influential than ease of use in determining usage" suggests that the functional advantages of cryptocurrencies may ultimately prove more decisive than concerns about their technical complexity, an important consideration for institutional adoption strategies.

2.4. International Political Economy and Reserve Currency Competition

The literature on international political economy and reserve currency competition provides essential context for understanding how cryptocurrency reserves might influence global monetary relationships. Cohen's (2019) framework for analyzing international currency competition offers valuable concepts for understanding potential shifts in global monetary hierarchy. His argument that "currency power can matter greatly—not just for economic welfare but for broader questions of power and autonomy in international relations as well" highlights the geopolitical stakes of cryptocurrency reserve adoption.

Strange's (1988) structural power theory helps analyze how control over financial infrastructure translates into geopolitical influence. Her definition of structural power as "the power to decide how things shall be done, the power to shape frameworks within which states relate to each other, relate to people, or relate to corporate enterprises" provides a lens for assessing how cryptocurrency reserve adoption might reshape international financial governance.

Eichengreen et al. (2018) provide historical context for situating cryptocurrency reserves within longer-term patterns of international monetary evolution. Their observation that "political considerations and complementarities—not just economic factors of network effects and incumbency advantages—are central to currency status" highlights the complex interplay of economic, technological, and geopolitical factors that would influence cryptocurrency reserve adoption.

2.5. Cryptocurrency Characteristics and Reserve Asset Suitability

The literature on cryptocurrencies themselves reveals diverse approaches to blockchain technology and digital asset design relevant to reserve management. Ammous (2018) characterizes Bitcoin as "the first digital system to successfully transfer value from one person to another across distances without relying on a trusted third party," highlighting its potential as a digital analog to gold in reserve portfolios.

Antonopoulos's (2017) analysis of Ethereum emphasizes its programmability, describing it as "a generic platform for decentralized applications...designed to be flexible and adaptable to many different uses." This programmability introduces novel capabilities for reserve assets, potentially enabling complex financial operations through smart contracts.

The literature on cryptocurrency market structure, particularly Burniske and Tatar's (2018) observation that "each cryptoasset has unique liquidity characteristics that must be understood when developing an investment thesis," highlights important considerations for reserve management. This perspective underscores the need for tailored approaches to different digital assets within a diversified cryptocurrency reserve.

Blockchains introduce new governance structures that enable people to coordinate their economic activities through code rather than legal institutions, highlighting the regulatory challenges associated with cryptocurrency reserves. This shift from traditional regulatory frameworks to code-based governance creates a significant challenge for their effective implementation.

2.6. Gaps in the Literature

Despite the extensive theoretical groundwork laid by existing scholarship, significant gaps persist in understanding the practical and strategic implications of cryptocurrency reserves. While research has explored the theoretical underpinnings of digital assets within financial systems, critical dimensions remain insufficiently examined, particularly concerning their integration into sovereign monetary frameworks.

One of the most pressing gaps is the lack of rigorous analysis regarding the legal and constitutional mechanisms through which cryptocurrency reserves could be formally established within existing governmental and financial structures. The absence of clear regulatory and legislative pathways creates uncertainty, making it imperative to explore how sovereign entities might navigate these complexities while maintaining monetary stability and institutional integrity. Furthermore, empirical research on cryptocurrency performance across diverse economic conditions remains limited. The volatility of

digital assets raises fundamental questions about their resilience during financial crises and their correlation—or lack thereof—with traditional asset classes. Understanding these dynamics is essential for evaluating whether cryptocurrencies can function as reliable reserve assets or whether their speculative nature undermines their suitability for sovereign reserves.

Another area requiring further exploration is the security and governance of large-scale cryptocurrency holdings. While institutional investors have developed sophisticated custody solutions, there is scant research on how these frameworks could be adapted for national reserves. Secure storage, protection against cyber threats, and governance arrangements for sovereign cryptocurrency holdings demand deeper scrutiny to ensure robust risk mitigation strategies.

Additionally, the interaction between cryptocurrency reserves and traditional monetary policy tools remains underdeveloped in the literature. As central banks grapple with evolving digital financial ecosystems, the extent to which cryptocurrency holdings might complement—or disrupt—conventional monetary instruments such as interest rate adjustments and open market operations remain an open question. Addressing this theoretical tension is crucial for understanding the broader implications of digital assets on macroeconomic stability.

Perhaps most notably, there is an absence of comprehensive frameworks for managing the extreme volatility of cryptocurrencies within stable reserve portfolios. The unpredictable fluctuations in digital asset valuations pose significant challenges for sovereign wealth management, necessitating innovative approaches to risk mitigation and portfolio optimization. Without a well-defined strategy for integrating these assets into national reserves, governments may struggle to harness their potential benefits while safeguarding against destabilizing financial shocks.

As Prasad (2021) aptly notes, “digital technologies are reshaping money, finance, and even the structure of the international monetary system in ways that would have been unimaginable even a decade ago.” This transformation underscores the urgency of advancing both theoretical and empirical research to fully comprehend the implications of cryptocurrency reserves within national and global monetary systems. The unprecedented integration of decentralized digital assets into sovereign finance demands a more nuanced and interdisciplinary approach, drawing from monetary theory, institutional economics, financial innovation, and international political economy. Addressing these research gaps is essential for constructing a coherent and forward-looking framework that can inform policymaking and strategic financial planning in the digital age.

3. RESEARCH METHODOLOGY

This study employs a comprehensive mixed-methods research design to examine both the theoretical and practical implications of establishing a U.S. Crypto Strategic Reserve—an initiative that would incorporate major cryptocurrencies as national reserve assets. At the heart of this inquiry lies a fundamental question: Does such a strategic move represent a prescient adaptation to evolving financial technologies, or is it a speculative gamble with national financial resources? To address this critical issue, the study integrates qualitative theoretical analysis with quantitative assessment of market and economic data, ensuring a balanced approach that combines conceptual depth with empirical rigor.

The research unfolds in two interdependent phases. The first phase involves the construction of an integrated theoretical framework, drawing upon four key domains: Monetary Theory, Institutional Economics, Financial Innovation Diffusion, and International Political Economy. This interdisciplinary foundation allows for a nuanced exploration of the unprecedented intersection between state monetary authority and decentralized digital assets. The study applies Rogers' (2003) diffusion theory, and technology acceptance models (Davis, 1989; Venkatesh et al., 2003) to analyze the adoption pathways for cryptocurrency reserves. It further incorporates insights from institutional economics by drawing upon North's (1990) institutional framework, Ostrom's (2015) models of common resource governance, and Buchanan and Tullock's (1962) public choice theory to evaluate the governance challenges inherent in integrating decentralized assets within centralized financial institutions. The framework is further strengthened by perspectives from International Political Economy, particularly Cohen's (2019) analysis of currency competition, Strange's (1988) structural power theory, and Eichengreen's work on international monetary evolution, which together illuminate the geopolitical ramifications of cryptocurrency reserves. Finally, the study engages with monetary theory, considering classical and contemporary perspectives from Menger (1892), Hayek (1976), Knapp (1924), and modern monetary theorists like Wray (2015), offering critical insights into the evolving nature of money and the potential role of digital assets as sovereign reserves.

To complement this theoretical foundation, the study employs a multifaceted data collection strategy, incorporating historical comparative analysis, technical assessment of cryptocurrencies, policy document analysis, and financial market data evaluation. The historical comparative analysis investigates past monetary transitions, such as the shift from the gold standard to fiat currency systems, the evolution and eventual collapse of the Bretton Woods framework, and previous instances of reserve asset diversification. Through a systematic examination of primary and secondary historical sources, the study identifies patterns, challenges, and precedents relevant to cryptocurrency adoption. For instance, the abandonment of the gold standard in the twentieth century provides critical insights into the political and economic resistance that often accompanies monetary regime shifts, as well as the uncertainties associated with emergent financial systems (Eichengreen, 2019).

A rigorous technical assessment is conducted on major cryptocurrencies—Bitcoin, Ethereum, Ripple, Solana, and Cardano—focusing on their security models, scalability characteristics, governance structures, market dynamics, and regulatory status. This evaluation entails both qualitative analysis of technical whitepapers and quantitative analysis of network performance metrics. For example, Bitcoin's proof-of-work consensus mechanism is scrutinized for its security guarantees and energy consumption, while Ethereum's transition to a proof-of-stake model is examined in relation to scalability improvements and environmental sustainability (Antonopoulos, 2017).

In parallel, a systematic policy document analysis is undertaken to assess governmental positions on cryptocurrency reserves. This includes a structured content examination of U.S. Treasury Department policies on reserve management, Federal Reserve statements regarding digital currencies, congressional legislative proposals on cryptocurrency regulation, executive branch communications concerning digital assets, and international monetary authorities' perspectives on sovereign cryptocurrency holdings. A structured coding framework is applied to identify key themes, policy orientations, and potential avenues for implementation. Notably, the Treasury Department's Exchange Stabilization Fund (ESF) is analyzed as a possible institutional mechanism for acquiring and managing cryptocurrency reserves, given its existing mandate to operate in foreign exchange markets and financial instruments (Hunnicutt, 2025).

The financial market data analysis component further strengthens the empirical foundation of this study. Quantitative assessments include historical price volatility analysis, correlation analysis with traditional reserve assets such as gold and government securities, liquidity depth measurements across major exchanges, stress testing under various economic scenarios, and portfolio optimization modeling incorporating cryptocurrency allocations. Drawing from market data spanning 2017 to 2024, this analysis evaluates Bitcoin's historical price fluctuations to assess its stability as a reserve asset while examining its correlation with gold to determine its potential role as a hedge against inflation (Burniske & Tatar, 2018).

A key aspect of this study is the analytical evaluation of multiple strategic scenarios for cryptocurrency reserve implementation. Four distinct scenarios are developed and assessed: (1) an Incremental Adoption Scenario, wherein crypto assets are gradually accumulated as a minor reserve component; (2) a Strategic Holdings Scenario, in which substantial positions are acquired to enhance geopolitical and technological leverage; (3) a Crisis Response Scenario, where cryptocurrency reserves serve as financial stabilizers during market disruptions; and (4) a Policy Leverage Scenario, where crypto holdings are utilized as instruments of influence over global digital asset governance. Each scenario is meticulously examined in terms of projected economic outcomes, implementation challenges, and strategic implications. For instance, the Crisis Response Scenario is explored for its potential to provide liquidity during economic downturns, while the Policy Leverage Scenario is evaluated for its capacity to shape international regulatory norms in the digital asset space.

To further enrich the study's findings, a comprehensive stakeholder analysis is conducted, mapping key actors likely to influence or be affected by the establishment of cryptocurrency reserves. This includes domestic financial institutions, international monetary authorities, major cryptocurrency projects and foundations, regulatory bodies, congressional committees, corporate treasury departments, and key international actors. The analysis identifies areas of potential support, opposition, and collaboration. For example, domestic financial institutions may endorse cryptocurrency reserves as a diversification tool, while international monetary authorities could perceive the initiative as a challenge to the global dominance of the U.S. dollar (Cohen, 2019).

Institutional feasibility is also a critical dimension of this study. Various implementation mechanisms are evaluated, including the potential role of the Treasury Department's Exchange Stabilization Fund, Federal Reserve operations, special-purpose vehicles or public-private partnerships, congressional appropriations, and international coordination frameworks. Each mechanism is analyzed for its legal feasibility, operational viability, and governance implications. For instance, public-private partnerships offer the advantage of combining governmental oversight with private-sector technical expertise but also raise concerns about transparency and accountability (North, 1990).

Recognizing the importance of methodological rigor, the study employs multiple validation measures to ensure reliability and robustness. These include theoretical triangulation, methodological triangulation, researcher triangulation, member checking with subject matter experts, and reflexivity protocols to mitigate potential biases. However, the study acknowledges several inherent limitations, such as the relatively short historical data on cryptocurrency performance across diverse economic conditions, the rapidly evolving regulatory landscape, the absence of direct historical precedents for sovereign cryptocurrency reserves, and the technical complexity of digital asset networks requiring specialized expertise.

Ethical considerations are also carefully addressed in line with established guidelines for financial and policy research. The study emphasizes transparency regarding data sources and analytical methods, acknowledges inherent uncertainties in projections, considers the broader societal implications of its policy recommendations, and discloses any researcher affiliations with relevant organizations.

Through this rigorous and multidimensional methodological approach, the study aims to provide a comprehensive and well-substantiated examination of the feasibility, risks, and strategic considerations surrounding the potential establishment of a

U.S. Crypto Strategic Reserve. By bridging theoretical inquiry with empirical analysis, it seeks to contribute valuable insights to both academic discourse and policymaking in the rapidly evolving landscape of digital finance.

4. DISCUSSION

4.1. The Evolution of Reserve Assets: From Gold to Digital Scarcity

Throughout monetary history, the concept of reserve assets has undergone several transformations, each reflecting the economic and technological realities of its era. The gold standard that dominated the 19th and early 20th centuries gave way to the Bretton Woods system, which itself evolved into the current framework of fiat currencies backed primarily by government authority and economic output. In each transition, the fundamental characteristics sought in reserve assets remained relatively constant: stability, liquidity, universal acceptability, and resistance to debasement.

Eichengreen (2019) chronicles how the gold standard had been a creature of its time, dependent on specific political and economic conditions that eventually eroded. These historical transitions were seldom smooth or uncontested. The abandonment of the gold standard prompted fierce debates about monetary stability and government authority. Similarly, the collapse of Bretton Woods in the early 1970s generated profound uncertainty about the future of international monetary cooperation. In both cases, powerful economic forces eventually overwhelmed established systems, necessitating adaptation rather than permitting stasis. The current exploration of cryptocurrency reserves may represent a similar moment of systemic evolution—a recognition that technological innovation has created new monetary possibilities that cannot be indefinitely excluded from institutional frameworks.

Traditionally, national reserves have comprised gold, foreign currencies (particularly the U.S. dollar), and government securities. These assets serve multiple functions: facilitating monetary policy execution, stabilizing exchange rates during periods of volatility, providing confidence in national currencies, and offering financial buffers during economic crises. The introduction of cryptocurrencies into this established framework raises profound questions about how digital assets might complement or potentially supplant these traditional reserve components.

The specific digital assets identified for inclusion in Trump's proposed reserve—Bitcoin (BTC), Ethereum (ETH), Ripple (XRP), Solana (SOL), and Cardano (ADA)—represent diverse approaches to blockchain technology and cryptocurrency design. Each brings distinct technological advantages, governance models, and market characteristics that merit individual consideration.

Bitcoin, the pioneering cryptocurrency, offers a digital analogue to gold through its fixed supply of 21 million coins and energy-intensive mining process. Ammous (2018) claims that Bitcoin is “the first digital system to successfully transfer value from one person to another across distances without relying on a trusted third party.” Its decade-long market dominance provides liquidity advantages unmatched by other digital assets, while its decentralized governance model resists capture by any single entity or jurisdiction. As the first blockchain implementation, Bitcoin's technical limitations in transaction speed and programmability are counterbalanced by its unprecedented security and network effects, qualities that align with traditional reserve asset priorities.

Ethereum distinguishes itself through robust programmability, enabling complex financial operations through smart contracts. As Antonopoulos (2017) explains, Ethereum is “a generic platform for decentralized applications...designed to be flexible and adaptable to many different uses.” The network's transition from proof-of-work to proof-of-stake consensus has addressed environmental concerns while introducing potential yield generation through staking—a novel characteristic for reserve assets. Ethereum's expansive ecosystem of decentralized applications reflects its position as critical infrastructure rather than merely a store of value, potentially offering strategic advantages beyond simple asset appreciation.

Ripple's XRP was designed specifically for institutional financial transactions, emphasizing settlement speed and cost efficiency over absolute decentralization. Its inclusion signals recognition of cryptocurrencies' utility in cross-border payment infrastructure, an area of growing strategic importance as digital trade expands globally. However, Ripple's history of regulatory challenges highlights the legal uncertainties that still surround many digital assets.

Solana's architecture prioritizes transaction throughput and scalability, achieving speeds that rival traditional payment networks while maintaining blockchain security guarantees. This capacity for high-frequency, low-cost transactions positions Solana as a potential infrastructure for micropayments and financial inclusion initiatives—capabilities increasingly relevant to national economic competitiveness in digital markets.

Cardano's methodical, research-driven development process emphasizes formal verification and academic rigor, potentially offering enhanced security and predictability—qualities traditionally valued in reserve assets. Its focus on developing economies and financial inclusion also aligns with strategic interests in expanding American influence in emerging markets.

This diversified approach to crypto reserve composition suggests an appreciation for the varied utilities and characteristics these assets bring to a national stockpile. Rather than selecting a single cryptocurrency as the “digital gold” of the future, the

proposed reserve acknowledges the complex ecosystem of digital assets, each with unique technological attributes and market positioning. This diversification strategy potentially offers benefits like those sought in traditional reserve management: risk distribution, exposure to various growth vectors, and resilience against sector-specific vulnerabilities.

The inclusion of these cryptocurrencies in a national reserve represents a significant legitimization of digital assets as valuable financial instruments. Their decentralized nature presents opportunities for diversifying reserve holdings while potentially reducing reliance on fiat-based reserves controlled by other sovereign nations or central banks. This could, in theory, insulate the United States from certain forms of inflationary pressure and currency devaluation risks that accompany exclusively fiat-based reserves.

4.2. Macroeconomic Implications: Navigating the Digital Financial Frontier

From a macroeconomic perspective, the establishment of a national crypto reserve could signal a profound shift in institutional confidence toward decentralized financial instruments. By codifying cryptocurrencies as legitimate components of national reserves, the United States would effectively be acknowledging their role not merely as speculative investments or fringe technologies, but as genuine stores of value with strategic importance for national economic security. This institutional recognition would likely accelerate the integration of cryptocurrencies into mainstream financial services, potentially reducing the risk premium currently associated with digital assets. Vigna and Casey (2016) observe that "the marriage of cryptography and currency creates a uniquely powerful tool for managing twenty-first-century globalization." As regulatory uncertainty has consistently been cited as a primary obstacle to institutional adoption, the clear governmental endorsement implied by reserve status could catalyze capital flows into the cryptocurrency sector. This dynamic creates a potential positive feedback loop: governmental holdings legitimize the asset class, encouraging private sector adoption, which further entrenches the assets' importance and potentially increases their value, thereby validating the initial governmental investment.

The potential benefits of such a shift are multifaceted. Digital assets might serve as effective inflation hedges in an era of unprecedented monetary expansion by central banks worldwide. Their programmatically limited supply offers protection against the debasement risks inherent in fiat currencies. Their borderless nature could facilitate international transactions without the friction of currency conversion or correspondent banking networks. Furthermore, the embrace of cryptocurrency at the national level could accelerate financial inclusion by demonstrating governmental comfort with technologies that have the potential to bank the unbanked and reduce financial intermediation costs. However, this development also introduces significant challenges that would require careful management. The notorious volatility of cryptocurrency markets poses fundamental questions about the stability of reserves that include such assets. While traditional reserves typically prioritize stability overgrowth potential, cryptocurrencies have historically exhibited price movements that would be unacceptable in conventional reserve management frameworks. Bitcoin, for instance, has experienced multiple drawdowns exceeding 70% throughout its history—volatility that would severely compromise the reliability of reserves during economic crises when stability is most crucial.

This volatility could complicate balance sheet valuations, create unpredictable fiscal effects, and potentially undermine public confidence if not properly addressed through risk management strategies. These might include options-based hedging programs, strategic diversification across asset classes, or the establishment of volatility absorption mechanisms that smooth the impact of market fluctuations on reserve valuations. The implementation of such strategies would require sophisticated financial engineering and potentially new accounting frameworks for national assets.

Regulatory oversight adds another layer of complexity. The decentralized and often pseudonymous nature of many cryptocurrencies challenges traditional financial surveillance mechanisms. Blockchains introduce new governance structures that enable people to coordinate their economic activities through code rather than legal institutions. Integrating these assets into national reserves would require the creation of new compliance frameworks that balance the innovative aspects of blockchain technology with concerns related to financial crime, sanctions enforcement, and monetary sovereignty. This tension between the inherent characteristics of cryptocurrencies and traditional regulatory objectives presents a fundamental challenge that will influence implementation strategies.

Secure custody of digital assets at the national level would require sophisticated technical solutions far beyond the security measures currently employed for traditional reserves. The immutable nature of blockchain transactions means that security breaches could result in permanent, irrecoverable losses. Consequently, multi-signature authorization protocols, cold storage solutions, and distributed custody arrangements would likely feature prominently in any implementation strategy. These technical requirements introduce operational complexities and potential points of failure that must be mitigated through redundancy, expertise development, and rigorous security auditing.

Beyond these technical considerations lies a broader geopolitical calculus. The move could strengthen the United States' position in the evolving global financial order by signaling a pro-crypto regulatory framework at the highest level of government. This may encourage both domestic and foreign investment in U.S.-based blockchain enterprises, potentially

accelerating financial innovation within American borders. Nations that have traditionally sought to reduce their exposure to the U.S. dollar might view this development with interest, potentially seeing American crypto adoption as either a competitive threat or an opportunity for a more balanced international monetary system. However, increased adoption of cryptocurrencies as reserve assets could also introduce new forms of systemic risk into national monetary reserves. The relatively brief history of digital assets means there is limited empirical evidence regarding their performance during varied economic conditions or their correlation with traditional financial assets during crises. This uncertainty necessitates careful consideration of portfolio allocation and risk mitigation strategies that may differ substantially from conventional reserve management approaches.

4.3. Regulatory Architecture and Institutional Frameworks

The legal and institutional architecture that would support a U.S. Crypto Strategic Reserve remains a subject of significant uncertainty and debate. The mechanism through which such a reserve would be established, funded, and governed raises complex questions of administrative authority, legislative oversight, and constitutional boundaries that must be resolved before implementation.

Constitutional considerations loom large in this discussion. The Appropriations Clause requires that federal expenditures be specifically authorized by Congress, potentially constraining executive authority to unilaterally establish and fund such a reserve. Conversely, the President's foreign affairs powers and the Treasury's existing authorities regarding monetary stabilization might provide legal pathways for implementation without explicit new legislation. This constitutional tension reflects broader questions about separation of powers in economic policy that have periodically surfaced throughout American history.

If structured through the U.S. Treasury's Exchange Stabilization Fund (ESF), the initiative might potentially circumvent the need for specific congressional authorization. Established in 1934, the ESF grants the Treasury Secretary significant discretion to deal in foreign currencies and monetary instruments to promote exchange rate stability. An expansive interpretation of this authority might include the acquisition of digital assets, particularly those with significant international usage or potential impact on dollar exchange rates. This approach would expedite implementation while raising legitimate concerns about executive overreach in monetary policy.

Conversely, seeking explicit legislative endorsement through an act of Congress would grant the initiative broader democratic legitimacy and potentially more stable funding mechanisms. However, this path would inevitably introduce political and bureaucratic hurdles that could delay implementation or result in compromised design features. The current polarized political environment further complicates this calculus, as cryptocurrency policy has not yet solidified along traditional partisan lines.

The governance structure of the reserve presents additional challenges. Traditional reserve management typically falls under central bank authority with varying degrees of independence from political influence. The decentralized nature of cryptocurrencies, however, creates tension with these established governance models. Who would make decisions regarding portfolio allocation, rebalancing triggers, or strategic sales? What transparency requirements would apply? How would potential conflicts of interest be managed, particularly given the involvement of private sector expertise in blockchain technology?

One innovative proposal involves creating a specialized public-private partnership structure for reserve management. This would combine governmental oversight with private sector technical expertise, potentially creating a more agile and knowledgeable management framework than traditional bureaucratic models alone could provide. However, such arrangements introduce novel accountability questions and potential principal-agent problems that would require careful institutional design to address.

Another proposed approach involves utilizing cryptocurrencies seized in law enforcement actions as the initial foundation for the reserve. This method would sidestep direct appropriations while potentially addressing public concerns about using taxpayer funds for cryptocurrency acquisition. However, it would likely result in an unbalanced initial portfolio heavily weighted toward Bitcoin, the dominant cryptocurrency in illicit transactions. Additionally, this approach raises questions about due process and the proper disposition of forfeited assets.

Regardless of the specific implementation mechanism chosen, transparency and governance frameworks must be established to prevent misuse and ensure stability. Clear mandates regarding reserve objectives, permissible activities, risk tolerances, and reporting requirements would be essential to maintain public confidence and market stability. These governance mechanisms must balance operational flexibility with appropriate oversight, particularly given the technical complexity and rapid evolution of digital asset markets.

4.4. Monetary Policy Implications and the Federal Reserve's Evolving Role

The implications of a crypto reserve for monetary policy are profound and multifaceted. A national reserve partially backed by digital assets would introduce new dimensions to interest rate dynamics, liquidity provisions, and the Federal Reserve's broader policy toolkit. The relationship between cryptocurrency holdings and monetary aggregates would require reconsideration, potentially necessitating new frameworks for understanding money supply and its impact on inflation.

Traditional monetary policy operates primarily through interest rate adjustments and quantitative measures that expand or contract currency availability. Cryptocurrencies introduce novel considerations into this framework. Fixed-supply assets like Bitcoin operate on fundamentally different principles than elastic fiat currencies, creating potential friction with countercyclical monetary interventions. Programmable assets like Ethereum offer capabilities for conditional transactions and automated policy implementation that have no clear precedent in conventional monetary instruments.

Ammous (2018) argues that “the fundamental scarcity of Bitcoin makes it the only working alternative to central bank money.” This perspective, if shared by policymakers, would suggest that crypto reserve accumulation represents a hedging strategy against the potential debasement of fiat currencies rather than a complement to existing monetary tools. However, the volatility of cryptocurrencies raises questions about their reliability as policy instruments during economic crises.

The effect on private sector cryptocurrency adoption and investment patterns could reshape capital markets significantly. Institutional investors might interpret government holdings as implicit endorsement, potentially accelerating mainstream financial integration of digital assets. Tapscott and Tapscott (2016) suggest that “blockchain technology will unleash new institutional forms and business models that we cannot even fathom now.” This could blur traditional boundaries between public and private monetary spheres, creating feedback loops between government reserve management decisions and private market behaviors.

If managed effectively, a crypto reserve could offer strategic flexibility in monetary policy implementation. During periods of dollar strength, for instance, the reserve could accumulate digital assets without exerting excessive downward pressure on the currency. Conversely, during periods of dollar weakness or liquidity stress, cryptocurrency holdings could potentially be monetized to support intervention operations without depleting traditional foreign currency reserves. However, potential conflicts may arise between the Federal Reserve's traditional monetary objectives and the market dynamics of decentralized cryptocurrencies. Central banks typically aim for price stability and moderate, predictable inflation rates. Cryptocurrencies, particularly Bitcoin, often embody deflationary monetary philosophies that stand in tension with these objectives. Resolving these philosophical and practical contradictions would require innovative approaches to financial governance and monetary theory.

The intersection with fiscal policy adds another layer of complexity. If cryptocurrency holdings generate significant appreciation, how would these gains be recognized, utilized, or distributed? Would they flow to the general treasury, remain sequestered within the reserve for reinvestment, or potentially fund specific national priorities? These questions touch upon fundamental issues of intergenerational equity, democratic control of national assets, and the proper boundaries between monetary and fiscal authorities.

4.5. International Implications: Competition and Cooperation in the Digital Age

The establishment of a U.S. Crypto Strategic Reserve would reverberate across the international monetary landscape, potentially triggering responses from both allies and competitors. Nations already exploring central bank digital currencies (CBDCs) or cryptocurrency regulations would likely accelerate their efforts in response to American leadership in this domain. This could catalyze a period of rapid innovation in monetary policy globally, with nations competing to establish favorable regulatory environments for digital asset development. Cohen (2019) argues that “currency competition has always been an important dimension of international relations.” The introduction of digital assets into this competitive landscape adds new dimensions to traditional currency rivalry. For traditional U.S. allies, the initiative might present both opportunities and challenges. European nations with strong financial technology sectors could benefit from increased regulatory clarity and institutional acceptance of cryptocurrencies. However, concerns about dollar dominance extending into the digital realm might accelerate efforts to establish competing frameworks, particularly within the eurozone. The European Central Bank, already advancing its digital euro project, might interpret American cryptocurrency adoption as a competitive challenge requiring an accelerated response.

China's reaction would be particularly significant given its advanced CBDC development and generally restrictive approach to private cryptocurrencies. A U.S. embrace of decentralized digital assets would stand in stark philosophical contrast to China's centralized digital yuan, potentially framing a new dimension of great power competition around the nature of digital money itself. This could evolve into a fundamental contest between state-controlled and market-driven approaches to digital currency, with profound implications for privacy, surveillance capabilities, and individual economic liberty.

Developing nations might view the U.S. initiative through multiple lenses. On the one hand, countries that have suffered from currency instability or limited access to dollar funding markets might welcome the legitimization of alternative reserve assets. The potential for disintermediated access to global financial infrastructure through blockchain technology could reduce dependence on traditional banking channels often dominated by Western institutions. On the other hand, concerns about a new form of monetary dependence or technological colonialism could drive resistance or regional alternatives, particularly in areas where cryptocurrency adoption has already taken root organically.

International financial institutions would face pressure to adapt their frameworks to accommodate this evolution in reserve asset composition. The International Monetary Fund's Special Drawing Rights (SDRs), for instance, currently comprise a basket of major fiat currencies. Would digital assets eventually merit inclusion? How would cryptocurrency reserves factor into assessments of national financial stability or creditworthiness? These questions highlight the far-reaching institutional adjustments that would follow from a major power's formal adoption of cryptocurrencies as reserve assets.

The initiative might also accelerate the development of interoperability standards between different blockchain networks and between traditional and digital financial systems. As a major stakeholder in both ecosystems, the United States would have considerable influence in shaping these standards—potentially ensuring alignment with American strategic interests and values. This standard-setting power could prove as important as direct asset holdings in determining long-term geopolitical advantages in digital finance.

4.6. Market Structure and Liquidity Considerations

The market structure implications of a national crypto reserve are substantial and merit careful consideration. The cryptocurrency market, while growing rapidly, remains relatively insignificant compared to traditional financial markets. As of early 2025, the total market capitalization of all cryptocurrencies hovers around $3 trillion—significant, but still a fraction of global equity, bond, or forex markets. A substantial national reserve accumulating these assets could exert outsized influence on market prices, potentially distorting valuations and creating moral hazard.

Burniske and Tatar (2018) observe that “each cryptoasset has unique liquidity characteristics that must be understood when developing an investment thesis.” This market impact concern necessitates thoughtful acquisition strategies that minimize price disruption while building meaningful positions. Dollar-cost averaging approaches, over-the-counter (OTC) transactions with institutional counterparties, and specialized execution algorithms would likely feature prominently in implementation plans. Even with such measures, the reserve's accumulation phase would inevitably influence market dynamics, potentially creating price premiums that dissipate once acquisition goals are achieved.

Liquidity concerns are particularly salient. While Bitcoin and Ethereum enjoy relatively robust trading volumes, other cryptocurrencies mentioned for inclusion in the reserve exhibit more limited liquidity profiles. Large-scale government purchases or sales could trigger significant price volatility, potentially undermining the very stability that reserves are intended to provide. This concern necessitates careful consideration of acquisition strategies, position sizing, and market impact minimization techniques.

The custody infrastructure for institutional-scale cryptocurrency holdings continues to evolve, with various models offering different tradeoffs between security, accessibility, and governance. Cold storage solutions provide maximum security but limited operational flexibility. Multi-signature arrangements offer distributed control but increased operational complexity. Hardware security modules (HSMs) and specialized custody providers offer professional security guarantees but introduce counterparty risks absent in self-custody arrangements. The selection and implementation of appropriate custody models for national-scale holdings would require sophisticated technical expertise and rigorous security protocols. Furthermore, the technological underpinnings of different cryptocurrencies create varying considerations for national reserve managers. Proof-of-Work cryptocurrencies like Bitcoin raise questions about energy consumption and mining concentration. Proof-of-stake assets like the post-Merge Ethereum, Cardano, and Solana introduce considerations regarding validator selection, delegation strategies, and potential yield generation through staking. These technological distinctions would necessitate tailored management approaches for different components of the reserve.

The unique technological characteristics of crypto assets also create novel operational concerns for reserve management. Hard forks, airdrops, governance proposals, and other blockchain-specific events require active management decisions that have no clear parallels in traditional reserve operations. Developing institutional capacity to address these situations would require specialized expertise not typically found in government financial institutions.

5. CRYPTOCURRENCY RESERVES IN THE GLOBAL FINANCIAL ECOSYSTEM: CHALLENGES AND OPPORTUNITIES

The advent of cryptocurrencies has precipitated a paradigm shift in how we conceptualize money, value, and financial systems. These digital assets have evolved from experimental technologies to significant components of the global financial ecosystem, challenging traditional notions of monetary sovereignty and reserve management. As cryptocurrencies gain mainstream acceptance, central banks, financial institutions, and policymakers face the complex task of determining their

appropriate role within established financial frameworks (Brunnermeier et al., 2019). The decentralized nature of many cryptocurrencies offers potential advantages in terms of censorship resistance and reduced counterparty risk yet simultaneously presents profound challenges to regulatory oversight and financial stability.

The prospect of cryptocurrencies serving as reserve assets represents a particularly intriguing evolution in global finance. Traditionally, reserve assets have been characterized by stability, liquidity, and universal acceptability—qualities that most cryptocurrencies have yet to consistently demonstrate (Feyen et al., 2024). Nevertheless, the increasing digitalization of finance and the emergence of new technological capabilities have prompted thoughtful consideration of how cryptocurrencies might complement or potentially transform conventional reserve management strategies. This exploration exists against a backdrop of geopolitical realignments and technological innovations that collectively suggest the possibility of significant changes to the international monetary system.

5.1. Central Bank Digital Currencies (CBDCs) and Cryptocurrency Reserves

The development of Central Bank Digital Currencies (CBDCs) represents a significant institutional response to the emergence of cryptocurrencies. Auer et al. (2021) articulate three essential design principles for CBDCs: they must support rather than impair monetary policy transmission, they should promote coexistence with cash and other forms of money, and they must safeguard private sector innovation and competition. These principles reflect central banks' cautious approach to digital currency implementation, prioritizing financial stability and monetary policy effectiveness over rapid technological adoption.

The contrast between centralized CBDCs and decentralized cryptocurrencies illuminates fundamental questions about financial system architecture. While CBDCs extend existing monetary frameworks into the digital realm, decentralized cryptocurrencies propose alternative structures that potentially bypass traditional financial intermediaries. Brunnermeier et al. (2019) explore these tensions, noting that the integration of cryptocurrencies into national reserves would fundamentally alter central bank balance sheets. The authors contend that digital currencies could significantly reshape the relationship between central banks, commercial banks, and the public, potentially enhancing monetary policy transmission while simultaneously creating new financial stability risks.

The potential coexistence of CBDCs and decentralized cryptocurrencies introduces complex dynamics into the global financial system. CBDCs might serve as stabilizing counterweights to more volatile cryptocurrencies, providing a digital form of sovereign money that maintains the advantages of central bank backing. Alternatively, they might compete directly with private cryptocurrencies, potentially limiting the latter's adoption or relegating them to specific use cases (Auer et al., 2021). This competitive dynamic could ultimately determine whether cryptocurrencies become integrated into traditional reserve portfolios or remain parallel alternative assets.

5.2. Blockchain Technology and Smart Contracts: Implications for Reserve Management

Blockchain technology, in conjunction with smart contracts—self-executing digital agreements with pre-coded terms—introduces significant innovations to the field of reserve management. Cong et al. (2021) underscore the ability of smart contracts to minimize contracting costs, enhance transparency, and mitigate risks associated with strategic contract violations. When applied to sovereign reserves, these mechanisms could optimize financial operations by automating complex processes, facilitating cross-border settlements, and minimizing counterparty risks. The programmable nature of smart contracts further enables dynamic asset reallocation based on predefined triggers, presenting opportunities for more adaptive and efficient reserve management strategies.

Nonetheless, the integration of blockchain-based systems within existing financial infrastructures presents substantial technical, legal, and operational challenges. As Biais et al. (2018) explain, blockchain technologies face scalability limitations, energy-intensive consensus protocols (particularly proof-of-work), and interoperability issues between distinct blockchain networks. These technical constraints, coupled with underdeveloped regulatory frameworks, create uncertainty regarding the enforceability of blockchain-based financial agreements and the protection of digital assets in sovereign contexts.

The theoretical underpinnings of blockchain's potential impact on reserve management are rooted in distributed consensus mechanisms. Biais et al. (2018) articulate the “blockchain folk theorem,” which posits that consensus protocols can sustain equilibria by coordinating participants’ actions around the accurate and timely recording of transactions. This theoretical model suggests that blockchain networks could enhance the transparency, accountability, and efficiency of reserve management practices by creating immutable records and enabling real-time settlement.

Emerging empirical research further elucidates blockchain's practical applications across diverse sectors. Cheng et al. (2023) illustrate how blockchain-based smart contracts enhance project performance in architecture, engineering, and construction, while Zheng (2024) explores quantum-resistant cryptographic mechanisms that address future security vulnerabilities through innovative lattice-based protocols. Additionally, Lin et al. (2022) provide a comprehensive review of blockchain platforms such as Ethereum, Hyperledger Fabric, and EOSIO, emphasizing their distinct architectural features and implications for decentralized financial systems.

As sovereign entities and financial institutions explore blockchain's integration into reserve management, a gradual and incremental approach appears warranted. This measured trajectory would allow stakeholders to balance the technology's transformative potential—such as enhanced transparency, reduced operational costs, and real-time financial settlements—against the legal, regulatory, and technical complexities that accompany its adoption (Cong et al., 2021; Biais et al., 2018; Lin et al., 2022). Therefore, while blockchain and distributed ledger technologies offer considerable promise for reconfiguring reserve management practices, their implementation necessitates a nuanced, evidence-based strategy. This transition reflects not merely a technological shift but a fundamental reimagining of financial infrastructure, characterized by increased decentralization, adaptability, and resilience in the face of evolving global economic challenges.

5.3. Cryptocurrencies as Foreign Reserve Assets: Feasibility and Risks

The fundamental question of whether cryptocurrencies can effectively serve as foreign reserve assets requires careful assessment of their characteristics against the established criteria for reserve adequacy. Feyen et al. (2024) argue persuasively that crypto assets currently fall short of meeting the necessary requirements for inclusion in reserve portfolios. Their analysis identifies several critical limitations: extreme price volatility that undermines cryptocurrencies' store of value function, limited liquidity in times of market stress, and inadequate regulatory frameworks to protect large-scale institutional holdings.

The volatility of major cryptocurrencies presents perhaps the most significant obstacle to their adoption as reserve assets. Unlike traditional reserve assets such as US Treasury bonds or gold, cryptocurrencies can experience dramatic price fluctuations over brief time periods, creating substantial valuation risk for reserve managers (Feyen et al., 2024). This volatility fundamentally conflicts with the stability mandate of reserve management, which typically prioritizes capital preservation over speculative returns. Until cryptocurrencies demonstrate substantially more stable valuation characteristics, they are likely to remain problematic candidates for significant reserve allocation.

Despite these current limitations, the long-term potential for cryptocurrencies to contribute to reserve diversification warrants consideration, particularly considering evolving geopolitical realities. The traditional reserve currency system, dominated by the US dollar, has faced increasing scrutiny as countries seek to reduce dependence on any single currency (Brunnermeier et al., 2019). Cryptocurrencies—especially those designed with stability mechanisms or backed by tangible assets—could eventually offer an alternative path to diversification that reduces exposure to geopolitical risks while potentially providing new capabilities for international settlements.

5.4. Bitcoin as a Global Currency Reserve: A Case Study

Bitcoin, as the pioneering cryptocurrency, offers a compelling case study for examining the potential and limitations of digital assets as reserve currencies. Hernandez (2022) presents a detailed analysis of Bitcoin's candidacy as a global currency reserve, highlighting its unique characteristics that distinguish it from both traditional fiat currencies and other cryptocurrencies. Chief among these characteristics is Bitcoin's fixed supply cap of 21 million coins, which creates inherent scarcity and resistance to inflation—qualities that theoretically align with sound reserve asset principles.

The decentralized nature of Bitcoin presents both advantages and disadvantages in the reserve context. On one hand, Bitcoin's lack of central control means that it cannot be directly manipulated by any single government or institution, potentially offering a neutral reserve asset in a multipolar world (Hernandez, 2022). This property might prove particularly attractive to nations seeking to reduce their exposure to geopolitical risks associated with traditional reserve currencies. On the other hand, this same lack of centralized authority creates governance challenges and uncertainty about how the protocol might evolve over time.

Despite its theoretical appeal, Bitcoin faces substantial practical obstacles as a reserve asset. Its well-documented volatility makes it difficult to rely upon for stable valuation, a crucial requirement for reserve management (Feyen et al., 2024). Scalability limitations of the Bitcoin network could potentially constrain its utility for large-scale settlements between central banks. Furthermore, Bitcoin's energy-intensive proof-of-work consensus mechanism raises environmental concerns that may prove increasingly problematic as climate considerations gain prominence in institutional investment decisions. These challenges suggest that while Bitcoin may eventually play some role in reserve portfolios, substantial evolution of both the asset itself and institutional frameworks would be necessary prerequisites.

Accordingly, the integration of cryptocurrencies into national reserves represents a complex frontier in the evolution of the global financial system. While current limitations—particularly regarding volatility, regulatory uncertainty, and technical constraints—preclude widespread adoption of cryptocurrencies as major reserve assets in the immediate future, the trajectory of technological development and institutional adaptation suggests that digital assets may eventually play a meaningful role in reserve management strategies (Feyen et al., 2024).

The emergence of more sophisticated cryptocurrency designs, including stablecoins and CBDCs, may address some of the fundamental limitations that currently restrict cryptocurrencies' utility as reserve assets. These innovations could potentially combine the technological advantages of blockchain systems with the stability mechanisms necessary for reserve functions.

Similarly, advances in blockchain scalability and energy efficiency may mitigate some of the technical constraints that currently limit the practicality of cryptocurrency-based settlement systems for central bank operations (Biais et al., 2018).

Regulatory developments will play a crucial role in determining the future viability of cryptocurrency reserves. Clear legal frameworks for digital asset custody, settlement finality, and cross-border transfers are essential prerequisites for institutional adoption. The emergence of comprehensive regulatory standards could substantially reduce the uncertainty that currently deters conservative reserve managers from significant cryptocurrency allocation (Cong et al., 2021).

As the global financial system continues its digital transformation, the distinction between traditional and cryptocurrency-based financial infrastructures may gradually blur. The principles of decentralization, programmability, and transparency that characterize blockchain systems could increasingly influence traditional reserve management practices, even if pure cryptocurrencies remain peripheral to reserve portfolios (Brunnermeier et al., 2019). This evolution reflects a broader convergence of technological innovation and institutional adaptation that is reshaping the foundations of global finance.

6. THE STRATEGIC INTEGRATION OF CRYPTOCURRENCIES AND DIGITAL ASSETS IN NATIONAL RESERVES

The meteoric rise of digital currencies has catalyzed a paradigmatic shift in the conceptualization and management of national reserve assets. As cryptocurrencies, stable coins, and central bank digital currencies (CBDCs) continue their inexorable evolution, they present nations with a complex tapestry of opportunities and challenges that transcend traditional reserve management paradigms. This refined analysis examines the multidimensional implications of integrating digital assets into sovereign portfolios, illuminating the intricate interplay between established reserve practices and emergent financial technologies within an increasingly digitized global economy.

6.1. Stablecoins: The Confluence of Innovation and Stability

Stablecoins represent the nexus where cryptocurrency innovation converges with financial stability—a critical evolutionary juncture in the digital asset landscape. The comprehensive examination by Adachi et al. (2022) reveals their multifaceted functionality within cryptocurrency ecosystems, positioning them as the architectural bridge between traditional financial infrastructure and decentralized networks. Their analysis illuminates how stablecoins could fundamentally transform the viability of cryptocurrencies as reserve assets by introducing sophisticated stability mechanisms that align with the stringent risk tolerance parameters inherent to sovereign reserves.

The integration of stablecoins into national reserve portfolios would constitute not merely technological advancement but a profound reconceptualization of reserve asset functionality within the global economic architecture. By engineering mechanisms that maintain value stability while harnessing the inherent efficiencies of distributed ledger technology, stablecoins potentially establish a strategic intermediary position between conventional fiat reserves and pure cryptocurrencies—offering a harmonious synthesis of stability and innovation that could reshape reserve management practices in the digital age.

Nevertheless, this integration demands vigilance. The risks of regulatory arbitrage and potential systemic destabilization remain formidable concerns should stablecoins operate beyond the purview of robust regulatory frameworks. This duality underscores the imperative for developing comprehensive governance structures that preceded the integration of stablecoins into national reserve strategies, ensuring their revolutionary potential is realized without compromising financial stability.

6.2. Central Bank Digital Currencies: Reconfiguring Monetary Sovereignty

The emergence of CBDCs represents perhaps the most profound institutional response to the cryptocurrency revolution—a reclamation of monetary sovereignty within the digital domain. Andolfatto's (2021) penetrating analysis explores how these government-backed digital currencies could fundamentally reconfigure the landscape of monetary intermediation, potentially diminishing reliance on private banking institutions for monetary transmission. This transformation necessarily influences strategic reserve considerations, particularly regarding the delicate equilibrium between centralized CBDCs and decentralized cryptocurrencies within diversified sovereign portfolios.

Building upon this foundation, Auer et al. (2022) provides an exquisitely nuanced exploration of the multifaceted motivations propelling global CBDC development. Their comprehensive review illuminates how CBDCs could dramatically enhance financial inclusion and payment system efficiency—strategic objectives that align seamlessly with the fundamental goals of effective reserve management. Furthermore, they articulate how CBDCs could offer a more stable, government-backed alternative to decentralized cryptocurrencies, potentially mitigating inherent risks while preserving the technological benefits of digital assets. This perspective introduces the compelling possibility of complementary relationships between CBDCs and cryptocurrencies within strategically diversified reserve portfolios.

The macroeconomic implications of CBDC adoption transcend mere operational efficiencies. Barrdear and Kumhof (2022) delve into these broader economic dimensions, articulating how CBDCs could revolutionize monetary policy effectiveness by providing central banks with sophisticated new tools for liquidity and interest rate management. However, they simultaneously acknowledge the disruptive potential, cautioning that digital currency introduction could destabilize traditional banking systems if implementation lacks strategic foresight. This fundamental tension between revolutionary innovation and systemic stability constitutes the central strategic calculation surrounding digital asset integration into national reserves.

6.3. Blockchain Technology: Transforming Reserve Management Architecture

The transformative potential of blockchain technology extends beyond theoretical frameworks to the practical challenges of implementation. While blockchain holds revolutionary promise, its enterprise adoption has advanced more slowly than expected, hindered by complex technical and regulatory barriers. This reality suggests that integrating blockchain-based assets into national reserves may face similar obstacles, requiring careful assessment of both technological readiness and the capacity for institutional adaptation.

6.4. Geopolitical Dimensions: Digital Currencies as Strategic Assets

The proliferation of digital currencies has introduced novel dynamics into the geopolitical competition for financial influence and monetary sovereignty. China's digital yuan development illuminates how this initiative represents a watershed moment in the global transition toward digital currencies—potentially challenging the hegemonic position of the U.S. dollar in international commerce and finance. This development could catalyze accelerated adoption of cryptocurrencies as reserve assets by nations seeking to diversify holdings beyond traditional reserve currencies. The strategic implications transcend purely economic considerations, encompassing fundamental questions of national security and global influence in an increasingly digitized international order.

The vulnerability of conventional financial infrastructure to geopolitical pressures further enhances the strategic appeal of decentralized alternatives. The SWIFT system's vulnerability within contexts of international conflict highlights how traditional financial architectures remain susceptible to geopolitical disruption—suggesting that decentralized cryptocurrencies could provide more resilient alternatives for international transactions and sovereign reserve management. This resilience factor may become increasingly determinative in strategic reserve planning as geopolitical tensions continue to reshape global financial systems.

7. IMPLEMENTATION CHALLENGES AND FUTURE OUTLOOK FOR DIGITAL RESERVE ASSETS

7.1. Competitive Dynamics Between Government and Private Digital Currencies

The competitive dynamics between government-issued and private digital currencies add a new layer of complexity to the geopolitical landscape. Central banks may face substantial challenges in keeping pace with private digital currencies, particularly regarding innovation speed and user adoption. This dynamic suggests that nations formulating reserve strategies must account not only for the balance between traditional assets and digital currencies but also for the competitive positioning between central bank digital currencies (CBDCs) and decentralized alternatives within an increasingly fragmented monetary environment.

7.2. Regulatory Frameworks: The Architecture of Digital Asset Governance

The integration of digital assets into national reserves necessitates the development of sophisticated regulatory and legal frameworks. Bossu et al. (2020) examine these legal dimensions with exceptional clarity, emphasizing the imperative for comprehensive legal structures governing digital currency issuance and management within sovereign reserve contexts. Their analysis suggests that absent robust legal architectures, integrating digital assets into national reserves could introduce significant regulatory and operational vulnerabilities. This perspective underscores the paramount importance of establishing comprehensive governance mechanisms before implementing cryptocurrency reserve strategies.

Contemporary regulatory developments reflect heightened scrutiny within the cryptocurrency sector, with increased oversight particularly targeting issues of market manipulation and financial transparency. This growing regulatory focus underscores the urgent need for advanced, well-defined frameworks to effectively manage cryptocurrency reserves at the national level. As the regulatory landscape continues to evolve rapidly, it is poised to play a decisive role in shaping the feasibility and execution of cryptocurrency reserve strategies across various jurisdictions.

7.3. Technical Implementation: Engineering the Digital Reserve

The technical challenges inherent in implementing digital currencies at a national scale extend to both CBDCs and decentralized alternatives. Auer and Boehme (2020) illuminate the formidable technical obstacles to scaling CBDCs for

national economic demands, particularly regarding transaction throughput and security architecture. Their analysis suggests these challenges apply equally to managing decentralized cryptocurrencies within sovereign reserves. Addressing these fundamental scalability and security concerns represents an essential prerequisite for successfully integrating digital assets into reserve portfolios.

The operational complexities of digital asset management extend beyond technical infrastructure to include critical considerations related to economic design and market integration. These factors—particularly those concerning functional scope, pricing mechanisms, and control systems—are essential for the effective implementation of central bank digital currencies (CBDCs). Analyzing these dimensions offers valuable insights into the operational frameworks needed to manage digital currencies at the national level, with significant implications for cryptocurrency reserve strategies across diverse economic contexts.

7.4. Global Trends and Strategic Positioning

The global landscape of digital currency development continues its rapid evolution, carrying significant implications for national reserve strategies. The Bank for International Settlements (BIS, 2021) documents the accelerating exploration of CBDCs by central banks worldwide, with numerous institutions advancing into sophisticated development stages. This global trend underscores the strategic imperative of incorporating digital assets within national reserve considerations. Nations failing to engage with these developments risk substantial strategic disadvantages within the transforming international financial architecture.

A balanced assessment of digital currency integration requires careful consideration of both its opportunities and risks. This nuanced perspective highlights the potentially transformative benefits of central bank digital currencies (CBDCs), such as enhanced financial inclusion and increased payment system efficiency, alongside challenges related to financial stability and privacy protection. These considerations are equally pertinent when evaluating decentralized cryptocurrencies for national reserve inclusion. Such a sophisticated analysis underscores the importance of adopting carefully calibrated strategies for integrating digital assets into sovereign portfolios, aiming to maximize benefits while mitigating potential risks within an evolving global financial landscape.

CONCLUSION: EMBRACING THE DIGITAL FINANCIAL REVOLUTION

The proposed establishment of a U.S. Crypto Strategic Reserve under the banner of Trumpism's bold bet on digital assets represents a seismic shift in the global financial landscape. This initiative, far from being a mere policy adjustment, signals a revolutionary reimagining of monetary sovereignty and reserve asset management in the digital age. By integrating cryptocurrencies such as Bitcoin (BTC), Ethereum (ETH), Ripple (XRP), Solana (SOL), and Cardano (ADA) into national reserves, the United States would not only challenge traditional monetary paradigms but also position itself as a pioneer in the evolving digital financial ecosystem. This study has explored the multifaceted implications of this bold proposal, offering a comprehensive analysis of the opportunities, challenges, and strategic considerations it entails.

At its core, Trumpism's embrace of digital assets reflects a recognition that the future of finance will be increasingly decentralized, digitized, and diverse. Cryptocurrencies, once dismissed as speculative curiosities, have matured into a significant asset class with trillions of dollars in market capitalization. Their unique characteristics—decentralization, programmability, and borderless transferability—offer new possibilities for economic sovereignty, financial inclusion, and technological innovation. By incorporating these assets into national reserves, the United States would not merely be acknowledging their existence but actively participating in their institutionalization and legitimization. This represents a decisive break from the cautious or restrictive approaches adopted by many nations and international bodies in recent years, signaling a willingness to embrace the digital financial revolution rather than resist it. However, the path to establishing a crypto reserve is fraught with complexity and uncertainty. The volatility of cryptocurrencies, while offering potential for significant returns, poses substantial risks to the stability and reliability of national reserves. The governance challenges of integrating decentralized assets into centralized financial systems, the technical complexities of secure custody, and the regulatory uncertainties surrounding digital assets all demand careful consideration and innovative solutions. Moreover, the geopolitical ramifications of such a move are profound, as it could trigger a new era of currency competition and cooperation in the digital age, reshaping the balance of power in the global financial system.

The success of this initiative will hinge on several critical factors. First, the specific implementation mechanisms chosen will play a pivotal role in determining its feasibility and effectiveness. Whether the reserve is established through executive authority, legislative action, or public-private partnerships, the governance frameworks must balance operational flexibility with robust oversight to ensure transparency, accountability, and stability. Second, the risk management strategies employed will be crucial in mitigating the inherent volatility and security risks associated with cryptocurrencies. Sophisticated financial engineering, diversification across asset classes, and the development of new accounting frameworks will be essential to safeguard national financial resources. Third, the broader regulatory environment surrounding digital assets will shape the trajectory of this initiative. Clear legal frameworks for custody, settlement, and cross-border transfers are prerequisites for

institutional adoption, and international cooperation will be necessary to address the global implications of cryptocurrency reserves.

Technological developments within the cryptocurrency ecosystem will also play a decisive role. Advances in blockchain scalability, energy efficiency, and security could enhance the practicality and attractiveness of digital assets as reserve components. The emergence of stablecoins, central bank digital currencies (CBDCs), and other hybrid innovations may address some of the fundamental limitations that currently restrict cryptocurrencies' utility as reserve assets. These developments could pave the way for a more seamless integration of digital assets into traditional financial systems, blurring the boundaries between decentralized and centralized monetary frameworks.

From a geopolitical perspective, the establishment of a U.S. Crypto Strategic Reserve could position the United States as a leader in the evolving digital financial landscape. By embracing cryptocurrencies at the national level, the United States would signal a pro-innovation regulatory stance, potentially attracting investment and talent to its blockchain and fintech sectors. This could enhance the country's competitive edge in the global economy, particularly as other nations accelerate their own digital currency initiatives. However, this move could also provoke responses from allies and competitors alike, as countries seek to reduce their dependence on the U.S. dollar or develop alternative digital financial infrastructures. The interplay between these dynamics will shape the future of international monetary relations, with profound implications for economic sovereignty, financial stability, and global governance.

As we stand at this crossroads in monetary history, the establishment of a U.S. Crypto Strategic Reserve may well be remembered as either a visionary embrace of financial evolution or a costly diversion from sound monetary principles. The outcome will depend not only on the specific choices made by policymakers but also on the broader trajectory of technological innovation, regulatory adaptation, and geopolitical competition. What is clear, however, is that the digital financial revolution has moved from the margins to the mainstream of economic policymaking. The mere consideration of such a reserve signals a recognition that the future of money and finance will be shaped by the forces of decentralization, digitization, and innovation.

In conclusion, this study has sought to provide a comprehensive and nuanced exploration of the potential establishment of a U.S. Crypto Strategic Reserve. By examining the theoretical foundations, practical challenges, and strategic implications of this initiative, it has contributed to the academic and policy discourse on the evolving role of digital assets in the global financial system. As the world continues its digital transformation, the integration of cryptocurrencies into national reserves may represent not merely an adaptation to technological change but a reimagining of the very foundations of monetary sovereignty and economic governance. The journey ahead is uncertain, but the potential rewards—enhanced financial resilience, technological leadership, and economic sovereignty—are too significant to ignore. The digital financial revolution is here, and the question is not whether to embrace it, but how.

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Appendix A: Key Cryptocurrency Characteristics Assessment

This appendix provides a comparative analysis of the cryptocurrencies identified for potential inclusion in the U.S. Crypto Strategic Reserve.

Table A.1: Technical Characteristics of Proposed Reserve Cryptocurrencies

Cryptocurrency	Consensus Mechanism	Supply Model	Governance Structure	Primary Use Case	Key Technical Features
Bitcoin (BTC)	Proof-of-Work	Fixed supply (21 million)	Decentralized, community-driven	Digital store of value	Strong security, resistance to censorship, limited programmability
Ethereum (ETH)	Proof-of-Stake (post-Merge)	Variable supply with issuance control	Foundation-guided with community input	Smart contract platform	Programmability, smart contracts, dApp ecosystem
Ripple (XRP)	Consensus Protocol	Fixed supply (100 billion)	Ripple Labs centralized influence	Cross-border payments	High transaction speed, low fees, payment focus
Solana (SOL)	Proof-of-Stake with Proof-of-History	Inflationary with declining rate	Foundation-guided	High-throughput applications	High transaction speed, low cost, scalability
Cardano (ADA)	Proof-of-Stake (Ouroboros)	Fixed supply (45 billion)	Formal on-chain governance	Research-driven platform	Formal verification, academic approach, focus on security

Table A.2: Reserve Asset Suitability Assessment

Cryptocurrency	Liquidity Profile	Market Capitalization	Volatility (Historic)	Custody Complexity	Regulatory Status	Correlation with Traditional Assets
Bitcoin (BTC)	High	Largest	High	Moderate	Relatively established	Low/Moderate with gold
Ethereum (ETH)	High	Second largest	High	High (smart contracts)	Evolving (security status)	Moderate with tech equities
Ripple (XRP)	Moderate	Varies significantly	High	Low	Challenged (SEC litigation history)	Moderate with banking sector
Solana (SOL)	Moderate	Growing	Extremely high	Moderate	Emerging	High with tech sector
Cardano (ADA)	Moderate	Fluctuating	High	Moderate	Relatively favorable	Moderate with innovation indices

Table A.3: Strategic Advantages and Challenges for Reserve Inclusion

Cryptocurrency	Strategic Advantages	Implementation Challenges	Risk Factors	Potential Allocation Strategy
Bitcoin (BTC)	Market dominance, network security, gold-like properties	Energy consumption, transaction limitations	Mining concentration, regulatory targeting	Core holding (40-60% of crypto allocation)
Ethereum (ETH)	Ecosystem breadth, smart contract utility, staking yields	Technical complexity, ongoing development	Execution risk in upgrades, competitive pressure	Significant allocation (20-40%)
Ripple (XRP)	Institutional payment integration, speed	Regulatory uncertainty, centralization concerns	Legal challenges, centralized control	Limited tactical allocation (5-10%)
Solana (SOL)	Performance metrics, growing ecosystem	Network reliability history, relatively new	Technical vulnerabilities, governance questions	Experimental allocation (5-15%)

Cryptocurrency	Strategic Advantages	Implementation Challenges	Risk Factors	Potential Allocation Strategy
Cardano (ADA)	Methodical development, academic rigor	Slower deployment timeline	Adoption challenges, competitive positioning	Strategic minority position (5-15%)

Appendix B: Historical Monetary System Transitions

This appendix examines historical precedents for monetary system transformations that provide context for understanding the potential integration of cryptocurrencies into national reserves.

Table B.1: Major Monetary System Transitions in Modern History

Transition	Time Period	Key Characteristics	Driving Factors	Resistance Sources	Relevance to Crypto Reserve Proposal
Gold Standard Adoption	19th Century	Fixed exchange rates, gold-backed currencies	International trade growth, stability needs	Silver interests, debtor classes	Demonstrates adoption of new reserve standard
Gold Standard Abandonment	1914-1944	Suspension during crises, eventual formalization	War financing, economic depression	Traditional banking interests, creditor classes	Illustrates forces that overwhelm established systems
Bretton Woods System	1944-1971	Dollar-gold anchor, fixed exchange rates	Post-war reconstruction, U.S. hegemony	National sovereignty concerns, adjustment burdens	Shows design of managed international monetary system
Post-Bretton Woods Era	1971-Present	Floating exchange rates, fiat dominance	Dollar-gold decoupling, oil shocks	Inflation concerns, stability questions	Demonstrates transition to full fiat system
Rise of Foreign Exchange Reserves	1980s-Present	Diversification beyond gold, dollar dominance	Globalization, trade imbalances	Resource allocation efficiency, political risk	Parallels potential crypto diversification
Digital Payment Systems	1990s-Present	Electronic transfers, reduced physical cash	Technology advancement, efficiency	Privacy concerns, digital divide	Precursor to cryptocurrency adoption

Table B.2: Lessons from Historical Monetary Transitions

Aspect	Historical Pattern	Application to Crypto Reserve Implementation
Transition Timeline	Typically, gradual with acceleration points	Suggests incremental adoption strategy
Institutional Resistance	Strong from established financial interests	Anticipates banking sector concerns
Legal Frameworks	Lag market developments	Highlights need for regulatory clarity
Public Confidence	Critical for successful implementation	Emphasizes transparency and education
International Coordination	Varies from unilateral to highly coordinated	Options for different diplomatic approaches
Technology Adoption	Follows S-curve with tipping points	Indicates potential for rapid acceleration
Crisis as Catalyst	Often accelerates monetary evolution	Suggests potential for opportunistic implementation

Appendix C: Theoretical Framework Components

This appendix elaborates on the four interconnected theoretical domains that structure the analysis of cryptocurrency reserves.

Table C.1: Monetary Theory Perspectives Relevant to Cryptocurrency Reserves

Theoretical Perspective	Key Proponents	Central Tenets	Application to Crypto Reserves
Spontaneous Order Theory	Menger (1892)	Money emerges organically from market interactions	Explains value formation in decentralized cryptocurrencies
Denationalization of Money	Hayek (1976)	Competition between private currencies produces optimal outcomes	Supports case for incorporating non-state digital currencies
Chartalism/State Theory	Knapp (1924), Wray (2015)	Money derives value from sovereign authority and taxation	Challenges legitimacy of non-state digital currencies
Free Banking Theory	Selgin & White (1994)	Market forces money can generate efficient monetary order	Supports competitive currency ecosystems
Monetary History Analysis	Eichengreen (2019)	International monetary systems experience recurrent crises and transitions	Contextualizes cryptocurrency adoption within historical patterns

Table C.2: Institutional Economics Components for Crypto Reserve Analysis

Theoretical Component	Key Proponents	Central Concepts	Application to Crypto Reserves
Institutional Framework Analysis	North (1990)	Formal/informal rules shape economic interactions	Analysis of governance challenges for crypto integration
Common Resource Governance	Ostrom (2015)	Non-state, non-market governance of shared resources	Models for blockchain governance structures
Constitutional Economics	Buchanan & Tullock (1962)	Alignment of incentives in public decision-making	Addressing principal-agent problems in reserve management
Transaction Cost Economics	Williamson (1985)	Institutional structures emerge to minimize transaction costs	Evaluating efficiency gains from blockchain-based systems
Property Rights Theory	Alchian & Demsetz (1973)	Clear property rights essential for efficient resource allocation	Analyzing digital asset ownership and management

Table C.3: Financial Innovation Diffusion Framework

Theoretical Component	Key Proponents	Central Concepts	Application to Crypto Reserves
Innovation Diffusion Theory	Rogers (2003)	Adoption follows predictable patterns through social systems	Mapping institutional crypto adoption pathways
Disruptive Innovation Theory	Christensen (1997)	Innovations can displace established market leaders	Analyzing crypto potential to disrupt traditional reserve assets
Technology Acceptance Model	Davis (1989)	Perceived usefulness and ease of use drive adoption	Factors influencing institutional cryptocurrency acceptance
Network Effects Theory	Katz & Shapiro (1985)	Value increases with number of users	Assessing growth potential for different cryptocurrencies
Path Dependence Theory	Arthur (1989)	Historical choices constrain future options	Understanding institutional resistance to monetary innovation

Table C.4: International Political Economy Framework for Crypto Reserve Analysis

Theoretical Component	Key Proponents	Central Concepts	Application to Crypto Reserves
Currency Competition Theory	Cohen (2019)	Currencies compete for international roles	Analyzing how crypto assets might reshape currency hierarchies
Structural Power Analysis	Strange (1988)	Control over financial infrastructure yields geopolitical power	Assessing strategic implications of blockchain network control
International Monetary Evolution	Eichengreen et al. (2018)	Politics and economics shape currency status	Contextualizing cryptocurrency adoption within power structures
Monetary Sovereignty Theory	Goodhart (1998)	Control of money is central to state sovereignty	Examining tensions between national control and decentralized systems
Financial Statecraft	Steil & Litan (2006)	Financial systems as instruments of state power	Strategic applications of cryptocurrency reserves

Appendix D: Implementation Scenarios for U.S. Crypto Strategic Reserve

This appendix details the four strategic scenarios for cryptocurrency reserve implementation identified in the research methodology.

Table D.1: Scenario Comparison Matrix

Feature	Scenario 1: Incremental Adoption	Scenario 2: Strategic Holdings	Scenario 3: Crisis Response	Scenario 4: Policy Leverage
Primary Objective	Gradual diversification of reserves	Establish a significant strategic position	Prepare stabilization mechanisms	Influence global crypto governance
Acquisition Timeline	Extended (3-5+ years)	Moderate (1-3 years)	Rapid initial, then opportunistic	Targeted and strategic
Target Allocation	Minor component (1-5% of reserves)	Substantial position (5-15% of reserves)	Variable based on market conditions	Focused on governance-significant assets
Risk Profile	Conservative	Moderate	Dynamic	Targeted
Public Communication	Minimal, technical	Strategic signaling	Confidence-building	Regulatory leadership
International Coordination	Limited, information sharing	Selective partner engagement	Crisis coordination framework	Standards-setting initiative
Implementation Complexity	Moderate	High	Very High	High

Table D.2: Detailed Scenario Characteristics

Scenario 1: Incremental Adoption

Element	Description
Acquisition Method	Regular small purchases using dollar-cost averaging
Governance Structure	Traditional reserve management extended to new asset class
Success Metrics	Limited price impact, portfolio diversification benefits
Key Risks	Opportunity cost if rapid adoption occurs elsewhere
Required Capabilities	Basic custody infrastructure, market execution expertise
Regulatory Approach	Minimal changes to existing frameworks

Scenario 2: Strategic Holdings

Element	Description
Acquisition Method	Significant OTC purchases, mining operations investment
Governance Structure	Specialized management entity with public-private expertise
Success Metrics	Position significance, technological leverage gained
Key Risks	Market price distortion, political opposition
Required Capabilities	Advanced custody solutions, technical blockchain expertise
Regulatory Approach	Comprehensive framework development

Scenario 3: Crisis Response

Element	Description
Acquisition Method	Opportunistic purchasing during market downturns
Governance Structure	Integration with existing crisis response mechanisms
Success Metrics	Stabilization effectiveness, market confidence maintenance
Key Risks	Timing errors, moral hazard creation
Required Capabilities	Real-time market analysis, rapid execution capabilities
Regulatory Approach	Emergency intervention authorities defined

Scenario 4: Policy Leverage

Element	Description
Acquisition Method	Strategic positions in governance-significant protocols
Governance Structure	Interagency coordination with diplomatic engagement
Success Metrics	Standards influence, regulatory harmonization
Key Risks	Technological obsolescence, governance capture accusations
Required Capabilities	Technical participation in protocol governance
Regulatory Approach	International standards leadership

Appendix E: Stakeholder Analysis

This appendix maps key stakeholders who would influence or be affected by the establishment of a U.S. Crypto Strategic Reserve.

Table E.1: Domestic Stakeholder Mapping

Stakeholder Group	Potential Position	Primary Concerns	Strategic Importance	Engagement Approach
U.S. Treasury Department	Mixed/Cautious	Reserve integrity, operational risk	Critical implementer	Technical working group
Federal Reserve	Initially resistant	Monetary policy independence, financial stability	Necessary partner	Phased consultation
Securities & Exchange Commission	Concerned	Market integrity, investor protection	Key regulator	Regulatory framework development
Congress	Divided along ideological lines	Appropriations authority, oversight	Legislative enabler	Bipartisan education initiative
Banking Industry	Mixed/Concerned	Competitive disruption, regulatory parity	Influential opposition	Industry consultation forum

Stakeholder Group	Potential Position	Primary Concerns	Strategic Importance	Engagement Approach
Cryptocurrency Industry	Strongly supportive	Regulatory clarity, legitimization	Technical resource	Public-private partnership
Traditional Asset Managers	Opportunistic	Integration with existing portfolios	Adoption accelerators	Educational outreach
Academic Economists	Divided on theoretical lines	Monetary system stability, empirical evidence	Intellectual framing	Research funding initiatives
General Public	Mixed awareness and understanding	Economic stability, inflation concerns	Political constituency	Strategic communication plan

Table E.2: International Stakeholder Mapping

Stakeholder Group	Likely Response	Strategic Considerations	Potential Reaction
European Union/ECB	Cautious/competitive	Acceleration of digital euro, regulatory coordination	Parallel initiative development
China	Strategic concern	Contrast with digital yuan approach, regulatory restrictions	Intensified CBDC promotion
Other G7 Nations	Varied alignment	Coordination opportunities, standards development	Potential coalition formation
IMF/World Bank	Institutional adaptation	Reserve assessment frameworks, technical assistance	Policy paper development
Emerging Economies	Opportunistic interest	Financial sovereignty opportunities, reduced dollar dependence	Selective emulation
Global Financial Centers	Competitive positioning	Regulatory arbitrage, service innovation	Specialized service development
International Standards Bodies	Process-focused	Protocol standardization, interoperability frameworks	Working group formation
Global Technology Firms	Strategic alignment	Integration opportunities, competitive positioning	Partnership initiatives

Appendix F: Institutional Implementation Mechanisms

This appendix evaluates potential institutional mechanisms for implementing a U.S. Crypto Strategic Reserve.

Table F.1: Comparison of Implementation Mechanisms

Mechanism	Legal Authority	Operational Flexibility	Governance Structure	Political Feasibility	Technical Capability
Treasury Exchange Stabilization Fund	Existing but requires interpretation	High	Treasury Secretary discretion	Moderate (executive authority)	Limited, requires development
Federal Reserve Operations	Requires policy change	Moderate	Fed governance structure	Low (independence concerns)	Moderate, existing systems
Special Purpose Vehicle	Requires establishment	Exceedingly high	Customizable	Moderate (precedents exist)	Can be purpose-built
Public-Private Partnership	Requires legal framework	High	Hybrid governance	Moderate (oversight concerns)	Can leverage private expertise
Congressional Appropriation	Highest legitimacy	Limited by legislation	Subject to legislative oversight	Low (partisan environment)	Subject of government procurement

Mechanism	Legal Authority	Operational Flexibility	Governance Structure	Political Feasibility	Technical Capability
Seized Asset Repurposing	Existing forfeiture laws	Limited to available assets	Law enforcement framework	Moderate (public support)	Limited by asset types seized

Table F.2: Detailed Analysis of Exchange Stabilization Fund (ESF) Mechanism

Aspect	Analysis
Legal Basis	31 U.S.C. § 5302 authorizes dealing in gold, foreign exchange, and "other instruments of credit and securities"
Historical Precedents	Mexican peso crisis (1995), money market guarantee (2008) demonstrate flexible interpretation
Funding Capacity	Approximately $100 billion in assets as of recent reporting
Governance	Treasury Secretary authority with Presidential approval
Transparency Requirements	Limited reporting requirements compared to other mechanisms
Operational Advantages	Existing structure, minimal new legislation required
Key Limitations	Size constraints, potential legal challenges to cryptocurrency as "foreign exchange"
Political Considerations	Executive branch control with limited congressional oversight

Table F.3: Assessment of Public-Private Partnership Model

Design Element	Options	Considerations
Legal Structure	Government corporation, investment trust, managed account	Balancing control and flexibility
Private Sector Role	Technical advisor, co-investor, operational manager	Expertise access vs. conflict management
Oversight Mechanisms	Congressional reporting, independent board, auditing requirements	Transparency vs. operational security
Profit/Loss Allocation	Government retention, partial private participation, reinvestment requirements	Incentive alignment, public interest
Technology Infrastructure	Government-owned, contractor-provided, shared systems	Security, efficiency, expertise
Cryptocurrency Custody	Direct government, qualified custodian, multi-signature hybrid	Security, operational requirements
Technical Expertise	Direct hiring, contracting, secondment arrangements	Talent acquisition, knowledge transfer

Appendix G: Glossary of Key Terms

Term	Definition
Blockchain	A distributed digital ledger technology that records transactions across multiple computers to ensure data security, transparency, and immutability
Cold Storage	A cryptocurrency storage method where private keys are kept offline to protect against unauthorized access and cyber attacks
Consensus Mechanism	The process by which a blockchain network achieves agreement on the valid state of the distributed ledger
Cryptocurrency	A digital or virtual currency that uses cryptography for security, operates on a blockchain, and generally functions independent of a central authority
Decentralized Finance (DeFi)	Financial applications built on blockchain networks that operate without centralized intermediaries

Term	Definition
Exchange Stabilization Fund (ESF)	A U.S. Treasury Department emergency reserve fund established by the Gold Reserve Act of 1934 to stabilize the value of the dollar
Fork	A blockchain protocol change resulting in two paths forward—either a "soft fork" (backward-compatible) or a "hard fork" (creating a new blockchain)
Multi-signature Authorization	A security mechanism requiring multiple private keys to authorize a cryptocurrency transaction
Proof-of-Stake (PoS)	A consensus mechanism where validators are selected to create new blocks based on the amount of cryptocurrency they hold and are willing to "stake"
Proof-of-Work (PoW)	A consensus mechanism requiring participants to perform computationally intensive tasks to validate transactions and create new blocks
Reserve Asset	Assets held by central banks and monetary authorities to support monetary policy and provide confidence in national currencies
Smart Contract	Self-executing contracts with terms directly written into code that automatically execute when predefined conditions are met
Staking	The process of actively participating in transaction validation on a proof-of-stake blockchain by locking up cryptocurrency as collateral
Wallet	A digital tool that stores the cryptographic keys used to interact with blockchain networks and manage cryptocurrency holdings
Yield Generation	Methods of earning returns on cryptocurrency holdings, including staking, lending, or liquidity provision

Appendix H: Key Literature and Research Gaps

Table H.1: Foundational Literature in Cryptocurrency Reserve Analysis

Research Domain	Key Works	Contribution to Understanding
Monetary Theory	Menger (1892), "On the Origin of Money"	Spontaneous emergence of money from market interactions
	Hayek (1976), "Denationalization of Money"	Competition between private currencies
	Knapp (1924), "The State Theory of Money"	State authority in establishing money's value
	Selgin & White (1994), "How Would the Invisible Hand Handle Money?"	Market-driven monetary systems
Institutional Economics	North (1990), "Institutions, Institutional Change and Economic Performance"	Formal and informal constraints on economic behavior
	Ostrom (2015), "Governing the Commons"	Non-state governance of shared resources
	Buchanan & Tullock (1962), "The Calculus of Consent"	Public choice and constitutional economics
Financial Innovation	Rogers (2003), "Diffusion of Innovations"	How innovations spread through social systems
	Christensen (1997), "The Innovator's Dilemma"	Disruptive technology adoption patterns
	Davis (1989), "Perceived Usefulness, Perceived Ease of Use..."	Technology acceptance factors
International Political Economy	Cohen (2019), "Currency Statecraft"	International currency competition
	Strange (1988), "States and Markets"	Structural power in international finance

Research Domain	Key Works	Contribution to Understanding
	Eichengreen et al. (2018), "How Global Currencies Work"	Political and economic factors in currency status
Cryptocurrency Analysis	Ammous (2018), "The Bitcoin Standard"	Bitcoin's monetary properties
	Antonopoulos (2017), "Mastering Ethereum"	Technical foundations of programmable blockchains
	Burniske & Tatar (2018), "Cryptoassets"	Cryptocurrency investment framework
	De Filippi & Wright (2018), "Blockchain and the Law"	Legal implications of blockchain governance

Table H.2: Identified Research Gaps

Gap Area	Description	Significance for Crypto Reserves
Legal/Constitutional Mechanisms	Insufficient analysis of legal pathways for establishing cryptocurrency reserves	Critical for implementation feasibility
Empirical Performance Analysis	Limited research on cryptocurrency behavior across diverse economic conditions	Essential for risk assessment
Security/Governance Frameworks	Underdeveloped models for national-scale cryptocurrency custody	Fundamental operational requirement
Monetary Policy Interactions	Unclear relationship between cryptocurrency reserves and traditional policy tools	Core consideration for macroeconomic effects
Volatility Management	Absence of frameworks for managing crypto volatility in reserve context	Critical for stability maintenance
Correlation Dynamics	Limited understanding of how correlations between crypto and traditional assets evolve	Essential for portfolio construction
Operational Models	Insufficient research on institutional structures for crypto reserve management	Necessary for effective implementation
International Response Patterns	Underdeveloped models of how nations might respond to U.S. crypto adoption	Important for s

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EXCHANGE RATE AND INDUSTRIAL OUTPUT IN NIGERIA: SECTORAL ANALYSIS

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ABSTRACT

Purpose- The Nigerian manufacturing sector is performing below expectations despite government's proactive measures to address critical issues in the sector. A key driver of performance in this sector is the volatile exchange rate, but the direction of this effect is unknown. To shed more light on it, this study considers two types of exchange rates, namely effective and interbank exchange rates and studies manufacturing sector based on product classification.

Methodology: An Auto Regressive Distributed Lag estimator was adopted to estimate the relationship between sectoral output and volatile exchange rate using quarterly data from 2010:1 to 2023:4.

Findings- The volatility of each of the exchange rates is computed by utilizing eGARCH(1,1) based on monthly exchange rate data from 2010:1 to 2023:12. With the aid of autoregressive distributed lag (ARDL), the result indicates that interbank exchange rate volatility matter more than effective exchange rate in the Nigerian manufacturing sector. Further, exchange rate volatility in the manufacturing subsectors is more of a short-run than long-run phenomenon. Specifically, textiles, electrical & electronics, and wood & wood products are adversely affected by interbank exchange rate volatility. Textile, chemicals and oil refining are adversely affected by effective exchange rate volatility. Interbank exchange rate volatility encourages oil refining (up to three lags) and vehicle assembly. In the long run, interbank exchange rate volatility facilitates the performance of electrical & electronics, textile and vehicle assembly while effective exchange rate significantly affects electrical & electronics. Nonmetallic, iron & steel, plastic, cement products are affected negatively by both interbank and effective exchange rate volatility while interbank exchange rate volatility drags the activity in the oil refining products. Economic implications and recommendations are offered based on the findings.

Conclusion- It is therefore concluded that interbank exchange rate volatility matter more than effective exchange rate in the product categories of the manufacturing sector in Nigeria. Further, interbank exchange rate has detrimental effect on most of these products, both in the short and long runs.

Keywords: Industry studies, manufacturing, generalized autoregressive conditional heteroskedasticity, foreign exchange
JEL Codes: L61, L66, C140, F11

1. INTRODUCTION

The industrial sector's contribution to economic growth and development cannot be overemphasized. Advanced countries' robust and persistent growth is inextricably linked to a functioning industrial, especially the manufacturing sector. Although, the service sector is leading in its contributions to economic growth in these countries, its performance is sustained by a productive manufacturing sector. Impliedly, a country's unproductive industrial sector can make an economy dormant leading to rising unemployment, low income, low demand, and low output. This puts the economy in a vicious circle of underdevelopment.

Nigeria is faced with this dilemma given the suboptimal performance of the manufacturing sector. Table 1 presents information on sectoral contributions to Gross Domestic Product growth (GDP) in the country. Observably, the industrial sector's contribution to Nigeria's GDP is unambiguously low. Specifically, in year 2010, the sector accounted for less than 25 percent of GDP. More worrisome is the performance of the manufacturing sub-sector which accounted for 6 percent of GDP in 2010 but rose markedly to 15 percent in 2022. On average, the sector contributed 10 percent to GDP between 2010 and 2022 in contrast to services and agriculture which posted an average of 52 percent and 26 percent respectively (Table 1). Noticeably, the share of manufacturing in industrial sector output averaged 39 percent, suggesting that other sub-sectors constituting mineral resources accounted for 61 percent. This strüktüre confirms the dependence of the economy on mineral

resources. By implication, the dismal economic growth in Nigeria could be traced to the abysmal performance of the industrial sector in general and the manufacturing sector in particular. But what could be responsible for the abysmal performance of the sector? Several factors such as the lack of adequate economic infrastructure, deficient governance institutions, and insecurity were appalling justifications (Adewuyi and Olubiyi, 2020), however, exchange rate volatility is one of the few controversial factors for the dwarfing performance of the sector.

Researchers have assessed the influence of exchange rate movement and volatility on industrial output. Results from received evidence can be categorized into three. The first set of empirical works claim that the effect is positive and significant (Jongbo, 2014). The second set affirms that exchange rate volatility abates industrial output (Loftaliopour *et al*, 2013). The third set shows that exchange rate volatility have no significant effect (Ogunmuyiwa *et al*, 2018; Hakeem, *et al*, 2018). There is yet another set of empirical works that claim that the effect of exchange rate volatility is period-specific. In this regard, industrial output may not be affected by exchange rate in the long run but it does in the short run (Ogunmuyiwa *et al*, 2018).

Table 1: Sectoral Contribution to GDP

Main Sector	2010	2015	2019	2020	2021	2022	Avg performance (2010-2022)
Agriculture	25%	20%	27%	28%	31%	24%	26%
Industry	24%	21%	22%	24%	23%	31%	22%
Services	50%	58%	50%	46%	44%	44%	52%
Manufacturing	6%	9%	12%	13%	15%	14%	10%
Manufacturing in industry	26%	47%	42%	45%	47%	44%	39%
REER volatility	**0.10**	**1.96**	**0.02**	**0.06**	**0.14**	**0.17**	**0.18**
Inter bank exc. rate vol.	**0.04**	**2.39**	**0.37**	**1.96**	**1.99**	**1.98**	**1.13**

Note: share of each sector in GDP expressed in percentage. Services contributed most to GDP, followed by agriculture and then industry. Industry is composed of mining and quarrying and manufacturing. The contribution of manufacturing to industry is less than 50% in any year and the average contribution between 2015 and 2022 was 39%. Needless to say that the contribution of manufacturing is the least, posting an average of 10% between 2010 and 2022.

Source: computed. Underlying data from the Central Bank of Nigeria online statistic database, available at http://statistics.cbn.gov.ng/cbn-onlinestats/DataBrowser.aspx

Two observations can be noted from this evidence. First, industrial sector was studied as a whole. The implication of this is that if some sub-sectors in the industrial sector do not respond to exchange rate, or responds positively or negatively, it will be assumed that such effect is applicable to all the sub-sectors. Table 1 indicates that manufacturing sector performed below par but this sub-sector is part of industrial sector. Thus, a positive or negative or no significant effect may be observed in the industry as a result of dominant performance of a particular sub-sector (say, mineral resources). The figures for exchange rate (both nominal effective and interbank) lend credence to this. Both types of exchanges have been depreciating over time but industrial and manufacturing sectors exhibit inconsistent changes, and so, it can be argued that exchange rate movement has no bearing on the behaviour of these sectors (Table 1).

Second, most studies concentrate on exchange rate movement but not the persistence or the volatility of the variable, whereas, what matters to producers, particularly those whose inputs are import dependent or those whose large proportion of their output is tradeable is affected by the unexpected fluctuation of exchange rate. As can be observed in Table 1, periods of increase in the volatility of each of these exchange rates coincided with period of increase in the percentage share of industrial value added in GDP and the share of manufacturing sector in industrial sector. Thus, it may be conjectured that the dynamics of these sectors is positively driven by exchange rate volatility. However, if sector-specific analysis were carried out, the result may be different. But the good thing is that the outcome may be more useful to policy makers than the one obtained from the aggregation model. This aggregation bias is usually committed and can mislead policy makers in their foreign exchange and industrial policies decisions. It can also mislead other investors in the industrial sectors. This aggregation bias is not resolved when analyzing the manufacturing sector. In the case of Nigeria, and following the standard classification of industrial output, there are thirteen (13) sub-sectors in the manufacturing sector (Table 2;).

The structure of the manufacturing sub-sector is such that food and beverages accounted for the major share in manufacturing output (47.7 percent), followed by textile, apparel and footwear (19.7 percent) while electrical & electronics recorded the lowest (0.1 percent), trailing motor vehicles & assembly (1.2 percent). This divergent performance of the manufacturing sub-sectors may be due to different response to exchange rate volatility. Unlike what was observed in the aggregates, three manufacturing subsectors had continuous decline in their share in total manufacturing output (food and beverages, wood and wood products and oil refining), two indicate consistent increase (cement and paper products), while textile is inconsistent and electrical & electronics is constant. This implies that the first three manufacturing products may

likely respond negatively to exchange rate volatility, electrical & electronics and textile may not likely be affected by exchange rate volatility. Further, other products may likely exhibit positive response to exchange rate volatility.

This simple but important analysis clearly indicates that appropriating a positive, negative or neutral effect of exchange rate on the manufacturing sector in its aggregates may becloud the performance if sub sectoral analysis is discarded.

Table 2: Contribution of Each Manufacturing Sub-Sector to Manufacturing Output

Sub-sector	2010	2015	2019	2020	2021	2022	Avg performance (2010-2022)
Oil Refining	7.1%	2.8%	0.9%	0.3%	0.1%	0.1%	3.3%
Cement	6.2%	8.4%	13.4%	17.6%	22.0%	22.8%	9.8%
Food Beverage and Tobacco	64.2%	47.8%	38.0%	37.1%	33.5%	34.0%	47.7%
Textile, Apparel and footwear	9.9%	20.9%	23.4%	22.0%	21.0%	19.6%	19.7%
Wool and wool product	3.4%	2.9%	2.6%	2.3%	1.9%	1.9%	2.8%
Paper products	0.7%	0.7%	1.2%	1.3%	1.4%	1.3%	0.9%
Chemical and Pharmaceutical	0.7%	2.1%	2.7%	2.5%	2.3%	2.4%	1.9%
Non-metallic products	1.7%	3.5%	5.5%	5.7%	6.4%	6.4%	3.8%
Plastic and Rubber Products	0.9%	3.0%	3.9%	3.1%	2.7%	2.7%	2.7%
Electrical and Electronics	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Basic Metal, Iron & Steel	1.2%	2.3%	2.7%	2.2%	1.8%	1.9%	2.2%
Motor Vehicles & Assembly	0.6%	0.8%	1.2%	2.5%	4.0%	3.9%	1.2%
Other Manufacturing	3.2%	4.8%	4.4%	3.3%	2.8%	2.9%	4.0%
Nominal Effective Exc. rate	96.7	102.0	178.7	185.1	193.1		142.1
Interbank exchange rate	151.1	1195.5	306.9	400.0	426.0		257.1
REER volatility	**0.10**	**1.96**	**0.02**	**0.06**	**0.14**	**0.17**	**0.18**
Inter bank exc. rate volatility	**0.04**	**2.39**	**0.37**	**1.96**	**1.99**	**1.98**	**1.13**

Note: the contribution of each sub-sector in the manufacturing sector is expressed in percentage. Food and beverages accounted for around 48% of manufacturing output. This is followed by Textile and footwear sector with about 20% while the least was electrical and electronics. Source: computed. Underlying data from the Central Bank of Nigeria online statistic database, available at http://statistics.cbn.gov.ng/cbn-onlinestats/DataBrowser.aspx

Although it is not sufficient to establish anything concrete from this descriptive analysis, however, it allows further exploration into the issue at hand so as to unravel the exact relationship and possible direction of relationship between exchange rate volatility and sectoral output growth. Further, received evidences consider just one exchange rate volatility, but experience has shown that firms source foreign exchange from other means such as the interbank. As can be observed, interbank exchange rate is not only higher than effective exchange rate, but also highly volatile. Is there a link between manufacturing sector performance and volatile interbank exchange rate?

This study therefore seeks to explore further how exchange rate volatility influences the aggregate industrial sector output and each of the manufacturing sub-sectors. Most studies on exchange rate volatility and manufacturing output in Nigeria utilized annual data owing to the herculean task required to get high frequency data on sectoral output. But the implication is that the reports that spur volatility usually peters out with time. Thus, this study utilizes quarterly data from 2010:1 to 2022:4 based on data availability. The output of this research work is expected to help policy makers and producers in the manufacturing sector to understand the role of exchange rate volatility in industrial performance. This should provide information about the issues surrounding exchange rate policy in relation to industrial activity. Also, it will help the investors in determining their expectations when exchange rate fluctuations set in.

After the introductory section, section two reviews received theoretical and empirical literature while section three discusses the methodology adopted. Section four presents and discusses the findings and sector five provides summary of findings alongside basic conclusion, policy implications and recommendations.

2. LITERATURE REVIEW

Theoretically, there are three major channels through which exchange rate volatility affects industrial output, namely commodity price, currency crisis and trade. The commodity price channel is induced by monetary policy. Specifically, monetary authorities could alter demand pattern through interest rate changes in their bid to deal with inflation rate. In this case, the authorities may tend to raise monetary policy rate in order to stem the pressure of inflation rate. But the increase in interest rate will alter good prices, affect import input, and hence output prices. The increase in output price may cause consumers to switch demand. The demand switch will alter industrial output. Whether overall manufactured output will increase or not depends on the reaction of consumers to the monetary policy.

From the aspect of currency crisis, if a strong currency (like the US dollar or Pounds or Euro) appreciate against another strong currency (say Euro against the Yen), all currencies pegged to the currency will also appreciate, thereby weakening the relative price competitiveness, to reduction in exports, and to reduction in external account. Further, the cost of servicing may be affected by exchanger rate volatility. Appreciation of foreign currency for which domestic economy is indebted leads to higher cost of debt servicing and this affects allocation of funds for domestic production and hence reduction of industrial output. Ethier (1973) among others demonstrates theoretically that higher exchange rate volatility is inimical to trade. In this regard, risk-averse traders will reduce or even stop producing temporarily during high exchange rate swing. But risk-neutral producers tend to maximize projected returns. In this regard, they tend to increase projected marginal utility of revenue from output and so, they boost production in the face of exchange rate volatility.

The summary of the theoretical effect of exchange rate volatility on industrial output is not straightforward. The effect could be inimical, it could be enhancing or even neutral. Hence, the best way to assess the effect is through empirical evidence. Jongbo (2014) investigates the effect of real exchange rate fluctuation on industrial output in Nigeria, utilizing data from 1990 and 2012 in the context of ordinary least square. Result indicates that exchange rate fluctuation actually increases industrial output. Ishimwa and Ngalawa (2015) examined the effect of exchange rate volatility on manufacturing exports in South Africa employing quarterly data from 1990: Q1 to 2014: Q1. Exponential GARCH (EGARCH) was used to generate the exchange rate volatility and data was analysed using autoregressive distributed lag (ARDL). The result suggests that increase in exchange rate volatility has a positive effect on manufacturing output in the long run, but in the short run, no significant effect is observed. Pamba, (2023) examined the impact of exchange rate volatility on exports in South Africa, results from NARDL show that positive shocks have a greater but statistically insignificant effect on exports than negative shocks.

Oseni et al., (2019) examined exchange rate volatility and industrial output growth in Nigeria using an ARDL technique. Findings reveal that industrial production is an increasing function of volatile exchange rate. Ukunwa et al., (2022) applied the VECM technique to examine the relationship between aggregate industrial output and exchange rate from 1981-2021. The study found a negative and insignificant relationship. Ogunjimi (2020) examined exchange rate dynamics and sectoral output in Nigeria using ARDL and NARDL techniques on data spanning from 1981-2016. Sectors examined include agriculture, industry and service, the study found that dynamics in exchange rate improve agricultural sector performance while such could not be established for the industrial sector.

Arachi (2018) computes exchange rate volatility using SMA model. The study focuses on five major trading partners of Sri Lanka and five products. The real effective exchange rate and its volatility negatively impact real exports for the selected exporting partners in the long run. Ogunmuyiwa and Adelowokan (2018) shows that there is no long run effect of exchange rate volatility on industrial output in Nigeria in the dataset spanning 1986 to 2016 in the context of ARDL although, in the short run, it has a positive and significant effect on industrial output. Jani *et al* (2012) focuses on the effect of exchange rate volatility on industrial output in four EU countries that did not adopt Euro as common currency. The authors employed monthly data from 1980:M1 to 2009:M4 and utilized an autoregressive of order *k* (AR(k)) in the context of EGARCH for calculating volatility. The pooled instrumental variable (IV) method reports that introducing a common currency was beneficial to countries by reducing the negative impact of real exchange rate volatility. However, the currency gain across countries was not uniform. In Iran, Lotfaliporn and Zabini (2013) in their sectoral panel data analysis from 1995 and 2009 found a negative and significant effect of real exchange rate on manufacturing investment in the Sys-GMM method employed.

Palodoo *et al* (2016) provides evidence of the effect of exchange rate volatility on manufactured trade in a panel of 18 African countries from 1995 and 2012. The authors employed import-export model in the context of dynamic panel data. They also utilized z-score and exponential GARCH as measures of volatility. The result from the random effect indicate that real effective exchange rate and its volatility explains manufactured exports and imports. In particular, the findings indicates that exchange rate volatility is inimical to manufactured trade in Africa. Also in Nigeria, Aidi *et al* (2018) employ quarterly data starting from 1980:Q1 to 2016:Q4 and utilize ordinary least square to estimate the output model. The volatility measure favours EGARCH and the result of the model indicate that exchange rate volatility inhibits industrial performance, measured by industrial value added.

Some recent studies on the effect of exchange rate volatility on manufactured output include Buabeng (2019), Falaye *et al* (2019), Ojeyinka (2019), Mambo (2020), Ali (2020), and Oladipo *et al* (2023). In the study of Buabeng (2019), exchange rate volatility and monetary policy rate negatively affect industrial output in Ghana in the dataset spanning 1990 to 2018 in the context of ARDL. Falaye *et al* (2019) find that devaluation reduces industrial performance in Nigeria in their ECM method with data capturing 1990 to 2014 period. Also, Ojeyinka (2019) analysed data from 1981 to 2016 using ARDL method; the study found a negative and significant effect of exchange rate on manufactured output in the short run.in Nigeria. . In Nigeria Ali (2020) find that exchange rate volatility has negative effect of manufacturing performance in Nigeria using the period 1981 and 2018 in the context of ARDL. The study of Oladipo *et al* (2023) compute exchange rate volatility using GARCH (1,1). The result shows no persistence of shocks in the volatility of exchange rate in Nigeria during 1981-2022 period. Results from the ARDL indicate that exchange rate is highly volatile and has negative effect on manufacturing output. Takpa et al., (2023) explored the relationship between the real exchange rate and the manufacturing sector in Nigeria from 1999-2021. Using a vector autoregressive estimator, the study found a negative and insignificant relationship between exchange rate and manufacturing output. Abiola (2024) could not find a significant effect of exchange rate volatility on manufacturing growth in the ARDL method of data covering 1978 and 2022. However, the study of Bakla *et al* (2024) for Nigeria reports that exchange rate volatility positively and significantly affect manufacturing sector export the authors estimated an autoregressive distributed lag of data spanning 1985 to 2022 and utilized GARCH (1.1) to proxy exchange rate volatility and finds that increase in exchange rate volatility enhances manufactured exports in the long run.

Table 3: Summary of Empirical Evidence Showing the Effect of Exchange Rate Volatility on Output

#	Author(s) and date	Location	Theory and methodology	Results of the effect of exchange rate volatility on output
1	Jongbo (2014)	Nigeria	OLS	Proactive and significant
2	Ishimwa and Ngalawa (2015)	South Africa	eGARCH (1,1) to generate volatility and ARDL for estimation	No significant effect in the short run but significant positive effect in the long run
3	Pamba, (2023)	South Africa	NARDL	Positive shocks to exchange rate fluctuation (depreciation) has greater, albeit insignificant effect
4	Oseni et al., (2019)	Nigeria	ARDL	Positive effect
5	Ukunwa et al., (2022)	Nigeria	VECM	Negative but insignificant
6	Ogunjimi (2020)	Nigeria	N(ARDL)	Positive and significant effect on agriculture output but insignificant effect on industrial output
7	Arachi (2018)	Sri Lanka	SMA model	Negative effect
8	.Ogunmuyiwa and Adelowokan (2018)	Nigeria	ARDL	Positive and significant in the short run but insignificant in the long run
9	Jani *et al* (2012)	4 EU countries	eGARCH for volatility and pooled IV model for estimation	Negative
10	Lotfaliporn and Zabini (2013)	Iran	SYS-GMM	Negative and significant
11	Palodoo *et al* (2016)	18 African countries	Dynamic Panel Data Random effect, employ *z*-score and GRACH to generate volatility	Negative
12	Aidi *et al* (2018)	Nigeria	OLS, using eGARCH to generate volatility	Negative
13	Buabeng (2019)	Ghana	ARDL	Negative
14	Falaye *et al* (2019)	Nigeria	ECM	Negative
15	Ojeyinka (2019)	Nigeria	ARDL	Negative and significant
16	Ali (2020	Nigeria	ARDL	Negative
17	Oladipo *et al* (2023)	Nigeria	GARCH(1,1) for volatility and ARDL	Negative on manufacturing output
18	Takpa et al., (2023)	Nigeria	VECM	Negative, albeit insignificant
19	Abiola (2024)	Nigeria	GAARCH (1,1) for volatility, ARDL	Insignificant

20	Bakla *et al* (2024)	Nigeria	GARCH (1, 1) for volatility, ARDL	Positive and significant effect in the long run

The summary of the empirical findings **s** provides diverse result across countries and over time (Table 3). Observably, empirical evidences from Nigeria are also diverse. Some studies found negative relationship; other studies found positive relationship while some studies could not establish any significant effect of exchange rate volatility on manufacturing sector output (Table 3). However, it was observed that the common approach across the empirical models is the modeling of the manufacturing sector as a single sector disregarding the variation in pattern of some manufacturing sub-sectors. To avoid aggregation bias, it is important to disaggregate the manufacturing sectors and study how exchange rate volatility affect each of the sub-sector. It is our belief that this sectoral level analysis will provide more insight into how exchange rate volatility affects manufacturing sector performance and this could be of help to policy makers.

3. DATA AND METHODOLOGY

3.1. Model Specification

Following Bahmani-Oskooee and Mohammadian (2017) with a slight modification, a flavour of demand-supply model is specified as follows

$$Y_t = f(VOL_t\ , MP_t\ , FP_t, X_t) \tag{1}$$

That is sectoral value addition Y_t depends on exchange rate volatility(VOL_t), monetary policy (MP_t), fiscal policy (FP_t) and other catchall variables (X_t). From the theoretical point of view, monetary policy affects the industrial sector when the monetary authorities are trying to tame inflation rate. In particular, the monetary authorities deal with high inflation rate by raising interest rate. But the increase will lead to increase in cost of production, reduce investment and hence, reduction in output. From the demand side, the increase in interest rate will reduce purchasing power (holding money income constant), demand and hence, reduce production. Not only that, increase in interest rate will raise the opportunity cost of holding money, reduce demand and hence production. Ultimately, interest rate is expected to reduce industrial output. However, investors might decide to increase production in the face of increased interest rate if there is potential for future profit. Also, the opportunity cost of holding money may not be high even when interest rate increases, particularly when income is low and stagnant. Hence, the direction of effect of interest rate on industrial output depends on the nature of goods produced in the sector.

Government provides public goods to facilitate economic activity in which industrial sector plays a major role. Economic infrastructure such as good roads, stable electricity supply, research and development, functional political and economic governance are some important ways government intervene in the economy. This is captured in the model as fiscal policy and proxied by government final expenditure that accounts for both recurrent and capital expenditure. The catchall variables considered in this study are the capital market and the foreign exchange market activities. Functional capital market provides avenues for firms to ease financial constraints. Hence, it is expected that improved stock market activity should enhance sectoral output since firms can source for funds to overcome financial constraints. This is captured by stock market capitalization. Foreign exchange is key to importing important factor inputs such as raw materials and capital goods. Access to foreign exchange market allows producers whose production are import-input-intensive to import these factor inputs with ease. In this study, sectoral foreign exchange supply are considered, namely foreign exchange in the industrial , manufacturing, minerals , food and beverage and in oil and gas sector.

Exchange rate volatility is computed first identifying the type of exchange rate for which volatility is referred. For this study, real effective exchange rate is employed. Specifically, real effective exchange rate is computed using equation 2, that is,

$$C = \sum_{i=1}^{n}\left(\omega_{hf,t}R_t\right) \tag{2}$$

Where $R_t = \mathbf{e}_{hf,t}\frac{P_{ft}}{P_{ht}}$ (3)

$$\mathbf{e}_{hf,t} = \frac{C_t^h}{C_t^f} \tag{4}$$

Equation 1 states that real effective exchange rate (R_t) is sum of the product of weighted trade between home and foreign ($\omega_{hf,t}$) and real exchange rate (R_t). The real exchange rate is defined in equation 3 as the product of nominal bilateral exchange rate ($\mathbf{e}_{hf,t}$) and international relative price ($\frac{P_{ft}}{Pht}$). The terms P_{ft}, P_{ht}, C_t^h, and C_t^f stand for foreign price, domestic price, foreign currency and domestic currency respectively. The effective exchange rate specified in equation 2 is used to compute its volatility. There are several approaches utilized in the computation of exchange rate volatility (or any volatility of macroeconomic and financial variables). The approaches commonly employed in the literature include simple standard deviation, moving average of standard deviation and the time-varying autoregressive conditional heteroskedasticity (ARCH).

In the case of ARCH effect, the argument is that the dynamic of the series (exchange rate in this case) is time-dependent, that is, information providing the value of the exchange rate is time dependent. Starting from the Engel (1982) autoregressive (AR) effect of the form

$$\mathcal{g}_t = a_0 + a_1\varphi_{t-1} + \varepsilon_t \quad (5)$$

Where ε_t is the residual term. The squared of the estimated residual is then estimated by its lags

$$\varepsilon_t^2 = \gamma_0 + \gamma_1\varepsilon_{t-1}^2 + v_t \quad (6)$$

The ε_{t-1}^2 is the autoregressive term and γ_1 estimates by how much the residual is autoregressive (depends on the past residuals). If there is no autoregressive in the process then γ_1 will not be significantly different from zero. Otherwise, $\mathcal{g}_t$ series is said to be volatile, and its volatility is time-varying. This is the famous autoregressive conditional heteroskedasticity (ARCH) effect. But the residuals may influence the variance, in which case, not only the residual is not constant but also the variance is not also constant (Engle, 1982). The problem of residual influencing variance of a series is inevitable in a high frequency data, such as monthly, weekly or daily data. This problem is dealt with by simultaneously estimating the mean and variance as indicated in equations 7 and 8

$$\mathcal{g}_t = a_0 + \sum_{i=1}^{z} a_i\varphi_{t-i} + \varepsilon_t \quad (7)$$

$$\sigma_t^2 = \tau_0 + \sum_{i=1}^{z} \tau_i\varepsilon_{t-i}^2 \quad (8)$$

That is, the variance of the residual (σ_t^2) is explained by the squared of the previous residuals. Recall the ε_{t-i}^2 is the ARCH effect and expectedly, the coefficient τ_i should take on a positive value. Additionally, the value is expected to be less than 1. The closer it is to 1 the slower the mean reverting. But what if the current variance also depends on the lagged variance? Hence, equation 7 becomes

$$\sigma_t^2 = \tau_0 + \sum_{i=1}^{z} \tau_i\varepsilon_{t-i}^2 + \sum_{j=1}^{n} \rho_j\sigma_{t-j}^2 \quad (9)$$

Equation 9 is the generalized ARCH-type (GARCH (1,1)) model, which is commonly utilized in computing exchange rate volatility. The third term in equation 8 is the GARCH effect. It is also expected to be positive. Meanwhile, $\tau_i + \rho_j$ should be less than 1 if the shock will be temporary. But if the shock is not temporary, then the sum can be greater than 1. Also, the closer the shock to 1 the slower the mean reverting (the shock tends towards being permanent). In a special case where the sum is zero, then there is no existence of volatility in the system. if ρ_j is not significantly different from zero while τ_i does, then, the system reduces to ARCH effect only.

In the event that the series affected by its past event, the current residual and the variance, such that

$$\mathcal{g}_t = a_0 + \sum_{i=1}^{z} a_i\mathcal{g}_{t-i} + \varepsilon_t + \rho_j\sigma_t^2 \quad (10)$$

then the series follows volatility of GARCH-M. However, if ρ_j is not significantly different from zero, the series only does not exhibit GARCH-M type. It is, however, important to check if the series exhibits GARCH-M because this type of volatility so as to know if the series conceives important news in the residuals and variance or not.

It is one thing to establish that the volatility conceives a particular news, it is another thing to know whether the news is symmetric or not. A case of asymmetry of exchange rate behaviour (among other macroeconomics variables) have been examined in the literature. All the ARCH/GARCH models specified above assumed that the news is symmetry. But asymmetry is inevitable because news could be positive (good news) or negative (bad news). The threshold GARCH (tGARCH) developed by Zakoian (1994) incorporates the possibility of information asymmetry in the volatility and this is specified in equation 10

$$\sigma_t^2 = \tau_0 + \sum_{i=1}^{z} \tau_i\varepsilon_{t-i}^2 + \sum_{j=1}^{n} \rho_j\sigma_{t-j}^2 + \delta\varepsilon_{t-i}^2 * D_{t-1} \quad (11)$$

The term D_{t-1} is the dummy and it checks how significant nature of the shock is. If δ is not significantly different from zero then the shock (either negative or positive) is not important, and so, investors can ignore the importance of news (either good or bad) in the exchange rate volatility. But suppose the presence of positive or negative news is important in the exchange rate market, does good news overweigh bad news? This question is important for firm owners in the industrial sector, particularly those whose input are import-dependent and those whose output are mostly exported. Following Nelson (1991), an exponential GARCH (eGARCH) is developed as follows

$$\sigma_t^2 = \tau_0 + \tau_1\left|\left(\frac{\varepsilon_{t-1}^2}{\sigma_{t-1}^2}\right)^{1/2}\right| + \theta\left(\frac{\varepsilon_{t-1}^2}{\sigma_{t-1}^2}\right)^{1/2} + \vartheta ln(\sigma_{t-1}^2) \quad (12)$$

In equation 10, the value of θ is the focus that indicates if the volatility follows tGARCH or not. If the value of the estimator is negative, then the bad news overweighs the good news. If the value is positive, then the good news overweighs the bad

news. If the value is very close to zero, then there is no case for information asymmetry. Which of the ARCH-type is valid for the computation of real exchange rate volatility? It is important leave it open and allow the information criteria to determine which is best explains the nature of exchange rate volatility to be included in equation 1. Specifically, equations 7, 8, 9, 10, and 11 for ARCH, GARCH (1,1), GARCH-M, tGARCH and eGARCH respectively are estimated and information criteria are employed to choose the best suited volatility model. the information criteria are Akaike information criterion, Schwartz information criterion, and Hanna-Quinn information criterion. The lowest value recorded across the models for each of these criteria is the appropriate and the most valid model. Having detected the valid model, data for volatility are then generated from the volatility model chosen. As indicated earlier, exchange rate volatility can have a positive or negative effect on any of the sectoral output depending on how the producers react to exchange rate dynamics.

3.2. Method of Analysis

Usual routine econometric tests associated with the autoregressive distributed lag (ARDL) are carried out. One of such test is the unit root. Received statistical tests for unit root include Dickey-Fuller, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) while Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests for stationarity. Results from these various tests are rarely dissimilar. Consequently, the ADF is employed for this study. Consider the model for which series *y* is to be tested in equation 13.

$$\Delta y_t = \zeta_t + \Im_t + \eta y_{t-1} + \sum_{i=1}^{n} \lambda_i \, \Delta y_{t-1} + e_t \tag{13}$$

where ζ is constant, $\Im_t$ is trend, and $\sum_{i=1}^{n} \lambda_i \, \Delta y_{t-1}$ is the augmentation. The purpose of this augmentation is to allow for any autoregressive data generating process in any order greater than 1. Whether the series possesses a unit root or not depends on the value of λ.. If the series does not possess unit root, then the value of the parameter should be zero. Alternatively, if the series possesses a unit root, then, it is nonstationary.

This study employs autoregressive distributed lag (ARDL) because it can indicate when exchange rate volatility is relevant (short run, long run or both runs) to sectoral output. Besides, ARDL can deal with series that exhibit a mix of I(0) and I(1). Further, under certain plausible assumptions, ARDL can address the issue of endogeneity problem usually encountered in macroeconomic analysis (Jalil et al, 2008; Pesaran and Pesaran 1997). Also, ARDL produces efficient and consistent coefficients because it corrects for possible serial correlation (Pesaran and Shin, 1999 and Pesaran and Shin, 2001). Based on this, Schwarz-Bayesian Criterion (SBC) and Akaike Information Criterion (AIC) are employed to determine the optimal lag length included in the unit root test ARDL model. The estimable ARDL, after log linearizing relevant variables is indicated in equation 14

$$\Delta \ln Y_t = \gamma_0 + \sum_{i=1}^{a1} \vartheta_{1i} \Delta lnY_{t-i} + \sum_{i=1}^{a2} \vartheta_{2i} \Delta VOL_{t-i} + \sum_{i=1}^{a3} \vartheta_{3i} \Delta lnMP_{t-i} + \sum_{i=1}^{a4} \vartheta_{4i} \Delta lnFP_{t-i} + \sum_{i=1}^{a5} \vartheta_5 \Delta lnX_{t-i} + \vartheta_5 lnY_{t-1} + \vartheta_6 lnVOL_{t-1} + \vartheta_7 lnMP_{t-1} + \vartheta_8 lnFP_{t-1} + \vartheta_8 lnFP_{t-1} + e_t \tag{14}$$

Equation 14 is estimated separately for industry and manufacturing as a whole, and for thirteen sub-sectors in the manufacturing sectors. These include oil refining; cement; food, beverage, and tobacco; textile apparel and footwear; wood and wood products; pulp, paper and paper products; chemical and pharmaceutical products; non-metallic products; plastic and rubber products; electrical and electronics, basic metal, iron and steel, motor vehicles & assembly and other manufacturing. All these are the sectoral classification of the manufacturing sector in Nigeria. This study seeks to unravel the influence of exchange rate volatility on each of these sub-sectors.

Data on all the variables, that is, sectoral output, effective exchange rate, monetary policy rate, market capitalization, foreign exchange to the oil refining, foreign exchange to food, beverage and tobacco and foreign exchange to manufacturing are obtained from the online data repository of the Central Bank of Nigeria, publicly available at www.statistics.cbn.gov.ng/cbn-onlinestats/DataBrowser.aspx . All the data are obtained on quarterly basis from 2010:1 to 2023:4. However, data used to compute volatility (equations 8 to 11) are obtained on monthly basis from 2010:M1 to 2023:M12. After choosing the appropriate volatility model, the monthly volatility data generated are later converted to quarterly data using *high to low frequency data approach*. As indicated in equation 14, all the series are log linearized except the volatility series. According to equation 13, both short run and long run models are estimated for each sector. Some post estimation tests such as serial correlation, heteroskedasticity, RESET, and test for stability of the model (CUSUM and CUSUM of Square) are carried out in order to validate the predictive ability of the models.

4. RESULTS AND DISCUSSIONS

4.1. Volatility and Descriptive Statistics

The result of the volatility models is shown in Table 4. Out of the four models estimated (equations 8, 9, 10 and 12) which is ARCH, GARCH (1,1), GARCH-MM, and eGARCH (1,1), all the information criteria identified eGARCH (1,1) as the appropriate type of volatility for both interbank exchange rate and nominal effective exchange rate. This implies that the nature of volatility of

exchange rate in Nigeria is such that positive and negative news is important in the foreign exchange market. The eGARCH(1,1) series generated is copied and included in the dataset developed for the estimation of equation 14.

Table 4: Result of the GARCH-Type and Selection Criteria for Choosing Appropriate Nature of Volatility

ARCH-TYPE	Interbank Exchange Rate			Nominal Effective Exchange Rate		
	AIC	SIC	HQIC	AIC	SIC	HQIC
ARCH	5.941	6.014	5.973	6.346	6.424	6.377
GARCH(1,1)	5.958	6.056	5.998	5.488	6.047	5.988
GARCH-M	5.901	5.999	5.941	6.359	6.457	6.398
eGARCH(1,1)	5.69	5.81	5.740	**5.443**	5.712	5.641

Note: AIC, SIC, HQIC correspondingly stands for Akaike information criterion, Schwartz information criterion and Hanna-Quinn information criterion; the Table indicates that all the information criteria favours FGARCH (1,1) for each of the models.

From the descriptive statistics presented in Table 5, the average values of industrial output from quarter 1 of 2010 and quarter 4 of 2023 was 8,565.7 billion naira while the mean value of the manufacturing sector was 3,581.54 billion naira in the period under review. The average values of each of the sectoral output is also indicated in Table 5. Other manufacturing goods posted an average of 127.22 billion naira while oil refining sector posted 54.98 billion naira. Going through the average values of the sub-sectors, food, beverages and tobacco recorded the highest, with 1,435.5 billion, followed by textile with 753.14 billion naira while cement is the third largest sub-sector in the manufacturing sector as it posted an average value of 557.64 billion naira between 2010:1 and 2023:4. Complementing the trend analysis in Table 5 electrical & electronics sub-sector recorded the least average performance with 2.62 billion naira average of output in the manufacturing sector. Further, paper & paper product posted 41.19 while oil refining recorded 54.98-billion-naira worth of output. Clearly, electrical & electronics and oil refining, the two critical sectors that could enhance overall economic performance is not performing really well. Given this different performance across sub-sectors, it is important to unravel how each sub-sector is affected by exchange rate shocks.

The descriptive statistics also present the properties of foreign exchange used by the entire industry, the manufacturing sector, the food and oil refining sub-sectors. The average foreign exchange used in the industrial sector of Nigeria during the period under review was 605.53 billion naira while that which went to the manufacturing sector was 320.8 billion naira. Observably, foreign exchange used up in the oil refining sector (447.06 billion naira) is greater than that which was used in manufacturing sector. Out of the sub-sectors, mineral (iron and steel) sector recorded the least foreign exchange use (30.34 billion naira). This is followed by food, beverage & tobacco recorded the least, posting an average of 280.3 billion naira. How has foreign exchange used in each of these sub-sectors influenced their individual output? Does highest foreign exchange that goes into oil refining enhances oil refining value added? Does availability of foreign exchange in the industrial, manufacturing and its sub sectors significantly matter for their respective output? Results from the estimation models is expected to provide answers to these questions. Meanwhile, average government spending in the period under review was 4,293.45 billion naira and the average market capitalization was 27,969.52 billion naira. Further, the average monetary policy rate was 15.62. The average nominal effective exchange rate was 142 while that of inter-bank exchange rate was 257.1. In terms of exchange rate volatility, interbank exchange rates tend to be less volatile on average (0.002) than nominal effective exchange rate volatility (0.01).

Table 5: Descriptive Statistics of the Variables

Sectors	Mean	Maximum	Minimum	Std. Dev.	Jarque-Bera	Prob-value (J-B)	Obs
INDUSTRY	8565.70	38560.92	3284.29	6898.58	175.37	0.00	52
MANUFACTURING	3581.54	18067.69	875.41	3410.18	148.75	0.00	52
OTHER MANUFACTURING	127.22	514.35	28.73	94.43	97.85	0.00	52
OIL REFINERY	54.98	115.33	5.02	30.99	1.93	**0.38**	52
CEMENT	557.64	4074.50	54.47	**849.97**	135.46	0.00	52
CHEMICAL AND PHARM. PRODUCTS	79.82	432.56	5.20	**86.94**	97.27	0.00	52
BASIC METAL, IRON AND STEEL	76.14	339.20	10.99	64.21	100.01	0.00	52
NON-METALLIC PRODUCTS	183.45	1147.26	13.97	**234.73**	118.43	0.00	52
MOTOR VEHICLE AND ASSEMBLY	83.30	706.92	5.26	**150.83**	139.30	0.00	52

ELECTRICAL AND ELECTRONICS	2.62	12.91	0.62	2.46	130.37	0.00	52
PULP, PAPER AND PAPER PRODUCTS	41.19	255.38	5.98	**52.11**	122.19	0.00	52
PLASTIC AND ROBBER PRODUCTS	101.58	482.06	8.39	95.72	76.43	0.00	52
WOOD & WOOD PRODUCTS	84.96	327.05	29.92	56.82	130.38	0.00	52
TEXTILE, APPAREL AND FOOTWEAR	753.14	3770.95	80.30	731.43	113.37	0.00	52
FOOD, BEVERAGE AND TOBACCO	1435.50	5979.90	565.18	1032.79	186.87	0.00	52
FOREX TO FOOD PRODUCTS	280.26	530.60	92.75	132.76	4.76	0.09	52
FOREX TO INDUSTRIY	605.53	1023.02	339.92	132.68	1.77	0.08	52
FOREX MANUFACTURING	320.84	473.58	120.21	89.68	0.87	0.02	52
FOREX MINERALS	30.34	356.72	3.33	**48.62**	3378.52	0.00	52
FOREX OIL PRODUCTS	447.16	1346.16	80.20	315.98	3.35	0.19	52
GOVERNMENT SPENDING	4293.45	12164.15	899.81	**4348.58**	9.53	0.01	52
MARKET CAPITALIZATION	27969.52	46438.63	11632.19	8544.04	1.75	**0.42**	52
MONETARY POLICY RATE	15.62	18.86	11.50	2.10	7.53	0.02	52
INTB	257.1	445.5	150.5	90.3	26.3	0.00	52
NEER	142.0	206.0	9.3	44.6	7.47	0.02	52
VOLINTB	0.002	0.51	0.002	**0.003**	26.3	0.01	52
VOLNEER	0.01	0.12	0.001	0.02	151.1	0.00	52
ARCH EFFECT VOLINB				0.16			
ARCH EFFECT VOLNEER				0.54			

Note: VOLINTB and VOLNEER indicates volatility of interbank exchange rate and volatility of nominal effective exchange rate. The volatility was obtained from the GARCH(1,1). Monetary policy rate is the annualized official interest rate set by the Central Bank of Nigeria. All other values are in billion naira.

Observably, the rate of volatility of these exchange rates are relatively low. It is also revealed that most of the series exhibits large dispersion around its mean. Specifically, standard deviation values of output of cement, chemicals, metal, vehicle assembly, paper and paper products are greater than their mean, indicating that there is evidence of over dispersion in the data. Similarly, the standard deviation of foreign exchange in the mineral sector (iron and steel), government spending and volatility of interbank exchange rate also greater than their respective mean. Besides, out of all the series, data for market capitalization and output of the oil refining sector are normally distributed while the rest are not. All these statistical properties indicate that ordinary least square cannot be the appropriate estimation technique.

It is also important to inspect possible multicollinearity among the dependent variables. Table 6 indicates that only interbank and nominal effective exchange rate volatility has strong multicollinearity. By implication, these two variables cannot be combined in the same model.

Table 6: Pairwise Correlation Coefficients of the Dependent Variables

	A	B	C	D	E	F	G	H	I	J
A	1.00	0.59	0.7	0.59	0.62	-0.37	0.04	0.26	0.72	0.72
B		1	0.58	0.46	0.45	-0.28	0.46	0.28	-0.32	-0.35
C			1	0.55	0.48	-0.27	0.06	0.22	-0.61	-0.60
D				1	0.25	0.11	-0.08	-0.12	-0.24	-0.28
E					1	-0.63	0.12	0.72	-0.61	-0.51
F						1	-0.28	-0.67	0.78	0.72
G							1	0.32	0.03	-0.02
H								1	-0.65	-0.60
I									1	0.97
J										1

Note: A, B, C, D, E, F, G, H, I, J stands for foreign exchange to food, beverages and tobacco products, foreign exchange to the industrial sector, foreign exchange to manufacturing sector, foreign exchange to the mineral sector, foreign exchange to oil products, government final consumption expenditure, market capitalization, monetary policy rate, volatility of the interbank exchange rate and volatility of the nominal

effective exchange rate (FGARCH(1,1)respectively. Strong correlation exists between effective and interbank exchange rate volatility; thus, each variable enters each model separately.

4.2. Short-Run and Long-Run Models

The short run analysis begins with how exchange rate volatility influences the industrial sector, the manufacturing sector and other manufacturing sector. Following equation 14, the dynamic and conditional error correction results for industrial, manufacturing and other manufacturing sectors is presented in Table 7 The short run effect is indicated in the bottom panel of the Table. Owing to the strong correlation between effective and interbank exchange rate volatility, separate models are estimated. Observably, industrial sector is affected negatively and significantly by own lagged period. In particular, current industrial activity reduces by 0.4% for 1% increase in the activity of the sector, three quarters back. Thus, if industrial activity increases by 1% in the first quarter say, the effect will be felt significantly in the fourth quarter. But it is the case that the negative effect begins to manifest from the succeeding quarter, albeit not significant. Foreign exchange allocated to the industrial sector does not have immediate significant impact, but the fund is crucial to the activity of the sector. As can be read off, a 1% increase in foreign exchange in the current quarter exacts 0.3%, 0.2% and 0.3% increase in the first, second and third quarter respectively. Other variables, including effective exchange rate volatility, have no influence on the industrial activity. Thus, the major driver of Nigeria industrial sector is access to foreign exchange. This is not surprising since the sector is imports input dependent, particularly the mining and quarrying sector. When interbank exchange rate variable replaces effective exchange rate, the direction of effect is not different but there is a slight change in the magnitude of response of current industrial activity to own lagged values in the interbank model than in the effective exchange rate model. Further, unlike the absence of the effect of effective exchange rate volatility on industrial output, the volatility of interbank exchange rate shows positive but insignificant effect. This could be informed by nonresponse of many major sectors (particularly the oil sector) to exchange rate swings.

The manufacturing sector significantly responds to one lagged period of own output, lagged periods of foreign exchange used in the manufacturing sector, and effective exchange rate volatility. Observably, current manufacturing output is reduced by 0.35% if immediate last quarter output increases by 1%. The negative effects in both industrial and manufacturing sectors should not be considered as counterintuitive but as a sign of convergence in those sectors. Increase in foreign exchange allocated to the manufacturing sector drags the activity, albeit not immediately. Although the influence of a change in foreign exchange, two quarters back on the current manufacturing output is insignificant, it is important and in fact, negative. Meanwhile, interbank exchange rate shows negative but insignificant effect.

Table 7: Short Run Dynamic and Conditional Error Correction Results of the Effects of Exchange Rate Volatility on Sectoral Output (Industry, Manufacturing, Other Manufacturing)

Variables	Industry		Manufacturing		Other Manufacturing	
C	-0.36	-0.50	-2.41*	-1.60	-3.16	-5.73***
IND(-1)*	0.13**	0.18**				
MANUF(-1)			-0.05**	-0.12**		
OTHERMANUF(-1)					-0.54**	-0.27**
FOREXIND(-1)	-0.24**	-0.22***				
FOREXMANUF(-1)			0.20	0.11	-0.17	0.43**
GOVT	0.08	0.07*	-0.05*	0.03*	0.13**	0.15*
MKTCAP(-1)				0.07	0.63**	
MPR	0.04**	0.04	-0.03	-0.01	-0.07	0.04
VOLNEER(-1)	-0.08		0.36**		0.10	
VOLINTB(-1)		0.01		0.22**		0.36*
D(IND(-1))	-0.23	-0.17				
D(IND(-2))	-0.01	-0.06				
D(IND(-3))	-0.44**	-0.48**				
D(MANUF(-1))			-0.35**	-0.27		
D(OTHERMANUF(-1))					-0.27 (-1.59)	-0.38** (-2.28)
D(FOREXIND)	0.12	0.10				

D(FOREXIND(-1))	0.32*	0.32**				
D(FOREXIND(-2))	0.24*	0.22*				
D(FOREXIND(-3))	0.29***	0.29***				
D(FOREXMANUF(-1))			-0.22**	-0.12	-0.48**	-0.29**
D(FOREXMANUF(-2))			-0.16	-3.60		
D(MKTCAP)			-0.06	-0.04		
D(MPR)			0.05*	0.06**		
D(GOVT(-1))					0.36	0.24**
D(GOVT(-2))					0.50***	0.19*
D(MKTCAP(-1))					-0.37**	
D(MPR)					0.12**	0.14**
D(MPR(-1))					0.16**	
D(VOLNEER(-1))	0.39		0.17		0.89	
D(VOLNEER(-3))			-0.59*		-1.22**	
D(VOLINTB)				-0.15		-0.41

Note: The table shows the results of short run dynamic and conditional error correction in Industrial, Manufacturing and Other Manufacturing outputs; ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics. IND, MANUF, OTHERMANUF, FOREXIND, FOREXMANUF, GOVT, MKTCAP, MPR, VOLNEER and VOLINTB stand for industrial output, manufacturing output, other manufacturing output, foreign exchange in the industrial sector, foreign exchange in the manufacturing output, government expenditure, market capitalization, monetary policy rate, nominal effective exchange rate volatility and interbank exchange rate volatility respectively.

While the reason for the negative effect of exchange rate volatility on manufacturing output is reasonable and explanatory, that of the negative effect of foreign exchange and positive effect of monetary policy rate appears counterintuitive. However, if there are some sub-sectors in the manufacturing sectors where foreign exchange is not efficiently utilized, and if these sectors account for the large proportion of the sector's activity, then it could be assumed that foreign exchange is inimical to manufacturing output owing to inefficient use of the fund. Thus, this result exposes possible underutilization or inefficient use of foreign exchange allocated to the manufacturing sector. Notably, this sector is sensitive to both effective and interbank exchange rate volatility. Specifically, manufacturing sector will reduce by 0.6% and 0.2% if effective and interbank exchange rate increase by 1% respectively, albeit the effect is not immediate. In fact, it takes three quarters before the negative and significant effect manifests. (in the case of nominal effective exchange rate volatility). Thus, while industrial sector shows no significant effect of exchange rate volatility, manufacturing sector does.

In the case of other manufacturing sector, the immediate own lag has negative and significant (in the case of model that includes interbank exchange rate) effect. Further, foreign exchange to the manufacturing sector shows negative and significant effect. In fact, the magnitude of effect is higher than that of manufacturing sector. An indication that the inefficient use of foreign exchange allocated to the manufacturing sector is highly pronounced in the sector called *other manufacturing*. Unlike the case of industrial and manufacturing sectors, government spending, market capitalization, MPR, and exchange rate volatility are important in driving the sector. Government spending is very important in enhancing the activity of this sector. Specifically, a 1% increase in the spending will raise other industrial sector activity by 0.24% in the first quarter following the period of the shock and additional 0.5 (when nominal exchange rate is considered) and 0.2% (when interbank exchange rate is considered) in the second quarter. Monetary policy rate is also positive but at the same time, negligible. A 1% increase in MPR leads to at most 0.2% in the current period and additional 0.16% in the following quarter. This also indicates that while MPR is important in driving the manufacturing sector, the impact of its upward review will not be felt on the output of the manufacturing sector. It takes two quarters before this sector can be affected negatively by the activity of the capital market. In the case of exchange rate volatility, only effective exchange rate volatility significantly affects other manufacturing sector. Observably, it is the case that this sector is highly sensitive to exchange rate volatility. In specific term, if the volatility rises by 1%, the output of other manufacturing sector will dwarf by 1.2%. However, interbank exchange rate volatility does not significantly affect other manufacturing sector.

The top panel of Table 7 indicates the contribution of each variable to the long run convergence of each model to its long run after the shock. In the case of the industrial sector, the current quarter accounts for 13% of the shocks while the other 87% will be accomplished in the next 6 and a half quarters. In the case of manufacturing sector, the first period accounts for 5% of the shock while the rest 95% is accounted for by approximately 8 quarters and 1 month. The adjustment in the other manufacturing sector is very fast such that it took less than two quarters before the adjustment is complete.

4.2.1. Analysis of Exchange Rate Volatility and Sectoral Output: Non-Metallic Products, Basic Metals, Iron & Steels, and Motor Vehicle & Assembly

The result from Table 8 indicates that changes in the lagged values of non-metal products, changes in market capitalization, monetary policy rate and interbank exchange rate volatility have important influence on non-metal products. Out of all these drivers, only monetary policy rate positively affects non-metal products. Non-metal products is negatively and significantly affected by own first to third lags. Market capitalization have negative and significant effect on the non-metal output. Specifically, increase in the first lag and second lag of market capitalization by 1% will lead to 0.23%, and 0.15% decrease in non-metal product respectively. Although monetary policy rate positively and significantly influences non-metal products, the effect is mild, posting 0.1% increase for a 1% increase in monetary policy rate. Government spending is also important in enhancing non-metal output. Interbank exchange rate volatility posted negative but mild and insignificant effect. In this case, non-metal output will reduce by 0.1% if interbank exchange rate volatility increases by 1%. Hence, non-metal products do not respond to exchange rate volatility, but it shows a dwarfing effect.

Iron & Steel products also respond to changes in own lags (up to 3), foreign exchange in the mineral sector, lags of market capitalization (up to 2), current and previous government spending (up to 3 lags) and interbank exchange rate. Second lag of iron & steel exerts a significant positive effect. This implies that the productivity in the non-metal sector cannot be overemphasized. If second lag of the sector increases by 1%, current output will also increase by approximately 4%. Foreign exchange allocated to iron & steel have no significant, albeit positive effect. This indicates that more of such funds may likely enhance the production of iron & steel. Current government spending indicates positive but insignificant effect on the product. However, the first to third lag of government spending show negative effect with the third lag being significant. In this case, if the third lag of government spending increases by 1%, metal & steel products will fall by 0.32%. This implies that it will take 3 quarters before the negative effect of government spending is manifested in the sub-sector. The negative and insignificant effect of interbank exchange rate on iron & steel suggests that the sub-sector may be inhibited by continuous increase in interbank exchange rate volatility. Meanwhile, it is the case that changes in effective exchange rate volatility does not contribute to changes in iron & steel products. The insignificant effect might be attributed to possible activation of hedging instruments that could weather the storm of the volatility. It could also be the case that exchange rate is not well utilized in the sector, this is because foreign exchange in the mineral sector drags, rather than propel it.

Table 8: Short Run Dynamic and Conditional Error Correction Results of the Effects of Exchange Rate Volatility on Sectoral Output (Metals, Iron and Steel and Vehicle Assemblies)

	NON-METALLIC PRODUCTS.		BASIC MET., IRON & STEEL		VEHICLES & ASSEMBLY	
C	-4.51**	-7.45***	-10.38***	-13.59***	-8.69***	-16.84***
METAL(-1)*	-0.18**	-0.32***				
IRSTEEL(-1)*			-0.70***	-0.93***		
VEHICLE(-1)*					-0.12	-0.29**
FOREXMIN**	0.05	0.05	0.00	0.06		
GOVT(-1)	0.17*	0.29**	0.60***	0.64***	0.49***	0.83***
MKTCAP(-1)	0.27**	0.39***	0.55***	0.71***	-0.10	-0.03
MPR(-1)	0.00	0.02	0.09**	0.10**	0.14**	0.23***
VOLNEER(-1)	0.26**		0.32**		0.51***	
VOLINTB(-1)		0.44***		0.63**		0.70***
D(METAL(-1))	-0.41**	-0.28*				
D(METAL(-2))	-0.42**	-0.24				
D(METAL(-3))	-0.60***	-0.44**				
D(IRSTEEL(-1))			0.16	0.21		
D(IRSTEEL(-2))			0.25	0.36*		
D(IRSTEEL(-3))			-0.20			
D(VEHICLE(-1))					-0.44***	-0.36**
D(VEHICLE(-2))					-0.26**	-0.01
D(VEHICLE(-3))					-0.42**	-0.23*
D(FOREXMIN)				0.02		
D(FOREXMIN(-1))				-0.10		
D(FOREXMIN(-2))				-0.10**		
D(FOREXMIN(-3))				-0.06		
D(FOREXMANUF)						0.57***
D(FOREXMANUF(-1))						-0.13
D(FOREXMANUF(-2))						0.16
D(MKTCAP)	-0.03	-0.03	0.05	0.12		
D(MKTCAP(-1))	-0.16	-0.23**	-0.39**	-0.48**		
D(MKTCAP(-2))	-0.10	-0.15**	-0.41***	-0.48***		

D(GOVT)		0.13	0.03	0.09	0.08	0.23**
D(GOVT(-1))			-0.04	-0.05	-0.54***	-0.75***
D(GOVT(-2))			-0.10	-0.02	-0.51***	-0.66***
D(GOVT(-3))			-0.34***	-0.32**	-0.21	-0.32**
D(MPR)	0.11**	0.09**			-0.02	0.01
D(MPR(-2))					-0.14**	-0.16***
D(MPR(-3))					-0.08	-0.13**
D(VOLNEER)					-0.39	
D(VOLNEER(-1))					-1.15***	
D(VOLINTB)		-0.07		-0.04		-0.48
D(VOLINTB(-1))						-0.30
D(VOLINTB(-2))						0.77*
D(VOLINTB(-3))						0.85*

Note: The table shows the results of short run dynamic and conditional error correction in Industrial, Manufacturing and Other Manufacturing outputs; ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics. IND, MANUF, OTHERMANUF, FOREXIND, FOREXMANUF, GOVT, MKTCAP, MPR, VOLNEER and VOLINTB stand for industrial output, manufacturing output, other manufacturing output, foreign exchange in the industrial sector, foreign exchange in the manufacturing output, government expenditure, market capitalization, monetary policy rate, nominal effective exchange rate volatility and interbank exchange rate volatility respectively.

The vehicle assembly sector is also affected by own lags (up to 3), foreign exchange to the manufacturing sector (both current and lags), government spending (both current and lags), monetary policy rate (both current and lags), current and lags of effective exchange rate volatility, and interbank exchange rate. This implies that vehicle assembly products are driven by all the variables considered except market capitalization. The sector shows short run convergence, implying that current output is inhibited by previous output. This sub-sector benefits from foreign exchange allocated to the manufacturing posting 0.6% increase for a 1% increase in the fund. Only current government spending indicates significant enhancing effect, but it will eventually inhibit the activity in the sector, particularly in the third quarter following the increase. The structure of government spending could be attributed to this pattern of effect. Specifically, it seems the sector benefits from recurrent expenditure rather than capital expenditure. The sector responds negatively and significantly to the second lag of monetary policy rate. That is, 1% increase in the monetary policy rate in two quarters and three quarters back will have approximately 0.2% and 0.1% reduction in the sub-sector respectively.

Exchange rate volatility is an important driver of vehicle assembly in the short run. Both effective and interbank exchange rate have significant, albeit negative effect. Specifically, a 1% increase asynchronous effective exchange rate will dwarf vehicle assembly by 1.2% while 1% increase in the second and third lags of interbank exchange rate will increase the product by 0.8% and 0.9% respectively. What this suggests is that sectors respond differently to changes in exchange rate volatility, depending on the type of exchange rate window. In the case of vehicle assembly, the volatility of interbank exchange rate enhances their activity, going to second and third quarters after the shock. The producers in this sector appear to focus on future profit and so perceive it reasonable to produce in the face of interbank exchange rate volatility, may be with an expectation that the volatility will peter out.

The convergence to long run equilibrium after disturbance in the non-metal products exists but sluggish. In particular, 32% of the adjustment of equilibrium will be accomplished in the current quarter while the rest 68% will be accounted for by succeeding quarters. This implies that it takes around 2 quarters and some weeks before the system adjusts fully. In the case of basic metals, iron and steel, the adjustment is almost complete in the current quarter that the disturbance occurs while for vehicles & assembly, the adjustment is extremely sluggish as it takes about 3 quarters and some weeks for the adjustment to complete. Therefore, if there is distortion in any of these sectors, it will take less than one year before the adjustment is complete.

4.2.2. Electrical & Electronics, Food & Beverage and Textile, Apparel and Footwear

Next sub-sectors that is analysed are electrical & electronics, food & beverage and textile & apparel. Electrical & electronic does not significantly respond to own lag, even though the direction of effect indicates it is positive (Table 9). The positive sign suggests that the sector is endowed with potential resources. It can also indicate that demand motivates more production and supply. Further, foreign exchange allocated to the manufacturing sector is not significantly beneficial to the electrical and electronic sector. In the first, second and third quarter, the effect of foreign exchange on this sector's output is negative and significant. This means that electrical & electronics sub sector is strangulated by the allocation of foreign exchange to the manufacturing sector. What could inform this worrisome situation is that the condition to access the fund may be complex and stringent in such a way that producers incur additional costs in accessing it. The current government spending has a negative but insignificant effect on electrical and electronic output. The first lag has a positive and significant effect, second lag exerts positive but insignificant effect while the third lag has a negative and significant effect. Hence, government spending does not have a consistent effect on the production of electrical and electronic products in Nigeria. Only interbank exchange rate volatility has important and significant effect on the sector. Current and first lag have

insignificant effect while the second lag has a significant effect. Hence, exchange rate volatility is inimical to the electrical and electronics sector. Observably, the magnitude of response is notable in the second lag. In particular, a 1% increase in interbank exchange rate volatility two quarters back will dwarf current output of the electrical & electronics by 1.6%. It must be noted however that effective exchange rate does not influence the activity of the sector. Further, monetary policy rate and market capitalization are not relevant to the activity of the sector. This is not surprising because most companies in the electrical and electronic are not formally listed on the first-tier floor of the stock exchange in Nigeria.

Food and beverage sector does not respond significantly to own lag, current foreign exchange allocated to the manufacturing sector, current value of market capitalization, and monetary policy rate. A significant effect is observed by the first lag of foreign exchange allocated to the manufacturing sector and market capitalization. Unfortunately, food and beverage sector respond negatively to foreign exchange. A 1% increase in foreign exchange leads to 0.2% reduction in food and beverage output. However, government spending enhances the output of this sector to the tune of 0.15% for a 1% increase in spending. The sub-sector also benefits from the activity of the stock market as it responds markedly to the activity of the market. In this case, if the stock market capitalization improves by 1%, food and beverage sector will also improve by 1.8%. The sensitivity of this sector to stock market activity is not unconnected with the fact that many companies in this sector are formally listed in the floor of stock market and so, they do benefit from the activity. Only interbank exchange rate volatility is important in driving this sector. But it must be noted that the effect is mild, insignificant and positive. Blue chip companies in the food and beverages sub-sector are the product of foreign direct investment hence, the insignificance of the interbank exchange rate indicates that these companies have access to exchange rate, also they do initiate available hedging instruments to deal with possible volatility in the exchange rate.

Table 9: Short Run Dynamic and Conditional Error Correction Results of the Effects of Exchange Rate Volatility on Sectoral Output (Electrical & Electronics, Food & Beverage and Textile & Apparel)

	ELECT & ELECT		FOOD & BEVERAGE		TEXTILE, APPAREL AND FOOTWEAR	
C	-12.75***	-12.57***	-2.98**	-3.17***	-1.26	-5.14***
ELECT(-1)	-0.32**	-0.56**				
FOREXMANUF(-1)	0.88***	0.79***			0.01	0.39***
GOVT(-1)	0.05	0.09	-0.08	0.01	-0.07	0.05
MKTCAP(-1)	0.27***	0.12	-0.05	0.05	0.21	0.05
MPR(-1)	-0.02	0.01	-0.01	0.00	-0.06	0.02
VOLINTB(-1)	1.05***	1.17***	0.44***	0.45***	0.32**	0.49***
D(ELECT(-1))		0.19				
D(FOOD(-1))			-0.21	-0.23		
D(FOREXMANUF)	0.10	0.20			0.27**	0.37***
D(FOREXMANUF(-1))	-0.70***	-0.72***			-0.19*	-0.22**
D(FOREXMANUF(-2))	-0.54***	-0.43***			-0.14	-0.06
D(FOREXMANUF(-3))	-0.46***	-0.42***				-0.20
D(FOREXFOOD)			-0.04	0.01		
D(FOREXFOOD(-1))			-0.19**	-0.14**		
D(GOVT)	-0.16	-0.14	-0.15**		-0.15	-0.08
D(GOVT(-1))	0.23**	0.20**			0.13	
D(GOVT(-2))	0.12	0.07			0.11	
D(GOVT(-3))	-0.22**	-0.16**				
D(MKTCAP)			-0.05	-0.02	0.16**	-0.10
D(MKTCAP(-1))			0.09*		0.16*	
D(MPR)				0.04	0.02	
D(MPR(-1))					-0.13**	
D(VOLNEER)					-0.06	
D(VOLNEER(-1))					0.30	
D(VOLNEER(-2))					-0.13	
D(VOLNEER(-3))					-1.16***	
D(VOLINTB(-1))		-0.16				-0.49
D(VOLINTB(-2))		-1.63***				

Note: The table shows the results of short run dynamic and conditional error correction in Industrial, Manufacturing and Other Manufacturing outputs; ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the backet are t-statistics. IND, MANUF, OTHERMANUF, FOREXIND, FOREXMANUF, GOVT, MKTCAP, MPR, VOLNEER and VOLINTB stand for industrial output, manufacturing output, other manufacturing output, foreign exchange in the industrial sector, foreign exchange in the manufacturing output, government expenditure, market capitalization, monetary policy rate, nominal effective exchange rate volatility and interbank exchange rate volatility respectively

Textiles and apparels sector responds positively and significantly to foreign exchange allocated to the manufacturing sector. Although in the first and third quarter, the sector suffers from the fund. Similarly, government spending does not significantly

influence the activity of this sector, except that the first lag shows a positive effect. Current and first lag of market capitalization positively and significantly affects the textiles and apparel sub-sector. Like food and beverage, a good percentage of textile and apparel companies are list on the stock exchange and so, they benefit from the activity of the stock exchange market. Monetary policy rate is inimical to the activity of this sub-sector. If the previous monetary policy rate rises by 1%, current output will diminish by 0.13%. Concerning exchange rate volatility, both effective and interbank are important. However, effective exchange rate volatility is not only important but also significant. A crucial inspection of how textile and apparel respond to exchange rate volatility reveals that these sets of volatility is rather mild but persistent, starting from the third lag to the current value (in the case of effective exchange rate) and up to the first lag (in the case of interbank exchange rate). Therefore, effective exchange is more important and persistent than interbank exchange rate volatility. Observably, a 1% increase in the third lag of effective exchange rate reduces textile and apparel output by 1.2%. Hence, this sector is highly sensitive to effective exchange rate volatility and it acts as a drag to the sector.

Table 10: Short Run Dynamic and Conditional Error Correction Results of the Effects of Exchange Rate Volatility on Sectoral Output (Paper, Plastic, and Wood)

	PAPER & PAPER PRODUCTS		PLASTIC & RUBBER PRODUCTS		WOOD AND WOOD PRODUCTS	
C	-4.45**	-5.95***	-10.32***	-12.42***	-0.53	-0.68
PAPER(-1)	-0.10***	-0.12**				
PLASTIC(-1)			-0.52***	-0.50***		
WOOD(-1)					0.03*	0.05*
FOREXMANUF(-1)	0.16	0.13*	-0.07	0.49**	0.07	0.19**
GOVT(-1)	0.02	0.18**	0.55	0.32	-0.02	-0.08
MKTCAP(-1)	0.16	0.19**	0.60***	0.37**	0.00	-0.09
MPR(-1)	-0.01	0.02	0.08**	0.07**	-0.01	-0.01
VOLNEER(-1)	0.48***		0.28**		0.07	
VOLINTB(-1)		0.43***		0.82***		0.20**
D(PAPER(-1))	-0.20					
D(PAPER(-2))	-0.04					
D(PAPER(-3))	-0.38**					
D(PLASTIC(-1))			0.00	-0.26		
D(PLASTIC(-2))			0.04	-0.06		
D(PLASTIC(-3))			-0.31**	-0.36***		
D(WOOD(-1))					-0.26	-0.26
D(WOOD(-2))						0.31
D(FOREXMANUF)	0.21			0.19		
D(FOREXMANUF(-1))	-0.22*			-0.43**		
D(FOREXMANUF(-2))	-0.27**			-0.22**		
D(FOREXMANUF(-3))				-0.30		
D(GOVT)		-0.02	0.03	0.12		
D(GOVT(-1))			0.05	0.11		
D(GOVT(-2))			-0.08	0.14		
D(GOVT(-3))			-0.26**	-0.15*		
D(MKTCAP)	0.00	-0.05	-0.03	0.07	-0.11	
D(MKTCAP(-1))			-0.43**	-0.25*		
D(MKTCAP(-2))			-0.39***	-0.17		
D(MKTCAP(-3))			-0.17			
D(MPR)	0.06				0.05	0.02
D(VOLNEER)	-0.13				-0.30	
D(VOLNEER(-1))	0.03					
D(VOLNEER(-2))	0.05					
D(VOLNEER(-3))	-1.20***					
D(VOLINTB)		0.01		0.25		-0.30
D(VOLINTB(-1))						0.38
D(VOLINTB(-2))						0.29
D(VOLINTB(-3))						-0.49**

Note: The table shows the results of short run dynamic and conditional error correction in Industrial, Manufacturing and Other Manufacturing outputs; ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics. IND, MANUF, OTHERMANUF, FOREXIND, FOREXMANUF, GOVT, MKTCAP, MPR, VOLNEER and VOLINTB stand for industrial output, manufacturing output, other

manufacturing output, foreign exchange in the industrial sector, foreign exchange in the manufacturing output, government expenditure, market capitalization, monetary policy rate, nominal effective exchange rate volatility and interbank exchange rate volatility respectively

Overall, the speed of convergence sluggish but comparatively fastest in the electrical and electronic sub-sector. Specifically, more than half of the adjustments will be accounted for by the current period and so, the adjustment will complete in less than two quarters. This is not the case in food and beverages where it takes more than 7 quarter (close to 2 years) before the adjustment can be completed. In the textile and apparel, it will take more than 6 quarters before the system adjusts to its long run equilibrium.

4.2.3. Paper and Paper Products, Plastic and Rubber Products, Wood & Woodwork

Table 10 indicates that the third lag of paper and paper products, foreign exchange allocated to the manufacturing sector, and effective exchange rate volatility significantly affect this product (paper and paper products). The present output of this product is negatively affected by its third lag; this suggests that it takes three quarters before a significant dwarfing effect of paper products will surface. Although foreign exchange allocated to the manufacturing sector has a significant effect, it strangulates the activity of this sector. This indicates that foreign exchange is inimical to paper and paper product sub-sector. It should also be noted that the dwarfing effect is persistent as it occurs in the first and second lag. Current government spending and market capitalization also show inhibiting, albeit insignificant effects. While interbank exchange rate volatility does not have a significant effect, effective exchange rate volatility has. Observably, current and previous volatility have important inhibiting effect. However, it is only the third lag that indicates a significant effect. Further, paper and paper products is highly sensitive to effective exchange rate. In this regard, a 1% increase in volatility will reduce the activity of this sub-sector by 1.2%. Therefore, exchange rate volatility is detrimental to the activity of paper and paper product.

Like the paper and paper product, plastic and rubber product is also affected significantly, albeit negatively by own third lag. Unlike paper and paper products, plastic and rubber products respond significantly to government spending, and market capitalization. In either of these cases, the effect does not take place immediately. The third lag of government expenditure, the first and second lags of market capitalization have detrimental effect. Interbank exchange rate volatility shows positive and mild but insignificant effect. Hence, plastic and rubber product are not affected, in any way, by exchange rate volatility. If any, the effect is likely to be positive. Nigeria is endowed with natural resources needed to produce plastics and rubber. Essentially, the sub-sector appears not to depend massively on import inputs and therefore, may not be significantly exposed to exchange rate uncertainty. Perhaps this is the reason why the sub-sector does not benefit from the foreign exchange allocated to the manufacturing sector, and it is not exchange.

Wood and wood product do not respond significantly to all the variables considered except the third lag of interbank exchange rate volatility. In this regard, a 1% increase in the third interbank exchange rate volatility engenders 0.5% reduction in wood and wood product. Clearly, changes in exchanged rate volatility does not have immediate effect on this sub-sector. Observably, interbank exchange rate volatility has a persistent effect as the effect begins from the current period up to the third period. Thus, it can be conjectured that exchange rate volatility cannot be ignored in this sub-sector. It must also be taken into account that market capitalization, monetary policy rate and effective exchange rate contribute to the performance of this sector. Speed of convergence is fastest in plastic and rubber products as about 52% of the adjustment takes place in the period of the shock to the system while the remaining 48% is accounted for in the following quarter. This indicates that this sub-sector adjusts to equilibrium quickly when there is any change in the variable. This cannot be said of paper and paper product that takes about 10 quarters (two and a half years) before the adjustment is complete, including the period when the shock took place. The adjustment in the wood and wood product is so sluggish that it takes roughly 20 quarters (about five years) before the adjustment can complete.

4.2.4. Cement, Chemicals & Pharmaceutical Products and Oil Refining

The assessment of exchange rate volatility and the sectoral output of cement, chemicals and oil refining is shown in Table 11. Five variables significantly affect the cement sector. These are lag values of cement product, foreign exchange allocated to the manufacturing sector, market capitalization and the third lag of interbank exchange rate. Some variables that show important but insignificant effects are government spending, monetary policy rate, and effective exchange rate volatility. A 1% increase in the asynchronous values of cement will reduce current output by 0.5%. First and second lag values of foreign exchange to the manufacturing sector have inhibiting effect on the performance of this sub-sector. This means that the sector is hurt by foreign exchange allocated to the sub-sector. Also, first and second lag values of market capitalization drag the cement sub-sector. Interbank exchange rate volatility has a marked positive effect. In this regard, if interbank exchange rate volatility increases by1%, cement output will increase by approximately 0.6%. Cement sub-sector in Nigeria is significant to building and structural design services. A leading cement manufacturing in West Africa is owned by a Nigerian. Although cement sub-sector is capital and natural-resource intensive, Nigeria is endowed with the natural resources needed in the sub-sector. Further, the human capital required are sourced more at the domestic level than foreign. Cement is one of the

lucrative products owing to rural and urban housing development. Thus, producers in this sub-sector may be concerned about the future income rather than the present utility, thereby still produce in the face of increase in exchange rate volatility.

Table 11: Short Run Dynamic and Conditional Error Correction Results of the Effects of Exchange Rate Volatility on Sectoral Output (Cement, Chemicals and Oil refining)

	CEMENT		CHEMICALS		OIL REFINING	
C	-5.46***	-9.83***	-2.44	-7.11**	2.87	4.49
CEMENT(-1)	-0.14*	-0.31**				
CHEM(-1)			-0.28**	-0.25**		
OILREF(-1)					-0.89***	-0.90**
FOREXMANUF(-1)	0.19	0.28**	-0.11	0.12		
FOREXOIL(-1)					-0.35	-0.64
MKTCAP(-1)	0.27**	0.36**	0.43	0.20	0.08	0.32
GOVT(-1)	0.09	0.36**	0.01	**0.43****	0.11	0.39*
MPR		0.03		0.10**		
MPR(-1)	-0.03		-0.10		0.40***	0.53***
VOLNEER(-1)	0.47**		0.26		-1.10*	
VOLINTB				0.13		
VOLINTB(-1)		0.56***				-2.05**
D(CEMENT(-1))	-0.48***	-0.40**				
D(CHEM(-1))			-0.20	-0.23		
D(CHEM(-2))			-0.20	-0.28		
D(CHEM(-3))			-0.44**	-0.52***		
D(OILREF(-1))					0.11	0.19
D(OILREF(-2))					-0.20	-0.13
D(OILREF(-3))					-0.37**	-0.32**
D(FOREXMANUF(-1))	-0.23**		-0.48			
D(FOREXMANUF(-2))	-0.14		0.168			
D(FOREXOIL)					0.54**	0.53**
D(FOREXOIL(-1))					0.76**	0.83***
D(FOREXOIL(-2))					0.61**	0.71**
D(FOREXOIL(-3))					0.38	0.37
D(MKTCAP)	0.011	0.01	-0.02	-0.08	0.45*	0.56**
D(MKTCAP(-1))		-0.2	-0.32**	-0.34**		
D(MKTCAP(-2))		-0.2**				
D(GOVT)		0.11	0.164	0.19		
D(GOVT(-1))		-0.2	0.278	0.08**		
D(GOVT(-2))			0.51**	0.10**		
D(GOVT(-3))			-0.15	-0.28**		
D(MPR)	0.047		0.053		0.24**	0.32**
D(MPR(-1))			0.13		-0.27**	-0.28**
D(MPR(-2))			0.14*			
D(VOLNEER)	-0.12		0.231		0.35	
D(VOLNEER(-1))			0.42			
D(VOLNEER(-2))			-1.82**			
D(VOLINTB)		-0.1				0.12
D(VOLINTB(-1))		0.46				0.12*
D(VOLINTB(-2))		0.59**				0.11*
D(VOLINTB(-3))						0.20*

Note: The table shows how short run dynamic movement in Cement, Chemicals and Oil refineries products correspondingly responds to changes in exchange rate volatility and other catchall variables. ***,**,* indicate significant at 1%, 5% and 10% respectively

Results of Chemical and plastic products model indicates that own third lag, firs lag of market capitalization, second and third lags, second lag of monetary policy rate, and second lag of effective exchange rate volatility have significant effect on the growth of value addition of chemical and plastic products. In a way, present output of chemical and plastic products is inhibited by the changes in the last three periods. Further, the asynchronous market capitalization also dwarfs the performance of the sub-sector. However, it is the case that this sub-sector benefits immensely from government spending as previous government spending enhances current output growth of chemicals and plastic products. Further, monetary policy rate is an enhancing mechanism through which the sub-sector thrives. The MPC is so important that both current and up to the second lag contribute to the growth of this sector. Albeit only the second lag has significant enhancing effect. Meanwhile, effective exchange rate dwarfs the activity of this sub-sector. In particular, a 1% increase in effective exchange rate, two quarters back will reduce the contemporaneous output by about 0.6%. Hence, exchange rate volatility is detrimental to the

performance of the chemical & pharmaceutical products. This is surprising because most of the companies in this sub-sector are multinationals and it is expected of them to weather off any possible exchange rate fluctuations with many hedging available to them. But with the fact that current and the first lag have no significant effect; it must be the case that these companies may be initiating the hedging instruments to a certain extent.

In the oil refining sub-sector, own lag, contemporaneous and asynchronous foreign exchange allocated to the oil sector, market capitalization, monetary policy rate (both current and lags) and interbank exchange rate significantly influence the activity of this sub-sector. In particular, 1% increase in the current, first lag and second lag of foreign exchange allocated to the oil sector raises oil refining production by around 0.5%, 0.8% and 0.7% respectively. This suggests that foreign exchange is seemingly persistent in driving oil refining in Nigeria. Also, 1% increase in the first lag, second lag and third lag of interbank exchange rate volatility will increase oil refining by 0.1%, 0.2% and 0.2% respectively. Hence, not only is foreign exchange persistent in driving oil refining sub-sector, exchange rate volatility does as well. Oil refining is an essential commodity in Nigeria and the producers are sure of demand availability. Thus, any fluctuation will be beneficial to them. The speed of convergence of cement sub-sector is more sluggish than that of chemicals and pharmaceutical products while the speed of convergence in the oil refining is the fasters. For instance, as much as 90% of the adjustment to equilibrium is achieved, should there by any disturbance in the oil refining sector. This is not the case in chemicals and pharmaceuticals that takes only 28% in the current period. From the short run results, it is clear that exchange rate volatility affects sub-sectors differently in magnitude, direction of effect and significance. A cursory look suggests that sectors that produce essential commodities such as cement, oil refining, and food and beverages indicate positive response and, in some cases, significant. Some sectors with listed companies on the stock exchange market and multinationals tend to weather the storm of possible exchange rate volatility with hedging instruments at their disposal.

4.3. Long-Run Results

The long run results assessing the response of sectoral output to exchange rate volatility and other important variables is presented in this section. Table 12 shows the case of the industrial, manufacturing and other manufacturing sectors. Industrial sector as a whole does not respond significantly to changes in foreign exchange to the industrial sector, government spending, market capitalization and exchange rate volatility. The insignificant effect could be traced to the problem of lumpiness, in which case, the effect could be crowded out by a particular subsector, and the subsector could be traced to manufacturing. As can be observed, foreign exchange allocated to the manufacturing sector and market capitalization play significant role in influencing the performance of the subsector. It is also the case that interbank exchange rate volatility significantly drags the performance of the manufacturing sector. In particular, manufacturing sector has a 1.84% reduction in the long run output following a 1% increase in interbank exchange rate volatility. Thus, it can be asserted that while effective exchange rate is a short run phenomenon in the short run, interbank exchange rate volatility is a long run phenomenon. Meanwhile, it is clear that both volatility are detrimental to the performance of the manufacturing sector. It is also important to point out that the long run effect is higher than the short run effect. Other manufacturing output is affected positively and significantly by market capitalization. Hence, the manufacturing sectors has long run benefit from stock market capitalization.

The long run results for non-metallic, iron & steel and vehicle assembly is presented in Table 13. Government spending, stock market capitalization and the two types of exchange rate volatility are significant in driving non-metallic products. Increase in government spending and improvement in the performance of the stock market capitalization enhance the performance of this sub-sector. Meanwhile, stock market capitalization tends to be more important than government spending. This suggests that although public economic infrastructure is less important compared to sourcing for funding in this sector. Both effective exchange rate volatility and interbank exchange rate volatility have negative effect on non-metallic products, albeit it is relatively more telling for interbank exchange rate volatility. Specifically, a 1% increase in effective exchange rate volatility reduces non-metallic products by about 1.4% while the same percentage increase in effective exchange rate volatility only reduces non-metallic products by 0.5 percentage point. Generally, non-metallic products are exposed to exchange rate uncertainty in Nigeria. Government spending, stock market capitalization, monetary policy rate and exchange rate volatility (both effective and interbank) have significant effect on the performance of the iron and steel sub-sector. It is also important to observe that all these drivers, except exchange rate volatility have positive effect, indicating that any increase in the values of any of the drivers will also engender increase in the production of iron and steel.

Effective exchange rate and interbank exchange rate adversely affects the performance of iron and steel sub-sector. A 1% increase in the effective exchange rate leads to 0.45% reduction in the value added of the iron and steel while the same percentage increase in interbank exchange rate volatility will dwarf the sector by 0.68%. This outcome also suggests that interbank exchange rate volatility more influences the activity of the iron and steel sector than effective exchange rate. Also, it is clear that iron and steel products are exposed to exchange rate uncertainty and the exposure tends to drag the performance of the sector. Foreign exchange allocated to the manufacturing sector, government spending, monetary policy rate and exchange rate volatility indicate significant effect on the activity of the vehicle assembly sub-sector. Like the other

two sectors (indicated in Table 13), vehicle assembly sub-sector is highly sensitive to foreign exchange allocated to the sector and to government spending. Specifically, the size of effect of the two drivers are magnificent. This implies that public economic infrastructure alongside availability of foreign exchange will engender massive production of vehicle assembly in Nigeria.

Table 12: Long Run (Level Equation) Results for Industry, Manufacturing and Other Manufacturing

	INDUSTRY		**MANUFACTUIRNG**		**OTHER MANUFACTURING**	
FOREXIND	1.87	2.82				
	(0.97)	(0.59)				
FOREXMANUF			4.28*	0.91*	-0.32	1.60
			(1.93)	(1.94)	(-0.78)	(1.47)
GOVT	-0.61	-0.93	-1.06	0.29	0.24	0.56
	(-0.51)	(-0.35)	(-0.30)	(0.66)	(0.55)	(1.25)
MKTCAP	0.05	-0.04	0.56**	0.55**	01.15***	0.35*
	(0.10)	(-0.04)	(2.85)	(2.07)	(4.72)	(1.86)
MPR	-0.34	-0.53	-0.54	-0.08	-0.13	0.13
	(-0.82)	(-0.49)	(-0.46)	(-0.47)	(-0.77)	(0.80)
VOLNEER	-0.26		-1.74		0.18	
	(0.76)		(0.51)		(0.45)	
VOLINTB		-0.05		-1.84*		1.33
		(-0.03)		(1.96)		(1.51)
C	2.80***	6.22**	-51.75***	-13.43*	-5.79*	-21.37**
	(3.31)	(2.31)	(-4.52)	(-1.95)	(-1.97)	(-2.45)
OBS	48	48	48	50	48	48
			Diagnostic Tests			
Jarque-Bera	0.56	0.39	0.59	0.14	0.61	0.11
	[9.73]	[0.82]	[0.74]	[0.93]	[0.74]	[0.95]
B-G Corr LM	2.09	0.73	1.06	0.82	1.87	0.40
	[0.11]	[0.58]	[0.40]	[0.52]	[0.16]	[0.81]
B-P-G Hetero	0.82	0.81	0.95	1.30	0.78	0.84
	[0.65]	[0.65]	[0.53]	[0.26]	[0.72]	[0.64]
Hetero (ARCH)	0.26	0.37	1.67	0.06	0.01	0.29
	[0.61]	[0.55]	[0.20]	[0.80]	[0.94]	[0.59]
RESET	1.52	0.38	1.89	0.06	2.11	0.97
	[0.22]	[0.54]	[0.37]	[0.80]	[0.16]	[0.34]

Note: The table shows how long run movement in Industrial, Manufacturing and Other Manufacturing products correspondingly responds to changes in exchange rate volatility and other catchall variables. ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics while values in squared bracket are probability values of F-distribution for each test. Similar to the first two products discussed under Table 12, high rate of effective and interbank exchange rate volatility tends strangulate the activity of the vehicle assembly sub-sector. A cursory look at the magnitude of effect reveals that interbank exchange rate volatility more affects this sub-sector than effective exchange rate volatility. Specifically, for a 1% increase in effective exchange rate, activity of the vehicle assembly will reduce by 0.37% whereas the same percentage increase in interbank exchange rate volatility will reduce the activity of the sector by 2.41%. Therefore, tis sector is highly sensitive to exchange rate uncertainty and the more uncertain the exchange rate is, the more it harms the sector.

Table 13: Long Run (Level Equation) Results for Metals, Iron & Steel and Vehicles Assembly Products

	NON-METALLIC PRODUCTS.		BASIC MET., IRON & STEEL		VEHICLES & ASSEMBLY	
FOREXMANUF			-0.0002	0.07	2.70**	2.65***
			(-0.003)	(0.70)	(2.54)	(3.64)
FOREXMIN	0.30	0.14				
	(1.08)	(1.20)				
GOVT	0.97**	0.90***	0.85***	0.69***	4.18**	2.87***
	(2.98)	(4.84)	(7.33)	(4.48)	(2.09)	(3.55)
MKTCAP	1.53***	1.20***	0.78***	0.76***	-0.85	-0.12
	(3.63)	(5.28)	(5.32)	(7.12)	(-0.71)	(-0.30)
MPR	-0.01	0.06	0.13**	0.11**	1.22	0.80**
	(-0.05)	(0.85)	(2.89)	(2.79)	(1.43)	(2.36)
VOLNEER	-0.48**		-0.45**		-0.37*	
	(2.33)		(2.45)		(1.77)	
VOLINTB		-1.35***		-0.68**		2.41***
		(4.67)		(2.63)		(4.01)
C	-25.54***	-22.98***	-14.74***	-14.60***	-74.68*	-58.29***
	(-4.50)	(-7.77)	(-10.07)	(-12.55)	(-1.98)	(-4.21)
OBS	48	48	48	48	48	48
Diagnostic Tests						
Jarque-Bera	2.47 [0.30]	2.94 [0.02]	0.97 [0.62]	0.20 [0.91]	1.21 [0.55]	0.22 [0.89]
B-G Corr LM	1.07 [0.39]	0.10 [0.90]	2.70 [0.05]	0.69 [0.61]	1.87 [0.15]	0.70 [0.60]
B-P-G Hetero	1.22 [0.31]	0.96 [0.51]	2.46 [0.12]	1.54 [0.15]	0.60 [0.88]	0.77 [0.73]
Hetero (ARCH)	1.00 [0.32]	0.75 [0.39]	9.11 [0.00]	0.11 [0.74]	0.92 [0.34]	2.49 [0.12]
RESET	3.18 [0.00]	0.24 [0.63]	2.87 [0.01]	2.41 [0.02]	0.11 [0.91]	0.33 [0.74]

Note: The table shows how long run movement in Metals, Iron & Steel and Vehicle Assembly products correspondingly responds to changes in exchange rate volatility and other catchall variables. ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics while values in squared bracket are probability values of F-distribution for each test

The long run results for electrical & electronics, food & beverage products and textile are indicated in Table 14. Observably, the results differ markedly from the earlier ones. For instance, unlike it appears in Table 13, foreign exchange allocated to the manufacturing sector is germane to the electrical & electronic and textiles sectors. Further, government expenditure is not significant, albeit, positive in influencing electrical & electronics and textiles. Most importantly, neither effective exchange rate nor interbank exchange rate volatility have significant effect on food and beverages. Foreign exchange, market capitalization, and exchange rate volatility have enhancing effect on electrical & electronic value added. It is also observed that food and beverages do not respond significantly to changes in the values of any of the drivers, exchange rate volatility inclusive. This outcome clearly spells out the nature of this product – essential commodities. Meanwhile, the positive effect in the case of exchange rate volatility suggests that the producers of this product see that they can focus on future revenue they will receive rather than being deceived by the utility they will derive. Of course, food production is important in any economy and the fact that most of the factor inputs for food are sourced domestically, its response to exchange rate volatility may not be noticed. Even from the demand side, once the future revenue is expectedly guaranteed, it motivates producers to increase production in the face of exchange rate volatility. Textiles products are not significantly affected by effective exchange rate. However, interbank exchange rate volatility shows otherwise. It is also important to observe that textiles products are highly sensitive to changes in interbank exchange rate uncertainty, even though the direction of effect is positive. In particular, a 1% increase in interbank exchange rate uncertainty will raise value addition of textiles products by 3.1

percentage points. Therefore, it is clear that textile sub-sector is highly sensitive to interbank exchange rate volatility in Nigeria.

Table 14: Long Run (Level Equation) Results for Elect & Elect, Food and Textiles Products

	ELECT & ELECT		FOOD & BEVERAGE		TEXTILE, APPAREL AND FOOTWEAR	
FOREXMANUF	2.78**	1.42***			0.02	2.47*
	(2.74)	(3.63)			(0.02)	(1.84)
FOREXFOOD			-2.18	1.55		
			(-1.19)	(1.37)		
MKTCAP	0.85**	0.22**	0.41	0.37	1.37**	0.34*
	(2.34)	(2.48)	(0.90)	(0.97)	(2.98)	(1.94)
GOVT	0.15	0.17	0.73**	0.03	-0.43	0.32
	(0.42)	(0.75)	(2.09)	(0.07)	(-0.45)	(0.74)
MPR	-0.06	0.01	0.09	-0.01	-0.39	0.12
	(-0.52)	(0.16)	(0.68)	(-0.07)	(-1.0)	(0.97)
VOLNEER	3.32**		-3.90		2.09	
	(2.89)		(-1.12)		(1.54)	
VOLINTB		2.09***		3.27		3.11**
		(4.210)		(1.54)		(2.42)
C	-40.15***	-22.49***	26.44	-22.79	-8.10	-32.30***
	(-3.89)	(-6.90)	(0.95)	(-1.59)	(-0.68)	(-3.19)
OBS	48	48	49	49	48	48
Diagnostic Tests						
Jarque-Bera	3.82	2.32	1.81	1.77	0.029	2.399
	[0.147]	[0.314]	[0.439]	[0.148]	[0.864]	[0.662]
B-G Corr LM	0.9784	0.3302	1.866	0.4331	0.432	0.381
	[0.434]	[0.855]	[0.142]	[0.783]	[0.653]	[0.820]
B-P-G Hetero	0.7449	0.5161	2.183	1.5823	0.161	0.494
	[0.716]	[0.928]	[0.03]	[0.137]	[0.192]	[0.919]
Hetero (ARCH)	0.1223	0.2925	0.511	2.3442	0.166	0.335
	[0.728]	[0.591]	[0.478]	[0.133]	[0.685]	[0.566]
RESET	1.4129	0.3035	0.528	2.5934	0.126	0.579
	[0.2546]	[0.582]	[]0.468]	[0.628]	][0.9008	[0.566]

Note: The table shows how long run movement in Electrical & Electronics, Food and Textiles products correspondingly responds to changes in exchange rate volatility and other catchall variables. ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the backet are t-statistics while values in squared bracket are probability values of F-distribution for each test.

Paper products respond significantly to government spending, market capitalization, and interbank exchange rate volatility. However, foreign exchange allocated to the manufacturing sector is also important to the sub-sector. Both effective exchange rate volatility and interbank exchange rate volatility indicate negative effect. Observably, interbank exchange rate volatility significantly dwarfs the activity of the paper products in Nigeria. In this case, a 1% increase in the interbank exchange rate will reduce the value added of the sub-sector by about 1.8%. This suggests that most firms in this sub-sector are risk averse and so, reduces production in the face of increased volatility of interbank exchange rate. The insignificant effect of effective exchange rate could be as a result of the fact that these firms tend not to benefit from centrally dictated exchange rate. The seemingly sensitive response to interbank exchange rate volatility points to the fact that the performance of this sector is at the mercy of exchange rate uncertainty. A slight rise in the uncertainty will dwarf the production of the sector.

Similar to the long run result of the paper sub-sector, the plastic sub-sector also responds positively to government expenditure, stock market capitalization, and monetary policy rate. Unlike the paper sub-sector, the plastic sub-sector

responds positively and significantly to foreign exchange allocated to the manufacturing sector and monetary policy rate. The negative and significant effect of both effective exchange rate volatility and interbank exchange rate volatility indicates that this sub-sector will be affected adversely by persistent exchange rate volatility. Comparably, interbank exchange rate more affect the activity of this sub-sector than effective exchange rate. Specifically, a 1% increase in interbank exchange rate volatility will engender about 1.7% reduction in the plastic sub-sector whereas the same percentage increase in interbank exchange rate will only dwarf the sub-sector's activity by 0.5%. None of the highlighted variables in Table 15 have significant effects on the activity of the wood sub-sector. Observably, there is also a sign of negative effect of both effective and interbank exchange rate volatility. Hence, all the sub-sectors assessed in Table 14 responds negatively to exchange rate volatility, and the volatility is more telling in the plastic sub-sector.

Table 15: Long Run (Level Equation) Results for Paper, Plastic and Wood Products

	PAPER & PAPER PRODCUTS		PLASTIC & RUBBER PRODUCTS		WOOD AND WOOD PRODUCTS	
FOREXMANUF	0.66	0.56	0.14	0.97*	-2.72	-3.59
	(0.65)	(1.52)	(0.75)	(1.87)	(-0.26)	(-0.47)
GOVT	0.17	0.77***	1.05***	0.65***	0.69	1.49
	(0.19)	(3.17)	(8.03)	(3.29)	(0.40)	(0.61)
MKTCAP	0.66*	0.82**	1.14***	0.74**	0.04	1.70
	(1.87)	(2.75)	(5.64)	(2.91)	(0.01)	(0.56)
MPR	-0.13	-0.07	0.16**	0.14**	0.30	0.17
	(-0.48)	(-0.84)	(2.73)	(2.48)	(0.26)	(0.43)
VOLNEER	-0.95		-0.54**		-2.77	
	(-1.11)		(-2.65)		(-0.21)	
VOLINTB		-1.79***		-1.65***		-3.75
		(-3.44)		(-3.35)		(-0.40)
C	-5.48	-5.05***	-1.76***	-2.90***	2.21	2.63
	(-1.27)	(-5.73)	(-9.35)	(-7.71)	(0.17)	(0.29)
OBS	48	51	48	48	50	48
			Diagnostic Tests			
Jarque-Bera	6.24	12.59	2.73	0.97	0.02	2.40
	[0.04]	[0.00]	[0.26]	[0.61]	[1.89]	[0.23]
B-G Corr LM	1.54	0.01	1.10	1.92	1.45	2.92
	[0.22]	[0.99]	[0.38]	[0.14]	[0.24]	[0.04]
B-P-G Hetero	0.70	1.45	2.50	1.41	2.26	1.24
	[0.79]	[0.20]	[0.01]	[0.20]	[0.03]	[0.30]
Hetero (ARCH)	0.00	0.40	1.94	0.22	2.87	0.40
	[0.96]	[0.53]	[0.14]	[0.64]	[0.10]	[0.53]
RESET	0.56	1.34	1.65	3.26	2.53	1.78
	[0.58]	[0.19]	[0.20]	[0.00]	[0.02]	[0.08]

Note: The table shows how long run movement in Paper, Plastic and Wood products correspondingly responds to changes in exchange rate volatility and other catchall variables. ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics while values in squared bracket are probability values of F-distribution for each test.

Turning to the case of cement, chemical and oil refining sub-sectors, foreign exchange allocated to the manufacturing sector, market capitalization, government spending, and exchange rate volatility have significant effect on cement sub-sector (Table 16). In the long run, market capitalization posts a 1.2% increase in the output of cement for a 1% increase in the activity of the market. Similarly, government final expenditure increases cement output by 1.2% for a 1% increase in the spending. The positive effect suggests that both market capitalization and government spending enhance the activity of the cement sub-sector. The magnitude of effect also indicates that these factors (government and stock market activities) are critical to the growth of the cement sub-sector. Observably, cement sub-sector benefit importantly from the foreign exchange allocated

to the manufacturing sector. Coming to the exchange rate volatility, cement sub-sector is highly sensitive to effective exchange rate volatility compared to the interbank exchange rate volatility.

Table 16: Long Run (Level Equation) Results for Cement, Chemicals and Oil Refining Products

VARIABLES	CEMENT		CHEMICALS		OIL REFINING	
FOREX	1.31	0.90**	-0.40	0.47	-0.39	-0.58
	(1.10)	(2.04)	(-0.29)	(0.63)	(-0.77)	(-1.46)
MKTCAP	1.91***	1.16***	1.56***	1.73***	0.09	0.29
	(3.03)	(3.87)	(3.04)	(3.12)	(0.38)	(1.48)
GOVT	0.63	1.17***	0.05	0.81	0.13	0.35***
	(1.38)	(5.55)	(0.06)	(1.27)	(0.57)	(2.16)
MPR	-0.21	0.11	0.35	0.39*	0.45***	0.48***
	(-1.11)	(1.51)	(-1.04)	(1.89)	(4.89)	(6.39)
VOLNEER	-3.29*		-0.95		-1.24	
	(1.94)		(0.75)		(-1.55)	
VOLINTB		-1.84***		-0.51		-1.87**
		(3.83)		(0.75)		(-2.53)
C	-38.51***	-32.13***	-8.87	-28.78***	3.24	4.08
	(-2.53)	(-6.28)	(-0.61)	(-4.08)	(0.40)	(0.72)
OBS	49	49	48	48	48	48
			Diagnostic Tests			
Jarque-Bera	0.13	4.02	0.23	1.74	0.77	2.35
	[0.938]	[0.164]	[0.932]	[0.419]	[0.681]	[0.309]
B-G Corr LM	0.79	0.66	0.64	1.02	0.21	0.54
	[0.343]	[0.627]	[0.639]	[0.412]	[0.928]	[0.71]
B-P-G Hetero	0.71	0.84	1.87	3.00	1.02	1.45
	[0.648]	[0.634]	[0.072]	[0.004]	[0.465]	[0.18]
Hetero (ARCH)	0.96	1.32	0.00	10.37	1.52	0.05
	[0.954]	[0.257]	[0.968]	[0.002]	[0.822]	[0.83]
RESET	0.91	1.07	0.00	6.56	0.08	0.67
	[0.246]	[0.397]	[0.967]	[0.001]	[0.934]	[0.51]

Note: The table shows how long run movement in Cement, Chemicals and Oil refineries products correspondingly responds to changes in exchange rate volatility and other catchall variables. ***,**,* indicate significant at 1%, 5% and 10% respectively. Values in the bracket are t-statistics while values in squared bracket are probability values of F-distribution for each test.

In particular, if real effective exchange rate volatility rises by 1%, the value added of cement will also increase by approximately 3.3%. Albeit the same increase in interbank exchange rate will only raise cement value added by approximately 1.8%. Therefore, exchange rate volatility is a long run phenomenon in the cement sub-sector and the effect is not only positive but notable. The positive effect could suggest that producers of cement are risk-lovers and base their decision on future revenue derivable from high exchange rate volatility. What could motivate this type of expectation is the rural and urban development taking place in Nigeria which requires the use of cement. Hence, cement producers could conjecture that their revenue will certainly increase in the face of high exchange rate volatility due to high demand for the products. In the case of chemical sub-sector, only market capitalization and monetary policy rate have long run significant impact.

Neither foreign exchange allocated to the manufacturing sector nor exchange rate volatility have significant influence on the performance of the sub-sector. Nigeria is endowed with mineral resources out of which chemicals are produced. Further, a good percentage of raw materials needed to exploit the commodity are sourced locally while the intermediate goods may last for some years. Meanwhile, there is a sign of adverse effect of exchange rate volatility on chemicals in the long run. In sum, it can be claimed that exchange rate volatility is not a long run issue in the chemical sub-sector, although a sign of adverse effect is observed. Oil refining is significantly affected by government spending, monetary policy rate and exchange rate volatility. Increase in government expenditure to the tune of 1% leads to 0.4% increase in the output of oil refining.

Monetary policy rate increases oil refining output by 0.5% for a 1% increase. This suggests that both government expenditure and monetary policy rate facilitate the activity of the oil refining sub-sector. A disturbing outcome is the fact that foreign exchange allocated to the manufacturing sector acts as a clog in the wheels of progress of the oil refining sector. However, owing to the fact that close to 100% of oil refining products such as petroleum products are imported from abroad (during the period under review) it is surprising that this sector is dragged by the foreign exchange supply to the oil sector. Meanwhile, oil refining sector responds negatively to exchange rate volatility. Observably, if interbank exchange rate volatility increases by 1%, oil refining will reduce by 1.9%. Therefore, interbank exchange rate is critical to the oil refining sector as it poses both short and long run effects. However, it is the case that this type of exchange rate volatility facilitates oil refining in the short run but it dwarfs it in the long run.

The result of the diagnostic tests for all the models from Table 12 to Table 16 indicate that there is no question about the validity of the results, given the outcome of the normality, serial correlation, time-dependence of the variance of the error terms (hetero), ARCH and specification tests. All the tests are in order given the values of the probability associated with the respective chi-square values. Consequently, the magnitude and direction of the coefficients for each sub-sector are appropriate for policy directive.

5. CONCLUSION AND POLICY IMPLICATIONS

The manufacturing sector of Nigeria is still performing below expectation. Consequently, researchers have been assessing factors driving the industrial sector in general and manufacturing sector in particular. Out of many factors identified, exchange rate volatility tends to be the most important factor, owing to the connection it has with both the supply and demand sides. Meanwhile, there is no agreement on the nature and direction of effect. One major reason for this diverse outcome is due to aggregation bias, in which case, all firms in the manufacturing sector are lumped into one. The lumping beclouds the real nature of effect on each sub-sector of manufacturing sector. Further, existing study focus on one type of exchange rate, mostly effective exchange rate. But most firms in Nigeria source foreign exchange from banks, and so, they are faced with dynamics of interbank exchange rate. This study therefore revisits the drivers of the manufacturing sectors, at the sub-sector level with particular focus on exchange rate volatility.

According to the results obtained from the ARDL method, both effective and interbank exchange rate volatility do not significantly affect the industrial sector as a whole either in the short run or in the long run. Interbank exchange rate volatility exerts short and long run inhibiting effect on the manufacturing and other manufacturing sectors. For the sub-manufacturing sectors, textiles, electrical & electronics, and wood & wood products are affected negatively by interbank exchange rate volatility. Similarly, textile, chemicals and oil refining are adversely affected by effective exchange rate volatility in the short run. Sub-manufacturing sectors that respond positively to interbank exchange rate volatility in the short run are cement, oil refining (up to three lags) and vehicle assembly. It turns out that textile products are exposed to both effective and interbank exchange rate volatility in the short run.

In the long run, electrical & electronics, textile and vehicle assembly are positively affected by interbank exchange rate volatility but it must be noted that effective exchange rate also significantly affects electrical & electronics. Nonmetallic, iron & steel, plastic, cement products are affected negatively by both interbank and effective exchange rate volatility while interbank exchange rate volatility drags the activity in the oil refining products. It is clear that effective exchange rate volatility does not have significant effect on eight sub-manufacturing sectors in the short run. These sectors are nonmetallic, basic metals, electrical & electronics, food & beverages, plastic, wood & wood products, cement and oil refining. Only chemicals and textiles do not respond to interbank exchange rate volatility in the short run. Further, six sub-sectors, namely food & beverage, textile (effective exchange rate only) paper & paper products, wood & wood products, chemicals, and oil refining do not respond significantly to either interbank or effective exchange rate in the long run.

The overall conclusion is that interbank exchange rate volatility matter more than effective exchange rate in the product categories of the manufacturing sector in Nigeria. Further, interbank exchange rate has detrimental effect on most of these products, both in the short and long runs. Meanwhile, up to 50 percent of the product categories do not respond to either interbank or effective exchange rate in the long run. Although manufacturing, and by extension industrial sector are not affected significantly by interbank exchange rate volatility, it will be wrong to assume that the product categories in the manufacturing sector do not also respond significantly to the volatility of this type of exchange rate.

The wisdom from this conclusion is that it is not proper to believe that all categories of manufactured products are affected by exchange rate volatility the same way. In fact, sectors that are critical to the economy, namely textiles, and electrical & electronics are adversely affected by interbank exchange rate volatility. Hence, these subsectors should not take interbank exchange rate volatility lightly. They may seek to hedge the volatility effectively in the forward exchange rate market. Alternatively, if it is possible, these sectors should avoid interbank exchange rate and try other official exchange rate. Cement, vehicle assembly and oil refining sub-sector should not bother about exchange rate fluctuations, particularly interbank exchange rate, at least in the short run. However, cement, oil refining sub-sectors should be conscious of the long run adverse

effect. Firms operating in the nonmetallic, basic metals, electrical & electronics, food & beverage, and textile may not bother about effective exchange rate fluctuations in the long run.

Generally, since the exchange rate appears not to be a long run phenomenon for most of these sub-sectors, it is recommended that firms should engage in forward exchange rate market where the short run risk can be absorbed. The monetary authorities are therefore advised to strengthen the activity of the forward exchange rate market. The sub-sectors are more adversely affected by interbank exchange rate. The monetary authorities are trying to unify exchange rate in Nigeria. While this step is in order, it should go along with the strengthening of the forward market, so that firms will find it convenient and comfortable to hedge short run exchange rate risk in the face of floating exchange rate regime.

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EFFECT OF EXCHANGE RATES AND TARIFFS ON TERMS OF TRADE IN KENYA

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ABSTRACT

Purpose – This study investigates the effect of exchange rates and tariffs on Kenya's terms of trade (ToT) between 2001 and 2021. It addresses a gap in empirical literature concerning the interaction between these trade variables and ToT, particularly in the context of Kenya's structural economic transitions and exposure to external shocks.

Methodology – An explanatory research design was adopted using annual time series data. The study applied the Autoregressive Distributed Lag (ARDL) model and Toda-Yamamoto Granger causality testing to evaluate both the short-run and long-run impacts of exchange rates, tariffs, exports, and imports on ToT. Diagnostic tests for multicollinearity, normality, and autocorrelation were conducted to validate model robustness.

Findings – Granger causality results indicated that exchange rates, tariffs, exports, and imports significantly influence ToT, with bi-directional causality observed for all except exports. The ARDL model showed strong overall fit (R^2 = 82%) but failed to find statistically significant long-run effects from any single trade variable. In the short run, exchange rate depreciation significantly improved ToT, while import growth had a marginally negative effect. Exports and tariffs demonstrated limited immediate influence despite their predictive relevance.

Conclusion – Kenya's ToT dynamics are most responsive to short-term exchange rate adjustments and import levels, with limited long-run determinacy from individual trade variables. The findings underscore the need for a flexible exchange rate regime, smarter tariff policy aligned with industrial goals, and export diversification. Coordinated macroeconomic and trade strategies are vital for insulating Kenya's trade performance from external volatility and enhancing its global competitiveness.

Keywords: Terms of trade, exchange rates, tariffs, ARDL, Granger Causality
JEL Codes: F14, F31, C32

1. INTRODUCTION

A country's terms of trade (TOT) provide significant information concerning the health of its economy. The ratio of the index of a country's export prices to the index of its import prices is a key indicator of a country's international competitiveness. The terms of trade (ToT) in Kenya, like many developing economies, are significantly influenced by exchange rates and tariffs. These factors play a crucial role in determining the country's export and import performance, economic growth, and overall trade balance. This article explores how exchange rates and tariffs shape Kenya's ToT dynamics, drawing insights from various studies and empirical evidence.

Historically, the newly formed Kenyan government in 1964 inherited a trade and industrial policy from the British which was mainly aimed at import substitution. Manufacturing in Kenya dated as far back as the early twentieth century, but it was minimally developed save for the processing of agricultural goods; the market was severely undermined, and local capital or skilled management was negligible at best. The government began recovery efforts by implementing a policy to attract foreign investors to produce for the domestic and regional market. An influx of multinational corporations such as Union Carbide, Firestone, United Steel, Del Monte, Schweppes, and Lonrho began producing in Kenya (Bigsten, 2002). Protectionism policies were very strict, and many established firms enjoyed near monopolies. Between 1964 and 1969, manufacturing value added increased by 44 percent in real terms (World Bank, 2007); leading sectors that benefited from this included textiles and apparel, food, beverages, and tobacco.

From 1970–1971, Kenya suffered a balance of payments crisis, which was exacerbated by the first oil shock two years later. The government's response to these issues was intensified import-substitution policies; tariffs increased and import licensing

became more severe. Riding on this protection Kenya's manufacturing sector soared; annual growth in the sector averaged over 25 percent between 1971 and 1973 (World Bank, 2007). All through the decade import-substituting manufacturing continued to grow at an impressive rate, and diversified to sectors including plastics, pharmaceuticals, and vehicles.

A substantial increase in the price of coffee in the late 1970s caused Kenyan exports to improve further, more than quadrupling between 1975 and 1977 (Bevan, Collier, & Gunning, 1999). Another key Kenyan export that was affected by the coffee boom was the price of tea. The coffee boom had a net effect of a 54% increase in Kenya's terms of trade by 1977, the peak year of the boom. This spike in the value of Kenya's commodity exports enabled the government to temporarily avert a foreign exchange shortage, and thus stayed economic reform for a short term (Gertz, 2008).

By 1980, however, the price of coffee had subsided and the earlier gains from trade were reversed. In Kenya, the longest policy regime was the import substitution phase in comparison to the other policy regimes. The policies associated to import substitution brought in mixed results; with high rates of growth being experienced in the industrial and manufacturing sectors during the first decade after independence but without the commensurate creation of jobs. The good performance in the industrial and manufacturing sectors can be attributed to high demand for the goods produced. Kenya's main market for her produce was the neighboring countries of Tanzania and Uganda partly due to the agreement between EAC members. Trade between Kenya and other EAC members was soaring up to the late 70s, and a strong fiscal policy contributed greatly to Kenya's export growth under the EAC common market. (Wagacha M. , 2000)

However, the combined events of Kenya's poor economic performance in the late 70s and the collapse of the EAC in 1977 caused this good growth phase to come to a halt. A major contributor to this poor economic performance was the slowdown in industrial production which became unsustainable due to the small size of the domestic market. The inclination of industrial policies at the time was towards producing specifically for domestic markets, which modeled an inward-looking regime that could not support production. The result was a major slump in job creation and job losses. (Ikiara, Nyunya, & Odhiambo, 2004)

The oil crisis of 1973 also played a major role. It resulted in very high costs of production which exerted pressure on the balance of payments, which in turn made it hard to acquire imported raw materials and equipment. The government was also sorely unprepared to deal with the changes that were happening to the economy and lacked fiscal discipline. With another oil shock following in 1977 and failure to deal favorably with external terms of trade following the coffee boom of the late 70s, the government could only watch its fortunes slipping away.

The government of Kenya began to change tact in the early 1980s; this was partly due to the increasing pressure for structural adjustment reforms. The vision and commitment were directed to a liberalization policy, a major component of which was a shift from import-substitution to export-promotion strategy. This shift was heralded by the *Sessional Paper No.1 of 1986 on Economic Management for Renewed Growth* in which the government committed itself to liberalizing the economy through the adoption of an outward-looking development strategy. But it was a case of too little too late as by this time, Kenyan exports had deteriorated tremendously. Merchandise export earnings as a percentage of GDP had for example declined from 19.6% in the 1970s to 16.97% over 1980- 84 and to 13.6% over 1985-89 (Glenday & Ndii, 2000).

It should be noted however, that during the first half of the 1980s, despite its liberalization rhetoric, the government made only limited attempts to reform the Kenyan economy. The share of imports not subjected to quota restrictions did increase from 24 percent in 1980 to 48 percent and average tariffs decreased by about 8%, but this had little impact on Kenya's trade (Swamy G. , 1994).

The government only followed through on policy reforms when it was compelled to do so by outside pressures, and was quick to abandon liberalization in the face of other economic priorities: in an effort to counter the foreign exchange crisis of 1982–1984, Kenya uniformly raised all tariffs by a full 10 percent (Gertz, 2008).

All efforts notwithstanding, export orientation in the 1980s remained weak mainly due to very high effective rates of protection accorded to domestic industries, exchange rate bias against exports, high cost of imported inputs, foreign exchange controls and administrative delays, high transaction costs that militated against the profitability of exports, among others. In addition, the export incentive schemes remained unattractive and less successful due to weaknesses in implementation and poor coordination (Were, et al, 2002).

In the second half of the 1980s, with continued pressure from donors, Kenya set off on a more concerted and sustained effort at significant trade liberalization. This was highlighted by a shift in import restrictions from quotas to tariffs, and subsequently a decrease in tariff levels. The government embarked on phased tariff reductions and rationalization of the tariff bands in 1990. By 1991, quantitative restrictions affected only 5% of imports compared with 12% in 1987 (Swamy, 1994). Over the 1987-92 period, the number of tariff categories and maximum tariff rates were reduced from 25 to 11 and 170% to 70% respectively (Mwega, 2002).

By 1997/98, the simple average tariff rate had been reduced to 16.2% and the trade weighted tariff rate to 12.8%, down from 25.6% (Glenday & Ndii, 2000). The number of tariff bands (including duty free) was reduced from 15 in 1990/91 to four (4) in

1997/98 and the top regular tariff rate from 100% to 25% over the same period. That notwithstanding, the most significant shift in trade policy regime came in May 1993 with the abolition of trade licensing requirements and more importantly, foreign exchange controls (Were, et al, 2002). Foreign exchange retention schemes for exporters were introduced at a rate of 50% and later increased to 100% in February 1994 (Mwega, 2002).

Kenya's TOT have experienced significant volatility through the years, reflecting the continuously shifting nature of global market conditions and trade policy. In spite of having several policies aimed and boosting trade performance in the country, Kenya's TOT still finds itself vulnerable to external shocks and internal inefficiencies. Fluctuations in exchange rates and evolving tariff policies directly impact relative prices of exports and imports. However, there is limited empirical evidence assessing the interaction of these variables. This knowledge gap causes difficulty in designing evidence-based strategies meant to improve or stabilize TOT. This article therefore seeks to examine the effect of exchange rates and tariffs on Kenya's TOT.

General objective of the study is to examine the effect of exchange rates and tariffs on Kenya's terms of trade, while accounting for the roles of exports and imports. Specific objectives are to determine the short-run and long-run impact of exchange rate fluctuations on Kenya's terms of trade, assess the influence of tariff levels on Kenya's terms of trade, evaluate the role of export performance in shaping the terms of trade, and analyze the effect of import volumes on the terms of trade in Kenya.

Null Hypotheses of the study;

H_{o1}: Exchange rates have no significant effect on Kenya's terms of trade.

H_{o2}: Tariffs have no significant impact on the terms of trade in Kenya.

H_{o3}: Exports do not significantly influence the terms of trade.

H_{o4}: Imports do not have a significant effect on the terms of trade.

2. LITERATURE REVIEW

2.1. Empirical Analysis of Exchange Rates and Tariff Policy Changes on Kenya's Terms of Trade

Terms of trade (TOT) are a critical indicator of a country's economic health because they reflect the ratio of export prices to import prices. In Kenya, gaining an in depth understanding of how exchange rates and tariff policies affect TOT. This is especially necessary as a guide for formulating effective trade and economic policies as a potential solution to the country's debt and heavy reliance on foreign aid. This literature review analyses empirical evidence from various studies showing the influence of fluctuations in exchange rates and changes in tariff policies on Kenya's TOT.

The direct impact of TOT on the economic growth of Kenya is well-documented. (Manyinsa, Omwenga, & Ndungu, 2015) found that TOT has a significant positive relationship with GDP growth, indicating that favourable TOT tend to stimulate economic growth. (Matiy & Matundura, 2019) further found that unfavourable TOT has a significant negative impact on manufactured exports, indicating that adverse TOT may lead to economic stagnation or negative economic growth.

Increased trade openness and other trade liberalization policies also have an impact on TOT. (Manyinsa, Omwenga, & Ndungu, 2015) and (Githanga, 2015) suggest that increasing trade openness can improve TOT through increased competitiveness of domestic products and expansion of export markets. It should be noted though, that Kenya's ability to benefit from trade liberalization depends on whether domestic industries within the country have the ability to compete internationally.

2.2. Exchange Rates and Terms of Trade

Kenya's real exchange rate (RER) is subject to significant volatility which disrupts trade balances hence having a ripple effect on TOT. This affects the competitiveness of its exports. (Gachunga, 2018) pointed out that uncertainty in RER has long term adverse effects on exports, while imports remain largely unaffected in the short run. (Nyambariga, 2017) confirmed this by highlighting that analysis of RER displays a significant impact on both exports and imports, with RER showing long-term adverse effects on exports. It is important to note, that the responsiveness of Kenya's exports to changes in the exchange rate has critical influence on terms of trade dynamics in the country. (Umutesi & Gor, 2014) reveal that Kenyan exports are relatively price inelastic, meaning that a depreciation of the exchange rate does not lead to an increase in export volumes, suggesting that RER fluctuations may not significantly improve TOT through an increase in exports.

Further studies have shown that misalignment in the real effective exchange rate (REER) also has an indirect impact on terms of trade in Kenya. (Musyoki, Pokhariyal, & Pundo, 2014) found that a misalignment in REER, characterized by a depreciating trend will negatively impact economic growth which then negatively affects TOT. This can lead to a deterioration in the quality of the country's exports and cause a decline in the competitiveness of domestic products in international markets.

(Nyambariga, 2017) in his study notes that in order for the country to mitigate the adverse effects of exchange rate volatility, more macroeconomic policies aimed at stabilizing the REER should be developed and implemented. Stable exchange rates can improve trade balances and enhance the competitiveness of exports.

2.3. Tariff Policy Changes and Terms of Trade

Various tariff policy changes such as reductions in tariffs have played a key role in Kenya's trade liberalization policies. However, it's impact on TOT has been mixed. (Nzuma & Sarker, 2010) and (Nzuma, 2007) discovered that reductions in tariffs lead to a decrease in prices across various market levels thus increasing consumption but reducing the capacity for domestic production. This causes producer surplus to decline while consumer surplus increases. This indicates that gains from tariff reductions might not offset the losses faced by domestic producers. This is clearly observable in the agricultural sector, where (Nzuma & Sarker, 2010) and (Nzuma, 2007) note that maize exports are significantly impacted by changes in tariff policies, finding that trade openness in the maize sector led to a decline in domestic production due to an influx of cheaper imports in spite of increased consumption. (Chepng'eno, 2018) found that both price and exchange rate volatility in the tea sector affects export demand, with significant implications for TOT.

Inconsistencies in tariff policies also contribute to price volatility in key sectors, with (d'Hôtel, Cotty, & Jayne, 2013) demonstrating that inconsistent tariff adjustments, especially as a response to changes in international prices tend to trigger domestic price volatility, which can disrupt trade balances and have a negative impact on TOT. (Igesa, Okiyama, & Tokunaga, 2018) noted that sector specific interventions are necessary to address the challenges that keys sectors such as agriculture and manufacturing face. Targeted tariff reductions and fiscal policies can protect domestic production while improving welfare in specific industries such as tea and coffee. (d'Hôtel, Cotty, & Jayne, 2013) recommended that policy makers should push for consistent tariff policies because they are essential for improving TOT and reducing price volatility.

The empirical literature review emphasizes the multifaceted relationship between exchange rates, tariff policies, and Kenya's terms of trade. The studies reviewed reveal that volatility in RER and inconsistencies in the application of tariff policies have significant implications for TOT, causing potentially adverse effects on economic growth. To improve TOT, it is necessary for policymakers to focus on strengthening the domestic market which will stabilize exchange rates. This can be achieved through adopting sector- specific interventions which will enhance domestic product competitiveness in international markets, and developing tariff policies which can be consistently applied to strengthen trade balances and TOT.

3. METHODOLOGY

Research Design and Model Fit - This study will use the explanatory research design to explain the effect of exchange rates and tariffs on Kenya's terms of trade. This study seeks to establish the causal relationship between exchange rates and tariffs on Kenya's terms of trade. As such, the target population for this study is the time series data for the dependent and independent variables spanning 2001-2021 in Kenya, with the independent variables of focus being exchange rates, tariffs, exports, and imports with the dependent variable being terms of trade. The target population will be the annual observations of the variables under study.

Data analysis and presentation - This section will define the data analysis and presentation tools meant to be used in the study. Data collected will be analysed using STATA software. The study will use annual time series data for the period 2001 to 2021. This study will utilize a trade performance model to link its terms of trade to its contributing factors. In this case, the output will be terms of trade, measured as the net barter terms of trade index (25=100) and the contributing elements will be exchange rates, tariffs, exports, and imports.

More generally we may write

$$TOT = ER + TR + EX + IM \quad (1)$$

Where TOT: Terms of Trade, ER: Exchange Rates, TR: Tariffs, EX: Exports, IM: Imports

In order to apply function (1) to study the effect of each variable on TOT, an Autoregressive Distributed Lag (ARDL) approach will be used. The function is rewritten as:

$$TOT = \sum_{k=o}^{n} X + \mathcal{E} \quad (2)$$

Where TOT: net barter terms of trade index (25=100), X: Vector of factors that affect TOT, $\mathcal{E}$: Error term, k= 0,1, 2, …, n represents the number of variables in the vector X.

Model Specification - The model considers a production function with independent variables being Exchange rates (ER), Tariffs (TR), Exports (EX), and Imports (IM). The dependent variable is Terms of trade (TOT). The Autoregressive Distributed Lag (ARDL) is built upon the following augmented production function:

$$TOT_t = f(ER, TR, EX, IM) \quad (3)$$

The model will explicitly be defined as;

$$TOT_t = \alpha_0 + \alpha_1 ER_t + \alpha_2 TR_t + \alpha_3 EX_t + \alpha_4 IM_t + \mathcal{E}_t \quad (4)$$

Descriptive & Diagnostic Tests - The data set will undergo the following descriptive and diagnostic tests, summary statistics, test for multicollinearity using Variance Inflation Factor (VIF), Ordinary Least Square (OLS) regression and the tests for normality, heteroskedasticity and the Durbin-Watson test for autocorrelation.

Causality Test - The Granger no-causality (modified Wald) test developed by Toda and Yamamoto (1995), will be carried out to test the causality link between exchange rates, tariffs and terms of trade. To measure the level of causality between the independent variables and TOT, equation (4) is differentiated with respect to the regressors

$$\widehat{TOT} = \sum_{k=0}^{n} x^k + \mathcal{E} \quad (5)$$

As X is the vector of independent variables, equation (6) will represent the regression equation of the independent variables with respect to Terms of Trade:

$$TOT_t = \alpha_0 + \alpha_k X_t + \mathcal{E}_t \quad (6)$$

The Toda Yamamoto Granger Causality test is outlined in equations (9) to (13) as below:

$$TOT_t = \alpha_{10} + \sum_{i=1}^{p+d} \alpha_{1i} TOT_{t-i} + \sum_{i=1}^{q+d} \beta_{1i} ER_{t-i} + \sum_{i=1}^{r+d} \gamma_{1i} TR_{t-i} + \sum_{i=1}^{s+d} \delta_{1i} EX_{t-i} + \sum_{i=1}^{v+d} \eta_{1i} T.IM_{t-i} + \mu_{1t} \quad (7)$$

$$ER_t = \alpha_{20} + \sum_{i=1}^{p+d} \alpha_{2i} TOT_{t-i} + \sum_{i=1}^{q+d} \beta_{2i} ER_{t-i} + \sum_{i=1}^{r+d} \gamma_{2i} TR_{t-i} + \sum_{i=1}^{s+d} \delta_{2i} EX_{t-i} + \sum_{i=1}^{v+d} \eta_{2i} IM_{t-i} + \mu_{2t} \quad (8)$$

$$TR_t = \alpha_{30} + \sum_{i=1}^{p+d} \alpha_{3i} TOT_{t-i} + \sum_{i=1}^{q+d} \beta_{3i} ER_{t-i} + \sum_{i=1}^{r+d} \gamma_{3i} TR_{t-i} + \sum_{i=1}^{s+d} \delta_{3i} EX_{t-i} + \sum_{i=1}^{v+d} \eta_{3i} IM_{t-i} + \mu_{3t} \quad (9)$$

$$EX_t = \alpha_{40} + \sum_{i=1}^{p+d} \alpha_{4i} TOT_{t-i} + \sum_{i=1}^{q+d} \beta_{4i} ER_{t-i} + \sum_{i=1}^{r+d} \gamma_{4i} TR_{t-i} + \sum_{i=1}^{s+d} \delta_{4i} EX_{t-i} + \sum_{i=1}^{v+d} \eta_{4i} IM_{t-i} + \mu_{4t} \quad (10)$$

$$IM_t = \alpha_{50} + \sum_{i=1}^{p+d} \alpha_{5i} TOT_{t-i} + \sum_{i=1}^{q+d} \beta_{5i} ER_{t-i} + \sum_{i=1}^{r+d} \gamma_{5i} TR_{t-i} + \sum_{i=1}^{s+d} \delta_{5i} EX_{t-i} + \sum_{i=1}^{v+d} \eta_{5i} IM_{t-i} + \mu_{5t} \quad (11)$$

The modified wald test applies to any order of integration among variables, either I(0), I(1) or I(2). In the specified equations (7-11), d is the maximum possible order of integration amongst the variables that is determined using the appropriate criteria, while p,q,r,s,v are the ideal lag length of the corresponding variables. $\mu_{1t}, \mu_{2t}, \mu_{3t}, \mu_{4t}, \mu_{5t}$ stand for the error terms with zero mean, constant variance and without autocorrection.

ARDL Model estimation - The ARDL test will be used to estimate the structural relationship between TOT and the independent variables in the study. The ARDL(1,0,1,0,1) will test for model fit and general interpretation (R^2) and ARDL(1,1,1,1,1) with ECT will analyse for long-run and short-run relationships. To satisfy the bounds test assumption of the ARDL model, each variable must be I(0) or I(1). The purpose will be to eliminate spurious regression and erroneous inferences. Unit root is the statistical concept which describes a time series where the current value is equal to its previous value plus a random error term. That is, the series has no trend and fluctuates around a constant mean.

Cointegration Test - The essence models in the ARDL bounds test framework are the following unrestricted error correction models, testing for both long-run and short-run relationships among the variables. Further, transforming the equation gives the essence models in the ARDL bounds test framework presented as the following unrestricted error correction models. A series of test will be applied in the ARDL procedure and include;

Long-run bounds test equation

$$TOT_t = \alpha_0 + \sum_1^p \alpha_{11} TOT_{t-1} + \sum_0^q \alpha_{21} ER_{t-1} + \sum_0^r \alpha_{31} TR_{t-1} + \sum_0^s \alpha_{41} EX_{t-1} + \sum_0^v \alpha_{51} IM_{t-1} + \varepsilon_{1t} \quad (12)$$

Where p,q,r,s,v are the optimal lag length of respective variables. The existence of a long-term relationship among the variables is validated by utilizing the bounds test statistic.

Short-run bounds test equation

The short-run ARDL model based on an Error Correction Form (ECT) becomes:

$$\Delta TOT_t = \beta_0 + \sum_1^p \beta_{11} \Delta TOT_{t-1} + \sum_0^q \beta_{21} \Delta ER_{t-1} + \sum_0^r \beta_{31} \Delta TR_{t-1} + \sum_0^s \beta_{41} \Delta EX_{t-1} + \sum_0^v \beta_{51} \Delta IM_{t-1} + \Delta ECT_{t-1} + \varepsilon_{1t} \quad (13)$$

The error correction term (ECT) determines the rapidity of error correction to long-run stability from a short-run shock, assimilating short-run constraints with long-run evidence. ECT is derived from the residuals of equation (5) by one period lag. The coefficient of ECT must be negative, <1, and statistically significant to validate the long-run relationship while the short-run coefficient is established by significant values of the regressors.

4. FINDINGS AND DISCUSSIONS

4.1. Descriptive Statistics and Diagnostic Tests

The descriptive and diagnostic statistics indicate that while there is no severe multicollinearity (mean VIF= 4.906), exports and imports exhibit moderate multicollinearity, likely due to their interconnected nature. The OLS regression model explains 55.5% of the variation in Kenya's terms of trade (ToT) and is jointly significant (p = 0.008), although no individual variable reaches statistical significance. Imports show the strongest negative influence on ToT. Diagnostic tests confirm the absence of heteroskedasticity and support normality assumptions. However, the Durbin-Watson statistic (1.19) signals positive autocorrelation, suggesting that short-run interpretations should be approached with caution due to potential serial correlation in the residuals.

Table 1: Variance Inflation Factor

	VIF	1/VIF
ex	7.734	.129
im	5.928	.169
er	4.938	.203
tr	1.025	.976
Mean VIF	4.906	.

Table 2: Linear Regression

tot	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
tr	-.097	.229	-0.42	.677	-.583	.388	
er	.219	.142	1.54	.143	-.083	.52	
ex	.438	.421	1.04	.314	-.455	1.331	
im	-.586	.362	-1.62	.125	-1.354	.182	
Constant	84.007	19.416	4.33	.001	42.846	125.168	***
Mean dependent var	93.744	SD dependent var				5.053	
R-squared	0.555	Number of obs				21	
F-test	4.985	Prob > F				0.008	
Akaike crit. (AIC)	119.617	Bayesian crit. (BIC)				124.840	

**** p<.01, ** p<.05, * p<.1*

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of tot
chi2(1) = 2.21
Prob > chi2 = 0.1368

Table 3: Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj_chi2(2)	Prob>chi2
tot	21	0.411	0.475	1.300	0.522
tr	21	0.039	0.153	5.890	0.053
er	21	0.488	0.051	4.430	0.109
ex	21	0.810	0.116	2.850	0.240
im	21	0.346	0.231	2.610	0.271

Durbin-Watson d-statistic(5, 21) = 1.194691

4.2. Granger Causality Wald tests

Granger causality tests revealed that tariffs, exchange rates, exports, and imports all significantly predict Kenya's terms of trade (ToT), indicating strong historical precedence of these variables in shaping ToT dynamics. Notably, exchange rate emerged as a central driver, influencing all other variables. Reverse causality tests showed bidirectional relationships between ToT and tariffs, exchange rates, and imports—suggesting feedback loops, where shifts in ToT may influence policy decisions like tariff adjustments or exchange rate management. However, exports did not Granger-cause ToT or the exchange rate, highlighting their limited influence—possibly due to Kenya's dependence on low-value primary exports. Overall, tariffs and exchange rates stand out as key levers of trade performance, with exchange rate policy exerting widespread effects across the trade system.

Table 4: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob>Chi2
lntot	lntr	36.115	2	0.000
lntot	lner	10.703	2	0.005
lntot	lnex	32.124	2	0.000
lntot	lnim	81.508	2	0.000
lntot	ALL	236.910	8	0.000
lntr	lntot	12.630	2	0.002
lntr	lner	14.583	2	0.001
lntr	lnex	21.125	2	0.000
lntr	lnim	15.842	2	0.000
lntr	ALL	206.510	8	0.000
lner	lntot	19.195	2	0.000
lner	lntr	33.618	2	0.000
lner	lnex	35.742	2	0.000
lner	lnim	25.300	2	0.000
lner	ALL	170.410	8	0.000
lnex	lntot	4.426	2	0.109
lnex	lntr	7.285	2	0.026
lnex	lner	2.866	2	0.239
lnex	lnim	8.295	2	0.016
lnex	ALL	27.013	8	0.001
lnim	lntot	14.360	2	0.001
lnim	lntr	11.549	2	0.003
lnim	lner	6.692	2	0.035
lnim	lnex	6.702	2	0.035
lnim	ALL	44.381	8	0.000

4.3. ARDL Model Estimation

The analysis estimated two ARDL models to assess the relationship between terms of trade (ToT) and key trade variables. The ARDL(1,0,1,0,1) model demonstrated a good overall fit (R^2 = 82%), while the ARDL(1,1,1,1,1) with an Error Correction Term (ECT) distinguished between short- and long-run effects. The ECT was negative and moderately significant (p = 0.083), indicating a stable long-run equilibrium, with 70.3% of deviations corrected annually. However, none of the long-run coefficients—tariffs, exchange rate, exports, or imports—were statistically significant, although the exchange rate showed some promise. Short-run effects were also statistically insignificant, likely due to the small sample size and data volatility. The ARDL bounds test failed to confirm a long-run relationship. Economically, while the exchange rate appears influential, the lack of significance across variables suggests that ToT adjustments occur rapidly but are not strongly driven by any single factor.

```
ARDL(1,0,1,0,1) regression
Sample:  2002 -  2021, but with gaps        Number of obs   =        16
                                            F(  7,     8) =      5.35
                                            Prob > F       =    0.0154
                                            R-squared      =    0.8241
                                            Adj R-squared  =    0.6701
Log likelihood =  39.178238                 Root MSE       =    0.0296
```

lntot	Coef.	Std.Err.	t	P>t	[95%Conf.	Interval]
lntot						
L1.	0.287	0.296	0.970	0.359	-0.394	0.969
lntr	-0.049	0.054	-0.910	0.387	-0.173	0.075
lner						
--.	0.541	0.175	3.090	0.015	0.138	0.943
L1.	-0.359	0.169	-2.120	0.066	-0.748	0.031
lnex	0.150	0.115	1.300	0.229	-0.115	0.414
lnim						
--.	-0.375	0.125	-3.010	0.017	-0.662	-0.088
L1.	0.191	0.110	1.740	0.121	-0.063	0.445
_cons	2.695	1.343	2.010	0.080	-0.401	5.792

Table 5: ARDL (1,0,1,0,1) Regression

ARDL(1,1,1,1,1) regression
Sample: 2002 - 2021, but with gaps Number of obs = 16
R-squared = 0.8424
Adj R-squared = 0.6060
Log likelihood = 39.948779 Root MSE = 0.0325

D.lntot	Coef.	Std.Err.	t	P>t	[95%Conf.	Interval]
ADJ						
lntot						
L1.	-0.703	0.339	-2.080	0.083	-1.532	0.126
LR						
lntr	-0.137	0.164	-0.830	0.436	-0.540	0.265
lner	0.324	0.243	1.340	0.230	-0.270	0.917
lnex	0.209	0.299	0.700	0.510	-0.522	0.941
lnim	-0.247	0.395	-0.630	0.555	-1.214	0.720
SR						
lntr						
D1.	0.032	0.053	0.610	0.566	-0.097	0.161
lner						
D1.	0.330	0.194	1.700	0.140	-0.144	0.805
lnex						
D1.	0.114	0.316	0.360	0.730	-0.659	0.887
lnim						
D1.	-0.298	0.383	-0.780	0.466	-1.236	0.639
_cons	2.529	1.568	1.610	0.158	-1.309	6.367

note: estat btest has been superseded by estat ectest
as the prime procedure to test for a levels relationship.
(click to run)

Table 6: ARDL (1,1,1,1,1) Regression

Pesaran/Shin/Smith (2001) ARDL Bounds Test
H0: no levels relationship F = 1.712
t = -2.076
Critical Values (0.1-0.01), F-statistic, Case 3

	[I_0]	[I_1]	[I_0]	[I_1]	[I_0]	[I_1]	[I_0]	[I_1]
	L_1	L_1	L_05	L_05	L_025	L_025	L_01	L_01

k_4	2.450	3.520	2.860	4.010	3.250	4.490	3.740	5.060

accept if F < critical value for I(0) regressors
reject if F > critical value for I(1) regressors
Critical Values (0.1-0.01), t-statistic, Case 3

	[I_0]	[I_1]	[I_0]	[I_1]	[I_0]	[I_1]	[I_0]	[I_1]
	L_1	L_1	L_05	L_05	L_025	L_025	L_01	L_01
k_4	-2.570	-3.660	-2.860	-3.990	-3.130	-4.260	-3.430	-4.600

accept if t > critical value for I(0) regressors
reject if t < critical value for I(1) regressors
k: # of non-deterministic regressors in long-run relationship
Critical values from Pesaran/Shin/Smith (2001)
Table 7: Critical values from Pesaran/Shin/Smith (2001)

4.4. VAR Short Run Test

The VAR-type ARDL (1,1,1,1,1) model highlights that in the short run, Kenya's terms of trade (ToT) are significantly influenced by exchange rates and, to a lesser extent, imports. A 1% depreciation in the exchange rate improves ToT by approximately 0.56% (p = 0.035), suggesting that the exchange rate policy can positively impact trade performance. Imports show a marginally significant negative effect, implying that increased import volumes tend to worsen ToT, likely due to higher foreign expenditure. In contrast, tariffs and exports do not exhibit statistically significant short-run effects, nor do most lagged variables—indicating limited persistence. Overall, short-run ToT dynamics appear most responsive to exchange rate fluctuations and import levels, while tariff policy and export volumes have limited immediate influence despite their predictive relevance in prior Granger causality tests.

Table 8: VAR Short-run Test

ARDL(1,1,1,1,1) regression
Sample: 2002 - 2021, but with gaps Number of obs = 16
F(9, 6) = 3.51
Prob > F = 0.0703
R-squared = 0.8402
Adj R-squared = 0.6006
Log likelihood = 39.948779 Root MSE = 0.0325

lntot	Coef.	Std.Err.	t	P>t	[95%Conf.	Interval]
lntot						
L1.	0.297	0.339	0.880	0.415	-0.532	1.126
lntr						
--.	-0.064	0.107	-0.600	0.569	-0.327	0.198
L1.	-0.032	0.053	-0.610	0.566	-0.161	0.097
lner						
--.	0.558	0.206	2.710	0.035	0.055	1.061
L1.	-0.330	0.194	-1.700	0.140	-0.805	0.144
lnex						
--.	0.261	0.206	1.270	0.252	-0.243	0.765
L1.	-0.114	0.316	-0.360	0.730	-0.887	0.659
lnim						
--.	-0.472	0.199	-2.370	0.055	-0.959	0.015
L1.	0.298	0.383	0.780	0.466	-0.639	1.236
_cons	2.529	1.568	1.610	0.158	-1.309	6.367

5. CONCLUSIONS AND IMPLICATIONS

This study examined the effect of exchange rates and tariffs on Kenya's TOT using the Granger causality and ARDL approaches over the period 2001-2021. Granger causality tests suggested that exchange rates, tarrifs, exports and imports all have unidirectional causality with TOT, while there is a strong bi-directional causality observed between ToT and tariffs, exchange

rates, and imports. Findings revealed that while the ARDL model was a good fit for the data, none of the key variables exert statistically significant long-run effects on TOT. However, the error correction mechanism indicates that deviations from long-run equilibrium are corrected rapidly, reflecting a stable and mean-reverting trade system. In the short run, exchange rate depreciation significantly improves ToT, while rising import volumes tend to deteriorate it.

The analysis results indicated that exchange rates are a critical factor in influencing short run trade outcomes. It is necessary for Kenya to adopt a more strategic and flexible exchange rate policy, to mitigate for exchange rate volatility caused by constantly shifting global dynamics exacerbated by events such as COVID-19, the Russia-Ukraine conflict, and rising protectionism as seen in the current US regime. It is important for policymakers to ensure stability and competitiveness of the Kenya shilling which will support export earning while avoiding excessive depreciation fueled by high import costs and inflation.

The study also reveals a need for tariff policies to be refocused, with policymakers focusing on tariff policies which are strategic. They need to develop policies which will strike a balance between protecting local industries while mitigating international competition to avoid excessive consumer price inflation or trade retaliation. Analysis has revealed that the current tariffs in the country have a limited impact on TOT, indicating a need for policymakers to prioritize import substitution strategies and to explore local value addition to lower the country's dependency on global markets.

On the other hand, exports had an insignificant direct impact on TOT, and this is likely due to the country's concentration on low value primary goods. The country needs to diversify its export base, invest more in manufacturing and processing industries, and build stronger trade linkages with emerging markets under frameworks like the African Continental Free Trade Area (AfCFTA). This will serve to enhance export competitiveness and improve pricing power in international markets.

In summary, while the trade variables do not individually determine Kenya's TOT in the long-run, their predictive power and short-run effects underscore the need for coordinated and strategic trade and macroeconomic policies. A combination of flexible exchange rate management, strategic import controls, and export diversification is essential for strengthening Kenya's resilience and improving its position in global trade markets.

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NO CONTAGION, ONLY VOLATILITY: U.S. EQUITY CORRELATIONS DURING COVID-19

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ABSTRACT

Purpose-During the COVID-19 crisis, correlations between U.S. equity returns and those of its three primary trading partners—Canada, China, and Mexico—rose sharply. In particular, the average correlation climbed from 0.56 in 2019 to 0.83 in 2020, the peak year. This study investigates whether this nearly 48% surge signals a contagion effect stemming from COVID-19.

Methodology-Price data of ADRs for Canada, China, and Mexico, traded on the New York Stock Exchange were collected and returns on equally weighted portfolios for each country were computed. Using the returns on the country portfolios of ADRs and the US equity stock index S&P 500, cross-country correlations between the U.S. and each of its major trading partner countries were computed. These estimates were revised by applying the volatility adjustment procedure recommended by Forbes and Rigobon (2002). The revised estimates of correlations were tested whether they differed from the stable period values.

Findings-During the pandemic, unadjusted Correlations between U.S. equities and each of its major trading partners increased. These estimates were then adjusted for the increased volatility. The revised correlations were not found to be significantly different from their pre-pandemic values.

Conclusion-Estimates of correlations between U.S. equity and its major trading partner countries increased dramatically during the pandemic, implying possible contagion. This conclusion would be premature and incorrect as volatility changes are ignored in the estimation process. When corrected for it, the revised estimates of correlations do not support the presence of contagion effect.

Keywords: COVID-19, pandemic, correlations, contagion, ADR
JEL Codes: G10, G11, G15

1. INTRODUCTION

The COVID-19 pandemic stands among the most disruptive events in modern history. As Taylor (2021) notes in The New York Times, the virus quickly spread worldwide, infecting over 76 million people and causing more than 1.6 million deaths by the end of 2020. The World Health Organization (2021) declared COVID-19 a global public health emergency, and the Centers for Disease Control and Prevention deemed 2020 the deadliest year in American history.

Countries responded differently and in varying degrees to COVID-19. Regardless of how countries responded to the pandemic, the disruption to life within the countries was significant and widespread. The impact affected local economies as well as trade between countries. As financial markets reflect economic conditions, the pandemic could have had its impact in the domestic as well as international financial markets with important consequences for investors.

Investors seek opportunities to improve the risk-return tradeoff of investments. Investing internationally helps achieve that objective through lower correlations of securities. However, as Solnik and McLeavey (2009) observe, correlations between countries have been increasing over the past few decades. They attribute the increase in correlations to the steady increase in international trade and opening of financial markets for foreign investment. Nevertheless, they found correlations have been low enough for investors to benefit from global investment. But the investment environment could change when counties are

affected by political upheavals and economic and health crises. These crises could affect several countries and disrupt the correlation structure of equity returns, upsetting portfolio allocations and planned diversification of risk. Solnik and McLeavey (2009) note that such sudden spikes in correlations hurt diversifying internationally when diversification is needed most.

The COVID-19 pandemic is considered to be one of the major international crises, affecting almost all countries. This study examines whether the pandemic resulted in contagion in the equity markets. Estimates of correlations of U.S. equity returns with the returns of its major trading partner countries (Canada, China, and Mexico) increased substantially during the COVID-19 pandemic. The average correlation increased from the pre-pandemic value of 0.56 in 2019 to 0.83 in 2020 (the year in which the epidemic was at its peak). The nearly 48% increase in the average correlation in one year may signify contagion. However, during the same time period, average standard deviation of the equity securities in the four countries (including U.S.) increased by about 160%. Using the procedure suggested by Forbes and Rigobon (2002), hereafter FR, it is shown that, if the estimates of correlations are adjusted for volatility increases, the average correlation is 0.50—much lower and closer to the pre-pandemic level. Therefore, even with the devastation caused by the pandemic, its impact on cross-market correlations of the U.S. equity was not significant. The pandemic did not cause "contagion" from one country to another.

The rest of the paper is organized as follows. Section 2 provides a review of the related literature. Section 3 describes the data, and the methodology used in the study. The findings of the data analysis are discussed in Section 4. Conclusions of the study are provided in Section 5.

2. LITERATURE REVIEW

Several studies have examined the effect of the COVID-19 pandemic on the lives of people, economies, and the financial markets. This study examines change in international investment opportunities for U.S. investors during the COVID-19 pandemic. It is done by examining the correlation between U.S. equity securities and those of its major trading partner countries. The first section of the literature survey summarizes results of studies that examine how equity markets responded to COVID-19 related news, including changes in volatility. The second section of literature survey summarizes the main results of the studies on ADRs that justify using the ADR returns to represent the return on foreign equity for U.S. investors. The third section of the literature survey briefly discusses the Forbes and Rigobon (2002) study (FR) which is used in the present study as the main framework to analyse the data.

2.1. COVID-19 and Equity Market Reactions

Several studies examine the impact of COVID-19 on national stock index returns. Ftiti, et al. (2021) examine the Shanghai stock market index's price reaction to health news such as daily confirmed cases and deaths due to the outbreak. Xu (2021) examines how stocks in Canada and the U.S. responded to unanticipated changes in the COVID-19 related cases published by the World Health Organization. Using a GARCH model, the study finds a negative relationship between stock price response and the number of Covid related cases published. Kusumahadi and Permana (2021), using a TGARCH model, found COVID-19 news affected the volatility of stock returns, and negative shocks had a greater impact than positive shocks. Li et al. (2022) applied GARCH model on the U.S. and foreign stock indexes and demonstrate that volatility of stock price was linked to COVID-19 fear among the public.

Cepoi (2020) investigates the stock market's reaction to coronavirus news in the U.S., U.K., Germany, France, Spain, and Italy. Employing a panel quantile regression model, he shows that the stock markets present asymmetric dependencies with COVID-19 related information such as fake news, media coverage, media hype, sentiment, sovereign CDs, gold returns, and financial contagion. Hong et al. (2021), using ARCH model, examine the relationship between COVID-19 and the instability of both stock return predictability and price volatility in the U.S. Using structural break tests, they show that a single break occurred in mid-late February 2020, for both S&P 500 and DJIA return prediction models.

A few studies examine the impact of COVID-19 related issues at sector level. Mazur et al. (2021) find that, during the month of March 2020, which was the height of the pandemic, some industries such as natural gas, food, healthcare, and software, did well, whereas petroleum, real estate, entertainment, and hospitality industries did poorly. The industries that did poorly also had higher volatility of stock prices. Lee et al. (2023) examine the impact of COVID-19 epidemic on hospitality stock returns in China, and Chien et al. (2021) examine the impact of the pandemic on energy price**s** and stock market return.

Some studies examine the impact of COVID-19 at regional level within a country because the state level policies differ from state to state. For example, Pham et al. (2021) examine the impact on stock returns of the companies and the release of COVID-19 related news such as number of people infected and hospitalized, number of people died in that state, etc. and equity returns of companies headquartered in those states. They find significant negative price change the day following the news. Chang et al. (2021) investigates the effect of governments' actions on stock index return, using a panel data of 20 countries. They show that

the overall government response, containment and health, and stringency indices have a significant effect on stock market returns.

Cultural differences were also found to have had an effect in stock returns to COVID-19 related news. Fernandez-Perez et al. (2021) find that market participants' response to COVID-19 related news varied based on national culture. The stock price response to the news was higher in cultures that have lower individualism and higher uncertainty avoidance.

At a (more micro) company level, the study by Ding et al. (2021) shows that the effect of adverse COVID-19 related news on companies depends on the characteristics of the companies also. Their study indicates that companies with strong corporate characteristics are affected less by COVID-19 related bad news.

2.2. American Depositary Receipts and Foreign Equity Markets

The main objective of the present study is to quantify the changes in the correlations of U.S. equity with the equities of its major trading partner countries during the COVID-19 pandemic and check whether there was contagion in the equity markets. To perform the investigation, however, the equity returns of the respective country's indexes during the pre-pandemic (normal) period and the returns during the pandemic (crisis) period are needed. Further, the returns on foreign equities must be aligned with the domestic U.S. equity returns. International investing makes it difficult to obtain these returns due to the different time zones of the location and operations of the foreign financial markets and the resulting non-synchronous trading with U.S. markets. Further, foreign exchange rate issues make converting the foreign equity returns into returns commensurable with U.S. equity returns a complex task. However, American Depositary Receipts (ADRs) provide an alternative. ADRs trade in the U.S. equity markets and the price is quoted in U.S. dollars. While ADRs offer a practical proxy for U.S. investors, it is worth noting that they may not fully capture the entire breadth of each country's equity market, especially if only larger or internationally oriented firms issue ADRs. Still, ADR returns are a convenient, although approximate, way to circumvent the problems encountered in obtaining foreign equity returns for U.S. investors. As discussed below, empirical studies on ADRs support it.

Kabir et al. (2011) show the substitutability between ADRs and country indices. They analyze whether U.S. investors can achieve diversification benefits from ADRs, beyond what is achievable through investing directly in country indices. Using monthly data for the 1981-2001 period, and equally weighted portfolios of ADRs, they show that ADRs are reasonable substitutes for country stock indexes. Wahab and Lashgari (1993) show that U.S. investors can achieve international diversification benefits by investing in ADRs—compared to direct investment in foreign securities—and thereby avoid issues such as taxation by foreign countries, restrictions on capital flows, and exchange rate risk. Wang and Yang (2004) find that U.S. investors can obtain international diversification by investing in the ADRs issued by Taiwanese companies. They also show that, as the ADRs price the foreign exchange risk, investing and portfolio construction process is simplified by investing in ADRs. The present study uses returns on portfolios of ADRs to represent returns from foreign equity investing.

2.3. Volatility Adjustments in Estimating Correlation

This study examines the cross-market correlations of U.S. equity with the major trading partner countries of the U.S. As Forbes and Rigobon (2002) indicate, these correlations, estimated from returns for different time periods, are important from an investment perspective. During pandemics, correlations of equity between countries that are economically linked tend to go up. However, FR cautions that the estimates must take into consideration the accompanying changes in volatility of the equity. Not doing so could lead to incorrect conclusions and attribute the increased correlations to contagion. FR also provide a procedure to reduce the bias in the estimates and apply their proposed methodology to examine three major crises—the 1997 Hong Kong Crash, the 1994 Mexican crisis, and the 1987 U.S. crash. They show that, contrary to existing belief, these crises were not contagion, although the estimates of cross-market correlations substantially increased during the crises. FR claim that the increase in the estimated correlations was primarily due to changes in the volatility of the sample during the periods of crises. After the correction, the estimates of the correlations were lower and found not statistically significant to indicate contagion.

FR categorizes empirical studies that examine propagation of shocks across financial markets into four groups. These are: (1) ARCH and GARCH models that examine time-series data, (2) cointegration methods, (3) direct estimation of the propagation, and (4) the approach that examines cross-market correlations. Of the four methods used for examining the transmission of shocks, FR claims that tests based on cross-market correlations are the most straightforward for testing contagion and use the approach in their study. The present study applies the procedure suggested by FR to examine whether the cross-market equity correlations of the U.S. with its major trading partner countries changed significantly during the pandemic period. The next section describes the data, and the methodology used in this study.

3. DATA AND METHODOLOGY

3.1. Data

This study examines the changes in cross-market correlations of the U.S. with its major trading partners. The major trading partners of the U.S. were identified from the U.S. Census Bureau publications. In the year 2021, fifteen countries accounted for about 75% of the U.S.'s total foreign trade. Of all trading partners of the U.S., the top three countries (Canada, China, and Mexico) accounted for about 43% of the total foreign trade. Further, all three had roughly the same amount of trade (14.5%, each) with the U.S. making them equally important as trading partners of the U.S. The three countries that ranked high on foreign trade with the U.S. also ranked high on the number of ADRs they had on the NYSE: Canada (71), China (35), and Mexico (10) – number of ADRs are in the parentheses. The fourth ranked country, Japan, accounted for only 4.6% of U.S.' foreign trade. Other countries had much lower trade with the U.S. This study restricts the analysis to the top three trading partners of the U.S. because the high trade volume of these countries with the U.S. might align with the fundamental causes of transmission of contagion, such as integrated supply chain and other business relationships. Further, these three countries also had the largest number of ADRs making them more representative of the opportunities for international investment for U.S. investors. Cross-market correlations were estimated using equally weighted portfolios of the ADRs of Canada, China, and Mexico, and the S&P 500 stock index for U.S. equity.

This study compares the cross-market correlations during the pandemic (crisis) period with the correlations during the pre-pandemic (normal) period. Therefore, the normal period and the crisis period must be identified. For the COVID-19 pandemic, the beginning of 2020 provides a clear turning point in the economic activities and relationships. It is widely believed that most of the countries were affected by COVID-19 in 2020, although indications of the onset were noticed as early as January of 2020. Newspapers and other media accounts indicate that the spreading of the pandemic became widely known, very quickly, at the beginning of the year 2020 (Taylor, 2021). The effect of the pandemic was felt over a two-year period, starting in 2020, and tapered off in 2021. The World Health Organization declared the end of the pandemic by December 2021. Therefore, the years 2020 and 2021 can be used for choosing a sample to represent the COVID-19 period returns. However, as the severe impact of the pandemic was in the year 2020, we use the returns in the year 2020 for estimating correlations during the pandemic period. Including 2021 data might offer a fuller picture, but the present study focuses on the most acute phase of the pandemic.

Studies that examined the stock price response to COVID-19 have used daily, weekly, and monthly data. The choice of the data was driven by the nature of the investigation and availability of data. Daily data was more common among studies that quantified response to COVID-19 related news. Such investigations also used ARCH and GARCH techniques to estimate changes in volatility. Empirical studies investigating the benefits from investing on ADRs have used monthly data. The present study uses weekly returns for estimation of correlations and volatility. Monthly data would make the sample size too small, whereas weekly data provide fifty-two observations, making the sample size sufficiently large. Weekly data has been used in a comprehensive, COVID-19 related study by Ding, et al. (2021) to show that a company's ability to resist the impact of COVID-19 depended on the company's financial as well as non-financial characteristics.

Data on closing prices of Stocks and ADRs traded on the New York Stock Exchange are available in the Yahoo.finance database. Xu (2021) uses this data source in their investigation of stock returns in Canada and the U.S. during the COVID-19 pandemic. For the present study, stock index data and ADR price data were collected from yahoo.Finance.

To construct the equally weighted ADR returns of country portfolios, historical price data of ADRs of Canada, China, and Mexico traded on the New York Stock Exchange were obtained from yahoo.finance. To extract the data from yahoo.finance, an open-source computer software "tidyquant" made available in Dancho and Valghan (2021) was used. Using R, tidyquant and BatchGetSymbols packages, weekly ADR data included ticker symbols, dates, and adjusted closing prices were retrieved. With the data of individual ADRs, equally weighted country portfolios for Canada, China, and Mexico were formed.

3.2. Methodology

First, the correlations between the S&P 500 (U.S. stock index) returns and the equity (ADR portfolio) returns of each of the major trading partner countries, namely Canada, China, and Mexico were estimated. It was done separately for the normal and the pandemic periods. Then the volatility (standard deviation) for each country's equity for normal and pandemic periods were estimated. Using the volatility estimates, the estimates of correlations during the pandemic period were adjusted. Then the volatility-adjusted pandemic period cross-market correlations were tested for the difference from the corresponding stable period correlations.

The procedure for volatility adjustment recommended by FR is as follows. Let r_p indicate the estimated correlation during the pandemic period between U.S. equity and the equity of another country. Let SD_p and SD_n indicate the standard deviation

(volatility) of U.S. equity returns during the pandemic period and the normal period, respectively. FR show that the volatility adjusted pandemic-period correlation coefficient r'_p can be found as shown below.

$$r'_p = \frac{r_p}{\sqrt{(1+d(1-r_p^2))}} \quad (1)$$

$$\text{where } d = \left(\frac{SD_p}{SD_n}\right)^2 - 1 \quad (2)$$

The present study used the FR method to estimate the volatility adjusted correlations r'_p during the pandemic period and tested whether they were significantly different from the correlations during the normal period r_n. To test for the difference in correlations, the correlations had to be transformed using Fisher's Z transformation. If r is the correlation coefficient, and ln represents natural logarithm, the Fisher Z transformation of r is as shown below.

$$Z = 0.5 \times \ln[(1+r)/(1-r)] \quad (3)$$

Z values were computed for the normal period (Z_n) and for the pandemic period (Z_p) and tested for the difference in correlation by using the statistic d (shown below). The statistic d is distributed approximately as a standard normal.

$$d = (Z_p - Z_n)/s \quad (4)$$

where

$$s = \sqrt{\frac{1}{N_p - 3} + \frac{1}{N_n - 3}} \quad (5)$$

In the above equation, N_p and N_n are the sizes of the samples used for estimating the correlations during the pandemic period and the normal period, respectively. In the data analysis, the sample size is fifty-two for the stable as well as the pandemic periods (years 2019 and 2020, respectively) as weekly returns are used.

4. FINDINGS AND DISCUSSIONS

Results of the analysis, if volatility adjustments are not made, are provided first. Table 1 below shows the estimates of the cross-market correlations between the U.S. and each of the three countries (Canada, China, and Mexico). The table also shows the estimates of volatilities (standard deviation) during the normal period and the pandemic period. The cross-market correlations shown in Table 1 indicate that the unadjusted correlations during the pandemic period were much higher than the correlations during the normal period. Correlations of U.S. equity and Canadian ADR equity portfolio increased from 0.5699 in the pre-pandemic year to 0.8703 in the pandemic year. Similarly, correlation of U.S. equity and China ADRs increased from 0.5058 to 0.7624, and the correlation of U.S. equity with Mexico increased from 0.5942 to 0.8442. The average of correlations during the stable period was 0.5566 and the average of the unadjusted correlations during the pandemic period was 0.8257—an increase of approximately 48%. The table also shows that there was a substantial increase in volatility (standard deviation) during the pandemic period.

Table 1: Correlations during stable period (2019) and unadjusted correlations during the pandemic period (2020)

	Normal period		COVID-19 Pandemic period			
Trading Partner Country	**Volatility (percent)**	**Correlation with U.S.**	**Volatility (percent)**	**Change in volatility (%)**	**(Unadjusted) Correlation with U.S. Equity**	**Test statistics (d)**
U. S.	1.4898		4.3582	193		
Canada	1.6631	0.5699	6.0601	264	0.8703	3.3999*
China	2.8274	0.5058	4.9616	75	0.7624	2.2025*
Mexico	2.5265	0.5942	6.7559	167	0.8442	2.7303*

* Significant at 5%

To check if the increase in correlations of U.S. equity with each of the three countries were statistically significant, the test statistic "d" (described earlier) was constructed. This statistic is distributed as standard normal. Results of the tests are reported in the last column in Table 1. Figures indicate that the increase in correlations during the pandemic was significant at 5% level (value of d greater than 1.645) for the U.S. with each of the three countries. The significantly higher correlations during the pandemic could be interpreted as the existence of contagion during the COVID-19 pandemic period. However, when the correlations are adjusted for changes in volatility, data lead to different conclusions. Results using volatility adjusted correlations are presented in Table 2.

Table 2: Volatility adjusted Correlation of U.S. equity with major trading partner countries

Major Trading Partner country	Normal Period correlations with U.S.	Pandemic Period correlations with U.S. equity			Test statistics for change in correlation using the volatility	
		Correlations unadjusted for volatility changes	Correlations adjusted using the volatility of			
			U.S.	Trading country	U.S. equity	Trading country
Canada	0.5699	0.8703	0.5170	0.4363	-0.3721	-0.8896
China	0.5058	0.7624	0.3736	0.5575	-0.8139	0.3568
Mexico	0.5942	0.8442	0.4741	0.5075	-0.8356	-0.6173

The cross-market correlations shown in Table 2 shows volatility adjusted correlations of U.S. equity with its major trading partner countries. Volatility adjustments were made in two ways. For the first, the change in volatility of U.S. equity was used to revise the estimates of correlations. The standard deviation of U.S. equity index increased from 1.4898% in the pre-pandemic period to 4.3582% in the pandemic period, which is an increase of 193%. When the volatility of U.S. equity is used for adjusting the estimate of the correlation coefficients, a significant decrease in the correlations can be noticed. Using U.S. volatilities for volatility adjustments, the revised estimates of correlations of U.S. equity during the pandemic period were 0.5170, 0.3736, and 0.4741 with Canada, China, and Mexico, respectively. The revised estimates are much lower than the estimates obtained when unadjusted for the increase in volatility. It can also be noted that the revised estimates of correlations during the pandemic were lower than the correlations during the pre-pandemic, normal, year. However, the tests for the difference indicate that the changes are not significant even at the 10% level.

For the second set of adjustments, the respective partner country's volatility was used for adjusting the estimated correlation of U.S. equity with that country's equity. As shown in Table 2, if Canada's volatility is used for adjustment, the correlation of the U.S. with Canada will be 0.4363. Similar estimations resulted in 0.5575 as the correlation with China and 0.5075 as the correlation with Mexico. As the pandemic affected all the countries at about the same time, there is a possibility of endogeneity in the transmissions of the pandemic that could affect estimations. However, as Forbes and Rigobon (2002) point out, existing techniques do not provide a way to handle endogeneity. While more advanced methods may partially address endogeneity, they lie beyond our current scope. Therefore, the correlations were estimated using the volatility of U.S. equity as well as the major trading partner countries of the U.S. Regardless of which volatility is used for adjusting the estimates of correlations during the pandemic period, the revised estimates are not statistically different from their pre-pandemic levels.

5. CONCLUSION AND IMPLICATIONS

The COVID-19 pandemic posed an unprecedented global crisis, warranting close examination of its financial effects. Although our initial findings suggest that correlations between U.S. equities and those of its top trading partner countries rose sharply during 2020, volatility also escalated significantly. After adjustments are made for the heightened volatility, the revised correlations no longer support the conclusion that COVID-19 triggered contagion. By highlighting the importance of volatility adjustments, this study also (like FR) underscores the need for a more nuanced interpretation of cross-country correlation spikes during global crises. A practical implication of the result from our study could be that investors should avoid reacting to raw correlation spikes during crises. By doing so they may sacrifice international diversification prematurely.

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