Vol. 11 • No. 4 • 2023 ISSN 2308-944X (Print) ISSN 2311-0279 (Online)

Review of Business and Economics Studies

DOI: 10.26794/2308-944X

The journal was reregistered
in the Federal Service for Supervision
of Communications,
Informational Technologies,
and Mass Media:
PI No. ФС77–67072
of 15 September 2016

**Publication frequency —
4 issues per year**

Founder: Financial University

The Journal is included into the system
of Russian Science Citation Index

The Journal is distributed by subscription.
Subscription index: 42137
in the consolidated
catalogue “The Press of Russia”

Издание перерегистрировано
в Федеральной службе по надзору
в сфере связи, информационных
технологий
и массовых коммуникаций:
ПИ № ФС77–67072
от 15 сентября 2016 г.

**Периодичность издания —
4 номера в год**

Учредитель: Финансовый университет

Журнал включен в систему Российского
индекса научного цитирования (РИНЦ)

Журнал распространяется по подписке.
Подписной индекс 42137
в объединенном
каталоге «Пресса России»

Т. 11 • № 4 • 2023 ISSN 2308-944X (Print) ISSN 2311-0279 (Online)

Вестник исследований бизнеса и экономики

DOI: 10.26794/2308-944X

Review of Business and Economics Studies

REVIEW OF BUSINESS AND ECONOMICS STUDIES (RoBES) is the quarterly peer-reviewed scholarly journal published by the Financial University under the Government of the Russian Federation, Moscow. Journal's mission is to provide scientific perspective on topical economic and business subjects.

CONTACT INFORMATION
Financial University
Leningradsky prospekt, 53,
office 5.6
125167, Moscow,
Russian Federation
Telephone: +7 (499) 553-10-74
(internal 10-88)
Website: https://rbes.fa.ru/jour

AUTHOR INQUIRIES
Inquiries relating to the submission of articles can be sent by electronic mail to ambotchkarev@fa.ru.

ISSN 2308-944X

Вестник исследований бизнеса и экономики

Редакция научных журналов
Финансового университета
125167, Москва,
Ленинградский пр-т, 53,
комн. 5.6
Тел. +7 (499) 553-10-74
(вн. 10-88)
Интернет: https://rbes.fa.ru/jour

Журнал “Review of Business and Economics Studies” («Вестник исследований бизнеса и экономики») зарегистрирован в Федеральной службе по надзору в сфере связи, информационных технологий и массовых коммуникаций
15 сентября 2016 г.
Свидетельство о регистрации ПИ № ФС77-67072.

Подписано в печать: 02.02.2023.
Формат 60 × 84 1/8.
Заказ № 97
Отпечатано в отделе полиграфии Финуниверситета (Москва, Ленинградский проспект, д. 49/2).
16+

Review of Business and Economics Studies

Volume 11, Number 4, 2023

Вестник исследований бизнеса и экономики

№ 4, 2023

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-6-20
UDC 336.743.4:336.711(045)
JEL E420

Problems and Prospects of Cryptocurrency Usage in China and Cambodia

S. Liv, O.S. Awori, A.S. Fedyunin
Financial University, Moscow, Russia

ABSTRACT

The transformation of the digital economy has been constantly evolving in the society of the 4.0 industrial revolution, particularly under the governmental policies of developed countries. One of the most popular tools in digital economy activities is cryptocurrency, which has led to a rise in digital awareness among people who are more inclined to live their lives electronically and digitally. The **aim** of this study is to explore the problems and prospects associated with the usage of cryptocurrency and identify ways to address these issues using the governmental roadmap in China and Cambodia. The **methods** employed in this study include descriptive, explanatory, and comparative analyses. The **results** demonstrate that the adoption of cryptocurrency presents both opportunities and threats to the Chinese and Cambodian economies. These opportunities and threats need to be carefully considered and balanced by policymakers and stakeholders. The **conclusion** drawn from the study is that there is still no official acceptance and recognition of cryptocurrency by the Chinese and Cambodian governments. This is primarily due to the fact that the risks and challenges associated with cryptocurrencies are deemed to be greater than the foreseeable opportunities, making them difficult to manage effectively.

Keywords: cryptocurrency; blockchain; bitcoin; digital transformation; central bank digital currency; regulation; China; Cambodia

For citation: **Liv S., Awori O.S., Fedyunin A.S. Problems and prospects of cryptocurrency usage in China and Cambodia. *Review of Business and Economics Studies*. 2023;11(4):6-20. DOI: 10.26794/2308-944X-2023-11-4-6-20**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Проблемы и перспективы использования криптовалют в Китае и Камбодже

С. Лив, О.С. Авори, А.С. Федюнин
Финансовый университет, Москва, Россия

АННОТАЦИЯ

Трансформация цифровой экономики постоянно развивается в обществе промышленной революции 4.0, особенно в рамках государственной политики развитых стран. Одним из самых популярных инструментов в сфере цифровой экономики является криптовалюта, которая привела к росту осведомленности о цифровых технологиях среди людей, более склонных к электронному и цифровому образу жизни. **Целью** данного исследования является изучение проблем и перспектив, связанных с использованием криптовалюты, и определение путей решения этих проблем с использованием правительственной дорожной карты в Китае и Камбодже. **Методы**, использованные в данном исследовании, включают описательный, объяснительный и сравнительный анализ. **Результаты** подтверждают, что внедрение криптовалют представляет как возможности, так и угрозы для экономик Китая и Камбоджи. Эти возможности и угрозы должны быть тщательно рассмотрены и сбалансированы директивными органами и заинтересованными сторонами. **Вывод**, сделанный из исследования, заключается в том, что до сих пор нет официального принятия и признания криптовалюты китайским и камбоджийским правительствами. В первую очередь это связано с тем фактом, что риски и проблемы, связанные с криптовалютами, считаются более значительными, чем прогнозируемые возможности.

Ключевые слова: криптовалюта; блокчейн; биткоин; цифровая трансформация; цифровая валюта центрального банка; регулирование; Китай; Камбоджа

Для цитирования: **Лив С., Авори О.С., Федюнин А.С. Проблемы и перспективы использования криптовалют в Китае и Камбодже. *Review of Business and Economics Studies*. 2023;11(4):6-20. DOI: 10.26794/2308-944X-2023-11-4-6-20**

Introduction

The world financial system has developed quickly in the era of the digital economy, which refers to advances in science and technology that have been creating new business models, changing the production process, consumption, and distribution of goods and services, as well as gradually changing the way we work to expand the digital product base and digital services, to modernize production, and increase productivity and economic efficiency in response to technological advances [1]. Because of the adaptation of the digital economy, new risks and opportunities have continuously existed in modern society.

Another trend in the growth of the digital economy has been known as the creation of cryptocurrencies, which are decentralized digital assets that use cryptography for secure financial transactions, control the creation of additional units, and verify the transfer of assets [2]. Following the rapid evolution of global scientific and technological advances, cryptocurrency relies on a variety of technologies to function. Blockchain, the underlying technology that powers cryptocurrencies, offers a distributed and decentralized environment for Bitcoin and other upcoming cryptocurrency transactions. The blockchain is maintained by a network of computers, called nodes, that work together to validate and add new blocks to the chain. Each node has a copy of the blockchain, and they work together to ensure that the blockchain is consistent across all nodes. This decentralized approach makes it difficult for any one entity to manipulate the blockchain, thus ensuring the integrity and security of the network [3]. Cryptography is used to secure transactions and control the creation of new units of cryptocurrency. With the use of cryptography, there is no need for a bank, credit card company, government, or other third party to be present during the transaction. Cryptography uses mathematical algorithms to encrypt and decrypt data, ensuring that only authorized parties can access and manipulate the blockchain [4].

Additionally, consensus mechanisms are fundamental components of blockchain technology that enable decentralized networks to reach agreement on the state of the system. In the context of cryptocurrencies, consensus mechanisms play a crucial role in ensuring the validity and security of transactions. Consensus mechanisms such as proof of work (PoW), proof of stake (PoS), delegated proof of stake (DPoS), proof of authority (PoA) and proof of elapsed time (PoET) are employed in the cryptocurrency space, each with its own trade-offs in terms of security, scalability, decentralization, and energy efficiency [5].

Although several powerful countries across the globe have adopted cryptocurrency recognition in their digital economies, China and Cambodia have considered its usage risky, and the predictable challenges are higher than the opportunities.

The research objectives of this study are as follows:

- To reveal how cryptocurrency proceeds in the context of the 4.0 industrial revolution.
- To review the experience of cryptocurrency recognition and restriction in some countries.
- To identify the prospects and problems of cryptocurrency usage in China and Cambodia.
- To propose several approaches to the Chinese and Cambodian governments in solving and managing the problems of cryptocurrency.

Literature review

Cryptocurrency usage refers to the adoption and utilization of digital currencies as a medium of exchange, store of value, or investment asset. As demonstrated by present practice, more and more businesses are using cryptocurrencies in their operations. Investments in system development and the distribution of digital currency items are growing constantly [6]. However, there are various viewpoints on how they affect the economy.

One viewpoint suggests that cryptocurrencies have the potential to disrupt traditional financial systems and bring about positive changes in the economy. Proponents argue that cryptocurrencies offer several advantages over traditional fiat currencies. Firstly, they provide a decentralized and transparent system that eliminates the need for intermediaries such as banks, reducing transaction costs and increasing efficiency. This could lead to greater financial inclusion, especially in developing countries where access to banking services is limited. Cryptocurrencies offer faster and cheaper cross-border transactions, potentially boosting international trade and economic growth [7].

Furthermore, they can foster innovation and entrepreneurship by providing a platform for decentralized applications (DApps) and smart contracts. These technologies enable the creation of new business models and economic systems, potentially leading to job creation and economic development. Cryptocurrencies can empower individuals by giving them control over their own financial assets and data, reducing their reliance on centralized authorities [8].

The economic effects of cryptocurrencies are a subject of concern for some skeptics, on the other hand. Their instability and speculative character are their two main worries. The price of cryptocurrencies is subject to fluctuations, which might be driven more by market speculation than by underlying economic realities. This volatility raises concerns about financial stability and investor protection. Critics state that overly speculative behavior in cryptocurrency markets might result in price bubbles and subsequent collapses, which could possibly cause serious economic disruptions [9].

Another issue is the facilitation of illegal activities such as money laundering and fraud via cryptocurrency. It is challenging to identify and control illicit behavior due to the pseudonymous nature of transactions. Critics contend that this anonymity can encourage illegal activity and combat efforts to stop the financing of terrorism and money laundering.

Additionally, investor confidence and the possibility of fraud are questioned by the absence of governmental control and consumer protection in the digital currency market [10]. Also, cryptocurrencies may pose a threat to monetary policy and the central banks' ability to control the economy. The decentralized nature of cryptocurrencies means that they are not subject to traditional monetary policies, such as interest rate adjustments or quantitative easing. This lack of control could limit central banks' ability to manage inflation, stabilize the economy, and respond to financial crises. It is crucial to remember that the impacts of cryptocurrencies on the economy continue to evolve, and their long-term outcomes are yet unknown. Regulatory agencies and governments from all around the world are debating how to handle the opportunities as well as challenges that cryptocurrencies deliver [11].

The vast majority of people are unaware that encrypted money exists. It is hard to dismiss digital money, notwithstanding its relatively limited usage. Individual nations still accept cryptocurrencies as a form of payment today. It is then feasible to transfer it to bank accounts and electronic payment systems [12].

Cryptocurrency regulations in the United States are, for instance, complex and vary from state to state. However, the country has seen significant adoption of cryptocurrencies, with numerous businesses accepting digital currencies as payment, allowing users to make purchases using their digital wallets. The U.S. Securities and Exchange Commission (SEC) has been actively involved in regulating ICOs and cracking down on fraudulent activities in the crypto space. Furthermore, cryptocurrencies have become an attractive investment option for individuals and institutions in the US. The potential for high returns has attracted many investors to enter the market. Cryptocurrency exchanges provide platforms for buying, selling, and trading various digital assets. These exchanges operate under regulatory frameworks established by government agencies like the SEC and the Financial Crimes Enforcement Network (FinCEN). The US government has recognized the importance of regulating cryptocurrencies to ensure consumer protection and prevent illicit activities such as money laundering and fraud. As a result, several regulatory measures have been implemented to govern cryptocurrency usage in the country. For instance, exchanges are required to comply with Know Your Customer (KYC) and Anti-Money Laundering (AML) regulations. Additionally, the Internal Revenue Service (IRS) treats cryptocur-

rencies as property for tax purposes. This means that individuals who hold or transact with cryptocurrencies are required to report their gains or losses during tax filings. Failure to comply with these regulations can result in penalties or legal consequences. Despite regulatory efforts, cryptocurrency usage in the US has faced challenges due to its association with illicit activities and concerns over price volatility. The anonymous nature of transactions has raised concerns about money laundering and terrorist financing. However, advancements in blockchain analytics have improved the ability to track and trace illicit transactions, making it harder for criminals to exploit cryptocurrencies [13].

One of the nations that is most accepting of cryptocurrencies is commonly recognized as being Japan. The Japanese government approved Bitcoin as a legitimate payment mechanism in April 2017, which significantly increased the usage of cryptocurrencies in that nation. Regulations have been put in place by Japan's Financial Services Agency (FSA) to protect investor safety and the security of cryptocurrency exchanges. In addition, Japan has a thriving cryptocurrency ecosystem with a wide range of companies that accept cryptocurrencies as payment. The Japanese government has taken a supportive stance towards cryptocurrency adoption, with several government-backed initiatives aimed at promoting the use of digital assets. For example, the government has launched a pilot program to test the use of cryptocurrencies in social welfare programs and has also established a council to explore the potential uses of blockchain technology in various industries. Despite the growth in cryptocurrency adoption, there are still several challenges and concerns facing the industry in Japan. These include concerns about security and hacking, as well as the need for greater consumer protection and education [14].

Switzerland has emerged as a global hub for blockchain technology and digital currencies. One of the primary uses of cryptocurrencies in Switzerland is as a means of payment. Many businesses, particularly in the tech and tourism sectors, accept cryptocurrencies as a form of payment for goods and services. The acceptance has been facilitated by the country's favorable regulatory environment, which provides clarity and legal certainty for businesses dealing with digital currencies. Switzerland has also witnessed a surge in cryptocurrency startups and blockchain companies establishing their presence in the country. The Swiss government has actively supported these ventures through initiatives such as the "Crypto Valley" in Zug, which has become a prominent global blockchain hub. This ecosystem fosters innovation and collaboration among entrepreneurs, investors, and researchers in the cryptocurrency space. Switzerland is known for its strong tradition of financial privacy and security. Cryptocurrencies offer an additional layer of anonymity for individuals seeking to protect their financial transactions. Swiss residents can use cryptocurrencies to safeguard their wealth and maintain confidentiality. Switzerland has seen an increase in Initial Coin Offerings (ICOs), which are fundraising events where companies issue tokens or coins to raise capital. The country's regulatory framework provides guidelines for conducting ICOs while ensuring investor protection. This has attracted numerous ICO projects to Switzerland, making it one of the leading destinations for token sales [15].

As of January 1, 2021, Russia implemented a law that regulates the circulation of digital assets and currencies, including cryptocurrencies. The law defines digital financial assets as property rights in electronic form, including monetary claims, the possibility of exercising rights under negotiable securities, access rights to the results of intellectual activity, and the right to participate in investment funds. It also outlines the requirements for issuing digital financial assets and sets forth rules for conducting transactions with them. Additionally, the law introduces the concept of "mining" as the process of creating digital financial assets by verifying transactions in a distributed ledger. It specifies that mining activities are not considered entrepreneurial activities but are subject to taxation. Furthermore, the law addresses cryptocurrency exchanges by requiring them to be registered with the Russian government and comply with AML and counter-terrorism financing (CTF) regulations. In 2022, the Central Bank of the Russian Federation officially started recognizing cryptocurrencies, including unsecured cryptocurrencies and Stablecoins, as digital currencies under Russian law [16].

Nonetheless, not all countries have embraced this digital form of currency. There are several

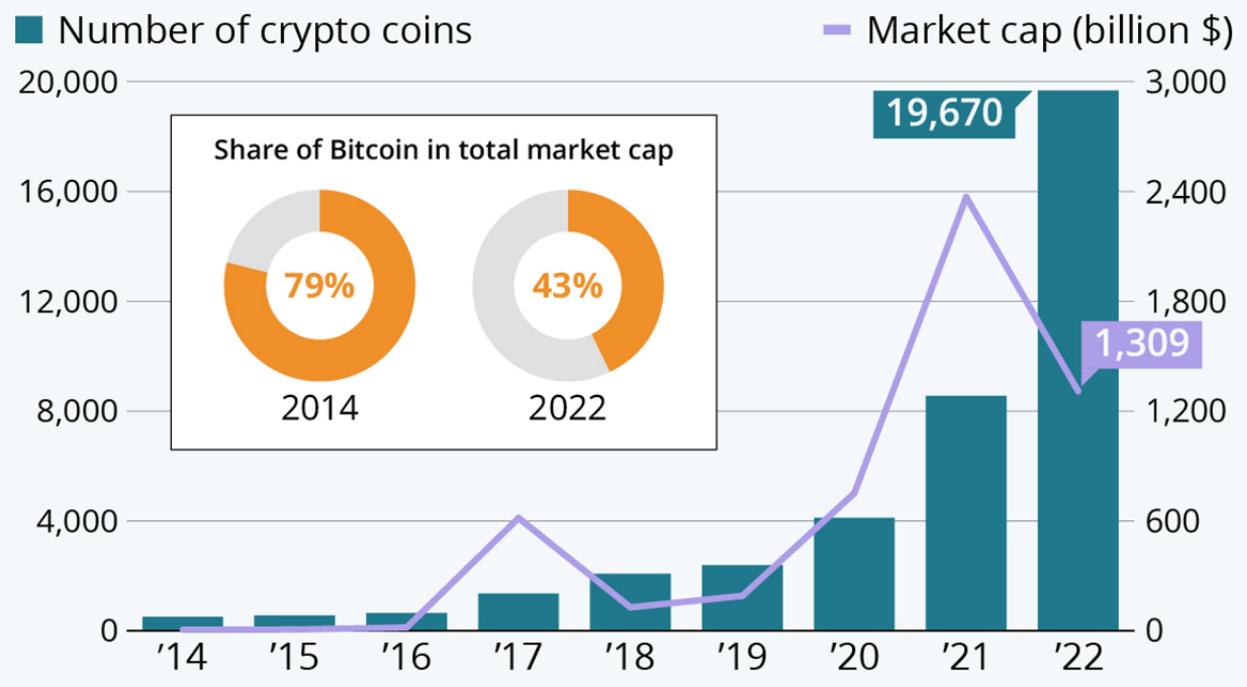

Fig. 1. **Total number of cryptocurrencies and overall market capitalization**

Source: The Evolution of the Crypto Economy, Statista Infographics, 2022. URL: https://www.statista.com/chart/27561/evolution-of-the-crypto-economy

reasons why certain countries have chosen not to accept or regulate cryptocurrencies within their borders. A country that has been cautious about embracing cryptocurrencies is India. The Reserve Bank of India (RBI) issued a circular in 2018 prohibiting banks from dealing with individuals or businesses involved in cryptocurrencies. This move was motivated by concerns over money laundering, consumer protection, and the potential impact on the country's fiat currency. However, the Indian Supreme Court overturned the RBI's ban in March 2020, allowing individuals and businesses to once again engage in cryptocurrency transactions [17]. Other countries that have expressed reservations or implemented restrictions on cryptocurrencies include Bolivia, Ecuador, Bangladesh, Nepal, and Algeria. These countries have either banned cryptocurrencies outright or have issued warnings to their citizens about the risks involved in using them.[1]

Over the past 10 years, blockchain-based cryptocurrencies have grown in popularity and attention with the fast development of blockchain technology. More than 7,000 cryptocurrencies have an active market worth of more than $300 billion as of the second quarter of 2020 [18]. The evolution of the cryptocurrency sector has been turbulent, with both significant advancements and setbacks since the inception of Bitcoin back in 2009. *Fig. 1* shows that the number of virtual currencies has increased dramatically in the last several years, from a few hundred at the end of 2014 to about 20,000 at the end of May 2022. The fact that generating a new cryptocurrency only requires a few clicks and costs nothing can be partially blamed for this explosion, which has been observed in the last three years. However, although their quantity is growing nearly at an exponential rate, their worth is not. Cryptocurrencies are still considered high-risk investments due to their enormous changes and annualized volatility, which frequently exceeds 100%. Following the surge of the previous year and the all-time high of $3 trillion in November 2021, market capitalization has dropped by about 50% to a level in 2022 of about $1.3 trillion. Even now, this number is twice compared to the value that was disclosed at the end of 2020. The graph also shows that, given the rise of alternative digital assets like Ethereum, the once-dominant Bitcoin is beginning to lose some of its significance in this market. In 2022, Bitcoin accounts for 40–50%

[1] Bitcoin Ban: These Are the Countries Where Crypto Is Restricted or Illegal, Euronews, 2022. URL: https://www.euronews.com/next/2022/08/25/bitcoin-ban-these-are-the-countries-where-crypto-is-restricted-or-illegal2

of the total cryptocurrency market capitalization, down from over 80% in 2014.

When looking at the topic of cryptocurrency's emergence, it should be noted that it is frequently associated with terms such as "money", "payment", "security", and "electronic money". Some researchers point out that because cryptocurrencies do not entirely adhere to contemporary monetary theory, they cannot be referred to as "money" [19]. This kind of asset cannot be compared to paper or other forms of commodity money. The properties of contemporary technology and money are combined in cryptocurrency, raising new economic issues. While some governments have begun to regulate cryptocurrency, there is still a lack of clarity and consistency in the regulatory environment. The lack of regulation can make it difficult for investors and users to understand their legal and financial obligations, and it can also make it easier for fraudulent activities, such as money laundering and terrorist financing, to occur [20]. Cryptocurrency is vulnerable to security risks, such as hacking and theft. The decentralized nature of cryptocurrency makes it difficult to protect against these risks, and the consequences of a security breach can be severe. For example, in 2018, the cryptocurrency exchange Coincheck was hacked, resulting in the theft of $530 million worth of cryptocurrency.[2] Cryptocurrency is also vulnerable to market manipulation, as the small market size and the lack of transparency make it easy for large investors to influence the price of cryptocurrencies. This can lead to price bubbles and market crashes, which can have significant economic consequences [21]. The rise of cryptocurrency has also raised questions about taxation. As cryptocurrencies are considered assets rather than currencies, they are subject to capital gains tax. However, the lack of clear taxation guidelines has led to confusion and controversy [22]. The process of mining cryptocurrency, which involves solving complex mathematical equations to validate transactions and secure the blockchain, consumes large amounts of energy. It has raised concerns about the environmental impact of cryptocurrency, as the energy consumption of mining is estimated to be as high as 110 TWh per year, which is comparable to the energy consumption of a small country [23]. While proponents of cryptocurrency argue that it has the potential to increase financial inclusion, others argue that it may exacerbate existing inequalities. For example, the high energy consumption of mining may make it difficult for individuals in developing countries to participate in the cryptocurrency market [24]. Cambodia's electricity prices are among the highest in the region, with an average cost of $0.15 per kilowatt-hour (kWh). This makes it challenging for individuals to afford the high energy costs required for mining cryptocurrencies, especially for those who rely on electricity from the grid.[3] The decentralized nature of cryptocurrency has also raised concerns about consumer protection. As there is no central authority to regulate the market, there is a lack of recourse for consumers who might become victims of fraud or other malicious activities [25].

The advantages of cryptocurrency usage in the Chinese and Cambodian economies

Cryptocurrency has gained significant popularity in China. While the Chinese government has taken a cautious approach towards cryptocurrencies, there are several advantages associated with their use in the country. The effectiveness and quickness it gives for transactions is one of the main benefits of cryptocurrencies in China. Intermediaries are frequently involved in traditional banking systems, which can cause delays and raise prices. On the other hand, cryptocurrencies operate on decentralized networks that provide peer-to-peer transactions without the need for intermediaries. It shortens the transaction process and does away with the requirement for third-party verification. Cryptocurrencies can significantly reduce transaction costs compared to traditional payment methods. In China, where online payment systems such as Alipay and WeChat Pay dominate, cryptocurrency transactions can provide an alternative with lower fees. Additionally, cross-border

[2] Cryptocurrency worth $ 530 million missing from Japanese Exchange, WSJ, 2018. URL: https://www.wsj.com/articles/cryptocurrency-worth-530-million-missing-from-japanese-exchange-1516988190

[3] High electricity bills push every Cambodian to the brink of despair, Khmer Times, 2022. URL: https://www.khmertimeskh.com/501052317/high-electricity-bills-push-every-cambodian-to-the-brink-of-despair

transactions using cryptocurrencies can be cheaper than traditional methods, as they bypass currency conversion fees and international transfer charges. Cryptocurrencies have the potential to promote financial inclusion in China by providing access to financial services for individuals who are unbanked or underbanked. Based on data acquired by Finbold, around 287 million adults, or 20% of the Chinese population, were unbanked as of Q1 2021. Cryptocurrencies can offer these individuals an opportunity to participate in the digital economy and access financial services without requiring a traditional bank account. In China, where trust issues exist due to various scams and fraudulent activities, blockchain-based cryptocurrencies can enhance transparency by recording all transactions on a public ledger that is accessible to all participants. This transparency reduces the risk of fraud and enhances trust among users. Industries such as supply chain management, healthcare, and intellectual property rights can benefit from the transparency and immutability offered by blockchain technology. By embracing cryptocurrencies, China can position itself as a leader in blockchain innovation. Cryptocurrencies can, as well, facilitate international trade and investment in China. By using cryptocurrencies for cross-border transactions, businesses can bypass the traditional banking system, reducing transaction costs and increasing efficiency. Cryptocurrencies can attract foreign investors who are interested in participating in China's digital economy. Decentralization provides individuals with greater control over their finances and reduces the risk of government interference or censorship. In a country like China, where there are strict capital controls and limitations on individual financial freedom, cryptocurrencies offer an alternative that promotes individuals' financial sovereignty.

Not much different from China, cryptocurrency offers several advantages in Cambodia, contributing to the growth and development of the country's financial ecosystem. Cryptocurrencies have the potential to provide financial services to the unbanked and underbanked population in Cambodia. About 70 percent of Cambodians have access to financial services, with more than 8.6 million e-wallet account holders at the end of 2021, according to the National Bank of Cambodia (NBC).[4] Cryptocurrencies can bridge this gap by allowing individuals to store, send, and receive money without the need for a traditional bank account. This can empower individuals and businesses, particularly in rural areas, to participate in the digital economy and access financial services. Cryptocurrencies eliminate intermediaries such as banks and payment processors, reducing transaction costs significantly. This can be particularly beneficial for Cambodian migrant workers who frequently send remittances back home, as they can avoid the hefty fees charged by traditional remittance services. Transactions recorded on a blockchain are immutable and transparent, making it difficult for fraud or manipulation to occur unnoticed. The government can, consequently, combat corruption and increase trust in financial transactions within Cambodia's economy. Cryptocurrencies enable innovative fundraising mechanisms such as ICOs and Security Token Offerings (STOs). These mechanisms allow startups and entrepreneurs in Cambodia to raise capital directly from investors globally without going through traditional venture capital or banking channels. The increased access to capital can foster entrepreneurship and innovation within the country. Cambodia has a significant reliance on remittances from overseas workers, particularly those working in countries like Thailand, Malaysia, and South Korea. Cryptocurrencies can facilitate faster and cheaper cross-border payments compared to traditional methods like bank transfers or money transfer operators. By leveraging cryptocurrencies, individuals can send money internationally with reduced fees and faster settlement times, benefiting both senders and recipients. Cryptocurrencies can offer an alternative to traditional fiat currencies, which can be subject to inflation or political instability. In countries with volatile economies, such as Cambodia, cryptocurrencies can provide a more stable store of value and medium of exchange. Such stability can help protect individuals' wealth and promote economic growth. Embracing cryptocurrencies can position Cambodia as an early

[4] 70 Percent of Cambodians Have Access to Financial Services, Khmer Times, 2022. URL: https://www.khmertimeskh.com/501052053/70-percent-of-cambodians-have-access-to-financial-services

adopter of emerging technologies. By fostering a supportive environment for blockchain and cryptocurrency startups, the country can attract investment and talent in the technology sector, which can lead to job creation, knowledge transfer, and overall economic development [26].

Problems of cryptocurrency recognition in China and Cambodia and ways to address them

The monetary unit serves as the standard measure of value and is used to price goods and services, calculate taxes and tariffs, and determine the value of international trade agreements. It is typically a unit of account that is widely accepted within a given country or region as a means of exchange for goods and services. Examples of monetary units include the U.S. dollar, the Euro, the Japanese yen, and the British pound [27]. The choice of the monetary unit can have significant implications for economic policy, international trade, and financial markets. Any state involved in the management of monetary circulation has a monetary system as a fundamental component. Previously, it has developed in a different state, and the applicable laws have fixed it. The monetary system is composed of components such as types of money; an emission system, which is a process for the issue and circulation of banknotes in accordance with the law; and regulation of monetary circulation. Central bank cryptocurrencies, also known as central bank digital currencies (CBDCs), refer to digital forms of national currencies issued and regulated by central banks. These digital currencies are designed to function as a secure and efficient medium of exchange, just like traditional fiat currencies, but in a digital format. Central bank cryptocurrencies have gained significant attention in recent years due to the increasing popularity and adoption of cryptocurrencies, such as Bitcoin and Ethereum. While these decentralized cryptocurrencies operate independently of any central authority, central bank cryptocurrencies are issued and controlled by central banks, making them more centralized and regulated. The concept of central bank cryptocurrencies emerged as a response to the growing interest in cryptocurrencies and the potential benefits they offer, such as faster transactions, reduced costs, and increased financial inclusion. Central banks recognized the need to explore the possibilities of digital currencies to modernize their payment systems and maintain control over their monetary policies. *Fig. 2* demonstrates the taxonomy of money, which categorizes different forms of money based on their underlying characteristics and functions. This taxonomy helps to understand the various types of money that exist in the modern financial system and highlights the role of central banks in issuing and regulating money, as well as the emergence of new forms of digital currencies, such as e-money and cryptocurrencies. Central bank money refers to the liabilities issued by a central bank, which typically include physical cash and reserves held by commercial banks at the central bank. Physical cash, such as banknotes and coins, is widely recognized as a medium of exchange and a store of value. Reserves held by commercial banks at the central bank are used for settlement purposes and to meet regulatory requirements. Commercial bank money refers to the liabilities created by commercial banks through deposit-taking activities. When individuals or businesses deposit funds into their bank accounts, they effectively lend those funds to the bank. These deposits are considered as commercial bank money and can be used for transactions through various payment methods like checks, debit cards, or electronic transfers. E-money, also known as electronic money or digital currency, is a form of money that exists only in electronic or digital form. It is typically issued by private entities and can be used for online transactions or stored on electronic devices like smartphones or prepaid cards. E-money is often backed by an equivalent amount of fiat currency held in reserve by the issuer. Cryptocurrencies are digital or virtual currencies that use cryptography for security and operate on decentralized networks called blockchains. Unlike traditional forms of money, cryptocurrencies are not issued or regulated by any central authority, such as a central bank. Bitcoin was the first widely recognized cryptocurrency, but many others have emerged since then, each with its own unique features and underlying technology. Central bank cryptocurrencies (CBCCs) are a subset of cryptocurrencies that are issued and regulated by central

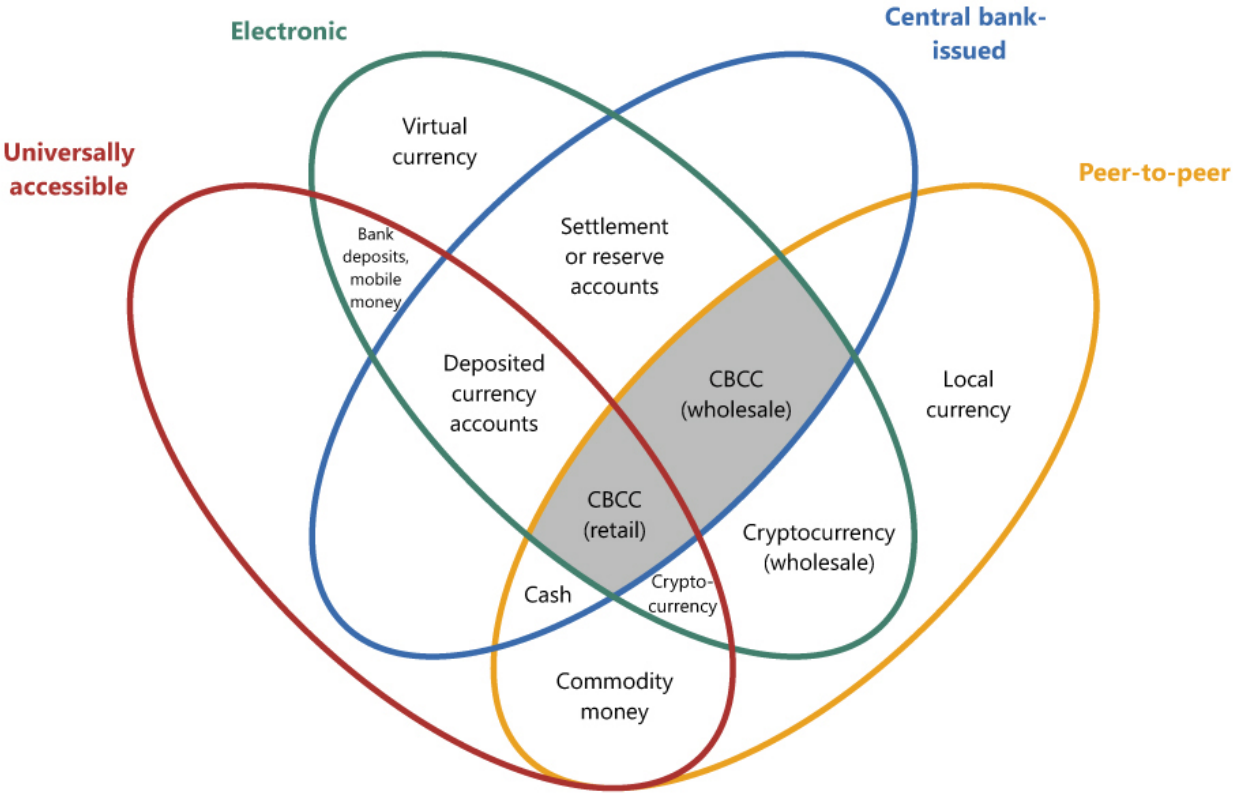

Fig. 2. **Taxonomy of money, based on "Central bank cryptocurrencies"**

Source: [28].

banks. CBCCs aim to combine the benefits of cryptocurrencies, such as fast and secure transactions, with the stability and trust associated with central bank money. CBCCs could be designed to operate on a centralized or decentralized network, depending on the specific implementation.

Currently, cryptocurrency is governed globally by a broad range of legal systems. In addition to safeguarding investors, several nations have included cryptocurrency markets in newly enacted tax, money-laundering, counterterrorism, and organized crime rules, forcing financial institutions to perform due diligence on their customers [29]. In China, for instance, the People's Bank of China (PBOC) has been working on creating a fully-backed digital fiat currency since 2014. This is anticipated to be one of the first digital currencies issued by a central bank.[5] Although it seems to be interested in creating digital money, the government has been extremely cautious. Chinese officials do not view virtual currencies like Bitcoin as a mechanism for retail payments similar to paper money, coins, or credit cards. Tokens or virtual currencies used in initial coin offering (ICO) financing were not issued by monetary authorities and could not be accepted as legal tender, circulated, or used as a currency in the markets, according to statements made in 2017 by a number of other government agencies that announced the ban of ICOs in China. Because of this, cryptocurrencies are neither used by the financial system to offer important services nor accepted by the appropriate agencies, despite its aim of creating a digital currency with full backing. To further protect investors and lower financial risk, the Chinese government has severely restricted private cryptocurrency trading. These limitations have included banning ICOs, limiting cryptocurrency trading platforms, and discouraging the nation's sizable Bitcoin mining industry, which has an impact on the world's cryptocurrency markets. The Chinese government has promoted the development of the underlying blockchain technology in an effort to modernize its financial system and establish China as a leader in this innovative technology. President Xi Jinping said in 2019 that block-

[5] China Accelerates Blockchain Adoption, Jones Day, 2020. URL: https://www.jonesday.com/en/insights/2020/01/china-accelerates-blockchain-adoption

chain represents an "important breakthrough in independent innovation of core technologies," and that China must "seize the opportunities" it offers.[6] Despite the fact that these developments have renewed investment in blockchain technology in China, the government is still taking precautions to prevent any possible societal issues brought on by the growth of blockchain. There are certain concerns with the blockchain technology recommendation. According to the PBOC, research should be done on blockchain technology and digital currency to improve services to the actual economy. The PBOC thinks that the development of blockchain technology is possible without the use of tokens, which are seen to be the source of a number of societal issues, including fraud and unlawful fundraising. The world's first digital currency supported and controlled by a central bank is most likely to be created by China, which has already finished constructing the infrastructure for its Digital Currency Electronic Payment (DCEP) system and laying the groundwork for giving the digital yuan the same legal standing as the physical yuan.[7] Cryptocurrency usage in China has faced several challenges and problems over the years. China has taken a strict stance on cryptocurrencies, imposing various regulations to control their usage within the country. In 2013, the PBOC issued a notice stating that Bitcoin was not a currency and prohibited financial institutions from handling Bitcoin transactions which led to the closure of several cryptocurrency exchanges in China. In September 2017, Chinese authorities went a step further and banned ICOs, which are fundraising methods involving the issuance of digital tokens. The ban was implemented due to concerns over fraud, illegal fundraising, and financial instability. Additionally, cryptocurrency trading platforms were also shut down in China. Furthermore, in 2019, the PBOC announced its plans to launch its own digital currency called the DCEP. The plans aim to establish greater control over the financial system and reduce the influence of decentralized cryptocurrencies [30]. Cryptocurrency usage in China has also raised economic concerns, which include capital flight. Cryptocurrencies provide an avenue for individuals to bypass capital controls and move money out of the country. It has been a concern for Chinese authorities, who aim to maintain stability in their financial system. Another economic concern is the potential for speculative bubbles and market manipulation. The volatile nature of cryptocurrencies can lead to price fluctuations that may have adverse effects on investors and the overall economy. Moreover, there have been instances of fraudulent activities associated with cryptocurrencies in China. Ponzi schemes and scams have emerged, leading to financial losses for unsuspecting investors [31]. The use of cryptocurrencies requires a robust technological infrastructure. However, China faces certain technological challenges, including scalability, that hinder widespread adoption. As cryptocurrencies gain popularity, the existing blockchain networks may struggle to handle a large number of transactions. This can result in slower transaction speeds and higher fees. Another challenge is energy consumption. Cryptocurrency mining, particularly for Bitcoin, requires significant computational power and energy. China has been a major hub for cryptocurrency mining due to its cheap electricity, but this has raised concerns about environmental sustainability. Additionally, the anonymity associated with cryptocurrencies has raised concerns about money laundering and illicit activities. Chinese authorities have been working on implementing stricter KYC and AML measures to address these concerns.[8] Concerning these challenges of cryptocurrency usage, the Chinese government has taken various measures to address the problems associated with cryptocurrencies in the country. Clear and consistent regulations could help provide a stable environment for the development of cryptocurrency. The government could establish a comprehensive legal framework that addresses issues such as taxation, AML and KYC requirements, and consumer protection. Improved security measures, such as multi-sig-

[6] With Xi's backing, China looks to become a world leader in blockchain as us policy is absent, CNBC, 2019. URL: https://www.cnbc.com/2019/12/16/china-looks-to-become-blockchain-world-leader-with-xi-jinping-backing.html

[7] In Depth: China's digital currency ambitions lead the world, Nikkei Asia, 2020. URL: https://asia.nikkei.com/Spotlight/Caixin/In-depth-China-s-digital-currency-ambitions-lead-the-world

[8] China makes cryptocurrency transactions illegal: An Explainer, China Briefing News, 2021. URL: https://www.china-briefing.com/news/china-makes-cryptocurrency-transactions-illegal-an-explainer/

nature wallets and cold storage solutions, can help protect users' assets. The development of more secure and decentralized exchanges could reduce the risk of hacking and other security breaches. Education and awareness campaigns could help increase public understanding of cryptocurrency and its potential uses. Additionally, the government could provide incentives for businesses and individuals to adopt cryptocurrency, such as tax breaks or subsidies. The development of more energy-efficient mining technologies and the use of renewable energy sources could help mitigate the environmental impact of cryptocurrency mining. The government could, moreover, implement policies to encourage the use of clean energy for mining activities. Strengthening AML/KYC regulations and improving cooperation between law enforcement agencies and the cryptocurrency industry could help prevent the use of cryptocurrency for illicit activities. The development of more transparent and accountable governance structures within the industry could help address these concerns. China also recognizes that addressing the problems of cryptocurrency requires international cooperation. The Chinese government has actively engaged with other countries and international organizations to share experiences, exchange information, and develop common regulatory approaches.

Throughout the cryptocurrency aspect in Cambodia, the lack of financial sector decentralization and the high interest in hacking and fraud led to the popularity of cryptocurrencies [32]. Therefore, the regulator should adhere to the Basel Committee in order to defend against the risk of cryptocurrencies. Concerns in Cambodia include the lack of web laws and regulations and insufficient financial technology knowledge. Even though there is no official prohibition, the General Commissariat of National Police, the Securities and Exchange Commission of Cambodia, and NBC jointly issued a warning statement saying that all cryptocurrencies are illegal in Cambodia because their spread is not supervised by appropriate authorities and could result in risks. The responsible authorities encouraged the general public to be careful of cryptocurrencies that did not have a license from them. Despite the letter of warning's publication, investors in Cambodia continue to discover ways to get involved with cryptocurrencies.[9]

The NBC has been actively working towards developing its own digital currency, known as the Bakong. The project was officially launched in July 2019 and has been under development since then. The primary objective of introducing the Bakong is to promote financial inclusion and enhance the efficiency of payment systems in Cambodia. One of the key motivations behind the development of the Bakong is to reduce the country's heavy reliance on cash transactions. Currently, a significant portion of Cambodia's population still relies on cash for their daily transactions, which can be cumbersome and inefficient. By introducing a digital currency, the government aims to provide a more convenient and secure alternative for conducting transactions. The Bakong digital currency operates on a blockchain-based platform, which ensures transparency, security, and immutability of transactions. It utilizes a centralized ledger system managed by the NBC, allowing for efficient monitoring and regulation of transactions. Users can access the Bakong through various channels, including mobile applications and participating financial institutions. The implementation of the Bakong involves collaboration with multiple stakeholders, including commercial banks, microfinance institutions, and other financial service providers. These entities are integrated into the Bakong system, enabling users to seamlessly transfer funds between different accounts and institutions. The Bakong supports merchant payments, which makes it easier for users to conduct transactions. With this feature, users can make purchases at merchants located both in and out of their physical locations. It is aimed at encouraging spending and promoting a cashless economy. Furthermore, the Bakong digital currency is designed to be interoperable with other payment systems in Cambodia. Users can transfer funds between their Bakong wallets and traditional bank accounts, further enhancing the convenience and accessibility of the digital currency. The Cambodian government has been actively promoting the adoption of the Bakong digital currency among its citizens. Various cam-

[9] Cryptocurrency in Cambodia, Standard Insights, 2022. URL: https://standard-insights.com/blog/cryptocurrency-in-cambodia

paigns and educational initiatives have been launched to raise awareness about the benefits and functionalities of the digital currency. Additionally, the government has been working on establishing a regulatory framework to ensure the proper functioning and security of the Bakong system.[10]

The absence of specific rules and regulations is one of the main obstacles to cryptocurrency adoption in Cambodia. For organizations and people wishing to engage in cryptocurrency-related activities, the lack of a complete legal framework from the government causes uncertainty. Lack of explicit laws makes it challenging for businesses to operate within the law and may discourage prospective investors. The inadequate knowledge and awareness of cryptocurrencies among the broader Cambodian population is a huge additional issue. The idea of digital currencies, how they operate, and their potential advantages are unfamiliar to many people. The adoption and acceptance of cryptocurrencies as a valid method of payment or investment are hampered by such a lack of understanding. Risks linked with cryptocurrencies include price volatility, weaknesses in security, and the possibility for usage in illegal activities. These worries have produced distrust among Cambodian regulators and financial institutions. Authorities are hesitant about completely adopting cryptocurrencies due to concerns about money laundering, fraud, and terrorist financing. The majority of transactions in Cambodia's financial system are made in cash, and the use of digital payment systems is still in its developmental stages. The general public utilizes traditional financial systems, which are well-established. It is difficult for cryptocurrencies to take off as a substitute for traditional financial services or a way to store value due to this dominance. However, several steps, such as a regulatory framework, public education, and collaboration with financial institutions, should be taken into account to address these problems and promote cryptocurrency recognition in Cambodia. The government should establish clear regulations that provide legal certainty for businesses operating in the cryptocurrency space. The framework should cover areas such as licensing requirements, consumer protection measures, AML policies, and taxation guidelines. Efforts should be made to educate the public about cryptocurrencies, their benefits, and potential risks. They can be done through awareness campaigns, workshops, and educational materials that explain the basics of cryptocurrencies and how to safely engage with them. Collaboration between cryptocurrency companies and traditional financial institutions can help bridge the gap between the two systems. Partnerships can be formed to develop secure and regulated cryptocurrency exchanges, enabling users to convert between digital currencies and traditional fiat currencies seamlessly.

Conclusions and recommendations

The findings of this study indicate that cryptocurrency has both positive and negative impacts on the economy. On the one hand, it offers numerous benefits, such as increased financial inclusion, reduced transaction costs, and enhanced security and privacy. Cryptocurrency also has the potential to foster innovation and economic growth, particularly in the context of the 4.0 industrial revolution, where digital technologies play a crucial role. On the other hand, there are several concerns associated with cryptocurrency. These include its volatility, potential for facilitating illicit activities such as money laundering and terrorism financing, regulatory challenges, and risks to financial stability. It is essential for governments to carefully consider these factors when formulating policies related to cryptocurrency.

The experiences of various countries in recognizing and restricting cryptocurrency provide valuable insights. Some countries have embraced cryptocurrency by implementing regulations that promote its development while mitigating risks. Others have taken a more cautious approach by imposing restrictions or outright bans. These experiences highlight the importance of striking a balance between fostering innovation and protecting consumers and financial systems.

In the case of China, there are both opportunities and challenges in relation to cryptocurrency usage. China has been at the forefront of technological advancements, including blockchain technology, which underpins many cryptocur-

[10] Is Cambodia's Bakong the future of digital currencies? World Economic Forum, 2021. URL: https://www.weforum.org/agenda/2021/08/cambodias-digital-currency-ishowing-other-central-banks-the-way

rencies. However, the Chinese government has also imposed strict regulations on cryptocurrency trading and ICOs. The study suggests that China should continue to monitor developments in the cryptocurrency space while considering measures to address risks and promote responsible usage.

Similarly, Cambodia faces its own set of prospects and problems regarding cryptocurrency adoption. The country has shown interest in leveraging blockchain technology for various applications, including cross-border payments and financial inclusion. However, there are concerns about consumer protection, money laundering, and the potential impact on the country's monetary policy. The study recommends that Cambodia take a cautious approach, closely monitoring developments in the cryptocurrency market and implementing appropriate regulations to mitigate risks.

To address the problems associated with cryptocurrency, several approaches were proposed for both China and Cambodia. These include enhancing regulatory frameworks to ensure investor protection, implementing robust anti-money laundering measures, promoting financial literacy and consumer education, fostering collaboration between government and industry stakeholders, and exploring the potential of CBDCs.

In conclusion, this study highlights the need for governments to carefully consider the implications of cryptocurrency on their economies. While cryptocurrency offers numerous opportunities, it also presents challenges that must be addressed through effective regulation and risk management. By adopting a balanced approach, governments can harness the benefits of cryptocurrency while minimizing its potential negative impacts.

REFERENCES

1. Brynjolfsson E., Kahin B. Understanding the digital economy: data, tools, and research. *MIT press*. 2002. URL: http://mitpress.mit.edu/9780262523301
2. Babkin A.V., Burkaltseva D.D., Pshenichnikov W.W., Tyulin A.S. Cryptocurrency and blockchain-technology in digital economy: development genesis. *π-Economy*. 2017;67(5):9–22. DOI: 10.18721/JE.10501
3. Yuan Y., Wang F.Y. Blockchain and cryptocurrencies: Model, techniques, and applications. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*. 2018;48(9):1421–1428. DOI: 10.1109/TSMC.2018.2854904
4. Gupta S.P., Gupta K., Chandavarkar B.R. The Role of Cryptography in Cryptocurrency. *2021 2nd International Conference on Secure Cyber Computing and Communications (ICSCCC)*. 2021:273–278. DOI: 10.1109/ICSCCC 51823.2021.9478099
5. Hazari S.S., Mahmoud Q.H. Comparative evaluation of consensus mechanisms in cryptocurrencies. *Internet Technology Letters*. 2019;2(3): e100. URL: https://onlinelibrary.wiley.com/doi/10.1002/itl2.100
6. Calandra D., Secinaro S., Massaro M., Dal Mas F., Bagnoli C. The link between sustainable business models and Blockchain: A multiple case study approach. *Business Strategy and the Environment*. 2023;32(4):1403–1417. URL: https://doi.org/10.1002/bse.3195
7. Chuen D.L.K., Guo L., Wang Y. Cryptocurrency: A new investment opportunity? *The journal of alternative investments*. 2017;20(3):16–40. DOI: 10.3905/jai.2018.20.3.016
8. Chohan U.W. Oversight and regulation of cryptocurrencies: BitLicense. *Cryptofinance: A New Currency for a New Economy*. 2022:105–120. URL: https://www.worldscientific.com/doi/abs/10.1142/9789811239670_0006
9. Catania L., Grassi S., Ravazzolo F. Predicting the volatility of cryptocurrency time-series. *Mathematical and Statistical Methods for Actuarial Sciences and Finance*. 2018:203–207. URL: https://link.springer.com/chapter/10.1007/978–3–319–89824–7_37
10. Forgang G. Money laundering through cryptocurrencies. *Economic Crime Forensics Capstones*. 2019. URL: https://digitalcommons.lasalle.edu/ecf_capstones/40
11. Fauzi M.A., Paiman N., Othman Z. Bitcoin and cryptocurrency: Challenges, opportunities and future works. *The Journal of Asian Finance, Economics and Business (JAFEB)*. 2020;7(8):695–704. DOI: 10.13106/jafeb.2020.vol7.no8.695
12. Luchkin A.G., Lukasheva O.L., Novikova N.E., Melnikov V.A., Zyatkova A.V., Yarotskaya E.V. Cryptocurrencies in the global financial system: problems and ways to overcome them. *Russian Conference on Digital Economy and Knowledge Management (RuDEcK 2020)*. 2020:423–430. DOI: 10.2991/aebmr.k.200730.077

13. Cherniei V., Cherniavskyi S., Babanina V., Tykho O. Criminal liability for cryptocurrency transactions: global experience. *European Journal of Sustainable Development*. 2021;10(4):304–316. DOI: 10.14207/ejsd
14. Bouri E., Lucey B., Roubaud D. Cryptocurrencies and the downside risk in equity investments. *Finance Research Letters*. 2020;33:101211. URL: https://doi.org/10.1016/j.frl.2019.06.009
15. Frick T.A. Virtual and cryptocurrencies — regulatory and anti-money laundering approaches in the European Union and in Switzerland. *Era Forum*. 2019;20:99–112. URL: https://doi.org/10.1007/s12027–019–00561–1
16. Iarutin I.K., Gulyaeva E.E. International and Russian Legal Regulation of the Turnover of Crypto-assets: Conceptual-Terminological Correlation. *Journal of Digital Technologies and Law*. 2023;1(3):725–751. URL: https://doi.org/10.21202/jdtl.2023.32
17. Jani S. The growth of cryptocurrency in India: Its challenges & potential impacts on legislation. *Research gate publication*. 2018. DOI: 10.13140/RG.2.2.14220.36486
18. Wu J., Liu J., Zhao Y., Zheng Z. Analysis of cryptocurrency transactions from a network perspective: An overview. *Journal of Network and Computer Applications*. 2021;190:103139. URL: https://doi.org/10.1016/j.jnca.2021.103139
19. Petruk O.M., Novak O.S. The essence of cryptocurrency as a methodological prerequisite for its accounting display. *«Bulletin of ZHTU»: Economics, Management and Administration.* 2017;4(82):48–55. URL: https://doi.org/10.26642/jen-2017–4(82)-48–55
20. Girasa R. Regulation of Cryptocurrencies and Blockchain Technologies: National and International Perspectives. *Springer*. 2018. URL: https://link.springer.com/book/10.1007/978–3–319–78509–7
21. Chen W., Wu J., Zheng Z., Chen C., Zhou Y. Market manipulation of bitcoin: Evidence from mining the Mt. Gox transaction network. *IEEE INFOCOM 2019-IEEE Conference on Computer Communications*. 2019:964–972. URL: https://ieeexplore.ieee.org/document/8737364
22. Middlebrook S.T., Hughes S.J. Regulating cryptocurrencies in the United States: current issues and future directions. *Wm Mitchell L Rev*. 2013;40(2):813–848. URL: https://open.mitchellhamline.edu/cgi/viewcontent.cgi?article=1567&context=wmlr
23. Sarker P.K., Lau C.K.M., Pradhan A.K. Asymmetric effects of climate policy uncertainty and energy prices on bitcoin prices. *Innovation and Green Development*. 2023;2(2):100048. URL: https://doi.org/10.1016/j.igd.2023.100048
24. Norta A., Leiding B., Lane A. Lowering financial inclusion barriers with a blockchain-based capital transfer system. *IEEE INFOCOM 2019-IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)*. 2019:319–324. DOI: 10.1109/INFCOMW.2019.8845177
25. Hughes S.D. Cryptocurrency Regulations and Enforcement in the US. *W St UL Rev*. 2017;45:1–24. URL: https://www.scotthugheslaw.com/documents/CRYPTOCURRENCY-REGULATIONS-AND-ENFORCEMENT-IN-THE-US-2.pdf
26. Sonksen C. Cryptocurrency Regulations in ASEAN, East Asia, & America: To Regulate or Not To Regulate. *Wash U Global Stud L Rev*. 2021;20(1):171–199. URL: https://journals.library.wustl.edu/globalstudies/article/id/8684/download/pdf/
27. Groot R.D., Brander L., Ploeg S.V.D., et al. Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem services*. 2012;1(1):50–61. URL: https://www.sciencedirect.com/science/article/pii/S 2212041612000101?via%3Dihub
28. Bech M.L., Garratt R. Central bank cryptocurrencies. *BIS Quarterly Review*. 2017:55–70. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3041906
29. Riley J. The current status of cryptocurrency regulation in China and its effect around the world. *China and WTO Review*. 2021;7(1):135–152. DOI: 10.14330/cwr.2021.7.1.06
30. Shen W., Hou L. China's central bank digital currency and its impacts on monetary policy and payment competition: Game changer or regulatory toolkit? *Computer Law & Security Review*. 2021;41:105577. URL: https://doi.org/10.1016/j.clsr.2021.105577
31. Vasek M., Moore T. There's no free lunch, even using Bitcoin: Tracking the popularity and profits of virtual currency scams. *Financial Cryptography and Data Security*. 2015;8975:44–61. URL: https://link.springer.com/chapter/10.1007/978–3–662–47854–7_4
32. Phat P. Anti-Money Laundering in Cambodia Should Cambodia Regulate or Ban Cryptocurrencies. *KDI School*. 2018. URL: https://core.ac.uk/reader/213855580

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Soksan Liv — Student of International Finance Master's Degree Program, Faculty of International Economic Relations, Financial University, Moscow, Russia
Соксан Лив — студент магистратуры «Международные финансы / International Finance» факультета международных экономических отношений, Финансовый университет, Москва, Россия
https://orcid.org/0009-0004-3346-6242
livsoksan7777@gmail.com

Omuvai S. Awori — Student of International Finance Master's Degree Program, Faculty of International Economic Relations, Financial University, Moscow, Russia
Омувай С. Авори — студент магистратуры «Международные финансы / International Finance» факультета международных экономических отношений, Финансовый университет, Москва, Россия
https://orcid.org/0009-0009-2094-3923
Aworihenry7@gmail.com

Aleksander S. Fedyunin — PhD, Associate Professor of the Department of World Economy and World Finance of the Faculty of International Economic Relations, Financial University, Moscow, Russia
Александр С. Федюнин — кандидат экономических наук, доцент департамента мировой экономики и мировых финансов факультета международных экономических отношений, Финансовый университет, Москва, Россия
https://orcid.org/0009-0008-7937-0747
Corresponding Author / Автор для корреспонденции:
fedunin2003@mail.ru

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.
The article was submitted on 27.10.2023; revised on 08.12.2023 and accepted for publication on 12.12.2023. The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-21-28
UDC 330.341(045)
JEL O18, O33, O53

Sustainability of the Digital Economy in Indonesia: Opportunities, Challenges and Future Development

N. Farliana[a], I. Murniawaty[b], H. Hardianto[c]
[a, b] Universitas Negeri Semarang (State University of Semarang), Semarang, Indonesia;
[c] Universitas Terbuka (Indonesia Open University), South Tangerang, Indonesia

ABSTRACT

This study **aims** to evaluate the challenges and opportunities arising from digital transformation and the digital economy, as well as their impact on human and physical resource development in the context of Indonesia. **The methods** used were a literature review and a qualitative approach. This study used secondary data obtained from academic articles published in the last 10 years. Data analysis techniques include material collection, data reduction, analysis and synthesis stages, and drawing conclusions. **The results** indicate that digital transformation brings economic and social opportunities. However, challenges also arise, such as digital divides among different groups, the level of human resource development, data and online system security, and taxation issues. Obstacles to be faced include slow regulatory reforms, bureaucratic complexity, government promotion in various regions, and digital infrastructure limitations. Strategic steps that need to be taken include developing appropriate policies, fostering collaboration between the public and private sectors, enhancing cybersecurity capacity, and promoting digital transformation domestically and internationally to advance national and regional economies. **The key conclusion** is that the main impact of the digital economy on the Indonesian economy as a whole includes market share growth, increased brand awareness, expanded customer reach, ease of business transactions, and increased product variety at competitive prices.

Keywords: digital transformation; digital economy; sustainability; human resource development; digitalization; governance; public policy; privacy; security; SME

For citation: **Farliana N., Murniawaty I., Hardianto H. Sustainability of the digital economy in Indonesia: Opportunities, challenges and future development. *Review of Business and Economics Studies*. 2023;11(4):21-28. DOI: 10.26794/2308-944X-2023-11-4-21-28**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Устойчивость цифровой экономики в Индонезии: возможности, вызовы и будущее развитие

Н. Фарлиана[a], И. Мурниавати[b], Х. Хардианто[c]
[a, b] Universitas Negeri Semarang (Государственный университет г. Семаранг), Семаранг, Индонезия;
[c] Universitas Terbuka (Открытый университет Индонезии), Южный Тангеранг, Индонезия

АННОТАЦИЯ

Цель данного исследования — оценить проблемы и возможности, возникающие в результате цифровой трансформации и становления цифровой экономики, а также их влияние на развитие человеческих и физических ресурсов в условиях Индонезии. Использованы такие **методы**, как обзор научной литературы и качественный анализ. В данном исследовании использовались вторичные **данные**, полученные из научных статей, опубликованных за последние 10 лет. Процесс анализа данных включал сбор материала, обработку данных, этапы анализа и синтеза, а также формулирование выводов. **Полученные результаты**

свидетельствуют о том, что цифровая трансформация открывает экономические и социальные возможности. Однако возникают и проблемы, такие как цифровое неравенство между различными группами населения, уровень развития человеческих ресурсов, безопасность данных и онлайн-систем, а также вопросы налогообложения. Среди препятствий, с которыми приходится сталкиваться, медленные реформы в сфере правового регулирования, бюрократические сложности, меры властей в различных регионах и ограничения цифровой инфраструктуры. Стратегические шаги, которые необходимо предпринять, включают разработку соответствующей политики, развитие сотрудничества между государственным и частным секторами, укрепление потенциала кибербезопасности и продвижение цифровой трансформации внутри страны и на международном уровне для развития национальной и региональной экономики. **Главный вывод** заключается в том, что основное влияние цифровизации на индонезийскую экономику включает в себя рост доли рынка, повышение узнаваемости брендов, расширение круга потребителей, упрощение деловых операций и увеличение разнообразия товаров по конкурентоспособным ценам.
Ключевые слова: цифровая трансформация; цифровая экономика; устойчивость; развитие человеческих ресурсов; цифровизация; управление; государственная политика; конфиденциальность; безопасность; малый и средний бизнес

Для цитирования: **Фарлиана Н., Мурниавати И., Хардианто Х. Устойчивость цифровой экономики в Индонезии: возможности, вызовы и будущее развитие.** ***Review of Business and Economics Studies*****. 2023;11(4):21-28. DOI: 10.26794/2308-944X-2023-11-4-21-28**

1. Introduction and literature overview

Eleven countries in the Southeast Asia (SEA) region, including Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Timor-Leste, Thailand and Vietnam, show variations in political regimes and levels of socio-cultural development. Also, these countries differ in their economic structures, progress, levels and patterns of life. However, most of them are making efforts to initiate digital transformation measures to boost their economic growth.

The development and spread of the Internet and advanced technologies such as mobile technology, virtual reality, big data, artificial intelligence and the Internet of Things (IoT) have connected customers, suppliers, businesses, regulators, devices, data and processes in various sectors and countries. It has changed the way we interact with other people and how we generate, market and consume offerings such as information, products, services and experiences. The digital economy, which is also known as the Internet economy, the new economy, the web economy, or the IoT economy [1, 2], refers to economic activities that connect various stakeholders in an economy through online transactions, communications, exchanges, and connectivity.

According to the Asian Development Bank (ADB), the digital economy can be defined as the contribution of every economic transaction involving digital products and industries to the Gross Domestic Product (GDP) [3]. To ensure optimal performance in the digital economy, the information technology/information and communication technology (IT/ICT) sector requires hardware (e.g., information services manufacturing, information systems management), software, as well as consulting and telecommunications services. In addition, social and technical aspects must be considered in the digital transformation process.

In recent years, attention to the digital economy in Southeast Asia has been increasing from various public and private organizations because of the potential and significant impact on the economies of the countries in the region, as well as the countries of their trading partners. In addition, a study conducted by Ha and Chuah [4], which explored the potential and impact of digital transformation and the digital economy in Southeast Asia. Schiliro's report [5] includes the views of senior executives from leading organizations on various aspects of the digital economy, such as uncertainties in the external environment, technological growth (such as the metaverse, IoT, Industry 4.0), new economic concepts (such as the circular economy) and sustainability, as well as the steps businesses must take to adapt to the new economy and optimize their potential in the digital age [6].

There is an increasing awareness that digitalization not only alters the cost of information from the transfer of specific company advantages but also transforms the characteristics of these advantages [7]. Observing the rapid pace of technological advancement, this paper proposes a

framework that integrates digitalization into existing theories. In line with the special edition's focus on internalization theory [8, 9], we seek to explore the following questions: How does digitalization impact the assumptions of internalization theory concerning the nature of specific advantages and predictions related to governance choices in cross-border transactions? To develop internalization theory in this digital era, we incorporate insights from the fields of management information systems (MIS) [10], strategic management [11–13], and network theory [14].

In addition to the benefits offered by digital adoption, such as business opportunities and the creation of new jobs, the potential for growth in the digital economy, improving public services, increasing efficiency and productivity in the economy, and so on, there are also challenges such as the threat of job loss due to technological disruption in various sectors, the digital divide, privacy and security issues, etc. Although much research has been conducted to examine the impact of digital adoption in Indonesia, only a few studies have specifically focused on the relationship between digital adoption and the digital economy in Indonesia, as well as the role of various stakeholders, such as the public sector, private sector, and civil society organizations, in the process of digital transformation. In addition, there are no definite answers to the following questions: (1) Can the digital economy be an extraordinary driver of economic development? (2) Can the digital economy drive job creation and sustainable economic growth? (3) What are the challenges and opportunities faced by Indonesia in the digital economy? (4) What is the role of the digital economy in the Indonesian economy?

Therefore, the purpose of this article is to fill this research gap by analyzing the opportunities and challenges arising from digital transformation and the digital economy and their impact on the development of human and physical capital. In addition, this paper provides policy recommendations that involve various sectors and stakeholders to help Indonesia manage digital transformation more effectively. This study is important because it covers various interdisciplinary perspectives, such as economics, digitalization, governance, management, public policy, technology, privacy, security, and human resource development.

2. Methodology

This research is a literature review using qualitative methods. The data sources used in this article are secondary data obtained from articles published in the last 10 years regarding the development of a sustainable digital economy in Indonesia. The data collection process was carried out by searching various sources, such as Google Scholar, Springerlink, ResearchGate, Emerald, etc.

In this literature review, four stages of data analysis are used, which must be carried out sequentially to provide acceptable answers to the questions posed. The first stage is to find and collect materials related to sustainable entrepreneurial intentions in tertiary institutions. The second stage involves simplification and coding, i.e., filtering and grouping material to suit the topics discussed. The third stage is analysis and synthesis, in which detailed information about the material obtained is examined and explored. The last stage is the final stage of the literature review process, which presents the new findings of the research and formulates conclusions.

The academic literature database analysis process was carried out by considering the following criteria: 1) Inclusion of articles related to "digital economy sustainability in Indonesia", published between 2014 and 2023, to obtain the latest information; 2) Research produced in the form of scholar articles, excluding comments, posters and quotations; 3) The use of quantitative data issued by institutions that have the authority and relevance to the intention to continue the digital economy in Indonesia. After the initial screening process, the authors independently reviewed articles that met these criteria on the basis of their titles and abstracts to ensure their relevance to the research objectives. Next, they checked the entire content of each article and matched it with data from authorized government agencies.

3. Results and discussion

3.1. Opportunities presented by digital transformation

The rise of the digital economy provides a number of benefits for individuals, companies and the country as a whole.

First, nationally, the technology sector has experienced an increase in job creation [15]. At the company and individual levels, digital platforms

enable small and medium enterprises (SMEs) to expand their market reach across countries, while aspiring entrepreneurs can start new businesses without the need for a physical office.

Second, digital transformation facilitated business recovery after the COVID-19 pandemic. Due to the disruption caused by the worldwide COVID-19 pandemic, the process of digitization has accelerated in all sectors of the economy [16], and has played a crucial role in the recovery from the crisis [17], had a significant impact on individuals, businesses and society [18]. For example, demand for digital infrastructure and connectivity, information and communication technology (ICT) services, online learning, telemedicine, and e-commerce platforms is increasing due to policies on remote work, virtual collaboration, online learning, and social distancing restrictions [17]. In addition, the implementation of digital solutions has also provided great benefits to SMEs [19, 20].

Third, digital transformation can encourage creativity and innovation. Digital transformation involves the relationship between humans and technology in an economic context [21]. In fact, successful digital transformation projects require a combination of the latest technologies, relevant human capabilities, creativity, innovative mindsets and sustainable business models, among other factors [21]. Successful transformation in this regard can increase productivity in various sectors, improve public services, and contribute to improving people's welfare through better access to information, knowledge, and data.

Fourth, digital transformation can contribute to overcoming policy challenges, both in meeting current and future energy, food and clean water needs, as well as in increasing the provision of quality health and education services [22]. This transformation enables more effective implementation and enforcement of policies and improves the provision of public services through the use of digital platforms. At the corporate level, digital transformation helps improve organizational performance through optimizing processes and procedures that are more efficient.

Fifth, digital technology can also promote social inclusion by increasing access to quality education, public health care, financial services, employment opportunities, and training and skills development, especially for older workers and individuals who wish to have more job opportunities elsewhere [22, 23]. Digital technologies enable the implementation and evaluation of policies that promote inclusive innovation, as well as provide opportunities to present solutions that promote social inclusion more broadly.

3.2. Challenges raised by digital transformation

One of the main challenges faced is the digital divide that occurs between various groups of people, such as differences in the speed of broadband Internet access. There are various factors that cause this digital divide, such as age, information technology literacy level, income level, skills, Internet access, and so on. However, on the positive side, there is potential for those who do not have Internet access or are not yet involved in online marketplaces to initiate digital transformation and benefit from digitalization and the digital revolution.

The second challenge is the level of human resource development. To measure a country's efforts and capabilities in developing and utilizing its human resources, the Human Capital Index adopted by the World Economic Forum is used. This index evaluates various variables such as the level of education, skills, employment, and the extent to which the country is able to utilize its human capital to boost the economy. The main components of this index consist of capacity, development, dissemination, and knowledge [15].

The third challenge is the issue of maintaining data privacy and online system security. Cybersecurity and crime have become a serious concern for the online community, including consumers, merchants and governments. In fact, the COVID-19 pandemic has created a favorable situation for cybercriminals [24]. Threats in cyberspace not only impact online businesses but also have a significant economic impact.

The fourth challenge is taxation issues related to jurisdictions. In accordance with the explanation provided by the OECD, the digital economy provides opportunities for companies to operate outside the territory of the country where they are registered. This results in "non-resident companies operating in market jurisdictions in a fundamentally different way than when international tax rules were drafted" [6]. Traditional companies must comply with the taxation and regulatory rules of the countries where they are

registered and operate, while digital companies may not be required to pay taxes due to not having a physical presence in certain countries. In addition to administrative complexities, this creates challenges for policymakers to ensure fair and balanced competition in both online and offline markets.

3.3. Digital economy impact

First, there are opportunities for millions of people to connect and conduct both commercial and non-commercial transactions online [25]. However, this requires an appropriate policy framework and effective law enforcement. During the COVID-19 pandemic, an increasing number of consumers in Indonesia turned to digital services and made purchases online. For those who are not yet fully familiar with the benefits of the digital economy, they will be on board soon as they can enjoy the convenience of transacting online, have access to a wide range of goods and services, and get better prices and value than through traditional channels [26].

Second, digital adoption will reduce operational costs, which can increase competitiveness in the manufacturing, supply chain and procurement management sectors [25, 27]. Companies can become more responsive and focused on customer needs by implementing e-commerce and digital marketing strategies, leveraging social media platforms, and using software to manage customers efficiently, both domestically and internationally. In addition, digitization can improve operational efficiency and supply chain management, especially in the face of the COVID-19 pandemic [28, 29]. During this pandemic, cost reductions and operational sustainability were clearly seen when most business activities shifted from offline to online.

Third, according to [30, 31], SMEs make a significant contribution in ASEAN member countries (AMS), covering between 88.8% and 99.9% of the total business entities and providing employment for 51.7% to 97.2% of the workforce. In addition, SMEs also play a role in contributing around 30% to 53% of the gross domestic product (GDP). In a situation where consumer demand is increasing, digitization has improved the manufacturing supply chain and financial infrastructure, providing greater opportunities for SMEs to expand their businesses regionally and internationally. With online platforms and digital technology, SMEs and other businesses have the opportunity to continue operating during the COVID-19 pandemic, which otherwise may have been forced to stop operating.

Fourth, digitalization provides opportunities for financial institutions to develop innovations and thrive in an ever-changing external environment. For example, blockchain technology, digital banking, internet banking services, e-wallets, e-payments, mobile banking, and banking applications have been introduced. This allows commercial and e-commerce transactions to be carried out digitally at lower costs and faster.

However, there are some negative consequences associated with the digital economy. Indonesia may face challenges in reviewing and harmonizing regulations and policies to keep up with the rapid development of digitalization and technology. Conventionally, regulatory costs are often seen as a heavy burden on businesses. In addition, there are several obstacles to entering the digital economy sector, such as the slow pace of regulatory reform, complex bureaucracy, and the lack of incentives and promotions from the government in various regions [4].

An additional challenge is ensuring the availability of digital infrastructure, including networks, hardware, and software, across regions to promote effective and efficient connectivity between regions in Indonesia. Apart from that, social and human aspects of the digital economy also need to be considered, especially in terms of the readiness of the workforce to face technological changes, including older workers.

3.4. Strategic steps to face the digital economy

To consider various views regarding the development of the digital economy, the following policy recommendations are proposed. There is a need to develop a shared data policy that follows a policy framework aligned with regional and international requirements. The development of this policy must be focused on three main areas: digital finance, digital training and development, as well as digital infrastructure, both physically and institutionally [32]. Understanding the importance of effective training and development policies will help address the digital literacy gap and increase digital inclusion.

Furthermore, cooperation between the public and private sectors is essential for building a solid

digital infrastructure foundation that will facilitate integration, cooperation, and development at both regional and national levels. In order to achieve this, it is important for the public and private sectors to work together, pool resources, and develop the necessary infrastructure, with the aim of creating mutually beneficial partnerships. In addition, the third sector or civil society organizations also have a significant role in public education, increasing awareness of the importance and benefits of digital adoption, and carrying out check and balance functions. As part of this effort, the third sector should also encourage public participation and contribute to relevant digital projects, with the aim of supporting public and private sector efforts [33].

Cyber security cooperation and capacity building at the regional level are very important. At the national level, it is necessary to increase trust and security in online platforms and markets, given that security and privacy incidents often hinder consumers from engaging in online activities [34]. To overcome cyber threats, all sectors should work together to fight hackers. Civil society organizations can play an important role in raising awareness about cyber security among the public, promoting the implementation of effective cyber security management, and participating in relevant cyber security projects. In addition, civil society organizations can also contribute to building cyber security capacity as well as building partnerships to improve overall cyber security [35].

Overall, Indonesia needs to encourage internal and external digital transformation to develop the national and regional economies. To achieve this digital transformation, it is important to align and address the gap between "Industry 4.0", "Technology 4.0", "Education and Training 4.0" and "Policy 4.0" at local, national and regional levels [22]. In addition, Indonesia should develop and implement a fair competition policy, invest adequate resources in digital education (human resources) and digital infrastructure to encourage digital innovation and inclusivity, and play an active role in building a "connected, safe, and secure digital region." [4].

4. Conclusion

The conclusion of this article is that the main impact of the digital economy on the Indonesian economy as a whole includes increasing market share, increasing brand awareness, wider reach to customers, ease of commercial transactions, and increasing product choices and competitive prices. This also contributes to overall economic and GDP growth. However, Indonesia is still faced with challenges such as the digital divide, different levels of economic development and human resource development, cybersecurity threats, privacy issues, taxation, financial infrastructure, technical skills, technological capabilities, and jurisdictions, which remain the focus of attention.

According to the recommendations that the authors provide, it is hoped that by reducing the digital divide, more and more people will be able to adopt digital technology and participate in the digital transformation process. Communities and economic actors are expected to increase their human and digital literacy in order to encourage economic growth. In addition, it is hoped that policymakers can adopt regulations that are adaptable and responsive to developments in technology and the digital economy. This becomes important in maintaining the balance between consumer protection, innovation and economic progress.

REFERENCES

1. Bukht R., Heeks R. Defining, conceptualizing and measuring the digital economy. *Development Informatics Working Paper. SSRN, August 3*, 2017(68). URL: http://dx.doi.org/10.2139/ssrn.3431732
2. Williams L. D. Concepts of digital economy and Industry 4.0 in intelligent and information systems. *International Journal of Intelligent Networks*. 2021;2:122–129. URL: https://doi.org/10.1016/j.ijin.2021.09.002
3. Barefoot K., Curtis D., Jolliff W, Nicholson J.R., Omohundro R. Defining and measuring the digital economy. *US Department of Commerce Bureau of Economic Analysis*. Washington, DC. 2018 Mar 15;15:210. URL: https://www.bea.gov/sites/default/files/papers/defining-and-measuring-the-digital-economy.pdf
4. Ha H., Chuah C. K. P. Digital economy in Southeast Asia: challenges, opportunities and future development. *Southeast Asia: A Multidisciplinary Journal*. 2023;23(1):19–35. URL: https://doi.org/10.1108/SEAMJ-02–2023–0023

5. Schiliro D. Digital Economy and Digital Transformation. IGI Global, 2022. DOI: 10.4018/978–1–6684–4265–4.ch002
6. Hathaway I. Tech starts: High-technology business formation and job creation in the United States. *Ewing Marion Kauffman Foundation Research Paper*. 2023:1–36. URL: https://dx.doi.org/10.2139/ssrn.2310617
7. Strange R., Zucchella A. Industry 4.0, global value chains and international business. *Multinational Business Review*. 2017;25(3):174–184.
8. Buckley P.J., Casson M.C. *The future of the multinational enterprise*. London: Macmillan. 1976.
9. Buckley P.J. The contribution of internalization theory to international business: New realities and unanswered questions. *Journal of World Business*. 2016;51:74–82.
10. Sambamurthy V., Bharadwaj A., Grover V. Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly*. 2003;27(2):237–263.
11. Jacobides M., Cennamo C., Gawer A. Towards a theory of ecosystems. *Strategic Management Journal*. 2018;39:2255–2276.
12. Gawer A. *Platforms, markets, and innovation*. Cheltenham: Edward Elgar, 2018.
13. Parker G., Van Alstyne M. Innovation, openness, and platform control. *Management Science*. 2018;64(7):3015–3032.
14. Powell W. Neither market nor hierarchy. *The sociology of organizations: classic, contemporary, and critical readings*. 2003;315:104–117.
15. Briguglio L., Cordina G., Farrugia N., Vella S. Economic vulnerability and resilience: concepts and measurements. *In Measuring Vulnerability in Developing Countries*. Routledge. 2014:47–65.
16. Kochetkov E.P., Zabavina A.A., Gafarov M. Digital Transformation of Companies as A Tool of Crisis Management: Đ N Empirical Research of The Impact on Efficiency. *Strategic decisions and risk management*. 2021. URL: https://doi.org/10.17747/2618–947X-2021–1–68–81
17. Banga K., te Velde D. Covid-19 and disruption of the digital economy: Evidence from low and middle-income countries. Oxford, United Kingdom: Digital Pathways at Oxford. Paper Series. 2020;7.
18. Schneider S., Kokshagina O. Digital transformation: What we have learned (thus far) and what is next. *Creativity and innovation management*. 2021;30(2):384–411. URL: https://doi.org/10.1111/caim.12414
19. Bagale G.S. et al. Small and medium-sized enterprises' contribution in digital technology. *Annals of Operations Research*. 2021:1–24. URL: https://doi.org/10.1007/s10479–021–04235–5
20. Bermeo-Giraldo A., Valencia-Arias J.D., Ramos de Rosas M., Benjumea-Arias J.A., Villanueva Calderón M.C. Factors influencing the use of digital marketing by small and medium-sized enterprises during COVID-19. *Informatics*. 2022;9(4):86.
21. Oliveira K.K.D.S., de Souza R.A. Digital transformation towards education 4.0. *Informatics in Education*. 2020;21(2):283–309.
22. Sen S., Ganguly S. Opportunities, barriers and issues with renewable energy development — A discussion. *Renewable and Sustainable Energy Reviews*. 2017;69:1170–1181.
23. Sanders C.K., Scanlon E. The digital divide is a human rights issue: Advancing social inclusion through social work advocacy. *Journal of Human Rights and Social Work*. 2021;6:130–143.
24. Zahra S.R., Chishti MA., Baba AI., Wu F. Detecting Covid-19 chaos driven phishing/malicious URL attacks by a fuzzy logic and data mining-based intelligence system. *Egyptian Informatics Journal*. 2022;23:2:197–214. URL: https://doi.org/10.1016/j.eij.2021.12.003
25. Ha H., Chuah C. Digital economy in Southeast Asia: challenges, opportunities and future development. *Southeast Asia: A Multidisciplinary Journal*. 2023. URL: https://doi.org/10.1108/SEAMJ-02–2023–0023
26. Porter M.E., Heppelmann J.E. How smart, connected products are transforming competition. *Harvard business review*. 2014;92(11):64–88.
27. Cole R., Stevenson M., Aitken J. Blockchain technology: implications for operations and supply chain management. *Supply Chain Management: An International Journal*. 2019;24(4):469–483. URL: https://doi.org/10.1108/SCM-09–2018–0309
28. Cui L., Wu H., Wu L., Kumar A., Tan K. Investigating the relationship between digital technologies, supply chain integration and firm resilience in the context of COVID-19. *Annals of Operations Research*. 2022:1–29. URL: https://doi.org/10.1007/s10479–022–04735-y

29. Zhao N., Hong J., Lau K. Impact of supply chain digitalization on supply chain resilience and performance: A multi-mediation model. *International Journal of Production Economics*. 2023;259:108817. URL: https://doi.org/10.1016/j.ijpe.2023.108817
30. Censon H.F., Sanque R.E., Villegas R., Cabauatan J.L. Impact of fiscal policies of the Philippines, Thailand, and Vietnam on MSMEs and their relative effects on GDP growth. *UJoST-Universal Journal of Science and Technology*. 2023;2(1):1–25.
31. Woźniak J., Duda A. Gąsior T., Bernat M. Relations of GDP growth and development of SMEs in Poland. *Procedia Computer Science*. 2019;159:2470–2480.
32. Tay H.T., Tai G.S., Tan L.Y. Digital financial inclusion: A gateway to sustainable development. *Heliyon*. 2022;8:1–10.
33. Lynn T., Rosati P., Conway E., Curran D., Fox G., O'Gorman C. Digital technologies and civil society. In Digital Towns: Accelerating and measuring the digital transformation of rural societies and economies. *Cham: Springer International Publishing*. 2022:91–108. URL: https://doi.org/10.1007/978–3–030–91247–5_5
34. Ha H. Stakeholders' views on self-regulation to protect consumers in e-retailing. *Journal of Electronic Commerce in Organizations (JECO)*. 2017;15(3):83–103. URL: https://doi.org/10.4018/JECO.2017070105
35. Bada A.M., Sasse J.R., Nurse M. Cyber security awareness campaigns: Why do they fail to change behaviour? *arXiv*.2019;1901.02672.

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Nina Farliana — Master of Education, Lecturer and Researcher, Economics Education Department, Faculty of Economics and Business, Universitas Negeri Semarang (State University of Semarang), Semarang, Indonesia
Нина Фарлиана — магистр образования, преподаватель и научный сотрудник кафедры экономического образования факультета экономики и бизнеса, Universitas Negeri Semarang (Государственный университет г. Семаранг), Семаранг, Индонезия
https://orcid.org/0000-0001-8531-3302
Corresponding Author / Автор для корреспонденции:
ninafarliana@mail.unnes.ac.id

Indri Murniawaty — Master of Education, Lecturer and Researcher, Economics Education Department, Faculty of Economics and Business, Universitas Negeri Semarang (State University of Semarang), Semarang, Indonesia
Индри Мурниавати — магистр образования, преподаватель и научный сотрудник кафедры экономического образования факультета экономики и бизнеса, Universitas Negeri Semarang (Государственный университет г. Семаранг), Семаранг, Индонезия
https://orcid.org/0000-0001-5399-2283
indri@mail.unnes.ac.id

Hanif Hardianto — Master of Law, Lecturer and Researcher, Department of Law, Faculty of Law, Social Science, and Political Science, Universitas Terbuka (Indonesia Open University), South Tangerang, Indonesia
Ханиф Хардианто — магистр права, преподаватель и научный сотрудник кафедры права факультета права, социальных и политических наук, Universitas Terbuka (Открытый университет Индонезии), Южный Тангеранг, Индонезия
https://orcid.org/0009-0000-3393-9493
hanifh@ecampus.ut.ac.id

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.
The article was submitted on 09.07.2023; revised on 07.09.2023 and accepted for publication on 25.09.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-29-44
UDC 330:658.155[.67:332.6](045)
JEL O16, O57, G15, G21

Foreign Direct Investment and Financial Development: Evidence from Selected Arab League Countries

H. Humta, İ.E. Şahin
Selçuk University, Konya, Türkiye

ABSTRACT

This study **examined** the impact of foreign direct investment on financial development in selected Arab League countries (Algeria, Comoros, Egypt, Jordan, Kuwait, Lebanon, Mauritania, Oman, and Qatar) for the period from 2010 to 2021. The study used one explanatory variable — financial development — and one explained variable — foreign direct investment. To obtain reliable and valid results, **panel data** were analyzed, and various **tests** were carried out**,** including the Chow test, Breusch-Pagan Lagrange multiplier test, Hausman test, Jarque-Bera normality test, Wooldridge test, generalized least squares, and ordinary least squares. The robust model of the study **revealed** a positive and significant relationship between foreign direct investment and the financial development index, human development index, and interest rate. Also, there is a negative and significant relationship between foreign direct investment and the consumer price index and domestic credit to private sector. Based on these **findings**, the study **recommends** that Arab League countries' policies and strategies should attract foreign investors to maintain and sustain economic developmental goals for healthy, literate, and wealthy lives.

Keywords: foreign direct investment; financial development index; panel data; Arab League countries; human development index; consumer price index; economic development; econometric models

For citation: **Humta H., Şahin I.E. Foreign direct investment and financial development: Evidence from selected Arab League countries. *Review of Business and Economics Studies*. 2023;11(4):29-44. DOI: 10.26794/2308-944X-2023-11-4-29-44**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Прямые иностранные инвестиции и финансовое развитие: результаты исследований отдельных стран Лиги арабских государств

Х. Хумта, И.Э. Шахин
Университет Сельчук, Конья, Турция

АННОТАЦИЯ

В данном исследовании **рассматривается** влияние прямых иностранных инвестиций на финансовое развитие отдельных стран Лиги арабских государств (Алжир, Египет, Иордания, Катар, Коморские Острова, Кувейт, Ливан, Мавритания и Оман) за период с 2010 по 2021 г. В исследовании использовались одна объясняющая переменная — финансовое развитие, а также одна объясняемая переменная — прямые иностранные инвестиции. Для получения надежных и достоверных результатов был проведен **анализ панельных данных** и различные тесты, включая тест Чоу, тест Бреуша-Пагана на основе критерия множителя Лагранжа, тест Хаусмана, тест на нормальность Харке-Бера, тест Вулдриджа, а также методы обобщенных наименьших квадратов и обычных наименьших квадратов. Робастная модель исследования позволила **выявить** положительную и значимую связь между прямыми иностранными инвестициями и индексом финансового развития, индексом человеческого развития и процентной ставкой. Кроме того, существует отрицательная и значимая связь между прямыми иностранными инвестициями и индексом потребитель-

ских цен, а также внутренним кредитом частному сектору. Исходя из результатов исследования, авторы **рекомендуют** странам Лиги арабских государств привлекать иностранных инвесторов для поддержания и реализации целей устойчивого экономического развития здорового, грамотного и обеспеченного населения.
Ключевые слова: прямые иностранные инвестиции; индекс финансового развития; панельные данные; страны Лиги арабских государств; индекс человеческого развития; индекс потребительских цен; экономическое развитие; эконометрические модели

Для цитирования: **Хумта Х., Шахин И.Э. Прямые иностранные инвестиции и финансовое развитие: результаты исследований отдельных стран Лиги арабских государств. *Review of Business and Economics Studies*. 2023;11(4):29-44. DOI: 10.26794/2308-944X-2023-11-4-29-44**

1. Introduction

Foreign direct investment (FDInvestment) plays a crucial role in fostering an open and efficient international economic system, in contrast to economies that are characterized by restrictive laws and regulations. FDInvestment[1] refers to the act of a person or firm making a direct investment in another country, specifically in production or for business purposes. FDInvestment may be undertaken via many methods, such as establishing a subsidiary, purchasing an already established foreign enterprise, or engaging in a merger or joint venture with a foreign corporation [1]. Foreign direct investment evidence indicates that FDInvestment inflows boost economic development through knowledge transfer and spillover efficiency. However, such a beneficial effect does not occur automatically; rather, it depends on the receiving country's absorptive ability. Absorption capacity has been the subject of several studies, and the success of FDInvestment focuses only on human capital and trade regimes [2].

According to the World Economic Forum's 2011 Financial Development Report, financial development is the sum of all elements — policy, institutions, and others — that support efficient financial markets and intermediation, as well as the provision of universally available capital and financial services [3].

The factors often used to measure financial development include financial depth, bank ratio, and financial activity, which may be generally characterized [4]. The prosperity of every economy is contingent upon the presence of a competent and efficient financial system since a robust financial system is essential for establishing a solid economic foundation. An enhanced financial system facilitates the provision of superior financial services, thereby enabling an economy to increase its GDP growth [5].

Foreign direct investment is an important source of growth and development, while financial development is a crucial input in developing nations for economics growth and poverty alleviation. Financial development fosters economic expansion and increases a nation's resilience. It enhances resource allocation, promotes information sharing and financial stability, mobilizes savings, and facilitates risk management and diversification [6].

The present study uses a relatively new measure of financial development proposed by the International Monetary Fund (IMF) [7]. The financial development index[2] combines 20 indicators and includes both banking and nonbanking institutions, as well as markets. It assesses financial development across three dimensions: depth, access, and efficiency. In addition, the study offers important policy recommendations for the selected OIC member countries.

There are strong connections between foreign direct investment and financial development. To find out how important FDInvestment is for financial development, correlation and regression models were used to figure out the best way to attract FDInvestment to encourage economic development.

2. Literature review

2.1. Foreign direct investment

Foreign direct investment occurs when a company from one nation establishes a business operation in another nation, either by estab-

[1] FDInvestment denotes Foreign direct investment.

[2] FDI indicates financial development index.

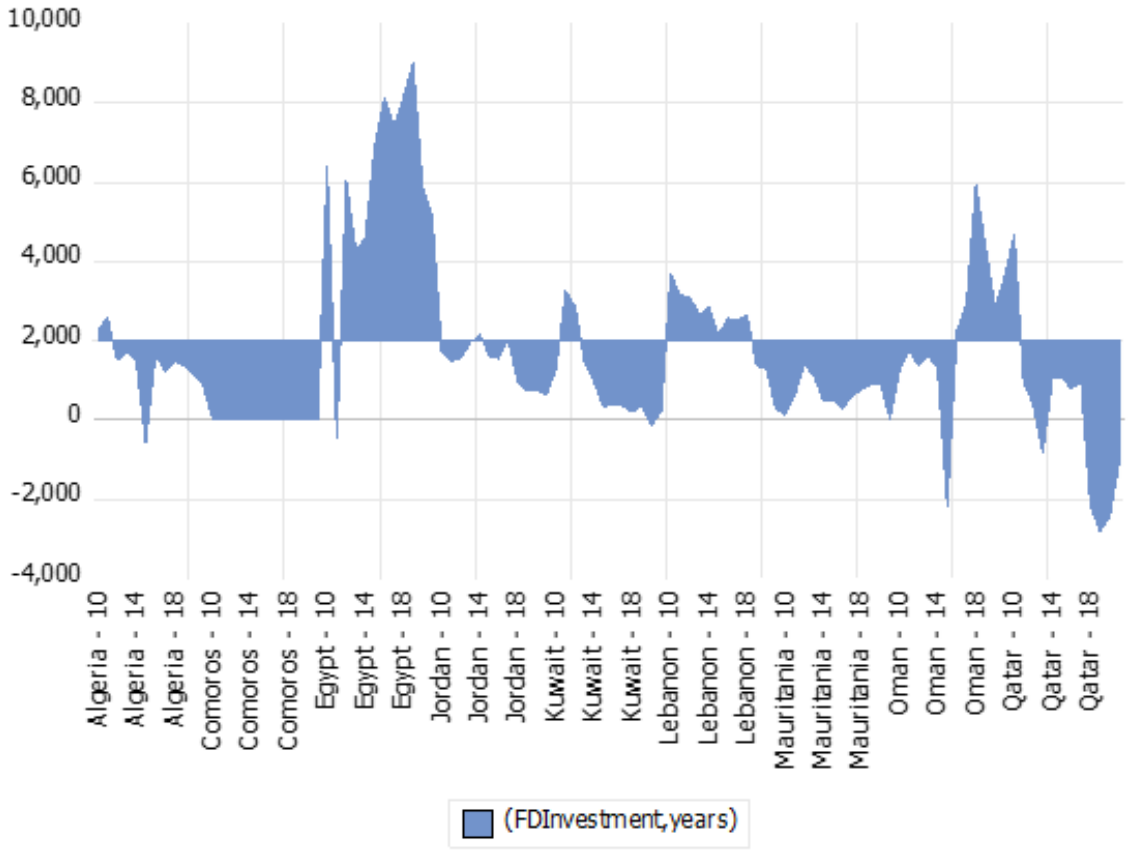

Fig. 1. **Foreign direct investment of Arab League countries, millions of dollars**

Source: The Organisation of Islamic Cooperation (OIC) Countries. OIC Statistics Database (OICStat) — Query 2023. URL: https://www.sesric.org/query.php.

lishing a new wholly owned affiliate, acquiring a local company, or organizing a joint venture in the host economy [8]. The potential advantages of foreign direct investment for the host economy are considerable, including several aspects such as the transfer of technology skills, support for capital development, assistance in fostering a competitive business environment, and facilitation of international trade integration. These advantages can stimulate the main economic sectors, including petroleum, mining, manufacturing, agriculture, transportation, communication, construction, and others. Numerous nations consciously seek to attract foreign direct investment due to their belief that multinational firms would significantly contribute to economic development via the creation of new employment prospects, added capital accumulation, and enhanced total factor productivity. Without a doubt, an extensive database of empirical data proves the notion that foreign direct investment often provides overall benefits for both the countries of origin and recipient nations. These sectors are crucial for attaining substantial levels of employment and fostering economic growth and development. However, the advantages of foreign direct investment for nations may vary based on economic conditions and resource availability [1]. Economic factors, infrastructure, technology, institutional-political factors, specific risks, legal integration, space factors, entrepreneurial matters, cultural factors, and para-cultural factors are believed to influence the attraction of foreign direct investment. Most studies prioritize examining the economic variables that influence FDInvestment flows while largely disregarding or briefly mentioning other categories of factors. Scientists have studied a variety of economic factors in relation to FDInvestment, with varying degrees of success [9]. These factors include income, exchange rate, economic freedom, economic stability, liquidity, market size, market size growth, inflation, trade, capital availability, wages, agglomeration, capital formation, financial market, and debt.

The ups and downs of foreign direct investment for some selected Arab League countries (*Fig. 1*) during the last decade revealed that factors having a relation to or effect on foreign direct investment could make it possible to attract investment, and as a result, economic development can be provoked.

2.2. Financial development

The advancement of the financial industry is a crucial element that contributes significantly to gaining a competitive edge. A resilient financial system encourages multinational corporations to make investments in the countries where they are based [10]. Financial development refers to the enhancement of services offered by the financial system, including the allocation of capital to profitable investments, savings, risk diversification and monitoring, and risk management of these investments, as well as facilitating the exchange of goods and services. Financial development has the potential to decrease the imbalance of knowledge between parties, promote the distribution of risk, and mitigate limitations on financial activities. Financial development enhances the capacity of the financial system to withstand economic shocks, mitigates the exacerbation of negative effects caused by such shocks, and reduces macroeconomic instability and social disparities.

The financial development index contains two sub-indices (the Financial Institution Index and the Financial Market Index). Each sub-index has its indicator in three (Depth, Access, and Efficiency) categories. Every category shows at least one indicator. The sum of the total indicator value is named the value of the financial development index. Financial development combines financial markets with financial institutions to extend the availability and access of debt or funds to clients or customers to maintain their organizational goals or profit. Financial markets are the channel through which FDInvestment may be beneficial for financial development and, most commonly, for growth. The theoretical model shows that improvements in financial markets increase output by increasing the marginal product of FDInvestment [7]. *Table 1* explains the indicators of the financial development index.

2.3. Correlation between FDInvestment and financial development index

Orji et al. (2021) utilized autoregressive distributed lag (ARDL) and ordinary least squares to analyze the impact of FDI on Nigeria's GDP growth. The findings indicate that both foreign direct investment and human capital training contribute positively and significantly to economic development in Nigeria. The exchange rate and inflation have a negative impact on Nigeria's economic growth, while trade openness has an opposite effect [11]. Gökmenoğlu et al. (2018) state that the impact of FDInvestment on the human development index (HDI) is a complex problem; thus, policymakers should be aware of and consider the pros and cons of FDInvestment inflows on all aspects of human development to achieve the best outcomes. The author's findings indicate that FDInvestment has a favorable impact on economic growth and educational advancement; therefore, they suggest that Nigerian policymakers should make attracting international investors a top priority. However, the dynamic ordinary least squares (DOLS) estimator shows that FDInvestment harms life expectancy in Nigeria due to FDInvestment-induced competition and insecurity [12].

In 2018, Saidi conducted an empirical study to examine the relationship between foreign direct investment, financial development, and economic growth in low-income countries. The study used data from 1990 to 2015. The findings of this study indicate that foreign direct investment operations can provide significant benefits for low-income countries in terms of technology acquisition, increased investment inflows, job generation, human capital development, and enhanced corporate growth. Moreover, the study revealed the presence of long-term cointegration and bidirectional causation between foreign direct investment and financial development in low-income nations [13].

According to Bayar and Gavriletea (2018), FDInvestment inflows do not significantly affect the level of financial development over the long and short terms. Nevertheless, it is evident that a one-way causal relationship exists between the growth of the financial sector and the influx of FDInvestment in the countries of the Central and Eastern European Union. Hence, based on theoretical analysis, no obvious influence, whether good or negative, can be identified [14].

Table 1
New broad-based index of financial development

Financial institution index	Financial markets index
Categories-based indicators of financial institution index	Categories-based indicators of financial markets index
Private-sector credit to GDP (Depth) Pension fund assets to GDP (Depth) Mutual fund assets to GDP (Depth) Insurance premiums, life, and non-life to GDP (Depth) Bank branches per 100000 adults (Access) ATMs per 100000 adults (Access) Net interest margin (Efficiency) Lending-deposits spread (Efficiency) Non-interest income to total income (Efficiency) Overhead costs to total assets (Efficiency) Return on assets (Efficiency) Return on equity (Efficiency)	Stock market capitalization to GDP (Depth) Stocks traded to GDP (Depth) International debt securities of government to GDP (Depth) Total debt securities of financial corporations to GDP (Depth) Total debt securities of nonfinancial corporations to GDP (Depth) Percent of market capitalization outside of the top 10 Largest Companies (Access) Total number of issuers of debt (domestic and external, nonfinancial, and financial corporations), (Access) Stock market turnover ratio (stocks traded to capitalization), (Efficiency)

Source: [7].

Majeed et al. (2021) analyzed 102 Belt and Road Initiative nations from Asia, Europe, Africa, and Latin America to determine the impact of foreign direct investment on financial development. They employed a suite of quantitative methods, including feasible generalized least squares and augmented mean group techniques, using data collected from 1990 to 2017. The results of the research indicate a statistically significant association between FDInvestment and trade openness, inflation, government consumption, and financial development. Asia, Europe, and Latin America experienced an increase in FDInvestment due to trade liberalization and government consumption, whereas Africa reported a reduction. Financial development is negatively impacted by inflation on every continent. Moreover, in Asia and Europe, the Dumitrescu–Harlin panel causality test validates a two-way causal link between FDInvestment, trade openness, and financial development. In contrast, FDInvestment and financial development in Latin America are interdependent in a unidirectional fashion. Due to high factor costs, low-income and middle-income countries attract more foreign direct investment than high-income countries, as indicated by income-based results [15].

Lestari et al. (2022) evaluated the impact of FDInvestment and corruption on financial development in developing nations. Furthermore, they examined the collective influence of financial development and corruption on FDInvestment. The study's findings indicated that financial development has a favorable and substantial influence on FDInvestment, but corruption does not exert a statistically noteworthy effect. This illustrates the significant role of financial development in fostering the expansion of foreign investment and serving as a crucial source of financing for emerging nations. Nevertheless, the correlation between financial development and corruption exerts an adverse impact on FDInvestment. Consequently, when FDInvestment experiences a decline due to an increase in corruption, these findings prompt policymakers to tackle concerns related to the combined influence of financial development and corruption on the inflow of foreign direct investment in developing nations [16].

Nguyen et al. (2023) examined the impact of the financial development index on the inflow of foreign direct investment in Vietnam between 1996 and 2021. The model used time series data to evaluate the impact of six factors representing financial development. Data on financial institu-

tion assessment, financial depth of institution, financial efficiency of the institution, financial assessment of the market, financial efficiency of the market, and domestic loans for the private sector were gathered from 1996 to 2021. The study reveals that a rise in financial institution assessment, financial efficiency of the institution, and financial efficiency of the market leads to a corresponding increase in Vietnam's FDInvestment inflow, whereas an increase in financial depth of the institution and financial assessment of the market, results in a fall in FDInvestment. The impact of domestic loans for the private sector is unreliable, and this study lacks any substantial correlation. This research all so reveals that the chosen financial development index has a substantial influence on attracting foreign direct investment to a country. Furthermore, the government and authorities must formulate suitable policies in the future [17].

3. Methodology

This section presents an overview of the study methods, econometric model, and tests employed to assess the research model results. Balanced panel data of selected countries (Algeria, Comoros, Egypt, Jordan, Kuwait, Lebanon, Mauritania, Oman, and Qatar) were collected from the website of the Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC) of the Organization of Islamic Countries (OICStat) database. A set of panel data was used in this investigation through Stata 17 and EViews 13. Panel data are a combination of cross-sectional and time-series data. For better measurement of financial development, the most general proxy, the Financial Development Index, is considered in the study, which consists of two different indexes named the Financial Institutions Index and the Financial Markets Index. Dependent, independent, and controlled variables are explained; descriptive statistics, correlation matrix, common, fixed, random, and robust models of effect were employed on the mentioned variables. Several tests (the Chow test, the Lagrange multipliers test, and the Hausman test) were performed to find the best model of effect. Once the model was chosen, other tests (the Breusch-Pagan Lagrange multiplier test for independence, the heteroskedasticity white test, the Wooldridge test for autocorrelation, and the Jarque-Bera normality test) were carried out to find the appropriate model.

4. Results and Findings

4.1. Definition of the variables

Definitions of the variables are presented in *Table 2*.

In order to investigate the association and regression between foreign direct investment and financial development, we first consider the descriptive statistics and correlation analysis of the variables. Subsequently, we use three different types of panel regression models to further analyze the previously discussed relationship, as shown in *Tables 3* and *4*.

According to descriptive statistics, we have the means, standard deviation, min, and max for all three categories of variables named as dependent, independent, and control variables.

Correlation matrix *Table 4* shows the type and degree of relationship between all three categories of variables (dependent, independent, and controlled variables).

4.2. Empirical models

This subsection covers the empirical models and techniques that provide the foundation for the subsequent estimation approach. These models and methods were used to estimate the impact of foreign direct investment on financial development of selected Arab League countries. The empirical model used to analyze the impacts of foreign direct investment of this type may be expressed in the following econometric equations:

$$FDInvestment = f\left(FDI, HDI, CPI, IR, TO, PCGDP, DCtPS-\%GDP\right), \quad (1)$$

$$FDInvestment = \beta_0 + \beta_1 FDI_{it} + \beta_2 HDI_{it} + \beta_3 CPI_{it} + \beta_4 IR_{it} + \beta_5 TO_{it} + \beta_6 PCGDP_{it} + \beta_7 DCtPS-\%GDP_{it} + U_{it}, \quad (2)$$

where, Foreign Direct Investment is a dependent variable, FDI is the financial development index, HDI is the human development index, CPI is the consumer price index, IR is the interest rate, TO is the trade openness, PCGDP is the per capita gross domestic product, and DCtPS%GDP stands for domestic credit to the private sector (% GDP). And β_0 is the intercept, (β_1, ..., β_7) are the coefficients, and U_{it} is the error term of the model.

Table 2
Definition of the variables

Full Name	Variables Description	Source
Dependent Variable Foreign Direct Investment	The inflows of FDInvestment refer to transactions that raise the investment held by foreign investors in domestic firms, excluding transactions that reduce the investment of foreign investors in domestic companies, expressed in the current USD	UNCTADST Database
Independent Variable Financial Development Index (Index Value)	Evaluate the comparative placement of nations based on the extent, availability, and effectiveness of their financial institutions and financial markets. Combining the Financial Institutions Index and the Financial Markets Index yields the comprehensive financial development index	IMF
Control Variables Human Development Index (Rank Value)	The standard competition ranking, often known as the «1224» ranking, assigns the same ranking number to countries with equal Human Development Index scores, leaving a gap between the ranking numbers	OICStat
Trade Openness (Percent)	Trade balance, calculated as the ratio of the sum of exports and imports of goods and services to the gross domestic product (GDP), is represented as a percentage	WDI Database
Domestic Credit to the Private Sector (Percent),% GDP	The private sector's share of financial resources provided by financial businesses, which includes loans, non-equity securities purchases, trade credits, and other accounts receivable, in relation to the Gross Domestic Product (GDP)	IFS World
Interest Rate (percentage)	Annual bank rate that usually meets the short- and medium-term financing needs of the private sector, expressed as a percentage	OICStat
Consumer Price Index (percentage)	The final value of the consumer price index (CPI) at the end of a certain period. The Consumer Price Index (CPI) measures the fluctuations in the expenses associated with purchasing a standardized assortment of goods and services by the typical consumer	OICStat
Per Capita Gross Domestic Product	Per capita real GDP, denominated in USD	OICStat

Source: Developed by the authors based on OICStat Data Base.

Table 3
Descriptive statistics of variables

Variable	Obs	Mean	Std.Dev.	Min	Max
FDInvestment	108	1670.449	2181.461	-2812.640	9010
FDI	108	0.284	0.152	0.040	0.600
HDI	108	0.721	0.107	0.510	0.860
CPI	108	132.635	57.616	16.600	452.500
IR	108	8.402	4.342	0.790	18.320
TO	108	79.708	28.306	29.860	163.980
PCGDP	108	15 057.205	20 571.258	1284.400	80 743.129
DCtPS-%GDP	108	51.312	35.710	−12.730	177.080

Source: Developed by the authors.

Table 4
Correlation matrix analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) FDInvestment	1.000							
(2) FDI	0.086	1.000						
(3) HDI	0.124	0.850	1.000					
(4) CPI	−0.407	−0.341	−0.244	1.000				
(5) IR	0.117	−0.590	−0.746	0.248	1.000			
(6) TO	−0.236	0.588	0.453	−0.010	−0.278	1.000		
(7) PCGDP	−0.232	0.720	0.645	−0.166	−0.496	0.430	1.000	
(8) DCtPS-%GDP	−0.177	0.669	0.605	0.030	−0.432	0.393	0.405	1.000

Source: Developed by the authors.

The general form of the panel data regression model is given by equation (3). The panel data regression model, which is briefly described in equations (4), (5), and (6), will be used in this study to estimate the impact of FDInvestment on financial development.

$$Y_t = \alpha_t + \sum_{j=1}^{k} \beta_{jit} X_{jit} + U_{it}, \quad (3)$$

where: Y_t is response variable of the (*i*) individual and t time period, α_t is constant value/intercept of the (*i*) individual and *t* time period, β_{jit} (β_{1it}, β_{2it},…,β_{kit}) are coefficients of (*K*) independent variables, X_{jit} is the independent variables value of (*i*) individual and *t* time period, U_{it} is the error of (*i*) individual and t time period, and (*i* and *t*) are the number of individual (*i*; 1, 2, 3…, *N*) and time period (*t*;1,2,3…, *T*), respectively.

4.3. Estimation of the panel data regression model

For parameter estimation, the model depends on the intercept and slope coefficient assumptions. Using panel data permits unique intercept and slope coefficients for each individual and time period. The following three types of models are applicable to this concept: CEM (common effect model or pooled regression); FEM (fixed effects model); and REM (random effects models).

Common effect model. Pooled regression (CEM model) implies that the intercepts and slope coefficients for all individuals and time periods have the same value. This model does not consider both individual dimensions and time [18]. Equation (4) illustrates the CEM model:

$$Y_t = \alpha + \sum_{j=1}^{k} \beta_j X_{jit} + U_{it}. \quad (4)$$

A common effect model was employed using Stata 17 software. As a result, the financial development index, human development index and interest rate have a positive statistically significant relationship with foreign direct investment, whereas the consumer price index, trade openness, per capita gross domestic product and domestic credit to the private sector calculated as a percentage of GDP have a negative significant relationship with FDInvestment (*Table 5*).

Fixed effect model. This approach assumes that the intercepts represent the differences in individual characteristics. Thus, intercepts for each individual will vary, whereas slope coefficients will remain constant across all time intervals [18].

$$Y_t = \alpha_i + \sum_{j=1}^{k} \beta_j X_{Jit} + U_{it}. \quad (5)$$

In this method, we used a dummy variable to estimate the intercept for each individual; thus, this approach is called least square dummy variable (LSDV) model.

$$Y_t = \alpha + \sum_{i=1}^{n} \alpha_i D_i + \sum_{j=1}^{k} \beta_j x_{jit} + U_{it}, \quad (6)$$

Table 5
Common effect

FD Investment	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
FDI	8828.658	2602.477	3.390	0.001	3665.417	13 991.898	***
HDI	14 652.036	3057.034	4.790	0.000	8586.968	20 717.105	***
CPI	−8.956	2.964	−3.020	0.003	−14.837	−3.075	***
IR	247.306	49.264	5.020	0.000	149.568	345.043	***
TO	−28.142	6.345	−4.440	0.000	−40.731	−15.554	***
PCGDP	−0.065	0.010	−6.380	0.000	−0.085	−0.044	***
DCtPS-%GDP	−25.245	5.810	−4.350	0.000	−36.771	−13.718	***
Constant	−7785.323	2144.541	−3.630	0.000	−12 040.032	−3530.613	***

Mean dependent var	1670.449	SD dependent var	2181.461
R-squared	0.597	Number of obs.	108
F-test	21.158	Prob > F	0.000
Akaike crit. (AIC)	1883.903	Bayesian crit. (BIC)	1905.360

Source: Developed by the authors.

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

where α_0 is the mean of the intercept from the error terms cross-section and time series; $u_{it} = \mu_i + \varepsilon_{it}$, where μ_i is the random error of the cross-sectional deviation, which explains the differences between individuals; and ε_{it} is the error term of the model.

As a result of employing the fixed effect model, it was determined that the human development index, per capita gross domestic product and interest rate have a positive statistically significant relationship with foreign direct investment, whereas the consumer price index has a negative significant relationship with FDInvestment (*Table 6*).

Random effect model. Error terms in REM take into account the variations in individual characteristics. Error terms may correlate between individuals and between time periods [18]. We can formulate it as follows:

$$Y_t = \alpha + \sum_{j=1}^{k} \beta_j X_{jit} + \mu_{i+\varepsilon_i}, \quad (7)$$

As a result of employing the random effect model, it was determined that the financial development index, human development index, and interest rate have a positive statistically significant relationship with foreign direct investment, whereas the consumer price index, trade openness, and domestic credit to private sector calculated as percentage of GDP have a negative significant relationship with FDInvestment (*Table 7*).

4.4. Selection of the panel data regression model

Multiple tests must be carried out to settle on the model that will be used to deal with panel data.

Table 6
Fixed effect

FD Investment	Coef.	St. Err.	t–value	p–value	[95% Conf	Interval]	Sig
FDI	8528.507	5191.465	1.640	0.104	–1782.189	18 839.204	
HDI	23 677.845	10402.984	2.280	0.025	3016.620	44339.070	**
CPI	–8.979	3.532	–2.540	0.013	–15.993	–1.965	**
IR	214.528	65.93	3.250	0.002	83.585	345.471	***
TO	–6.366	12.3	–0.520	0.606	–30.794	18.062	
PCGDP	0.124	0.067	1.860	0.066	–0.008	0.256	*
DCtPS–%GDP	–16.002	12.053	–1.330	0.188	–39.94	7.936	
Constant	–18 983.483	7835.655	–2.420	0.017	–34 545.770	–3421.197	**

Mean dependent var	1670.449	SD dependent var	2181.461
R-squared	0.351	Number of obs	108
F-test	7.096	Prob > F	0.000
Akaike crit. (AIC)	1831.444	Bayesian crit. (BIC)	1852.901

Source: Developed by the authors.

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

1. Chow Test. The Chow test is used to determine the most appropriate model for the study between the common effect and fixed effect models. Using this test, we test the null hypothesis (CEM is more appropriate than FEM). The hypothesis in the Chow test can be written as follows:

H0: Common Effect Model is more appropriate than Fixed Effect Model.

H1: Fixed Effect Model is more appropriate than Common Effect Model.

If the P-value is less than 0.05, then we can reject the H0 hypothesis. This means that the FEM is a better model than the CEM.

2. Lagrange multiplier (Bruch-Pegan) test. To decide whether the model, CEM or REM, is superior, researchers employ the Lagrange multiplier (Bruch-Pegan) test. The LM test hypothesis may be expressed as follows:

H0: The Common Effect Model is more appropriate than the Random Effect Model.

H1: The Random Effect Model is more appropriate than the Common Effect Model.

If the P-value is less than 0.05, then we can reject the H0 hypothesis. That means that the REM is a better model than the CEM.

3. Hausman Test. Finally, we performed the Hausman test to determine which of the two models (FEM or REM) would provide the most accurate results. In the Hausman test, one possible hypothesis states as follows:

H0: Random Effect Model is more appropriate than Fixed Effect Model.

H1: Fixed Effect Model is more appropriate than Random Effect Model.

If the P-value<0.05, then we can reject the null hypothesis, and conclude that FEM is a better model than REM. To select the best model from CEM, FEM and REM we will follow the diagram *Fig. 2*. As we can see, our base model is REM to finalize the most appropriate model.

Estimation of the parameter model in the CEM, FEM, and REM methodologies involves the use of ordinary least squares (OLS) and general least squares (GLS) methods. The classical assumption

Table 7
Random effect

FD Investment	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
FDI	12 389.857	4410.504	2.810	0.005	3745.428	21 034.285	***
HDI	11 211.597	6395.127	1.750	0.080	−1322.622	23 745.816	*
CPI	−9.238	3.394	−2.720	0.006	−15.889	−2.586	***
IR	280.303	57.825	4.850	0.000	166.969	393.637	***
TO	−22.100	9.871	−2.240	0.025	−41.447	−2.754	**
PCGDP	−0.037	0.031	−1.180	0.239	−0.097	0.024	
DCtPS-%GDP	−35.954	8.807	−4.080	0.000	−53.216	−18.693	***
Constant	−6907.591	4307.491	−1.600	0.109	−15 350.118	1534.937	

Mean dependent var	1670.449	SD dependent var	2181.461
Overall r-squared	0.493	Number of obs.	108
Chi-square	46.981	Prob > chi2	0.000
R-squared within	0.302	R-squared between	0.616

Source: Developed by the authors.

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

tests are conducted to obtain the optimal OLS or GLS estimator, often referred to as the best linear unbiased estimator (BLUE). Classical assumption tests include three specific tests: the Breusch-Pagan LM test of independence, the Modified Wald test for groupwise heteroskedasticity, and the Wooldridge test for autocorrelation. The Jarque-Bera normality test is a statistical test used to assess the normality of a given dataset. According to Gujarati (2022), in order to acquire the best estimator, it is necessary to meet the requirements of tests 2 and 3 among the four tests [20]. The results of the Breusch-Pagan LM test for independence, Heteroskedasticity White test, the Wooldridge test for autocorrelation, and the Jarque-Bera normality test are shown in the table below. These tests were conducted with random effect.

The LM test does not need to be performed if FEM is found to be the best in the Chow Test and Hausman Test. This test is only performed when the best model found in the Chow Test is FEM, whereas in the Hausman Test, the best model is REM. After selecting an appropriate model, we apply the robustness tests to determine the validity of the model.

When selecting a model for managing panel data, it is necessary to conduct various tests. These tests include the Chow test, which is employed to determine the superior model between CEM and FEM [19]. In addition, the Breusch-Pagan Lagrange multiplier test was used to select a better model between CEM and REM, while the Hausman test was employed to choose the preferred model between FEM and REM.

The results of the Chow test, Breusch-Pagan Lagrange multiplier test and Hausman tests are illustrated in *Table 8*.

We used the Chow test, the Breusch, and Pagan Lagrange multiplier test, and the Hausman test to determine which model most accurately reflected the data. The Chow test was used to check whether the intercept in each regression model showed any differences across the various countries. According to the Chow test, the regression reliability was 95% accurate, with a p-value of $0.000 \leqslant 0.05$. As a result, the random effect model is the correct choice and accepts the null hypothesis H0.

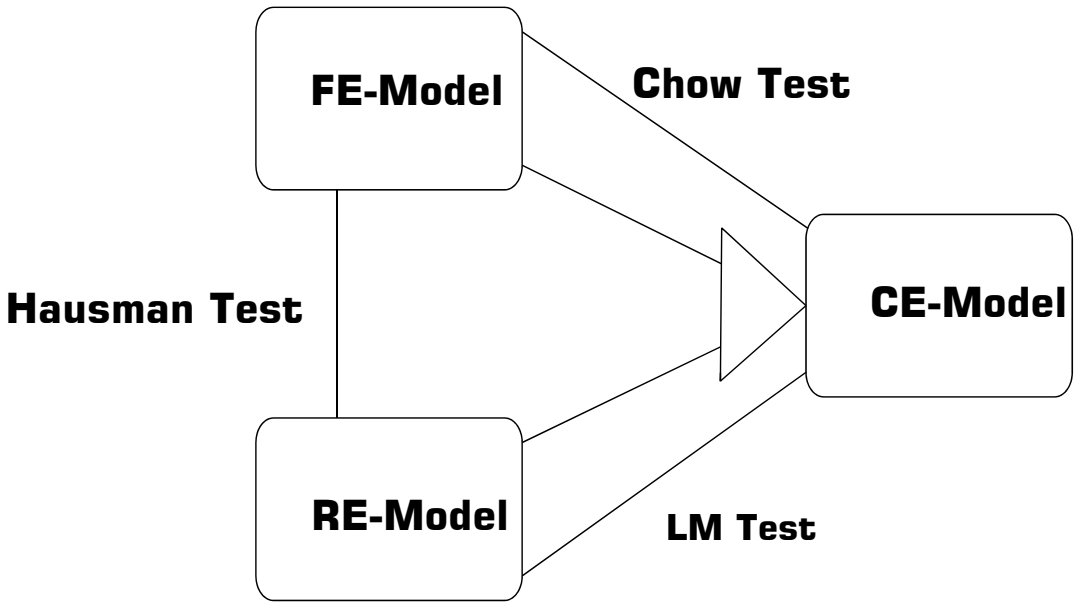

Fig. 2. **Diagram of selecting appropriate models of effects**

Source: Developed by the authors.

Table 8

Selecting the appropriate model for parameter estimation

Test name	Null hypothesis	P-value	Result
Chow Test	H0: CEM is more appropriate than FEM	0.000	Rejected
Breusch-Pagan Lagrange Multiplier Test	H0: CEM is more appropriate than REM	0.000	Rejected
Hausman Test	H0: REM is more appropriate than FEM	0.1780	Accepted

Source: Developed by the authors.

Note: common effect model (CEM); fixed effect model (FEM); random effect model (REM).

Hence, the appropriate model for this scenario is REM. The use of the Chow and Hausman tests suggests that REM is suitable for this analysis. After REM is selected as the panel data regression model, classical assumption tests are performed to obtain the best OLS estimator, known as the best linear unbiased estimator (BLUE).

Estimation of the parameter model in the CEM, FEM, and REM methodologies uses OLS and GLS methods. The classical assumption tests are conducted to get the optimal OLS or GLS estimator, often referred to as the BLUE. The classical assumption tests include three specific tests: the Breusch-Pagan LM test of independence, the Modified Wald test for groupwise heteroskedasticity, and the Wooldridge test for autocorrelation. The Jarque-Bera normality test is a statistical test used to assess the normality of a given dataset. According to Gujarati (2022), to acquire the best estimator, it is necessary to meet the requirements of tests 2 and 3 among the four tests [20]. The results of the Breusch-Pagan LM test for independence, the Heteroskedasticity White test, the Wooldridge test for autocorrelation, and the Jarque-Bera normality test are shown in *Table 9*. These tests were conducted with a random effect.

According to classical assumptions test, when residuals are not normally distributed and have dependency between cross sections, the model parameters (coefficient) will not be BLUE. In this

Table 9
Testing the validity of the selected model

Test Name	Null Hypothesis	Prob	Results
Breusch-Pagan LM test of independence	H0: There is no dependency between cross sections/individuals	0.000	Rejected
Heteroskedasticity White test	H0: The residuals are homoscedastic	0.002	Accepted
Wooldridge test for autocorrelation	H0: There is no autocorrelation between residuals	0.229	Accepted
Jarque-Bera normality test	H0: Residuals are normally distributed	0.000	Rejected

Source: Developed by the authors.

Table 10
Randon effect model robust SE regression

FD Investment	Coef.	St. Err.	t-value	p-value	[95% Conf	[Interval]	Sig
FDI	12 389.857	7034.772	1.760	.078	−1398.043	26 177.756	*
HDI	11 211.597	6028.547	1.860	.063	−604.138	23 027.332	*
CPI	−9.238	2.915	−3.170	.002	−14.951	−3.524	***
IR	280.303	110.393	2.540	.011	63.938	496.668	**
TO	−22.100	13.864	−1.590	.111	−49.274	5.073	
PCGDP	−0.037	0.037	−0.990	.324	−0.109	0.036	
DCtPS-%GDP	−35.954	9.192	−3.910	0.000	−53.970	−17.939	***
Constant	−6907.591	4130.732	−1.670	0.094	−15 003.677	1188.496	*

Mean dependent var	1670.449	SD dependent var	2181.461
Overall r-squared	0.493	Number of obs	108
Chi-square	512.249	Prob > chi2	0.000
R-squared within	0.302	R-squared between	0.616

Source: Developed by the authors.

Notes: *** p<0.01, ** p<0.05, * p<0.10.

case, we can use robust standard error to correct the standard error of the model. The final model for this research. To test the validity of the model results, we use the following robustness (classical assumptions) tests. After correcting the standard error of the model, the effect regression model will be Randon Effect Model Robust SE Regression as shown in *Table 10*.

The results could be concluded as follows:

1. Foreign direct investment has a positive and significant effect (p-value < 0.10) on the financial development index in selected Arab League countries; this means a 1% increase in financial development will increase foreign direct investment by about 12,389 million USD.

2. Foreign direct investment has a positive and significant effect (p-value < 0.10) on the human development index in some selected Arab League countries; this means an increase in each percent of human development will increase foreign direct investment by about 11,211 million USD.

3. Foreign direct investment has a positive and significant relation to the interest rate, whereas the consumer price index and domestic credit to the private sector have a negative and significant impact on financial development. Overall, the model is significant at 95 percent, with a confidence level F (8, 92) = 7.19 and p-value = 0.000 < 0.05, which clarifies that the null hypothesis (H0: the predictor variable simultaneously does not affect the response variable) is rejected. As a result, the predictor variable simultaneously affects the response variable. The value of $R^2 = 0.615$ shows that the independent variable (financial development index) and controlled variables (human development index, consumer price index, interest rate, and domestic credit to private sector as percentage of GDP) can affect the outcome variable (foreign direct investment) in the Arab League countries by 61.5 percent while assuming the other effecting factors are constant.

5. Discussion and conclusions

The paper explores the relationship between foreign direct investment and the financial development index. This relationship has been investigated using an econometric model with one independent, one dependent and six controlled variables. Panel data were analyzed using Stata 17 and EViews 13. Results indicate that there has been a positive and statistically significant relationship between foreign direct investment and the financial development index, human development index, and interest rates, whereas a negative relationship exists between foreign direct investment and the consumer price index and domestic credit to the private sector as percentage of GDP. In recent years, some studies have shown that foreign direct investment has an impact on financial development and vice versa, but only a few studies have identified that there is no effect between foreign direct investment and financial development. While our research has established a positive influence of FDInvestment on financial and human developments, this result agrees with the studies [14–17].

Furthermore, the results of the study indicate that the contribution of domestic investment is essential and more significant than the foreign investment of every country, especially in Organisation of Islamic Cooperation (OIC) member countries, such as Malaysia, where a 1% increase in foreign direct investment contributes 0.02% to GDP, while local investment contributes up to 0.025%. For greater efficiency and contribution to GDP regarding foreign investment, certain economic, political, and cultural structures must be changed according to the national strategies of countries. The selected OIC member countries should pay attention to monetary policy based on interest rates, domestic credit to the private sector and inflation, where the interest rate positively affects foreign direct investment. In contrast, inflation and domestic credit to the private sector negatively affect foreign direct investment. The limitation of this study was the focus on foreign direct investment instead of considering other types of investment, such as portfolio investment or financial assets. A further constraint of this analysis was the use of aggregate foreign direct investment instead of sector-specific foreign direct investment. The authors suggest that the future investigation maintain the controlled variables of the study as main variables in the context of OIC member countries and could compare one or a group of the member countries to the rest of the countries to find a solution to the problem. Several factors, including initial income, human capital, population growth, government consumption, black market premium, institutional quality, rate of inflation, and trade volume, may influence the

effectiveness of FDInvestment. In future research, these variables could be considered as moderated variables between foreign direct investment and financial development in the context of different continents. The study also recommended that the government and policymakers implement financial system quality standards, and that country authorities should also aim to boost the banking sector and financial markets by enacting market-friendly policies.

REFERENCES

1. Johnny N., Timipere E.T., Krokeme O., Markjackson D. Impact of foreign direct investment on unemployment rate in Nigeria (1980–2015). *International Journal of Academic Research in Business and Social Sciences*. 2018; Feb8(3):57–69. URL: http://dx.doi.org/10.6007/IJARBSS/v8-i2/3905
2. Ang J.B. Foreign direct investment and its impact on the Thai economy: the role of financial development. *Journal of Economics and Finance.* 2009; Jul33:316–323. URL: https://doi.org/10.1007/s12197–008–9042–6
3. Štreimikienė D. World economic forum 2012. *Intelektinė ekonomika.* 2012;6(1):806–810. URL: https://www.ceeol.com/search/article-detail?id=129960
4. Iršová Z., Havránek T. Determinants of horizontal spillovers from FDI: Evidence from a large meta-analysis. *World Development.* 2013;Feb1;42:1–5. URL: https://doi.org/10.1016/j.worlddev.2012.07.001
5. Ang J.B. Economic development, pollutant emissions and energy consumption in Malaysia. *Journal of Policy Modeling.* 2008;Mar1;30(2):271–278. URL: https://doi.org/10.1016/j.jpolmod.2007.04.010
6. Irandoust M. FDI and financial development: Evidence from eight post-communist countries. *Studies in Economics and Econometrics.* 2021;Apr3;45(2):102–116. URL: https://doi.org/10.1080/03796205.2021.1978859
7. Svirydzenka K. Introducing a new broad-based index of financial development. International Monetary Fund. 2016;Jan12. URL: https://www.elibrary.imf.org/view/journals/001/2016/005/article-A001-en.xml
8. Lenzen M., Moran D., Kanemoto K., Foran B., Lobefaro L., Geschke A. International trade drives biodiversity threats in developing nations. *Nature*. 2012;Jun7;486(7401):109–112. URL: https://doi.org/10.1038/nature11145
9. Tocar S. Determinants of foreign direct investment: A review. *Review of Economic and Business Studies*. 2018;11(1):165–196. DOI: 10.1515/rebs-2018–0069
10. Sahin S., Ege I. Financial development and FDI in Greece and neighbouring countries: A panel data analysis. *Procedia Economics and Finance.* 2015;Jan1;24:583–588. URL: https://doi.org/10.1016/S 2212–5671(15)00640–1
11. Orji A., Nwagu G.U., Ogbuabor J.E., Anthony-Orji O.I. foreign direct investment and growth nexus: Further evidence from Africa's largest economy. *Journal of Infrastructure Development*. 2021; Jun13(1):65–78. URL: https://doi.org/10.1177/09749306211024433
12. Gökmenoğlu K.K., Apinran M.O., Taşpınar N. Impact of foreign direct investment on human development index in Nigeria. *Business and Economics Research Journal.* 2018;9(1):1–4. DOI: 10.20409/berj.2018.90
13. Saidi K. Foreign direct investment, financial development and their impact on the GDP growth in low-income countries. *International Economic Journal*. 2018; Jul3;32(3):483–497. URL: https://doi.org/10.1080/10168737.2018.1529813
14. Bayar Y., Gavriletea M.D. Foreign direct investment inflows and financial development in Central and Eastern European Union countries: A panel cointegration and causality. *International Journal of Financial Studies*. 2018; May29;6(2):55. URL: https://doi.org/10.3390/ijfs6020055
15. Majeed A., Jiang P., Mahmood A., Khan M.A., Olah J. The impact of foreign direct investment on financial development: new evidence from panel cointegration and causality analysis. *Journal of Competitiveness*. 2021; Mar1;13(1):95. URL: https://doi.org/10.7441/joc.2021.01.06
16. Lestari D., Lesmana D., Yudaruddin Y.A., Yudaruddin R. The impact of financial development and corruption on foreign direct investment in developing countries. *Investment Management and Financial Innovations*. 2022;19(2):211–220. URL: http://dx.doi.org/10.21511/imfi.19(2).2022.18
17. Nguyen C.T., Nguyen C.D., Do Bui V. Index of financial development with foreign direct investment: case of Vietnam. *Contemporary Economics.* 2023;Sep1;17(3). DOI: 10.5709/ce.1897–9254.513
18. Jauhari A.F., Suprapto Y.K., Mauludiyanto A. Data panel modelling with fixed effect model (FEM) approach to analyze the influencing factors of DHF in Pasuruan Regency. ICASESS 2019. 2020:224. URL: http://repository.

umy.ac.id/bitstream/handle/123456789/35320/ICASESS_2019.pdf?sequence=1&isAllowed=y%23page=186#page=241
19. Greene W. Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. *Journal of Econometrics*. 2005; Jun1;126(2):269–303. URL: https://doi.org/10.1016/j.jeconom.2004.05.003
20. Gujarati D.N. Basic econometrics. Prentice Hall; 2022;Jan1. URL: http://portal.belesparadisecollege.edu.et:8080/library/bitstream/123456789/2098/1/Basic%20Economics-The%20McGraw-Hill%20Series.pdf

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Нитауип Нитта — Ph.D. Candidate in Accounting and Finance, Faculty of Economics and Administrative Sciences, Selçuk University, Konya, Türkiye
Хумаюн Хумта — аспирант банковского дела и финансов, Институт социальных наук, экономики и административных наук, Университет Сельчук, Конья, Турция
https://orcid.org/0000-0002-2921-6265
Corresponding Author / Автор для корреспонденции:
h.humta@gmail.com

İbrahim E. Şahin — Associate Professor of Accounting and Finance and Coordinator of Faculty Member Training Program, Faculty of Economics and Administrative Sciences, Selçuk University, Konya, Türkiye
Ибрагим Э. Шахин — доцент кафедры финансов и координатор программы подготовки преподавателей факультета экономики и административных наук/бухгалтерского учета и финансов, Университет Сельчук, Конья, Турция
https://orcid.org/0000-0002-0442-8499
eremsahin@selcuk.edu.tr

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.
The article was submitted on 09.11.2023; revised on 07.12.2023 and accepted for publication on 11.12.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-45-60
UDC 336.71:339.7:332.25(045)
JEL G21, G28, O14

Industry 4.0 and its Impact on the Development of Vietnamese Commercial Banks

T.T.D. Loan
Joint Stock Commercial Bank for Foreign Trade of Vietnam, Hanoi, Vietnam

ABSTRACT

The Fourth Industrial Revolution (Industry 4.0), with technological achievements in artificial intelligence, blockchain technology, big data, the Internet of Things, etc., has significantly affected various aspects of the economy, including the banking sector. **The aim** of this article is to evaluate and forecast the transformation of the banking industry globally and in Vietnam. This study employs **methods** of secondary data synthesis and comparative analysis and reviews the research reports of regulatory agencies and consulting organizations. The article **resulted** in identifying the characteristics of Industry 4.0 and its impact on the banking and finance industries. The author highlights the main challenges in applying digital technology in Vietnamese banks and draws the **conclusion** that digital technology in the banking sector in Vietnam is still at a low level, with one of the most critical issues being the lack of a legal framework related to digital finance and electronic transactions.

Keywords: Industry 4.0; digital banking; banking; digital technology; financial industry; commercial bank; Vietnam

For citation: **Loan T.T.D. Industry 4.0 and its impact on the development of Vietnamese commercial banks. *Review of Business and Economics Studies*. 2023;11(4):45-60. DOI: 10.26794/2308-944X-2023-11-4-45-60**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Индустрия 4.0 и ее влияние на развитие коммерческих банков Вьетнама

Т.Т.Д. Лоан
Акционерный коммерческий банк внешней торговли Вьетнама, Ханой, Вьетнам

АННОТАЦИЯ

Четвертая промышленная революция (Индустрия 4.0) с технологическими достижениями в области искусственного интеллекта, технологии блокчейн, больших данных, интернета вещей и т.д. существенно повлияла на различные аспекты экономики, включая банковский сектор. **Цель** этой статьи — оценить и спрогнозировать трансформацию банковской отрасли во всем мире и во Вьетнаме. В статье использованы **методы** синтеза и сравнительного анализа вторичных данных, а также обзор исследовательских отчетов органов государственного управления и консалтинговых организаций. Результаты исследования позволили определить характеристики Индустрии 4.0 и ее общее влияние на банковскую и финансовую отрасли. В статье освещаются основные проблемы применения цифровых технологий в деятельности вьетнамских банков. Автор делает вывод, что цифровые технологии в банковском секторе Вьетнама все еще находятся на низком уровне, а одной из наиболее острых проблем является отсутствие законодательной базы, связанной с цифровыми финансами и электронными транзакциями.

Ключевые слова: Индустрия 4.0; цифровой банкинг; банковское дело; цифровые технологии; финансовая индустрия; коммерческий банк; Вьетнам

Для цитирования: **Лоан Т.Т.Д. Индустрия 4.0 и ее влияние на развитие коммерческих банков Вьетнама. *Review of Business and Economics Studies*. 2023;11(4):45-60. DOI: 10.26794/2308-944X-2023-11-4-45-60**

1. Introduction and literature review

Industry 4.0, accompanied by the emergence of digital currencies, online payment platforms, and fintech service providers, as well as the entry and dominance of multinational companies with large data platforms and technological capabilities such as Google and Amazon, has a direct and profound impact on the banking and financial industries, creating unprecedented competitive pressure on traditional banking service providers. Many countries worldwide and advanced banks have accelerated the adoption of Industry 4.0 applications to develop banking services and build a customer-centric banking service ecosystem.

Several studies focus on various aspects of Industry 4.0, its components, and its impact on the banking system. Citigroup's 2018 [1] research shows that the growth drivers of banking digital transformation include: i) The increasing entry and dominance of financial technology companies (Fintech) and large technology companies (Bigtech) expanding into banking and financial services, such as Google, Amazon, Alibaba; ii) Changing customer needs and the growing demand for higher customer experiences; iii) Increasing compliance requirements, especially after the 2009 US financial crisis; iv) Rising costs of maintaining outdated core banking systems, inflexible designs focused on products rather than customers, prolonged and slow product life cycles; v) Gradual decline in profit margins. This research also revealed that the components of Industry 4.0, such as Big Data, machine learning, deep learning, artificial intelligence (AI), blockchain technology, big data, the Internet of Things (IoT), automation, and blockchain, have a significant impact on banking and financial services, influencing three crucial aspects: customer engagement, operations, and compliance and risk management. Research by Oliver Wyman in 2018 [2] and Baker McKenzie in 2022[1] on the impact of Industry 4.0 on the ecosystem, operational environment, and business models of banks interacting with financial technology companies (Fintech) shows that Fintech tends to collaborate and diversify the bank's ecosystem symbiotically. There are various forms of collaboration between Bigtech and banks to provide customer services. For example, Go-Jek collaborates with banks in Indonesia to provide microfinance for drivers; Amazon provides accounts through J.P. Morgan and Facebook*[2] partners with Western Union for real-time international money transfers with competitive exchange rates and real-time customer support on the Facebook* application.

In Vietnam, Industry 4.0 significantly transformed the nature of banking products and services. Many commercial banks have applied various Industry 4.0 technologies and solutions, such as big data analytics, artificial intelligence, and biometric authentication, to create digital payment services for digital banks, assess customer behavior, predict revenue and market demand, and issue risk warnings. Several studies in Vietnam have focused on Industry 4.0, including big data, digitization, bank's interaction with Fintech companies, and the development of the Fintech ecosystem. The research "Impact of the fourth industrial revolution on the banking industry and the digital banking goal of Vietcombank" by Nghiem Xuan Thanh (2020) [3], the reference book "Vietnam banking with the fourth industrial revolution and approaches" by Pham Xuan Hoe and co-authors [4], having examined the strategic development direction of Industry 4.0 outlined in the governmental guiding documents, stated that the Vietnamese government is determined in its digital transformation efforts. Simultaneously, a survey of the commercial banking system in Vietnam revealed that technological innovation is a central pillar in the development strategy of these banks. Most banks have plans to expand their operations with Fintech, particularly in areas such as payment services, internet banking, data research, personal finance, lending, and remittances.

The study "Digital banking — development orientation in Vietnam" by Pham Tien Dung in 2018 [5] assesses the current situation and digital banking development technologies in Vietnam. According to the survey conducted by the State Bank of Vietnam in April 2018, 94% of banks have started implementing or are

[1] URL: https://www.bakermckenzie.com/-/media/files/insight/publications/2022/02/baker-mckenzie — finding-balance — the-impact-of-new-technology-on-fis.pdf

[2] * Facebook designated as an extremist organization and banned in Russia. Marked with * throughout the text.

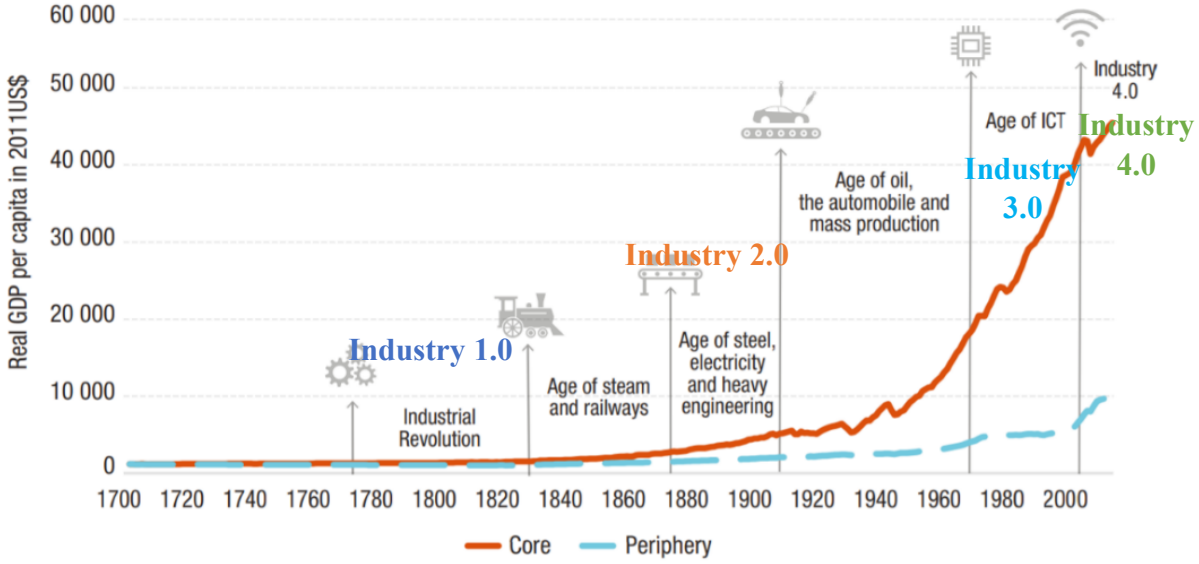

Fig. 1. **Technological changes and income disparity across the stages of Industrial Revolutions**

Source: UNCTAD [6].

researching and building a digital conversion strategy, with 59% of banks starting to implement it in practice. Cloud computing and big data analytics are applied and considered to impact digital transformation strongly. Artificial intelligence and blockchain technologies have great potential, whereas the Internet of Things and robotic automation are not widely applied. Evaluating the current deployment, most Vietnamese banks have implemented digital banking at the process level (improving automated transaction systems) and communication channels (some banks have implemented virtual assistants and 24/7 service advice on social media). Building on the results of research on various aspects, this paper takes a cross-sectional approach to developing banking services based on general technology applications, specifically Industry 4.0 technology.

2. Impacts of Industry 4.0

In the course of global industrial development history, there have been three industrial revolutions, and we are currently in the fourth industrial revolution (*Fig. 1*).

The First Industrial Revolution — Industry 1.0 (1784 — mid-19th century) was a revolution in the manufacturing sector, originating in England and later spreading worldwide with the development of steam engines and railways, replacing the simple, small-scale labor-based economy with an industrial economy and large-scale machinery manufacturing.

The Second Industrial Revolution — Industry 2.0 (1860–1960) was a revolution driven primarily by internal combustion engines and machinery using electricity. Economic and technical advancements were achieved through the development of the telegraph, telephone, railways, and mass production assembly lines.

The Third Industrial Revolution — Industry 3.0 (1969–1997) was a revolution in automated production based on the emergence and development of information technology, electronic devices, and the Internet. This revolution occurred with advancements in electronic infrastructure, computers, and digitization. These technologies were driven by the development of semiconductors, supercomputers, personal computers, and the Internet, along with technological developments in Western Europe, Australia, Canada, New Zealand, the United States, and Japan, which surged ahead to become the world's development centers. At the same time, other countries remained in the peripheral regions. The income gap between areas increased with development trends. Some East Asian countries (South Korea, Taiwan, etc.) later caught up through learning, imitation, and technological innovation [6].

The Fourth Industrial Revolution — Industry 4.0 (starting in the early 2000s) is characterized by integrating technologies from various fields, blurring the physical, digital, and biological boundaries (*Fig. 2*). Compared to previous revolutions, Industry 4.0 has developed

Fig. 2. **Overview of Industry 4.0**

Source: Amir Mehdiabadi et al (2020) [7].

exponentially rather than linearly. Technological breakthroughs occur rapidly, and mutual interaction accelerates the creation of a digitized, automated, and increasingly intelligent world, breaking existing standards in most industries worldwide. The breadth and depth of these changes foreshadow the transformation of the entire production, management, and governance systems.

In previous industrial revolutions, steam power, oil, and electricity were the fuels driving economic development. However, in the era of Industry 4.0, data are believed to become a new fuel source. In Industry 4.0, IoT technology and blockchain are "data drills," pouring into the reservoir of Big Data and refined by AI on cloud computing platforms into helpful information before being transferred to automation and IoT applications.[3] The Fourth Industrial Revolution (Industry 4.0) has profoundly impacted the global economy and the financial banking market.

2.1. For the economy

First, Industry 4.0 fundamentally changes the methods of global economic production and labor organization. While previous industrial revolutions focused on tangible production assets (steam engines, electricity with mass production assembly lines, the internet network), Industry 4.0 is a synthesis of digital, biological, and physical technological revolutions. It introduces unprecedented technological breakthroughs, forming new production and consumption models. Industry 4.0 also enhances specialization in the service sector by creating high-concentration business platforms that bring specific groups together horizontally through interactive models (P2P, the sharing economy with applications like ride-sharing and hotel services).

Global economic growth is calculated based on GDP and production activity indices. However, the latest technological revolution has shifted this dependence on services and technology. According to the World Economic Forum (WEF) [8], investing $1 in digital technology has increased GDP by an additional $20 over the past 30 years, whereas a similar investment in non-digital technology has only increased GDP by another $3 during the same period. WEF forecasts that 24.3% of global GDP will come from digital technologies such as artificial intelligence and cloud computing by 2025, while Market Watch predicts that the emerging

[3] URL: https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data

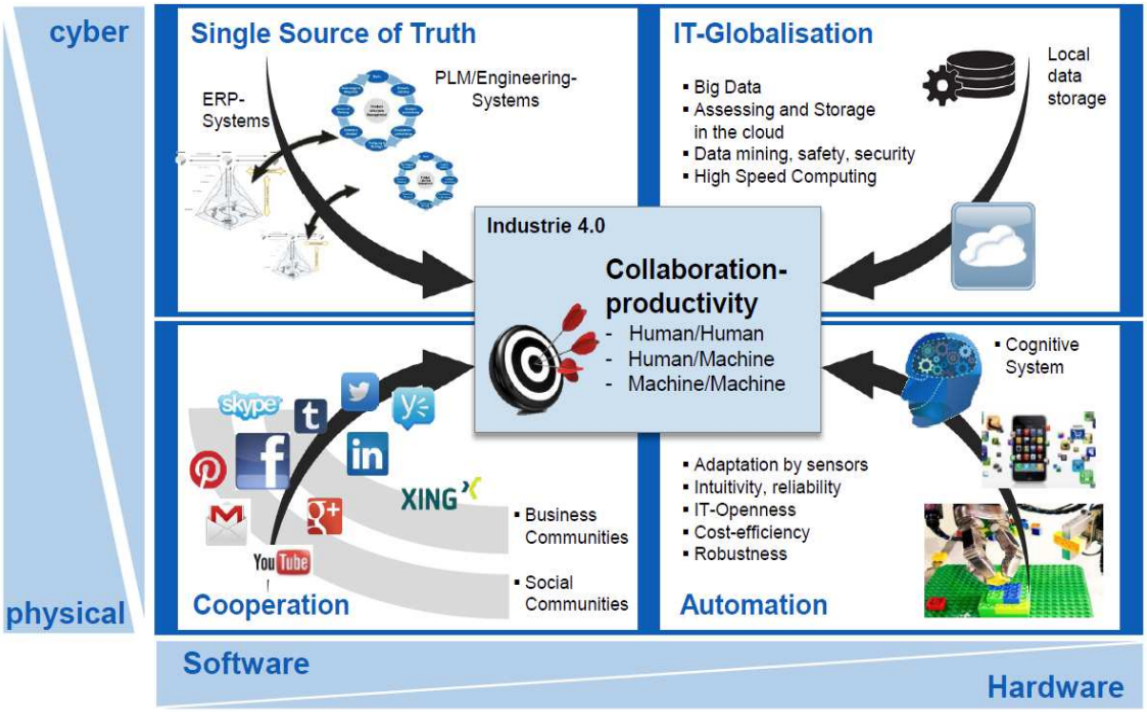

Fig. 3. **Four main preconditions of productivity growth**

Source: Jozef Hercko and Jozef Hnat (2015) [11].

self-driving car industry is expected to grow by USD 319.41 billion, accelerating at a CAGR of 38.45% between 2022 and 2027.[4]

Second, Industry 4.0 impacts global production capabilities' technology and comprehensive factors (*Fig. 3*). Industry 4.0 has the potential to increase international income levels and improve the quality of life for people worldwide. In the current conditions, the relatively high accessibility to digital and advanced technologies such as IoT, AI, cloud computing, big data, etc., has helped increase the daily life efficiency of the global population. Technological innovation in the coming years will provide more opportunities for access to the digital environment, delivering long-term benefits in terms of efficiency and productivity. WEF predicts that new technologies will reduce transportation and communication costs, leading to more efficient global logistics and supply chains. Reducing trade costs opens up new market opportunities, promotes global economic growth. Because it is less limited by marginal productivity and the scarcity of resources, Industry 4.0 is expected to create non-linear growth in global output and employment. McKinsey (2019) [9, 10] estimates that Industry 4.0 has the potential to create value for manufacturers and suppliers of $3.7 trillion by 2025. Though Industry 4.0 is an opportunity for countries to accelerate and rise strongly, it could also be a risk if countries lag behind in their integration into the game.

2.2. For the financial banking sector

Industry 4.0 is predicted to revolutionize operations, from online payments and network-based lending to digital currency and online foreign exchange transactions. Industry 4.0 brings various new opportunities for organizations operating in the financial banking sector:

Industry 4.0 introduces new models and business areas. The new technology eliminates financial intermediaries, facilitating faster and more cost-effective financial transactions and increasing accessibility to financial services 24/7 in real-time. According to Nielsen Research, mobile devices have become a new standard for banking activities, with the Asia-Pacific and African regions being the main drivers of global mobile banking growth. In the U.S., over 70% of stock transactions are algorithmically

[4] URL: https://www.marketwatch.com/press-release/autonomous-vehicles-market-size-is-projected-to-reach-a-growth-value-of-usd-319–41-billion-from-2022–2027-increasing-demand-for-autonomy-of-vehicles-by-oems-to-drive-the-market-growth-technavio-817cc0f0

determined, saving a significant amount on financial advisory services. Importantly, technology provides opportunities for the impoverished and those facing financial difficulties to access financial solutions for the first time. In Bangladesh, technology-supported microloans have opened a new era of empowering financial autonomy for those in challenging circumstances in rural areas.

Industry 4.0 enhances the customer experience. Technology enables companies to improve customer experiences up to tenfold by providing visual, personalized, and highly connected interactions. With big data, companies can access in-depth information about customer habits, preferences, and needs. AI helps companies easily adjust customer experiences, reach customers at crucial touchpoints, and modify products and services, accordingly, thus increasing customer satisfaction. Surveys show that 70% of customers consider connected processes a primary requirement, and 59% consider adjusted and contextually relevant interactions based on previous interactions as crucial factors in choosing financial service providers.

Industry 4.0 enhances efficiency and security. One of the inevitable consequences of Industry 4.0 is the transformation of the comprehensive banking system with the emergence of digital currency, particularly blockchain technology. Blockchain transparently and securely records transactions, allowing people worldwide to instantly send money everywhere at low costs. These transactions are protected by encryption, significantly minimizing the risk of attacks.

Industry 4.0 enhances the flexibility of financial organizations. Industry 4.0 places increasing pressure on industries to respond to events and customers immediately, 24/7. To achieve this, banks and financial organizations must be as flexible and agile as possible to quickly solve problems and change directions. Industry 4.0 also brings opportunities to apply technology, making financial organizations more flexible. For example, Hybrid Cloud is an IT infrastructure connecting public and private cloud spaces to create a relaxed and unique cloud environment. Additionally, Industry 4.0 applications help financial organizations market efficiently and purposefully, support effective customer service through low-cost robots, expand operational areas, minimize risks through data-driven assessments, improve business management, reduce human errors in financial activities, and enhance transparency and reliability with accountable explanations and more straightforward repairs.

However, along with the opportunities, Industry 4.0 also presents significant challenges for financial institutions and banks. These challenges are listed below.

Increase in cybersecurity risks and cybercrime. Network threats, including ransomware, fraud, information leaks, and daily data breaches, are becoming more sophisticated. The growing integration of technology into the financial industry through Industry 4.0 also amplifies the risk of companies facing cyberattacks. TechJury statistics reveal that up to 34% of financial enterprises are affected by internal threats annually, with fraudulent attacks accounting for 14% of total data breaches. A cyberattack not only has financial implications for an organization, with an average cost of approximately USD 18.3 million, but it can also cause irreparable damage to its reputation. For example, in the case of the consumer credit reporting agency Equifax, a cyberattack resulted in the exposure of 15.2 million customer profiles, unauthorized access to 10,000 credit card numbers, and over 15,000 customers being compromised with accessed personal information (usernames, passwords, security questions, phone numbers, and email addresses).

Challenges in building trust and relationships with customers. 95% of customers stated that trust in a company increases their loyalty. However, building trust becomes increasingly challenging with Industry 4.0 and the move towards a world where everything is virtually digitized with minimal human interaction. Computers and connected technologies cannot provide customers with emotions, creativity, imagination, empathy, or intuition. Banks will need to find new and innovative ways to incorporate human elements and personal touches into online services, and AI-based chatbots may become standard tools in this effort.

The intensifying competitive pressure in the financial industry. The emergence of new competitive players, such as FinTech and BigTech, along with rapid advancements in digital tech-

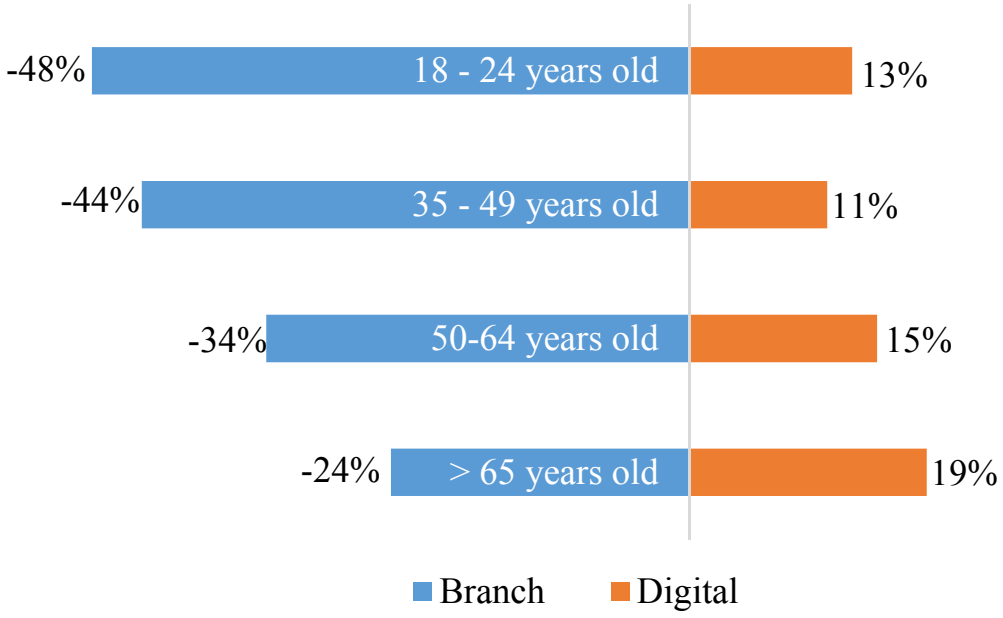

Fig. 4. **Changes in the number of bank customers across distribution channels by quarter, 2015–2020**

Source: Based on Deloitte (2021) [12].

nology, has created a substantial increase in competitive pressure in the financial sector. Research Gate assesses that the new competitive landscape could put banks at risk of losing one-third of their profits, and the subsequent stages of digital transformation may lead to even deeper declines in bank profits. Banks and financial organizations must adjust their operations, enhance competition with innovative digital services, embrace online services, and adapt to mobile-friendly systems. Based on these adjustments, financial organizations will gradually shift from traditional financial organizational forms to dynamic platforms focused on digital technology, offering competitive products and services with seamless user experiences based on customer data analysis.

3. Trends in the development of banking services

3.1. Global trends

The financial sector, particularly banking, is a dynamic industry with fierce competition for products and services. Banks continually strive to develop and transform to avoid falling behind their competitors. The history of banking competition has progressed from providing the first ATM, the first telephone banking, the first online banking, and the first mobile banking applications to the current race toward a digital banking structure.

Adverse impacts from the 2007–2008 financial crisis, such as slow economic growth, low interest rates, and increased compliance costs, led to a significant decline in bank profits (return on equity for banks, according to McKinsey's statistics [9], decreased from 16% to 8–10%). As a result, banks are facing intense competitive pressure. The combination of financial services and technology provides an opportunity for banks to penetrate the market rapidly.

Banks worldwide have capitalized on the development of new technology in the era of Industry 4.0 to upgrade not only the products and services provided to customers but also their internal operational distribution processes. Some prominent trends in the application of technology by banks worldwide in recent times include:

Expanding digital distribution channels. According to statistics from various research organizations, the number of physical branches of banks worldwide peaked in 2016 and began to decline later. The significance of non-branch banks is increasingly considered a result of digital banking. The digital banking market in the United States is estimated to reach $4.3 billion in 2021, holding a 28.78% market share globally. China, the world's second-largest economy, is forecast to have an estimated market size of $4.6 billion by 2026, with a compound annual

growth rate (CAGR) of 19.9% during the analysis period. Japan and Canada are predicted to grow at 11% and 13.1%, respectively. In Europe, Germany is expected to grow at a CAGR of approximately 14.5%.

The field of mobile banking has emerged as a new customer attraction channel, becoming the dominant channel for retail banking rather than just one of the segments in the previous stages. Financial organizations also consider mobile platforms necessary for effective competition. Some banks use the mobile channel as a strategic differentiator because customers can leverage it anytime, anywhere to access various banking products and services (balance inquiries, payments, fund transfers between accounts, account information access, account opening, credit or loan renewal applications, branch or ATM location search, investments, and access to content services). Customers are shifting based on age, and younger generations are predicted to drive the demand for mobile banking services. The lack of branch infrastructure in developing markets is also expected to boost the demand for mobile banking services, consequently driving mobile data traffic (*Fig. 4*).

Apart from distribution channels such as automated teller machines (ATMs), the internet, and mobile devices, banks can now reach their customers on alternative platforms through self-developed applications, providing more value to customers in an open environment through using API.[5] APIs are powerful tools to reshaping the old architecture of the banking information system and adjusting the operating methods to fit current conditions, thus increasing the flexibility of the banking information system and opening up new growth opportunities by separating products into new role-playing components at various levels of the value chain. With a banking system based on an API-driven open architecture, the payment infrastructure is expected to become commonplace shortly without requiring physical cards or point-of-sale terminals (Badr Machkou, 2020) [13]. In the UK, Monzo, an online bank entirely operated through an app established in 2015, now has over 5 million users, rapidly gaining market share from financial institutions that have been in the market for centuries. However, to successfully implement API-driven open banking ecosystems, banks require a clear strategy, enhanced data, robust technological architecture, and the ability to manage multiple business models in an investment portfolio.

Optimizing internal operational processes. Most financial organizations rely on cloud computing technology and data analysis to increase efficiency and enhance business analysis systems. However, organizations must seek new digital support tools that meet growing customer demand, processing speed, and higher security requirements. Financial organizations worldwide see these challenges as part of their business strategy and are currently using several new digital technology solutions to increase revenue, optimize costs, and minimize risks:

Robotic Process Automation (RPA) for process automation. Implementing RPA can enable banks to reduce manual efforts, provide better compliance, minimize risks, and enhance the overall consumer experience. For example, RPA can streamline the loan processing workflow to a record of 10–15 minutes by automatically extracting information from documents, using machine learning for data analysis, and generating automatic confirmation emails. RPA can also track all accounts, send automated reminders, automatically cancel transactions, directly record debts, and change interest rates and transfer fees. RPA collects customer information, filters and verifies data to shorten processing time, minimizes errors in customer verification, and helps save Know Your Customer (KYC) costs (up to USD 500 million per year, according to Thompson Reuters statistics). Furthermore, the most significant advantage of automation for banks and financial organizations is that it requires no additional infrastructure and provides easy access.

Integration between back-end operational support systems and user interaction (front-end). According to a study by the Capgemini World FinTech Report (2020) [14], over half of the surveyed banks do not provide an integrated experience, making it difficult for customers to access a single platform due to legacy systems, paper-based documentation, and complex manual processes slowing down information

[5] Application Programming Interface — information technology solutions that enable applications to communicate and exchange service data with each other.

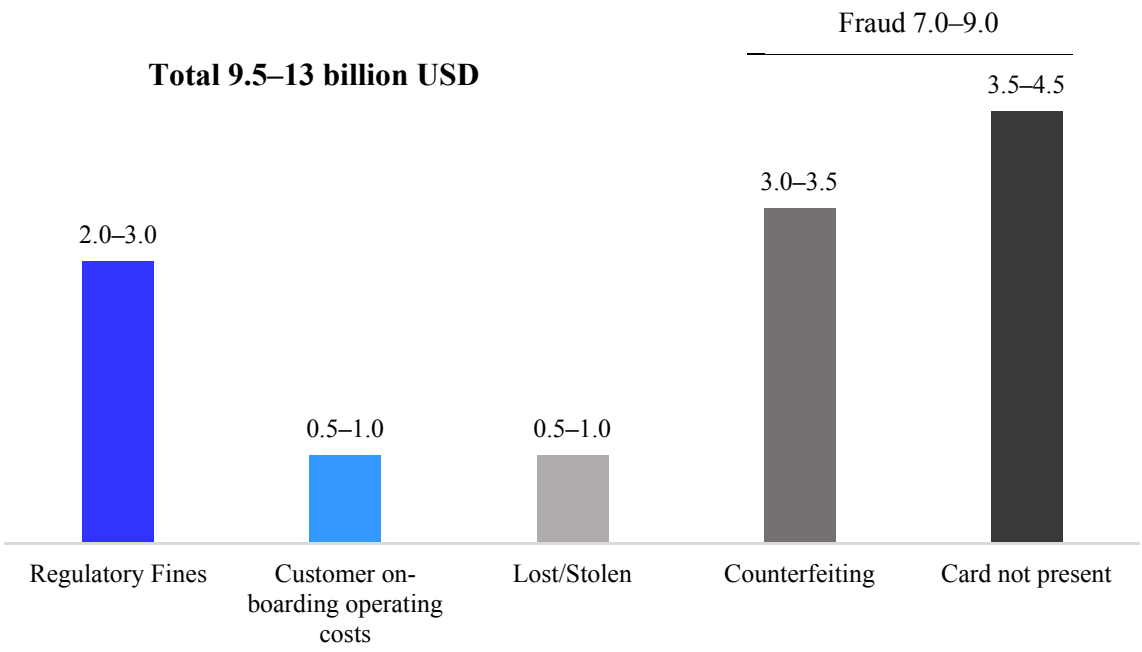

Fig. 5. **Cost savings in the banking industry due to blockchain solutions (billion USD)**

Source: Based on McKinsey (2019) [10].

technology systems and congesting the digital ecosystem that banks are striving to establish. Capgemini's statistics (2020) [14] show that banks have 300–800 intermediate processes and offices on a scale of operations with many complex processes extending across various business units. Many banks worldwide are collaborating with FinTech companies to build a customer journey map that places data collection at the center of the process, facilitating innovation for operational support departments within the bank. Some examples include Abbank and Datameer collaborating on data analysis and management; United Overseas Bank and Tookitaki Holdings collaborating on enhancing and applying technology in AML (anti-money laundering); DZBank and Vectra collaborating on using technology in security, electronic signatures, and electronic contract management; Deutsche Bank and Finantix collaborating on online customer verification (KYC); Morgan Stanley and Box collaborating on applying API technology in document processing to reduce intermediaries.

Application of Distributed Ledger Technology (Blockchain). Blockchain is considered to be the core of 4.0 technology, one of the most important innovative technologies in the financial industry's digital transformation. Blockchain can be used in three ways: asset transfer (money, securities, etc.), tracing the origin of assets and products, and executing smart contracts. Consequently, blockchain can perform e-commerce, banking, notary, and government transactions faster, cheaper, and more safely. Many banks worldwide have applied this technology, such as ABN Amro, ING, and Rabobank (Netherlands), which have announced R&D activities on Blockchain technology to improve payment systems; Bank of America, Deutsche Bank, Goldman Sachs, Citigroup, and Santander have also invested significantly and established research laboratories. According to McKinsey, banks will save 9.5–13 billion USD annually by applying blockchain solutions (*Fig. 5*).

3.2. Improving customer experience and increasing accessibility

As more customers opt for digital services, their expectations also rise. Investing in customer experience can yield clear profit margins by providing a seamless, multi-channel experience that enhances customer attraction and retention while reducing customer defection rates from the organization. Digital services can also help gather additional customer behavior data to identify new needs better, increasing cross-selling and upselling products and services to

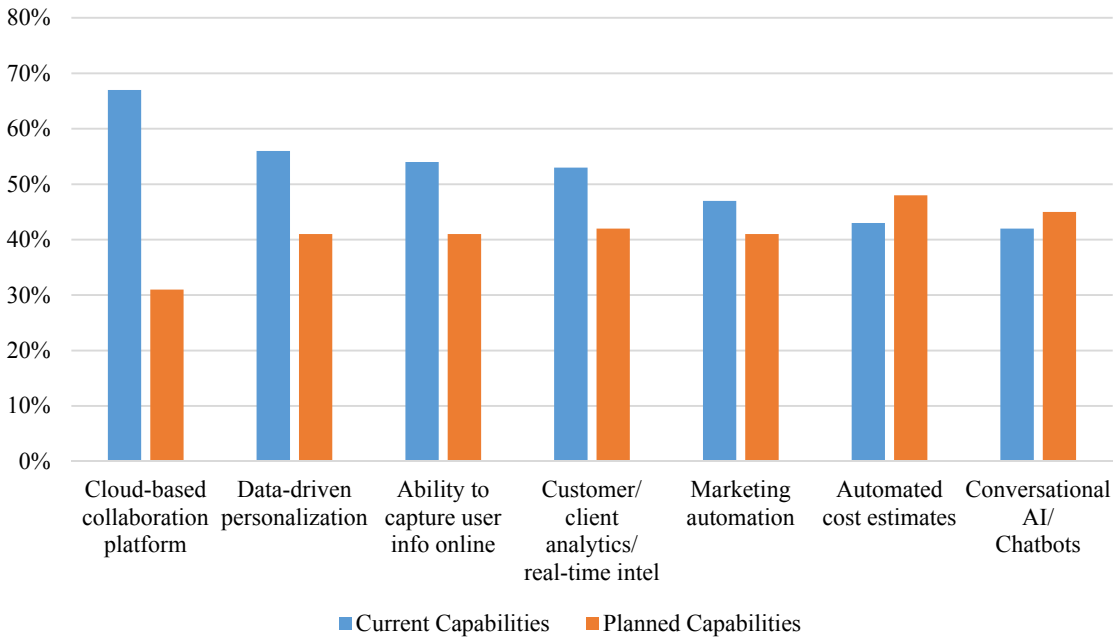

Fig. 6. **Deployment status of digital technology solutions in financial organizations**

Source: Based on BDO (2021) [15].

customers. According to Accenture's survey, 74% of consumers believe that "live data" with detailed personal interests would be valuable for managing personalized banking experiences, products, offers, and solutions. Banks hold and store a large amount of transaction, behavioral, and demographic data from customers, as many extensive data studies have shown to be crucial, especially in improving marketing operations in commercial banks, customer relationship management (CRM), fraud detection, risk management, and investment banking. In the last decade, chatbots have been a prominent trend in many financial banking products. The use of chatbots is expected to become widespread due to the familiarity with mobile devices, and the daily texting habits of Generation Y and Generation Z (*Fig. 6*). Chatbot applications in American Express (Amexbot) and Bank of America (Erica) are considered leading applications in the industry, and are expected to replace customer support centers.

The Covid-19 pandemic has profoundly impacted and disrupted global activities. Organizations are compelled to shift to remote work and use technological solutions to support these operations. Most financial organizations worldwide recognize that the Covid-19 pandemic is becoming a driving force for integrating new technologies within their structures. Mobile banking, Banking as a Service (BaaS), and AI technology are identified as the most rapidly developing areas in 2021 (*Fig. 7*). Conversely, the frequency of cyberattacks and online fraud has increased. According to a study by Finastra (2021),[6] 83% of the surveyed financial organizations increased their cybersecurity investments during the Covid-19 pandemic. The corresponding percentages in the UAE, United States, Singapore, and Hong Kong are 87%, 83%, 85%, and 81%, respectively (*Fig. 8*).

4. Discussion

4.1. Trends in Vietnam

The banking system in Vietnam is rapidly embracing Industry 4.0 as the demand for the application and development of high technology in the operations of banks in Vietnam is increasing. Most Vietnamese banks have implemented or are developing digital transformation strategies, including digitizing specific business segments, internal processes, and end channels. Some key trends in recent times include:

Banks have focused on developing services to enhance customer experience. Domes-

[6] URL: https://www.finastra.com/sites/default/files/documents/2021/06/financial-services-state-of-the-nation-survey-2021.pdf

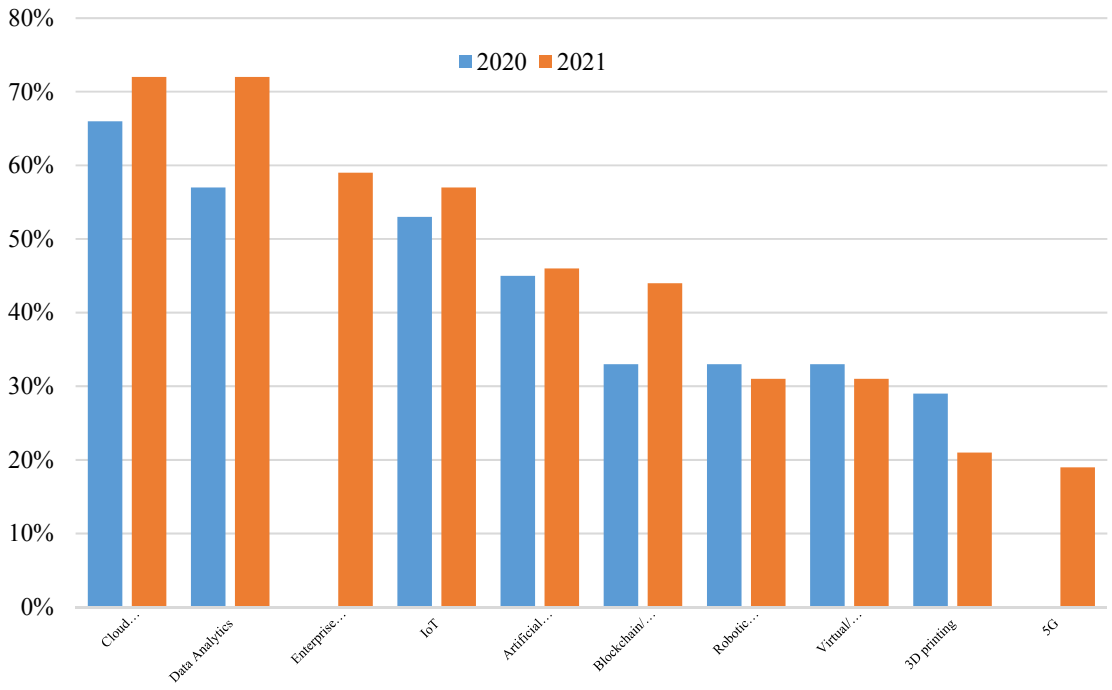

Fig. 7. **Technology adoption in financial organizations**

Source: Based on BDO (2021) [15].

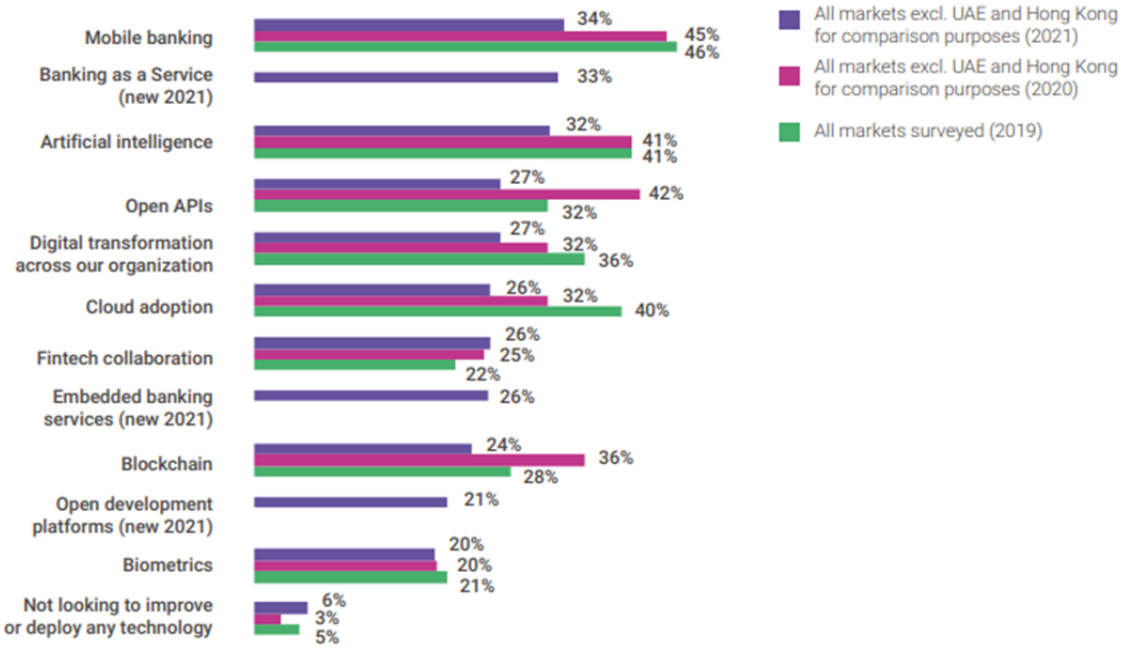

Fig. 8. **Technologies planned to be deployed or improved over the next 12 months**

Source: Finastra (2021). URL: https://www.finastra.com/sites/default/files/documents/2021/06/financial-services-state-of-the-nation-survey-2021.pdf

tic commercial banks have strengthened the provision of digital banking services to their customers. Large commercial banks in the system have quickly developed new services; for example, Techcombank and VIB allow customers to transfer money through social networks (Facebook*, Zalo, etc.) and withdraw money from ATMs without a card. VPBank has applied IBM's data analysis technology to synchronize customer data, supporting rapid customer behavior analysis. Regarding payment services, banks have deployed various convenient and fast

Table 1
The current status of cooperation with fintech by some Vietnamese banks

Commercial Bank	FinTech	Collaborative content
Techcombank	Fastcash	Transfer money via Facebook* and Google+
	Trusting Social	Develop credit scoring criteria
Vietcombank	M_Service	Money transfer payment
	VnPay	Services on a Mobile banking application
Vietinbank	Opportunity Network	Providing digital platforms for businesses
MBBank	Startup FinTech	Providing banking services in Facebook's* Messenger application
VIB	Wezzi Digital	Providing product MyVIB Keyboard — a new application to help transfer money via social networks

Source: Compiled by the author.

payment methods and channels 24/7, such as QR codes, contactless payments, mobile device Visa, and POS (mVisa, mPOS). Among these, QR codes and contactless payments are the most strongly implemented. Banking applications, beyond providing core financial services such as payments, deposits, and loans, have gradually expanded to include various other services such as payment of essential utility services (electricity, water, telecommunications), payment for public services (education, health care), shopping for goods and services, insurance, travel, entertainment, etc.

Banks have been directed toward transforming their business models, shifting from traditional banks to digital banks (examples include VPBank's Timo, TPBank's LiveBank, and BIDV), or aiming to develop the banking service ecosystem through collaboration with FinTech and BigTech to build an open bank with a comprehensive banking service ecosystem. Collaboration and partnership between commercial banks and technology financial companies (FinTech) on BigTech platforms is a prominent trend. Collaboration between banks and FinTech primarily focuses on payment (mobile payment solutions, e-wallets, or intermediary payment solutions) and customer authentication (*Table 1*). Some banks have also been pioneers in cooperating and investing in FinTech and have achieved specific successes, such as VPBank and Mastercard announcing the collaboration with Amazon Web Services (AWS) to issue the Mastercard — VPBiz credit card for SMEs using AWS cloud computing; VietinBank collaborating with 7 FinTech companies, such as ON (UK), BE Group (Sweden), etc., in various fields to bring technology products and services to customers; BIDV has connected with 24 FinTech companies and 756 service providers to provide over 1,500 spending payment services for customers.

However, many banks in Vietnam have implemented only multi-channel distribution systems or inter-channel compatibility between the Internet and mobile banking but have not actually achieved omnichannel compatibility. The current conditions in Vietnam have not yet met the conditions of an open banking ecosystem. IoT in Vietnam is not yet widespread, and embedding the banking service ecosystem in customers' daily lives through technology devices has not been fully realized.

Regarding internal management models, many banks are transitioning to data-driven management models. An exemplary case is Techcombank, which established the Data and Analytics (DnA) Division in 2020. Banks have also begun adopting agile working methods. For instance, Techcombank has created a "flat" and flexible cultural environment at the Techcombank Agile Center, where there is virtually no hierarchical distance between employees and leaders. Small group meeting areas are designed like café corners with lightweight partitions that can transform into whiteboards for easy idea presentation and discussion. In addition, many banks have established digital banking centers or financial solution centers. For ex-

Table 2
Actual implementation of core banking and database upgrades in some banks.

Commercial Bank	Status of core banking and the database
Vietinbank	Successfully replaced the CoreBanking system in February 2017 (Core SunShine), operated the new enterprise data warehouse (EDW) from April 2017
Vietcombank	Transform new generation Core banking and build a modern enterprise data storage facility EDW
VIB	Invest heavily in projects on automation, AI, and machine learning and pay special attention to standardizing Big Data to provide products according to each individual. VIB has combined with Amazon Web Services (AWS) to implement input data standardization projects and new investment in core banking and scorecard systems…
Vietbank	Replaced Finastra's Core Banking system; Investing in the entire core system for Cardzone cards; Prepared to replace Internet banking with a new digital channel system

Source: Compiled by the author.

ample, BIDV built the Digital Banking Center to build a consumer financial ecosystem. MBB and LienvietPostbank have also established digital banking units. ACB formed a technology team directly managed by the CEO or the Board of Directors, and Vietinbank decided to launch the Customer Financial Solution Development Center.

There is an emphasis on upgrading, innovating, and building a modern digital infrastructure. Many banks invest in technological innovation and prioritize international standard security measures. Some banks operate on multi-channel platforms to ensure customer experience, analyze behavior, and attract customers through an in-depth understanding of individual customers. For instance, OCB recently implemented an Omni-Channel platform. To support data analysis, many banks have upgraded their core banking systems and banking databases (Enterprise Data Warehouse — EDW) (*Table 2*).

Moreover, many new digital technologies have been and are being implemented in banks:

Mobile Device Payment Technology: This is the most widely applied technology, with a variety of mobile payment applications such as Vietcombank DigiBank, MyVIB, F@st Mobile (Techcombank), TPBank Mobile, Agribank E-Mobile Banking, Vietinbank Ipay, eFAST, OCB OMNI.

Biometric Technology: Serving user identification (eKYC) in the digital space, as of October 2021, the State Bank of Vietnam (SBV) reported that 21 banks officially implemented this, with over 2.2 million eKYC accounts actively operating and conducting around 23 million transactions.

Data Analysis, Artificial Intelligence (AI): AI in banks primarily serves compliance (AML) and operations. However, some banks have begun researching AI for analyzing customer behavior. For example, BIDV is testing the application of IBM Watson's artificial intelligence to analyze customer data, Techcombank is deploying AI to analyze trends and consumer behavior for highly personalized services, and VIB effectively combines AI with Big Data and e-signatures in the credit card approval process, allowing customers to open a credit card in just 15–30 minutes (1/500th of the average time in the market).

Cloud Technology: Used to enhance flexibility and interaction and synchronize with partners. In September 2021, Techcombank announced that it was selecting AWS as its cloud computing service provider and plans to migrate most of its applications from the bank's data center to AWS. VIB also signed a cooperation program with AWS to transfer technology innovation projects to the cloud computing platform.

Open Application Programming Interface (Open API): Some banks in Vietnam are pioneers in developing and applying Open Banking and open APIs, such as VietinBank, OCB, Agribank, Bac A, BIDV, VPBank, Vietcombank, etc. VietinBank has more than 127 APIs on the market and has relationships with over 73 partners (iConnect platform); OCB has implemented

more than 30 open APIs; BIDV has deployed the BIDV Paygate platform; Timo's digital banking application, in collaboration with VPBank and Ban Viet Bank, and TPBank recently introduced payment connection services through Open API, facilitating large enterprises with thousands of daily fund transfer orders.

Internet of Things (IoT) and Virtual/Augmented Reality (VR/AR): Recently, BIDV launched a new digital banking universe on the extended reality (XR) technology platform, encompassing virtual reality (VR) and augmented reality (AR) technologies to provide a combined physical and digital experience for customers.

Blockchain Technology for Value Exchange and Payments: Banks have researched and applied blockchain technology to certain services. Some Vietnamese banks, including HDBank, HSBC, VCB, Vietinbank, and MB, have joined Contour, an open commercial finance network, to enhance trade finance capabilities on the digital platform. NAPAS and three banks, VietinBank, VIB, and TPBank, successfully tested a blockchain-based money transfer model while sharing cloud computing resources. TPBank participated in the Ripple platform for cross-border payment and money transfer.

4.2. Challenges arising with the development of 4.0 technology banking services in Vietnam

Although the banking sector in Vietnam is poised to benefit from numerous advantages and significant opportunities for development, Industry 4.0 (4.0) technology presents several substantial challenges to the future growth of the Vietnamese banking industry.

4.2.1. First, legal framework issues

This is the most critical challenge and a prerequisite for advancing digital technology to develop banking products and enhance banking business operations. Various legal constraints pose significant obstacles for banks. The laws on electronic transactions and regulations on electronic transactions in the banking sector, enacted from 2005 to the present, have many provisions that are no longer compatible with digital transformation, general digital technology applications, and banking operations concerning issues such as electronic signatures, electronic contracts, electronic negotiations, etc. Regulations related to accounting, handwriting, signatures, circulation, and storage of accounting documents seem suitable for manual processes (two signatures, paper documents, fresh signatures, etc.) or digitally transformed manual processes. At the same time, Industry 4.0 technology allows changes to be made according to new models. Regulations related to lending activities are also not suitable for fully automating the approval, assessment, and post-lending monitoring processes, especially for the needs of small retail loans for individual customers. There are no regulations on issuing bank cards or restrictions on foreign exchange transactions through electronic means. Banks face challenges collaborating with FinTech due to the lack of legal documentation regulating collaboration mechanisms. Specific areas also lack legal frameworks, and the banking industry currently lacks regulations on the Sandbox to experiment with and test innovative models, products, and services.

4.2.2. Second, user perception issues with digital financial products and services

The increase in income, demographic shifts, and rapid development of technology have led to significant growth in online banking service customers. In June 2020, this indicator increased to 2.6 times (year over year) from 1.4 in the year before, with online transactions accounting for over 40% of total bank transactions, especially reaching up to 80% for some banks (Vietnam Digital Report, 2021). However, at present, users of electronic financial services still face several limitations: (i) uneven levels of understanding and application of technology among customer groups; (ii) the confidence in the security of information and the accuracy of transactions in the digital space in specific customer segments (mainly the middle-aged and older) still needs time to improve. From May 2020 to May 2021, according to the report of the Ministry of Public Security, over 5,400 cases of property fraud were detected, involving billions of Vietnamese dong (Vietnam's national currency), and nearly half of these cases occurred through cyberspace, a 1.5-fold increase compared to the same period in the previous year. The main reason for this is that education programs to enhance awareness of banking services in the digital age have not been systematically and comprehensively implemented to reach customers of all ages.

4.2.3. Third, high-quality human resources issues

The labor market in the banking industry will change by reducing the number of transaction officers and direct sales personnel at branches and increasing the source of high-quality, specialized human resources in banking finance while understanding information technology. The issue of high-quality human resources is a challenge for the banking industry and other sectors. Developed countries such as the United States have incorporated curricula on artificial intelligence and machine learning into MBA programs and university courses; South Korea and Taiwan have entered phases of training and preparing high-quality human resources; while in Vietnam, the availability of human resources in this segment is still minimal. According to a study by The Asia Foundation [16], the Vietnamese workforce ready for digital technology is not high, and university training programs change very slowly compared to the trend, which is the main reason for this slow development.

5. Conclusions

Industry 4.0 provides opportunities to drive economic growth, increase social productivity, and directly impact the financial banking industry. Vietnamese banks are not exempt from the global trend and have implemented or are in the process of developing digital conversion strategies, including digitizing specific business segments, internal processes, and end channels. However, the conversion and application of digital technology in the banking sector in Vietnam are still at a low level because the ecosystem is still in the process of perfection and faces many challenges, with one of the most critical issues being the lack of a legal framework related to digital finance and electronic transactions. With the rapid development of technology, digital technology-driven banking products and services will continue to expand. Regulatory bodies need to understand market changes and take measures to create conditions for developing digital technology applications in the financial sector, ensuring that domestic credit institutions can compete regionally and globally.

REFERENCES

1. Boyle K. et al. Bank of the future. Citigroup. 2018 March. URL: https://www.citibank.com/commercialbank/insights/assets/docs/2018/The-Bank-of-the-Future/
2. Petehoff D., Wuergler T., Urtheil R., Czervionke E., Calvey P., Nihalni A., Jayaweera S., Haff H., Froehlich M., Ochsner M. Global Market Infrastructure. Oliver Wyman company. 2018. URL: https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2018/october/Global-Market-Infrastructure-Report-2018.pdf
3. Nghiem X. Thanh. Impact of the Fourth Industrial Revolution on the Banking Industry and the Digital Banking Goal of Vietcombank. *Banking Review.* No. 3/2020.
4. Pham X. Hoe. et al. Vietnam Banking with the Fourth Industrial Revolution and Approaches. 2017. National Economics University Publishing House.
5. Pham T. Dzung. Digital Banking — Development Orientation in Vietnam. 2018 November. State Bank of Vietnam.
6. Sirimanne S., Freire C., Bell B., Maruichi D., Cyron L. Catching technological waves — Innovation with equity, Technology and innovation report 2021. UNCTAD. 2021. URL: https://unctad.org/system/files/official-document/tir2020_en.pdf
7. Mehdiabadi A., Tabatabeinasab M., Spulbar C., Yazdi K.A., Birau R. Are we ready for the challenge of Banks 4.0? Designing a roadmap for banking systems in Industry 4.0. *International Journal of Financial Studies*. 2020; May27;8(2):32. URL: https://doi.org/10.3390/ijfs8020032
8. Roy K. How is the Fourth Industrial Revolution changing our economy? World Economic Forum. 2019 November. URL: https://www.weforum.org/agenda/2019/11/the-fourth-industrial-revolution-is-redefining-the-economy-as-we-know-it/
9. Advinin W. et al. Industry 4.0 — Capturing value at scale in discrete manufacturing, McKinsey & Company. 2019 July. URL: https://www.mckinsey.com/~/media/mckinsey/industries/advanced%20electronics/our%20insights/capturing%20value%20at%20scale%20in%20discrete%20manufacturing%20with%20industry%204%200/industry-4–0-capturing-value-at-scale-in-discrete-manufacturing-vf.pdf

10. Higginson M., Hilal A., Yugac E. Blockchain and retail banking: Making the connection. McKinsey & Company. 2019 Jun. URL: https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/blockchain%20and%20retail%20banking%20making%20the%20connection/blockchain-and-retail-banking.pdf?shouldIndex=false
11. Hercko J. and Hnat J. Industry 4.0 as a factor of productivity increase. In: Transcom 22–24 June 2015 at Žilina. conf. Žilina. University of Žilina (In Slovak Republic).
12. Wodzicki M., Majewski D., MacRae M. Digital banking was redefined in 2021. Deloitte. 2021 October. URL: https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/FinancialServices/ie-digital-banking-maturity-2020.pdf.
13. Machkour B., Abriane A. Industry 4.0 and its Implications for the Financial Sector. *Procedia Computer Science*. 2020;177:496–502.
14. Sacchi M., Sezer B., Quinn A. World Fintech Report 2020. Capgemini & Efma company. 2020 April.
15. Cohron M., Lee M., Brown R., Knott B. 2021 Middle market digital transformation survey. BDO USA company. 2021. URL: https://www.bdodigital.com/getmedia/d0e58372–94d6–440e-bee8–8e64be8be1f9/2021-Middle-Market-Digital-Transformation-Survey_Web.pdf?ext=.pdf
16. Sann S., Hapsari F., Anandarajah S., Bolaños P., Sunchindah A., Huong Nguyen, Kuruvilla S., Alvord D., Sharma S., Charupatanapongse T., Hasson D., Armytage R.. The future of work across ASEAN. The Asia Foundation. 2020 February. URL: https://asiafoundation.org/wp-content/uploads/2020/02/The-Future-of-Work-Across-ASEAN_full.pdf
17. King B. Bank 4.0: Banking Everywhere, Never at a Bank. Singapore: Marshall Cavendish Business. e-ISBN: 9789814828383.
18. Kerse M., Staschen S. Digital banks: How can they be regulated to deepen financial inclusion? CGAP. 2021 December.
19. Krivkovich A., White O., Townsend Z., Euart J.. How US customers' attitudes are changing regarding Fintech during the pandemic. McKinsey company. 2020 December.
20. Bugrov D., Dietz M., Poppensieker T. Global Banking Annual Review 2016. Mc Kinsey company. 2016 December.
21. Nguyen V. Loi, Luu A. Nguyet. The Fourth Industrial Revolution: Opportunities and challenges in the banking sector. 2018. In: Conf on Vietnam's banking industry with the Fourth Industrial Revolution.

ABOUT THE AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

To Thi Dieu Loan — Master of Banking and Finance, Economic Analyst, Strategic Planning and Board of Directors Secretariat, Joint Stock Commercial Bank for Foreign Trade of Vietnam, Hanoi, Vietnam
То Тхи Дьеу Лоан — магистр банковского дела и финансов, экономический аналитик, секретариат стратегического планирования и совета директоров, Акционерный коммерческий банк внешней торговли Вьетнама, Ханой, Вьетнам
https://orcid.org/0009-0006-9067-2303
todieuloan@gmail.com

Conflicts of Interest Statement: The author has no conflicts of interest to declare.
The article was submitted on 28.11.2023; revised on 10.12.2023 and accepted for publication on 14.12.2023. The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-61-71
UDC 338.27(045)
JEL E37, F51, Q34

Analysis of Crude Oil Market Volatility and Macroeconomic Conditions: Empirical Evidence from Nigeria

N. Musa
Kogi State University, Anyigba, Nigeria

ABSTRACT

This study **aims** to investigate the relationship between the volatility of the crude oil market and the macroeconomic conditions in Nigeria. The author used the **methods** of the auto-regressive distributed lag (ARDL) model in conjunction with the generalized autoregressive conditional heteroscedasticity (GARCH) to determine the extent of volatility using a monthly dataset from January 2012 to December 2022. The author regressed the crude oil price volatility index on Organization of the Petroleum Exporting Countries (OPEC) production quotas, conflicts, GDP growth rate, exchange rate and inflation. The r**esults** indicate that oil price volatility relates negatively to GDP, implying that the volatility of crude oil prices dampens growth in Nigeria. The paper **concludes** that rising oil prices heighten inflation, depreciate the exchange rate and depress growth in Nigeria. To hedge against oil price volatility, the paper recommends that the Nigerian government adopt policy measures that would increase energy efficiency and reduce the country's dependency on oil exports through diversification in other related productive sectors such as agriculture and manufacturing.

Keywords: oil price; volatility; geopolitical risk index; conflict; GDP; inflation; exchange rate; macroeconomics; Nigeria

For citation: **Musa N. Analysis of crude oil market volatility and macroeconomic conditions: Empirical evidence from Nigeria. *Review of Business and Economics Studies*. 2023;11(4):61-71. DOI: 10.26794/2308-944X-2023-11-4-61-71**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Анализ волатильности рынка сырой нефти и макроэкономических показателей: эмпирические данные из Нигерии

Н. Муса
Университет штата Коги, Аньигба, Нигерия

АННОТАЦИЯ

Целью данного исследования является изучение взаимосвязи между волатильностью рынка сырой нефти и макроэкономическими показателями в Нигерии. Автор использовал **методы** авторегрессионного распределенного лага (ARDL) в сочетании с обобщенной авторегрессионной условной гетероскедастичностью (GARCH) для определения степени волатильности рынка на основе ежемесячных данных с января 2012 по декабрь 2022 г. Автор проводит регрессионный анализ индекса волатильности цен на сырую нефть и квот добычи Организации стран — экспортеров нефти (ОПЕК), конфликтов, темпов роста ВВП, обменного курса и инфляции. Результаты показывают, что волатильность цен на нефть отрицательно связана с ВВП. Это означает, что волатильность цен на сырую нефть снижает темпы роста в Нигерии. В статье делается **вывод**, что рост цен на нефть усиливает инфляцию, обесценивает обменный курс и снижает темпы роста в Нигерии. Чтобы избежать зависимости от волатильности цен на нефть, автор статьи **рекомендует** правительству Нигерии принять политические меры, которые позволят повысить энергоэффективность и снизить зависимость страны от экспорта нефти путем диверсификации в смежные производственные сектора, такие как сельское хозяйство и обрабатывающая промышленность.

Ключевые слова: цена на нефть; волатильность; индекс геополитического риска; конфликт; ВВП; инфляция; обменный курс; макроэкономика; Нигерия

Для цитирования: **Муса Н. Анализ волатильности рынка сырой нефти и макроэкономических показателей: эмпирические данные из Нигерии. *Review of Business and Economics Studies*. 2023;11(4):61-71. DOI: 10.26794/2308-944X-2023-11-4-61-71**

Introduction

Crude oil is one of the dominant mineral resources that Nigeria is endowed with. This makes the country one of the largest oil exporters in Africa [1]. In Nigeria, oil accounts for over 95% of export earnings, 25% of gross domestic product (GDP), and approximately 90% of government revenues.

Over the past few years, the global economy, including Nigeria, has experienced significant fluctuations in crude oil prices. The dynamics of world oil prices, in addition to demand and supply imbalances, is determined by several factors, including the actions of the Organization of Petroleum Exporting Countries (OPEC) to limit crude oil production (supply reduction), and heightened geopolitical events such as wars, terrorism and other political tensions such as the Iraq war, Gulf war, the Arab oil embargo, the global financial crisis of 2008–2009 and the ongoing Russian-Ukrainian conflict [2].

Nigeria has also experienced different geopolitical tensions, such as the Niger-Delta militancy and the Boko Haram insurgency. The activities of this group of terrorists led to massive destruction of property, pipe vandalism, crude oil theft, kidnapping and supply chain disruptions in Nigeria. It is pertinent to recall that in January 2023, after the removal of petroleum subsidies by the Nigerian Federal Government, Bonny Light oil prices swiftly rose to $110 per barrel, and diesel and gas prices also increased to N800 per litre (N stands for Nigerian currency, Naira; N800 approximately equals $1). Similarly, the price of Prime Motor Spirit (PMS) has also gone up from N195 to N617 per litre, with ripple effects on inflation pressures in the economy. Higher energy costs have the potential to push up commodity prices, production and transportation costs [3].

Fig. 1 shows the historical trend of oil prices. As shown above, crude oil prices were $19.64, $21.54, $20.54 and $18.43 in 1989, 1991, 1993 and 1995, respectively. In 1999, crude oil prices averaged $19.35 per barrel. In 2005, the price increased to US$56.6 per barrel, and in 2007, it declined to US$55.8 per barrel. As reflected in the figure, the highest crude oil price was recorded in 2008, when it rose to US$145.29 per barrel, as against US$55.8 per barrel in the previous years. In 2009, the world entered a recession popularly known as the global financial crisis, which led to a sharp drop in oil price to US$53.4 per barrel. In 2010, the price rose to US$79.48, $94.88 in 2011, US$112 in 2014 and slumped to US$38.5 in 2015. In 2016, it increased to US$43.29 and in 2017, the price rose to US$50.8 and then to US$65.23 in 2018. However, between 2019 and 2020, crude oil prices dropped to US$56.99 and US$39.65, respectively, due to the COVID-19 pandemic. In 2021, the Brent crude oil price increased to US$70.86 per barrel, up from US$39.65 in previous years.

This was probably due to the post-pandemic recovery of the economies of China and other Asian Pacific region countries, leading to an increase in the demand for oil. On February 24, 2022, with the beginning of the Russian special military operation in Ukraine, Brent oil swiftly jumped to US$103.08 in February 2022 and rose to US$125.53 per barrel in May 2022. By December of the same year, the Brent price traded at US$103.93 per barrel. The short-term, sudden increase in oil prices in the spring of 2022, immediately after the start of the conflict, was purely speculative. In January 2023, due to the presence of a discount on Russian oil, the price dropped to US$83.42 and dwindled further to US$74.51 as of June 2023.

Although several studies on oil price volatility exist, such as [4–6]. None of these studies make concerted efforts to explore the correlation between the volatility of the crude oil market and macroeconomic conditions in Ni-

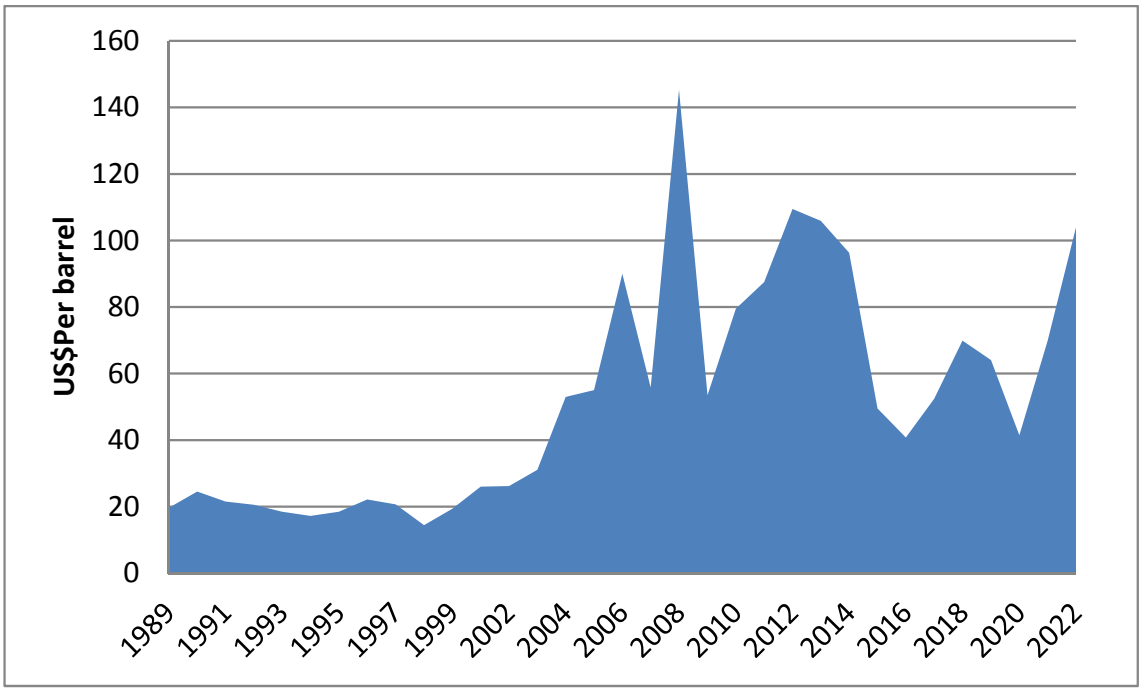

Fig. 1. **Trends of Brent crude oil prices, 1989–2022 (US$)**

Source: U.S. Energy Information Administration (EIA). URL: https://fred.stlouisfed.org/series/DCOILBRENTEU (accessed on 17.08.2023).

geria. The majority of previous studies focused more on the nexus between oil price volatility and growth; more importantly, volatility models were not appropriately applied. Therefore, there is a need for an empirical examination of the nexus between the volatility of oil prices and the Nigerian macro-economy using appropriate models. This is the research gap addressed in the current paper.

The contributions of this paper to the existing body of knowledge are twofold. First, this research provides an empirical study on a topical issue that has gained little attention in the literature. Second, the findings would help us understand the dynamics of the world oil market and assist policymakers in adopting appropriate policy measures to counteract price shocks and alleviate long-term impacts on the economy.

This paper demonstrates novelty by adopting the GARCH model to test the extent of volatility in the oil market and by computing the geopolitical risk index for Nigeria, which was not covered by the existing geopolitical risk (GPR) index [7]. The practical significance of this study is that the findings would help us to understand the dynamics of world oil prices and the need to reduce the country's dependency on oil exports through diversification of its export base to hedge against volatility.

The objective of this study is to investigate the relationship between the volatility of the crude oil market and the macroeconomic conditions in Nigeria. To achieve this goal, the study uses the GARCH model and the ARDL approach using a monthly dataset from January 2012 to December 2022.

Literature review

A study [8] found that wars and geopolitical tensions affect crude oil and stock market prices using time-varying parameter vector autoregressions (TVP/VAR) analysis. A study [9] also explored the effect of oil price volatility using structural VAR from 1991 to 2020. They found that oil price shocks lead to inflation in India. A study [10] investigated the effect of oil price shocks on oil-importing countries. They discovered that geopolitical risk increases oil prices, and oil-dependent countries are more sensitive to geopolitical risk. This finding is consistent with conclusions in other studies [11]. Similarly, a study [12] examined how geopolitical risk affects foreign direct investment outflows in China. Their findings show that geopolitical risk

is detrimental to foreign direct investment performance in China. An empirical study [13] on the impact of oil price shocks on Azerbaijan's economy using VAR showed a strong significant influence of crude oil price shocks on GDP. A study [14] on the impact of oil price changes in Malaysia from 1975 to 2015 used non-linear autoregressive distributed lags (NLARDL). Findings indicated that changes in crude oil prices contributed to GDP growth. The outcome in Malaysia is consistent with the findings by other scholars [9, 13].

Similar research on oil price shocks was also carried out in Nigeria. Ogungbenla [1] used data from 1980 to 2019 and employed the VAR regression technique. He found that volatile oil prices had a negative impact on real GDP using variables GDP, oil price (OILP), inflation (INF), and exchange rate (EXR). Using data from 2000 to 2018, study [4] found a similar investigation by applying the VAR regression technique. It was discovered that oil price shocks inversely affected GDP.

Maud and Evangelos [15] conducted research on oil price volatility from 1990 to 2021. The data were analyzed using the ARDL model. The results confirmed the existence of a negative association between oil prices and GDP growth. Their findings find support in previous studies [9]. In the same analysis, a study [4] used data from 1990 to 2012 to investigate oil price volatility. The data were analyzed using the ARDL model. The outcome of this research is consistent with [13]. A similar study was conducted [12] using structural vector auto-regression (SVAR) on a dataset from 1970 to 2010. The results confirmed that the volatility of oil prices negatively affected growth. Their findings also support those of [16–19].

Materials and Methods

The dataset used in this study contains monthly data and spans from January 2012 to December 2022. The period was selected based on the fact that Nigeria started experiencing major conflicts and terrorist attacks in oil-producing areas, which affected oil production levels. Data on GDP growth rate, inflation and exchange rate are obtained from the Central Bank of Nigeria Statistical Bulletin online database.[1] Data on Brent oil prices are from the U.S. Energy Information Administration (EIA), while data on OPEC oil production quotas are obtained from OPEC Annual Statistical Bulletin.[2]

We use the GPR index as an indicator of conflict. It is pertinent to note that the existing global GPR index by Caldara and Lacoviello [7] did not cover Africa and Nigeria in particular.[3] It only focused on developed and emerging economies without considering Africa. Our objective is to construct the GPR index for Nigeria, following the approach of Caldara and Lacoviello [7]. We calculate the monthly GPR index from January 2012 to December 2022 by counting the number of articles related to geopolitical events. Similar to [7, 20], we extracted relevant news articles from ten notable newspapers mentioning geopolitical events. These newspapers include Vanguard, This Day, The Punch, the Guardian, Independent Nigeria, Business Day, Daily Trust, Daily Champion, Nigerian Tribune, and P.M. News. We use relevant keywords (e.g., terrorism, terror, insecurity, bandits, Boko Haram, insurgent) relating to geopolitical events similar to the method of Caldara and Lacoviello [7], but with particular reference to Nigerian settings.

The generalized autoregressive conditional heteroscedasticity (GARCH (1, 1)) method was used to forecast crude oil price volatility. This approach is justified because of its adequacy in measuring volatility as used in most empirical literature [21, 22–26]. The main reason is that oil prices are subject to random movements, and failure to measure volatility may result in spurious regression; hence the use of the GARCH model. Following [26], the GARCH (1, 1) model takes the following form:

$$Y_t = \varphi_0 + \mu_t,$$

where Y_t denotes crude oil market volatility series; $\mu_t \sim N(0, \sigma^2_t)$

$$\sigma^2_t = \omega + \alpha_1 e_{t-1} + \beta h_{t-1},$$

$$\varepsilon_t = \alpha_t + \sigma^2_{t-1},$$

[1] URL: www.cbn.gov.ng
[2] URL: www.opec.org
[3] URL: http://www.matteoicoviello.com/gpr.htm

Table 1
Descriptive statistic results

	OILPV	CONF	OPEC	GDP	EXR	INFL
Mean	39.42000	50.82636	78.21818	86.27848	63.43879	68.49970
Median	9.700000	49.49000	15.10000	102.1000	37.74000	19.80000
Maximum	279.8000	145.2900	450.0000	161.9300	200.0700	157.5000
Minimum	–2.340000	16.60000	–12.40000	7.980000	6.130000	10.80000
Std. Dev.	80.61406	32.86887	124.9454	56.92622	57.05584	59.51063
Skewness	2.364066	0.836726	1.782341	–0.198368	0.661863	0.307081
Kurtosis	6.937446	3.158982	5.050664	1.418925	2.276235	1.273690
Jarque-Bera	52.05572	3.885356	23.25425	3.653649	3.129618	4.616344

Source: The author's computations.

Table 2
Results of GARCH (1, 1)

Variable	Coeff.	Std. Error	z-Statistic	Prob.
Mean Equation C***	0.085890	0.338521	0.253721	0.7997
oilpv(–1)***	2.219443	0.810438	2.738571	0.0062
	Variance Equation			
C*	1.131363	0.305707	3.700814	0.0009
ARCH*	–0.174157	0.090197	–1.930855	0.0535
GARCH(–1)***	0.043771	0.071363	0.613363	0.5396
	Diagnostic Test			
	ARCH-LM			
Obs.R^2	–0.107611			0.5557

Notes: *, ** and *** explain 10%, 5% and 1% significance level.

Source: The author's computations.

where σ^2_{t-1} represents the GARCH term; ω and h_{t-1} are the conditional mean and variance of the crude oil market.

Similar to [14], we the use crude oil price volatility index as the dependent variable, which is regressed on conflict, proxy by the geopolitical risk index, OPEC production, GDP growth, exchange rate, and inflation rate. We employ the autoregressive distributed lag (ARDL) model to estimate the equation. Thus, we specify our model in the following form:

$$OILPV = f(CONF, OPEC, GDP, EXR, INFL).$$

The econometric specification of the model can be written as follows:

$$OILPV = \delta_0 + \Sigma\delta_1 CONF + \delta_2 OPEC + \delta_3 GDP + \delta_4 EXR + \delta_5 INFL + \varepsilon.$$

The Auto-regressive Distributed Lag (ARDL) model takes the following form:

$$OILPV = \lambda_0 + \Sigma\delta_1 CONF_{t-i} + \Sigma\delta_2 OPEC_{t-i} + \delta_3 GDP_{t-i} + \Sigma\delta_4 EXR_{t-i} + \delta_5 INFL_{t-i} + \delta_6 ecm + \varepsilon_t,$$

where OILPV stands for oil price volatility index measured by Brent oil price, CONF is conflict measured by geopolitical risk index, OPEC is the OPEC production quotas, GDP is growth rate of GDP, EXR is nominal exchange rate (naira/US dollar), INFL is inflation rate, while λ_0 is the intercept, $\delta_1 - \delta_5$ are coefficients of

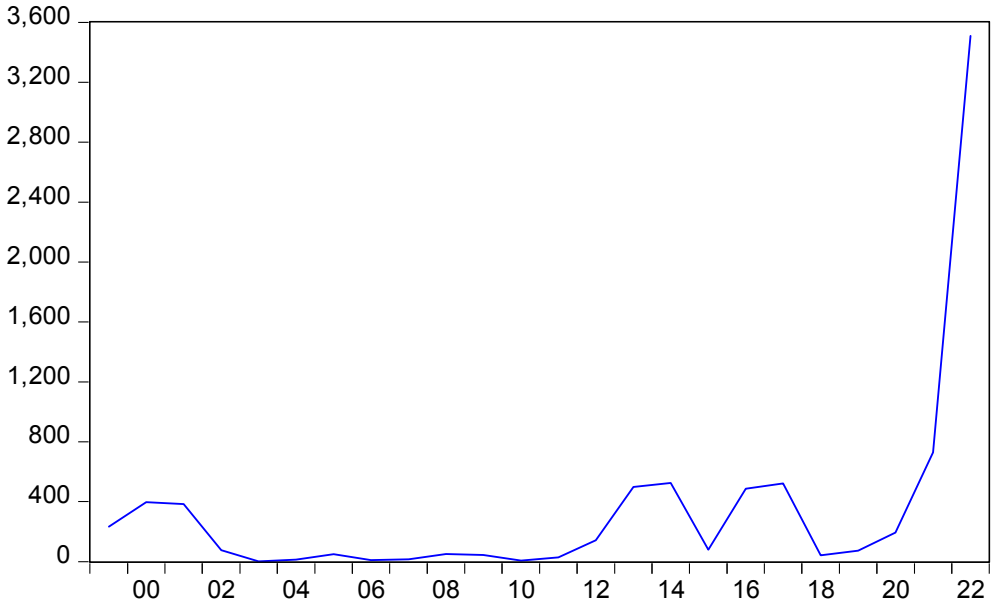

Fig. 2. **Conditional variance of oil price volatility series**

Source: Compiled by the author.

the independent variables and ε_t is a vector white noise.

Results and discussion

The results of the descriptive statistics are presented in *Table 1*. In *Table 2,* we present the result of the GARCH (1, 1) model and its diagnostic test. We proceed to calculate the volatility series (*oilpv*), by taking the first difference of the logarithm of the oil price [27–29]. The oil price volatility series is then tested for stationarity in line with [30]. We observed that the crude oil price is stationary in its level form using ADF and PP tests. As indicated in *Table 2*, the fact that the sum of the ARCH and GARCH coefficients are close to unity suggests that wars, conflicts, and other geopolitical events make the oil market more volatile. The diagnostic procedures of the GARCH (1, 1) in *Table 2* indicate that the mean and variance equations are correctly specified, and there is no problem of serial correlation, as reflected by the low probability values. Furthermore, the LM test demonstrates the absence of ARCH effect. *Fig. 2* plots the volatility series. The oil price volatility series over this time period show that changes in oil prices are persistent [31].

Our descriptive statistics in *Table 1* indicate the existence of negative asymmetry. The fact that Jarque-Bera values are greater than their Kurtosis values further demonstrates that the series are normally distributed. In addition, stationarity test results in *Table 3* show that the series CONF, OPEC, *GDP,* and *EXR* are stationary at order I(1), whereas *OILPV* and *INFL* are stationary at I(0). This means that the variables' levels of integration vary, as demonstrated by the ADF and PP unit root tests. Given the mixed order of integration in this instance, ARDL is preferable. Furthermore, to determine whether the variables used in this study have any long-term relationships, we used the bounds co-integration test. The computed F-statistic exceeds the critical value, as shown in *Table 4*. This indicates that stable long-term relationships exist among the variables.

The estimated results of the ARDL model are presented in *Table 5*. The short-run estimates show that wars, conflicts and other geopolitical events contribute to the volatility of crude oil prices. Our finding reveals a significant positive correlation between the geopolitical tensions in Nigeria and the volatility of the crude oil market, which is in line with the findings of [17, 19, 21–23].

OPEC oil production is found to be significant in explaining the dynamics of prices during the period of study, supporting findings by [14, 16]. The finding indicates that the influence of OPEC production quotas on

Table 3
Unit root test

Variable	ADF	Remark	PP	Remark
GDP	−4.64*	I(1)	−3.62*	I(1)
OILPV	−3.25***	I(0)	−4.39***	I(0)
GPR	−5.36***	I(1)	−5.36***	I(1)
TOP	−4.53***	I(1)	−4.53***	I(1)
INFL	−3.51**	I(1)	−4.65**	I(1)
EXR	−3.64**	I(0)	−3.75**	I(0)

Notes: *, ** and *** denote 10%, 5% and 1% significance levels, respectively.

Source: The author's computations.

Table 4
Bounds test results

Model	K	Computed F-statistics	Remarks
(F(OILPV, CONF, OPEC, GDP, EXR, INFL))***	5	4.271478	reject H0

K	10%		5%		1%	
5	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	2.08	3.00	2.39	3.38	3.06	4.14

Note: *** shows 1% significance level.

Source: The author's computations.

oil price volatility is positive and significant. This means that an increase in OPEC oil production would lead to a decline in crude oil price in international market, while a cut in OPEC production quotas leads to an increase in price.

Our analysis also reveals that oil price volatility slows down growth, as demonstrated by the negative value of GDP. The estimated coefficient of error correction term of –0.26 was significant at the five percent level, indicating that about 26 percent of any disequilibrium would be easily corrected in a short period of time.

The long-term association between OPEC production quotas and crude oil price is positive and significant, meaning that excess supply and production of crude oil by OPEC lead to surpluses and reductions in price, while a reduction in OPEC production has the potential to drive prices up. The import of this analysis is that shocks in oil production by OPEC can trigger higher oil price volatility. Our result also indicates that oil price shocks trigger inflation in Nigeria. A change in oil prices causes inflation to increase by 1.85 percent. The economic growth proxy by GDP growth rate was significantly and negatively impacted by oil price volatility. This result implies that OILPV slows growth over the long term. Additionally, OILPV relates negatively to the exchange rate. This means that over time, OILV would lead to a depreciation of the exchange rate.

The post-estimation test findings in *Table 6* show that the model does not have an autocorrelation problem because the probability value of the serial correlation LM test is 0.79, which is higher than 0.05. The model also does not have a heteroskedasticity issue. We also

Table 5
Estimated ARDL model

Dependent Variable: OILPV

Variables	Coefficient	t-Statistic	Prob.
Short-run			
CONF(−1)*	0.465875	2.300903	0.0352
D(OPEC)**	2.802577	7.019782	0.0000
D(OPEC(−1))**	1.032950	2.958014	0.0093
D(GDP)**	0.062744	2.359158	0.0400
D(GDP(−1))**	−3.380960	−5.030246	0.0005
D(EXR)**	−0.773321	−1.990892	0.0639
D(EXR(−1))**	1.843255	2.402754	0.0371
D(INFL)**	0.831096	2.231574	0.0403
ECT***	−0.269204	−10.84409	0.0000
Long-run			
CONF*	1.061804	2.043539	0.0578
OPEC***	1.520060	2.275624	0.0370
GDP**	0.062744	2.359158	0.0400
EXR***	−0.538709	−4.894435	0.0006
INFL**	1.858986	7.219760	0.0000
C***	−57.07929	−1.927503	0.0719
Diagnostic test			
Serial correlation	0.79^{p}		
Heteroscedasticity	0.55^{p}		
Specification bias	075^{p}		

Notes: *, ** and *** explain 10%, 5% and 1% significance levels respectively; ^{p} *indicates F-Statistic Probability.*

Source: Author's computations.

discover that the model does not suffer misspecification bias.

We ran the CUSUM and CUSUMSQ in order to confirm the model's stability. *Figs. 3* and *4* illustrate the results. The stability of the model is shown by the graphs of CUSUM and CUSUMSQ. None of the recursive residuals were outside the two critical lines; all are inside the 5% critical lines.

Conclusion

This study examined the volatility risk of the crude oil market and macroeconomic conditions in Nigeria using monthly data from January 2012 to December 2022. We used the GARCH (1, 1) model to estimate the volatility of the oil market and the ARDL method to analyze the data. We discovered that conflicts in Nigeria and OPEC oil production are significant in explaining the dynamics of the price of oil during the study period. Oil price volatility has also led to a high inflation rate, exchange rate depreciation and slowed down GDP. The paper concludes that oil price volatility significantly influences inflation and exchange rate depreciation. The alarming

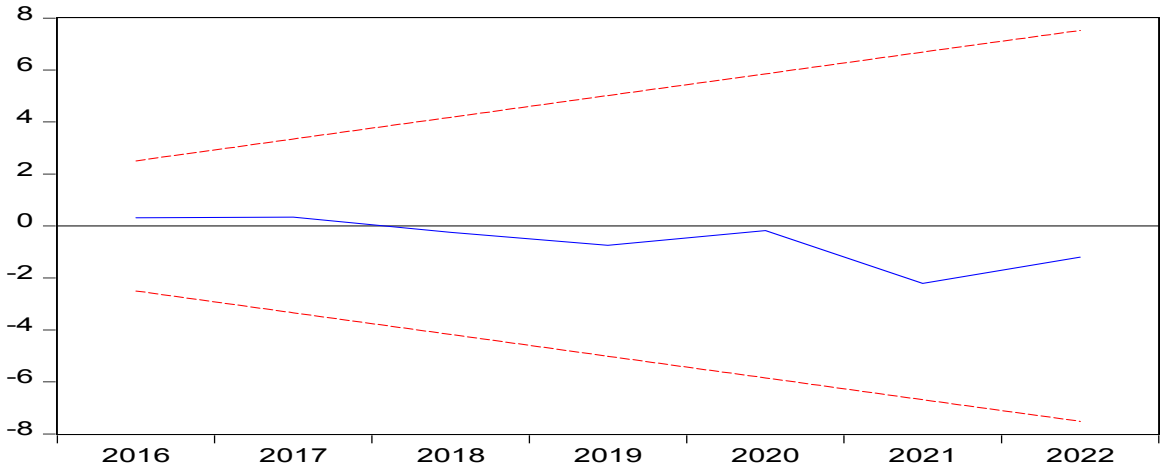

Fig. 3. **CUSUM**

Source: Author's computations.

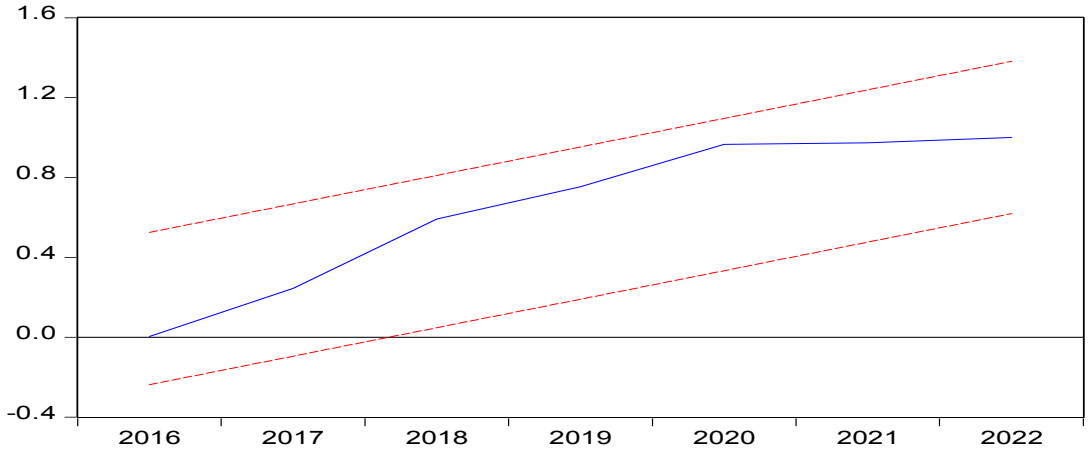

Fig. 4. **CUSUMSQ**

Source: The author's computations.

inflation rate in Nigeria is attributed to the sharp increase in oil prices.

Our findings have long-term policy implications for the Nigerian economy. Oil price volatility has heightened inflation pressures, causing spikes in energy and commodity prices, depreciation of currency, and a depressing long-term growth prospect.

This paper suggests that the Nigerian government and policymakers need to strongly adopt policy measures that would increase energy efficiency and lessen the country's dependency on oil exports through diversification of its export base to hedge against oil volatility; otherwise, the economy would deteriorate and crumble eventually as the volatility persists.

REFERENCES

1. Ogungbenla P. Macroeconomic impacts of oil price shocks on Nigerian economy. *European Journal of Business and Management Research*. 2020; 5(5):19–26. URL: https://doi.org/10.24018/ejbmr.2020.5.5.532
2. Rezaeinejad I. Analytical study of the international economic policies of Iran and Russia: A move to bilateral cooperation under sanctions. *Review of Business and Economics Studies*. 2022;10(4):36–44. URL: https://doi.org/10.2679/.2308–944X-.2022–10–4–36–44
3. Emon M. H. A systematic review of the causes and consequences of price hikes in Bangladesh. *Review of Business and Economics Studies*.2023;11(3):49–58. URL: https://doi.org/10.26794/2308–944X-2023–11–2–49–58

4. Afees A., Hakeem M. Modelling returns and volatility transmission between price and US-Nigeria exchange rate. *Energy Economics*. 2013;39(4):169–176. URL: https://doi.org/10.1016/j.eneco.2013.05.003
5. Musa N. Impact of exchange rate volatility on inflation in Nigeria. *Journal of Contemporary Research in Business, Economics and Finance*. 2021;3(1):26–38. URL: https://doi.org/10.33094/26410265.2021.31.26.38
6. Iwayemi A., Fowowe B. Impact of oil price shocks on selected macroeconomic variables in Nigeria. *Energy policy*. 2011;39(2):603–612. URL: https://doi.org/10.1016/j.enpol.2010.10.033
7. Caldara D., Lacoviello M. Measuring geopolitical risk. *American Economic Review*. 2022;112(4):1194–1225. DOI: 10.1257/aer.20191823
8. Fang Yi., Shao Z. The Russia-Ukraine conflict and volatility risk of commodity markets. *Finance Research Letters*. 2022; Dec1;50:103264. URL: https://doi.org/10.1016/j.frl.2022.103264
9. Tariq M., Syed M. Exploring macroeconomic implications of oil price fluctuations in India. *The Indian Economic Journal*. 2023;71(4). URL: https://doi.org/10.1177/00194662221139353
10. Muhammad J., Sharif F., Alkhathlan K. Oil price volatility and interdependency of GCC economies and North East Asian economies. *Energy Strategy Reviews*. 2018;2:172–179. URL: https://doi.org/10.1016/j.fesr.2018.06.008
11. Su C-W, Khan K., Tao R., Nicoleta-Claudia. Does geopolitical risk strengthen or depress oil prices and financial liquidity? Evidence from Saudi Arabia. *Energy*. 2019;187:116003. URL: https://doi.org/10.1016/j.energy.2019.116003
12. Bing L., Wenge L. Does comprehensive geopolitical risk deter FDI outflows: Evidence from China. *Defence and Peace Economics*. 2022;72:122–140. URL: https://doi.org/10.1080/10242694.2022.2160140
13. Farid Z., Mathias N. The impact of oil price shocks on selected macroeconomic indicators in Azerbaijan. *Economic Systems*. 2020;44(4):258–271. URL: https://doi.org/10.1016/j.ecosys.2020.100814
14. Umar B., Lee C. Asymmetric impact of oil price shocks on Malaysian economic growth: Nonlinear autoregressive distributed lag approach. *Iranian Economic Review*. 2018;24(4):959–981. URL: https://doi.org/10.22059/IER.2020.78830
15. Maud K., Evangelos G. The impact of oil price and oil volatility index on the exchange rate in Sub-Saharan Africa: evidence from oil importing/exporting countries. *Economies*. 2022;10(11):272–285. URL: https://doi.org/10.3390/economies10110272
16. Ahmed G., Wajdi H., Anis J. Dependence between oil and commodities market using time-series varying Archimedean Copulas and effectiveness of hedging strategies. *Journal of Applied Statistics*. 2016;44(9):50–65. URL: https://doi.org/10.1080/02664763.2016.1155107
17. Yi Fang, Shao Z. The Russia-Ukraine conflict and volatility risk of commodity markets. *Finance Research Letters*. 2022; Dec1;50:103264. URL: https://doi.org/10.1016/j.frl.2022.103264
18. Wen J., Mughal N., Kashif M., Jain V., Meza R. S.C., Cong P. T. Volatility in natural resources prices and economic performance: Evidence from BRICS economies. *Resource Policy*. 2022; Mar1;75:102472. URL: https://doi.org/10.1016/j.resourpol.2021.102472
19. Le T. H. Dynamic interlinkages between the crude oil and gold and stock during Russia-Ukraine war: evidence from an extended TVP-VAR analysis. *Environmental Science and Pollution Research*. 2023;30:23110–23123. URL: https://doi.org/10.1007/s11356–022–23456–0
20. Afees S., Suleiman S., Subair S. Constructing geopolitical risk index for Nigeria. *SSRN Electronic Journal*. 2023; DOI: 10.2139/ssrn.4539803
21. Chistiane B., Gert P. The role of time-varying price elasticities in accounting for volatility changes in the crude oil market. *Journal of Applied Econometrics*. 2013;28(7):1087–1109. URL: https://doi.org/10.1002/jae.2283
22. Diaz E. M., Juan C. M., Perez de Gracia. Oil price volatility and stock returns in the G7 economies. *Energy Economics*. 2016;54:417–430. URL: https://doi.org/10.1016/j.feneco.2016.01.002
23. Bakhsh S., Zhang W. How does natural resource price volatility affect economic performance? A threshold effect of economic policy uncertainty. *Resource Policy*. 2023;82:155–170. URL: https://doi.org/10.1016/j.resourpol.2023.103470

24. Gulsum A. Analyzing the impact of oil price volatility on electricity demand: the case of Turkey. *Eurasian Economic Review*. 2017;7:371–388. URL: https://doi.org/10.1007/s.40822–017–0078–8
25. Liu J., Ma F., Tang Y., Zang Y. Geopolitical risk and oil volatility: a new insight. *Energy Economics*. 2019;84:104548. URL: https://doi.org/10.1016/j.eneco.2019.104548
26. Zang Y.J., Yao T., He L.Y., Ronald R. Volatility forecasting of crude oil market: can the regime switching GARCH model beat the single regime GARCH models? *International Review of Economics and Finance*. 2019;59:302–317. URL: https://doi.org/10.1016/j.iref.2018.09.006
27. Antonakakis N., Gupta R., Kollias C., Papadamou S. Geopolitical risks and the oil-stock nexus over 1899–2016. *Finance Research Letters*. 2017;23:165–173. URL: https://doi.org/10.1016/j.fri.2017.07.017
28. Yue-Jun Z., Jin-Liang Z. Volatility forecasting of crude oil market: a new hybrid method. *Journal of Forecasting*. 2017;37(8):781–789. URL: https://doi.org/10.1002/for.2502
29. Demirer R., Gupta R., Ji Q., Tiwari A.K. Geopolitical risks and the predictability of regional oil returns and volatility. *OPEC Energy Review*. 2019;43(3):342–361. URL: https://doi.org/10.1111/opec.12160
30. Mei D., Ma F., Liao Y., Wang L. Geopolitical risk, uncertainty and oil future volatility. evidence from MIDAS models. *Energy Economics*. 2020;86:104624. URL: https://doi.org/10.1016/j.eneco.2019.104624
31. Plakandaras V., Gupta R., Wong W-K. Point and density forecasts of oil returns: The role of geopolitical risk. *Resource Policy*. 2019;62:580–587. URL: https://doi.org/10.1016/resourpol.11.006

ABOUT THE AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

Nuhu Musa — Ph.D. (Economics), Senior Lecturer, Department of Economics, Faculty of Social Sciences, Kogi State University, Anyigba, Nigeria
Нуху Муса — Ph.D. (экономика), старший преподаватель кафедры экономики факультета социальных наук, Университет штата Коги, Аньигба, Нигерия
http://orcid.org/0002-6202-0969
musanuhuadams@gmail.com

Conflicts of Interest Statement: The author has no conflicts of interest to declare.
The article was submitted on 23.08.2023; revised on 03.11.2023 and accepted for publication on 20.11.2023.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-72-83
UDC 336.14,336.27(045)
JEL G38, E52, E62, E31, H62, H72, H74

Money Supply, Inflation and Budget Deficit in Russia Compared to the United States

P.E. Zhukov
Financial University, Moscow, Russia

ABSTRACT

The author examines the causes and sources of the depreciation of money in Russia compared with that in the United States. The **subject** is causal connections between the budget deficit, money supply, and the depreciation of money. The **relevance** of the research for Russia is determined by concerns about macroeconomic stability and high inflation. In the case of the United States, an increase in the money supply and an inflation spike occurred because of the debt financing of the federal budget deficit. The **scientific novelty** of the paper lies in considering the two main options for monetary policy to support the liquidity of public debt: hard and soft, and the analytical methods and results of the research. One of the important scientific results is that the burden of public debt should be measured not as the ratio of public debt to gross domestic product (GDP) but as the share of public debt in a bond market. The second scientific result is very important for the practice: during 2011–2022, in the eight biennial periods, the GDP deflator was approximately equal to the growth of the money supply M2 minus GDP growth. Thus, the depreciation of money was directly caused by monetary policy. In the other three biennial periods, a substantial difference was observed, probably because of external shocks. As the **method** of the study, the author estimated the effect of interest rates caused by crowding out corporate debt by public debt. It was substantiated that to obtain the effects of soft monetary policy and thus the increase of M2 to GDP deflator, it is essential to use biennial periods. Based on the **results** of the analysis, it was revealed that, particularly in 2021–2022, the growth of the GDP deflator amounted to 139.8% and was due to the growth of the money supply M2 by 140.5%. At the same time, the effect on GDP growth was insignificant, at 3.4%. **The key conclusion** is that for the implementation of macroeconomic stability policies, it is necessary to manage the expansion of the M2 money supply, the exchange rate, and to use the GDP deflator as an important indicator in addition to the inflation index — consumer price index. A good way to achieve this is to adopt a special law for controlling inflation, similar to the USA Inflation Reduction Act.

Keywords: budget deficit; public debt; money supply; monetary aggregate M2; inflation; inflation tax; GDP deflator

For citation: **Zhukov P.E. Money supply, inflation and budget deficit in Russia compared to the United States. *Review of Business and Economics Studies*. 2023;11(4):72-83. DOI: 10.26794/2308-944X-2023-11-4-72-83**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Денежная масса, инфляция и дефицит бюджета в России в сравнении с США

П.Е. Жуков
Финансовый университет, Москва, Россия

АННОТАЦИЯ

Автор рассматривает причины и источники обесценивания денег в России, по сравнению с США. **Предметом** исследования являются причинно-следственные связи между бюджетным дефицитом, денежной массой и обесцениванием денег. **Актуальность** исследования для России определяется опасениями по поводу макроэкономической стабильности и высокой инфляции. В случае с США увеличение денежной массы и всплеск инфляции произошли в результате долгового финансирования дефицита федерального бюджета. **Научная новизна** исследования заключается в рассмотрении двух основных вариантов денежно-кредитной политики с целью поддержания ликвидности государственного долга: жесткого и мягкого;

а также аналитических методах и результатах исследования. Один из важных научных результатов состоит в том, что бремя государственного долга должно измеряться не как отношение государственного долга к ВВП, а как доля государственного долга на рынке облигаций. Второй научный результат очень важен для практики — в течение 2011–2022 гг. в восьми двухгодичных периодах дефлятор ВВП был примерно равен росту денежной массы М2 минус рост ВВП. Таким образом, обесценивание денег было напрямую вызвано денежно-кредитной политикой. В остальных трех двухлетних периодах наблюдается существенная разница, вероятно, из-за внешних шоков. В качестве **метода** исследования автор оценил эффект для процентных ставок, вызванный вытеснением корпоративного долга государственным долгом. Обосновано, что для получения эффектов мягкой денежно-кредитной политики и, следовательно, увеличения дефлятора М2 к ВВП необходимо использовать двухгодичные периоды. По **результатам** анализа выявлено, что, в частности, в 2021–2022 гг. рост дефлятора ВВП составил 139,8% и был обусловлен ростом денежной массы М2 на 140,5%. При этом влияние на рост ВВП оказалось незначительным — 3,4%. **Главные** в**ыводы:** для реализации политики макроэкономической стабильности необходимо контролировать расширение денежной массы М2 и обменного курса, а также использовать дефлятор ВВП в качестве важного индикатора в дополнение к индексу инфляции — индекс потребительских цен. Хороший способ сделать это — принять специальный закон о контроле над инфляцией, аналогичный закону о снижении инфляции в США.

Ключевые слова: дефицит бюджета; государственный долг; денежная масса; денежный агрегат М2; инфляция; инфляционный налог; дефлятор ВВП

Для цитирования: **Жуков П.Е. Денежная масса, инфляция и дефицит бюджета в России в сравнении с США. *Review of Business and Economics Studies*. 2023;11(4):72-83. DOI: 10.26794/2308-944X-2023-11-4-72-83**

Introduction

The first subject of this research is the impact of an increase in the money supply on inflation in Russia from 2011 to 2022. The second subject is the relationship between high levels of budget deficit financed by the issue of public debt and the possible expansion of the money supply. The relevance of the topic is due to the high importance of the above-mentioned fundamental ties for the Russian economy at the present stage. Ensuring stable economic conditions through compliance with the long-term principles of stability and balance of the budget system is one of the main goals of the state program "Public Finance Management and Financial Market Regulation" of the Ministry of Finance of the Russian Federation.[1] In particular, the President of Russia Vladimir Putin drew attention to high inflation risks in Russia in July 2023.[2] With the right policy of the Central Bank of the Russian Federation (Central Bank), inflation can be reduced to an acceptable level, and the risks of excessively high inflation can be completely eliminated. In fact, some of such measures are already being taken in Russia at the end of 2023. However, a proper analysis of this problem is required.

Literature review: budget deficit, money supply and inflation

As a rule, the problem of financing the primary deficit of the state budget and interest on debt is solved by new government borrowing. Theoretically, in the past, it was believed that this meant the transfer of expenditures to future periods; therefore, with a budget deficit, the debt should increase, and with a surplus, it should decrease [1]. To stimulate the development of the economy (or curb overheating), the classical theory of finance [2] usually proposes to apply primarily the methods of monetary easing (tightening) combined with reducing (increasing) the refinancing rate of the Central Bank. However, after 2000 (and especially after the 2008 crisis), constant monetary easing led to the situation where nominal interest rates in the US and the European Union (EU) became close to zero, and real interest rates became negative. Monetary methods of stimulating the economy have become ineffective, and the center of gravity of state policy has shifted to fiscal methods [3]. As a result, public debt in most developed countries is only growing, and interest payments are made at the expense of new borrowing. These changes in financial policy have been analyzed in some studies after 2008, including from the perspective of fiscal policy's effectiveness in stimulating the economy at zero interest rates [4].

[1] URL: https://minfin.gov.ru/ru/perfomance/budget/govprog/gosfin/

[2] URL: https://lenta.ru/news/2023/07/25/riski_infl/

For example, in the United States, the last year with a surplus was 2001, when the national debt was only $5.8 trillion. Today it is comparable to the annual expenditures of the US federal budget. Between 2000 and 2012, it seemed that the possibilities of government borrowing for the United States were almost limitless [5], and the use of these opportunities for fiscal stimulation of the economy seemed completely justified. However, after 2022, the situation does not look so clear. The rapid growth of the US national debt after 2001 (about five times in 21 years) was caused by the financial expansion of the state — the desire to increase fiscal incentives for the economy. With such a rapid increase in US debt, questions arise about the acceptability of such growth and its limits [6]. A sharp increase in the growth rate of the US national debt occurred in 2020–2022, due to the COVID-19 pandemic. The budget deficit for three years amounted to $6 trillion, which is higher than the budget revenues of 2022 (US federal budget expenditures in 2022 were $6.27 trillion, 25% of GDP, and the deficit was $1.4 trillion).[3]

A budget deficit within acceptable limits usually does not have an inflationary effect [7], since emission financing of the budget deficit is prohibited in most countries. Despite this, a large budget deficit often causes inflation to accelerate [6]. The fact is that only direct lending to the government or the purchase of public debt upon placement by the central bank is prohibited. The purchase of government debt by the central bank in the open market is a standard tool (open market operations), and if the increase in public debt is too large, then to ensure debt liquidity, central banks are forced to buy government securities in the open market on a large scale. Such open market operations increase the monetary base, which in turn tends to affect inflation. However, the expansion of the money supply alone does not necessarily lead to inflation. Under certain conditions (specifically, the presence of a GDP gap is required) [1, 2], it can lead to a greater increase in consumption or to an increase in investments, including, as a result, a fall in the interest rate.

After all, monetary stimulation (after the negative experience of the Great Depression) is the generally accepted paradigm of modern economic theory (often referred to as "monetarism"), the foundation of which was laid by Milton Friedman [1]. However, if the expansion of the money supply leads to an increase in demand that cannot be met with new goods or services, then (with some time lag) that will lead to an increase in inflation [1, 2]. Inflationary expectations, the propensity to save and invest, as well as psychological factors, play a significant role. If the population and firms perceive the increase in income as temporary and non-inflationary in nature, then new funds will be invested in financial instruments (increase in the money supply monetary aggregate M2). This usually entails an increase in investment in the real sector, as the funds will eventually be invested in business expansion. However, if the increase in the money supply is perceived as carrying a signal for inflation, there will be an increase in prices for consumer and capital goods, as well as an increase in the demand for money (monetary aggregates M1 and M0).

The US and EU countries faced the effect of abnormally high inflation caused by a high budget deficit in mid-2022, with inflation reaching 10% in the US (June 2022) and 10–11% in Europe (October 2022) on an annualized basis in some months[4] [6]. In August 2022, the United States passed a law aimed at reducing inflation ("Inflation Reduction Act"),[5] which drew criticism in the EU due to its protectionist orientation. In the United States, the problem of a surge in inflation was solved [6], first of all, by raising the Fed rate to 4.5%, but an increase in interest rates may inhibit the development of the economy.

Traditionally, the ratio of public debt to GDP is considered a limit on the amount of debt [7–10]. In the United States, by July 2023, this volume had already exceeded 141% of GDP ($32 trillion as of June 15, 2023), and even 261% of GDP in Japan (according to 2022 data). The traditional approach is used, for example, in a paper by experts from the World Bank [10], whereby analyzing data from 79 developed countries for 2001–2008, it is empirically shown that the critical level when the debt-to-GDP ratio begins to adversely affect economic growth is 77.1%. However, this approach seems

[3] URL: https://fiscaldata.treasury.gov/americas-finance-guide/national-deficit/

[4] URL: https://www.vedomosti.ru/economics/articles/2022/12/08/954239-kogda-inflyatsiya-v-ssha-i-evrope-vernetsya-k-tseli

[5] URL: https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/

overly simplistic, as it does not consider the fundamental differences between different countries. This approach is usually not used in studies using dynamic and stochastic models, such as dynamic stochastic general equilibrium (DSGE) models [6, 11–13]. The government can borrow new funds in the debt market either while maintaining the existing share of public debt or increasing this share. An increase in public debt usually leads to the crowding out of private investment by public investment. Cases of direct displacement — when public debt increases substantially due to an equal reduction in the volume of corporate debt — are relatively rare, since in this case the corporate debt shrinks and thus the interest rate rises. This has a negative impact on the economy and on the increase in the cost of debt. If total debt increases but public debt grows faster and corporate debt grows slowly, this does not lead to crowding out. However, in this case, the overall increase in the debt market is directly or indirectly financed by the Central Bank, which means an increase in the money supply and possibly inflation.

The amount of the inflation tax (*IT*) on the monetary savings of the population is usually calculated according to the following formula:

$$IT = C \times \text{inf} + D\,(\text{inf} - \text{dep}), \quad (1)$$

where: *C* is cash in circulation; inf is the inflation rate; *D* — cash on deposits; dep is the nominal interest rate on deposits.

This calculation does not take into account the fact that the real depreciation of money is not fully reflected in inflation based only on the Consumer Price Index (CPI) and requires the use of a GDP deflator. Next, we will apply an alternative to the (1) assessment of the losses of economic entities from the depreciation of money, which can be obtained if the costs of increasing it are subtracted from the increase in the money supply (like "seigniorage"). The difference is equal to the potential benefits of the monetary authorities and, accordingly, the losses of the population. Thus, GDP growth should be subtracted, because if the increase in the money supply corresponds to the growth of GDP, then the depreciation of money does not occur, and such an increase has a positive effect on economic growth, preventing deflation (provided that the velocity of money circulation is stable). Let us consider the classical identity of exchange [1, 2]:

$$M = PY / V. \quad (2)$$

This fundamental identity can be traced back to Walras's law, which is the basis of the Arrow-Debreu theory of equilibrium [1] (sometimes erroneously referred to as the Fisher equation, which is used to determine the velocity of money). Identity (2) in itself says nothing about the nature of inflation, unless one makes the additional assumption that all inflation is purely monetary (the growth of *P* with *V* and *Y* constant). In the works of *M*. Friedman [1, 2], it was proven that a moderate growth of the money supply in a situation of economic stagnation (provided that GDP is lower than potential) creates a stimulus for GDP growth, but also leads to a certain increase in inflation [1, 2]. Modern economic theory [1, 2] assumes that insignificant inflation (2–3% or even higher) in certain periods of economic growth is inevitable and even contributes to economic development [1, 2]. However, if the growth of the money supply exceeds the economy's ability to grow due to additional demand, then it only leads to a proportional increase in inflation, which, as world experience shows, may become high (30% and higher) and, with an uncontrolled growth in the money supply, turn into hyperinflation (50% per month and even higher).

Research method

The research method is data analysis and analytical assessments. First, an analysis of a possible increase in public debt in Russia and its impact on the interest rate is carried out. Then, an analysis of the impact of Russia's money supply expansion policy on inflation and the GDP deflator is conducted. The depreciation of cash and savings is assessed not only by the inflation index (CPI), but also by a broader indicator — the GDP deflator, which takes into account not only the growth of prices for consumer goods but also for capital assets and, accordingly, more comprehensively assesses the effect of the depreciation of cash and savings. Money supply growth is measured by the M2 money supply, which is a widely accepted measurement indicator [14] for the money supply and includes (in the national definition) M0 cash, demand accounts, and term deposits in the banking system.

To assess the losses of economic entities from the depreciation of money, the growth indicator M2 minus GDP growth is used. It is assumed that

to the extent that the increase in the money supply corresponds to the growth of GDP, the depreciation of money does not occur, and such an increase has a positive effect on economic growth, preventing deflation (provided that the velocity of money circulation is maintained).

To assess the possible future impact of fiscal policy on monetary expansion and inflation, internal sources of financing Russia's budget deficit for 2023–2025 are considered. A comparison of the volume of public debt with the volumes of domestic and foreign financial markets for Russia and the United States is carried out, and a possible increase in interest rates in the variant of the hard monetary policy of the Bank of Russia is calculated.

Next, the growth of the money supply in Russia from 2011 to 2023 is analyzed. Two-year periods are used to identify the relationship between the growth of the money supply and the GDP deflator. It is substantiated that, as a rule, the growth of the GDP deflator is approximately (or almost exactly) equal to the growth of the M2 money supply. This pattern is somewhat disrupted only in two periods of the study, when external shock happens, such as COVID-19 or sanctions. Particularly, in 2021–2022 there was unjustifiably rapid growth in the M2 money supply (140.5%), which is not related to the state fiscal policy and significantly exceeds GDP growth (3.4%), which led to an increase in the GDP deflator (139.8%).

Analyzing the sources of financing the feder5al budget deficit in Russia

For Russia, the problem of a real budget deficit has actually arisen since 2023. Prior to this, the federal budget deficit in Russia was artificial — part of the funds from exceeding oil and gas revenues to the established limits (for 2022 it was a limit of 8 trillion rubles) was transferred to the NWF (National Welfare Fund) in order to smooth out the effects of oil price fluctuations. The document of the Ministry of Finance of Russia "The Main Directions of the Budget, Tax and Tariff and Customs Policy for 2023–2025"[6] proposes three sources of financing the deficit (see *Table 1*): government securities (excess of the OFZ[7] issue over the redemption of OFZs), additional oil and gas revenues and the NWF (National Welfare Fund).

The balance of budget revenues and expenditures in 2023 is significantly worse than in 2022, when there were significant additional oil and gas revenues and a budget surplus. In the future, this situation is likely to only worsen due to international sanctions. According to the "Main Directions of Budget, Tax and Tariff and Customs Policy for 2023–2025,"[8] financing the primary federal budget deficit at the expense of government securities (excess the issue over the redemption of government securities minus interest on the debt) in 2023–2025 will be only 231.1, 334.2 and 142.7 bln. rb., respectively. At the same time, the primary federal budget deficit in the first three months of 2023 exceeded 3000 bln. rb. Additional oil and gas revenues in the amount of 1,961 bln. rb. in 2023 are in question under the current conditions of sanctions.

Thus, the increase in government debt in 2023–2025 is not considered a significant source for financing the primary deficit. As sources of financing the deficit in 2023 (see Appendix 40 to the Federal Law on the Federal Budget for 2023 and 2024–2025[9] (hereinafter referred to as 466-FZ), additional oil and gas revenues of 939 billion rubles are indicated (which is quite unlikely) and a the funds of the NWF in the amount of 2,903 billion rubles. To assess the possibility of financing a significant budget deficit by issuing new debt, see *Table 2*.

At the beginning of 2023, the value of government bonds amounted to 19.6 trillion. (51% of the bond market).[10] In the current version of 466-FZ, there is an increase in the share of public debt in the bond market with its growth of 10% from 50.66% to 53.17%. However, if we assume an annual additional primary deficit of 5000 bln. rb., in a hard version of monetary policy, provided that the entire deficit is financed by government bonds, public debt will take up 88.16% of the entire bond market, which means that corporate bonds are almost completely replaced by government bonds and is almost impossible. If we assume an extremely soft version of monetary policy, the option is the purchase of bonds by the

[6] URL: https://minfin.gov.ru/ru/document?id_4=300570

[7] OFZ — abbreviation for Russian: Облигации Федерального Займа, romanized: Obligatsyi Federal'novo Zaima, literally "Federal Loan Obligations".

[8] URL: https://minfin.gov.ru/ru/document?id_4=300570

[9] URL: https://minfin.gov.ru/ru/document/? DOCUMENT_NUMER_4=466-%D 0%A4%D 0%97&P_DATE_from_4=&P_DATE_to_4=&M_DATE_from_4=&M_DATE_to_4=&t_4=–8992603966332692413&order_4=M_DATE&dir_4=desc&by_doc_number_4=1&INF_BLOCK_ID_4=0

[10] URL: https://minfin.gov.ru/ru/document?id_4=300570http://www.cbr.ru/hd_base

Table 1

Sources of financing the federal budget deficit in 2022–2025, billion rubles (bln. rb.)

Year	2022	2023	2024	2025
All sources	1,313.1	2,925.3	2,192.6	1,264.3
Additional oil and gas revenues	3,193.6	1,961.0	643.7	–488.5
NWF (National Welfare Fund)	–1,880.5	964.2	1,549.0	1,752.8
Government securities (excess of the OFZ issue over the redemption of OFZs)	–953.6	1,747.4	1,937.6	2,000.5

Source: Compiled by the author with the data of the Ministry of Finance. URL: https://minfin.gov.ru/ru/document?id_4=300570

Central Bank of the Russian Federation annually in the amount of 5000 bln. rb. The private bond market will not be absorbed by the state, but the money supply will increase. For comparison, the US bond market in 2023 accounted for 51% of the global bond market capitalization, or $51 trillion (including $31 trillion of government bonds), and the US stock market accounted for 42% of the global stock market capitalization, or $52.2 trillion. In the United States, during 2020–2022, the combined federal budget deficit amounted to approximately $6 trillion.[11] In relation to the volume of the US debt market, $6 trillion accounts for 11.76%. The main variant of monetary policy was a soft option: the US Federal Reserve bought securities on the open market for about 3/5 of the volume of new debt [6].

Thus, the main constraint on the growth of state debt in both Russia and the United States (as well as, probably, other countries) is not the ratio of debt to GDP, as is usually believed [7–10], but the ratio of debt to the capacity of financial markets. In the case of Russia, the main problem is blocking access to world capital markets because of foreign sanctions. For the United States, the main problem is that the US stock market occupies a very large part of the world stock market [6] (taking into account debt and equity instruments of more than 56%). Metaphorically speaking, the American state financial elephant is too big for the china shop of financial markets. To assess the impact of the crowding effect on the interest rate in a tight version of monetary policy, we denote V — the total volume of the corporate bond market. As a result of the direct displacement effect, their cost will decrease by X of the budget deficit. The relative decline in the value of corporate bonds due to their displacement by government debt is equal to:

$$x\,\% = X / V\,\%.$$

Denoting D as the average duration of corporate bonds, and R% as the change in bond yield with a decrease in their value by x% (this is equal to a change in the interest rate in the debt bond market, and hence in the economy as a whole), using the common equation for the tie between interest and value of a bond, we obtain the following expression:

$$R\,\% = -x\,\% / D. \quad (3)$$

Thus, if the amount of public debt increases by the amount of deficit X without increasing the total size of the debt market, due to the direct displacement of corporate bonds, the interest rate may increase by the value of R%.

Using expression (3), we get that with an increase in public debt by X = 5000 bln. rb. and with an average duration of corporate bonds of 3 years, a potential increase in the interest rate:

$$R\% = (5/19)*100\% / 3 = 8{,}7\%.$$

The conclusion is that under the tight version of monetary policy in Russia, at the present it is impossible to significantly increase the financing of the primary budget deficit by increasing the public debt by about 5000 bln. rb. per year. In the soft version of monetary policy, the Bank of Russia should buy a similar amount of 5000 bln. rb. on the open market. In this case, there will be no increase in the rate of interest, but there will be an increase in the money supply M2.

Impact of money supply growth n the GDP deflator index and inflation

Fig. 1 shows monthly increases in M2 since January 1, 2011. Usually, after a peak in January, the

[11] URI: https://www.whitehouse.gov/omb/budget/historical-tables/

Table 2
The growth of public debt with financing of the primary deficit of the federal 5000 bln. rb. (in addition to 466-FZ), bln.rb.

	2023	2024	2025
Government securities (excess of the OFZ issue over the redemption of OFZs)	1,750.4	2,625.5	2,946.5
Interest on the OFZ debt	1,519.3	2,291.3	2,803.8
Financing of the primary deficit due to the growth of public debt, provided for by 466-FZ	231.1	334.2	142.7
Financing an additional primary deficit of 5000 bln. rb., increase in public debt	5,000.0	5,000.0	5,000.0
Additional expenses for interest on the debt with a yield of new placements of 10%)	250.0	750.0	1,250.0
Additional excess of the OFZ issue over the redemption of OFZs	5,250.0	5,750.0	6,250.0
Increase in public debt under 466-FZ from the level of 2022	1,750.4	4,375.9	7,322.4
Increase in public debt from the level of 2022 in the case of financing an additional annual primary deficit of 5000 bln. rb.	7,000.4	15,375.9	24,572.4
Public debt by 466-FZ	20,640.7	23,266.2	26,212.7
Public debt in the case of financing an additional annual primary deficit of 5000 bln. rb.	25,890.7	34,266.2	43,462.7

Source: Calculated by the author with the data from the Ministry of Finance. URL: https://minfin.gov.ru/ru/document?id_4=300570https://minfin.gov.ru/ru/document?id_4=300570

seasonal growth was further mitigated by a significant decrease in M2 in February–March, but this did not happen in 2023. The decrease in M2 in February 2023 was insignificant, however, a high increase in M2 (over 1 trillion rubles) was observed in March and April 2022 and 2023, August–September 2022, and in June–August 2023.

When analyzing the relative growth of M2 over a period of 12 months as a percentage (see *Fig. 2*) since 2013, one can see that normally this growth was less than 15% (except for two peaks in mid-2013 and early 2020), but since the second half of 2022, there has been an abnormal increase exceeding 25% at the end of 2022. Particularly, from August 2022 to September 2023, there was an abnormally high peak in the M2 money supply — over 20,000 bln.rb. from August 1, 2022, to October 1, 2023 (of which 13,000 bln.rb. for 9 months of 2023).

This may be a good approximation of the inflation tax burden, which is almost equal to the annual revenues of the federal budget. Unlike in the U.S., this excess cannot be explained by an increase in national debt. Such M2 growth rates as in 2022 and 2023 are obviously several times higher than the federal budget deficit and cannot be explained either by an increase in the Bank of Russia's reserves (which decreased from $630 billion to $563 billion in 2022–2023) nor the need to prevent a financial crisis in the banking sector (as in 2012) or other extraordinary events (such as the COVID-19 pandemic in 2020) that required a significant expansion of lending to the banking sector by the Central Bank.

Table 3 compares the growth of the M2 money supply, the GDP deflator index, and the GDP deflator index plus GDP growth from 2012 to 2022, as well as inflation (although this indicator is less significant).

As can be seen from *Table 3*, there is no obvious direct relationship between any two of the three factors: inflation, the growth of the M2 money supply, and the GDP deflator index. At the same time, in some years (periods) of high M2 growth (2012–2015, 2018, 2021–2022), there is an increase in the GDP and inflation deflator index, with some lags (about 1 year). GDP monetization was highest in 2020 and 2022 (54%), slightly declining in 2019 (47%) and 2021 (49%), and almost constant in 2016–2018 (45–46%).

Noteworthy is the sharp acceleration of the M2 growth rate in 2022 (124%) and unusually high

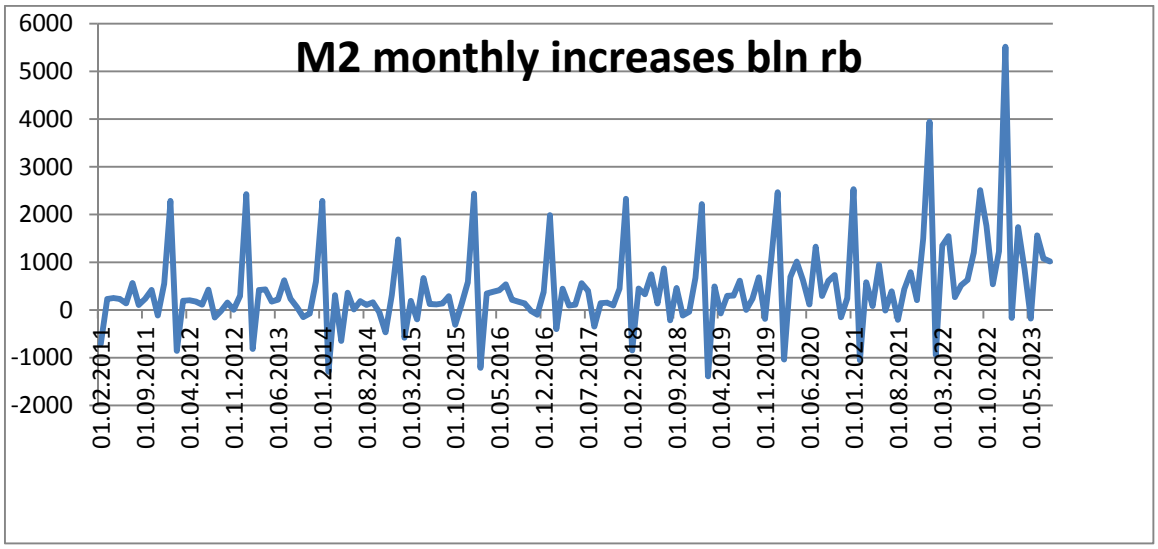

Fig. 1. **Monthly increases in M2 since January 1, 2011**

Source: Compiled by the author. URL: http://www.cbr.ru/hd_base

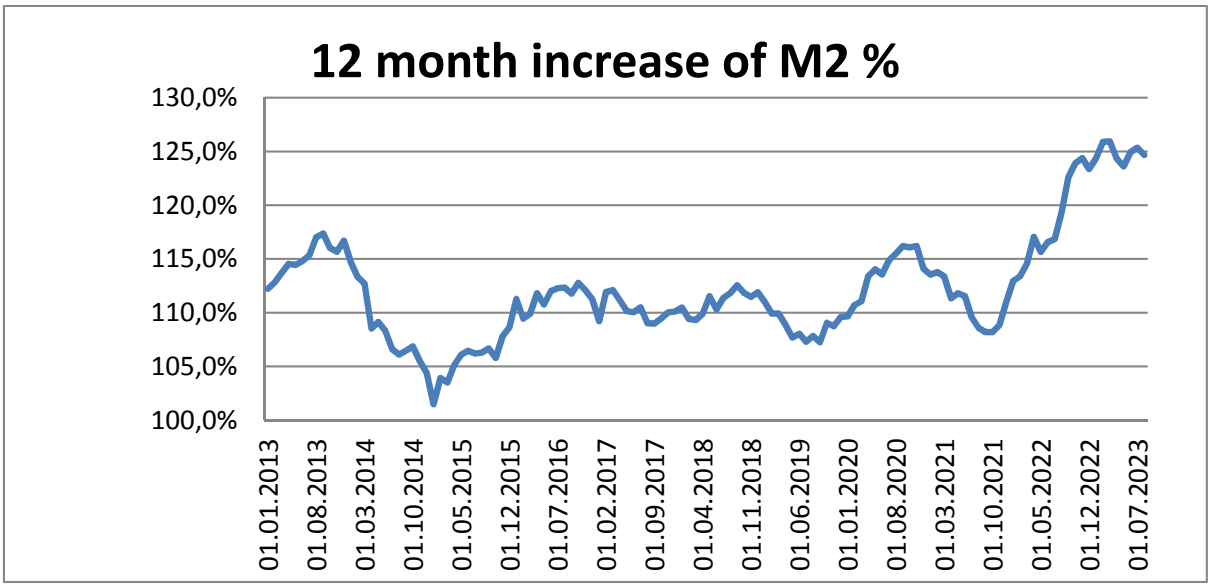

Fig. 2. **Growth of M2 over a 12-months period**

Source: Compiled by the author. URL: https://www.cbr.ru/statistics/macro_itm/svs/key-ind/

growth rates in 2020 (114%), 2021 (113%) and 2015 (115%). The GDP deflator index has extremely high values in 2021 (119%) and 2022 (114.3%). In 2015–2019, the M2 growth rate was relatively moderate (109–111%), and the GDP deflator index was also at a moderately high level in 2012 (113%), 2013 (107%) and 2014 (108%). At the same time, in 2012 and 2013, there were unusually high growth rates of M2 (115% and 112%), and in 2014, the growth of M2 cooled down, but there was a shock devaluation of the ruble by two times.

A comparison of the data for the years from 2012 to 2022 (*Table 3*) suggests that there is a lag relationship (with a lag of about 1 year) between the growth of the M2 money supply, the growth of the GDP deflator index, and even the growth of real GDP (although the latter is expressed very slightly). At the same time, the dependence of the GDP deflator index on M2 growth is obvious, but it is not possible to establish exact patterns for annual changes. Obviously, the patterns also depend on non-monetary factors (including external shocks, such as the COVID-19, sanctions, devaluation of the ruble, etc.).

An almost clear and evident relationship is provided by a comparison over biennial periods (see *Table 4*). It is quite obvious that over the most biennial periods, the growth of the M2 money supply and

Table 3

M2, growth of the M2 money supply, the GDP deflator index, real GDP growth, inflation index and monetization of GDP from 2012 to 2022

Year	M2 bln. rb.	M2 growth, %	GDP deflator index, %	Real GDP growth, %	Inflation index, %	Monetization of the GDP
2022	82,388	124	114.30	97.9	111.9	54%
2021	66,253	113	119.00	105.6	108.4	49%
2020	58,652	114	100.90	97.3	104.9	54%
2019	51,660	110	103.30	102.2	103.1	47%
2018	47,109	111	110.00	102.8	104.3	45%
2017	42,442	110	105.30	101.8	102.5	46%
2016	38,418	109	102.80	100.2	105.4	45%
2015	35,180	111	107.20	98	112.9	42%
2014	31,616	101	107.50	100.7	111.4	40%
2013	31,156	115	105.30	101.8	106.5	43%
2012	27,165	112	108.90	104	106.6	40%

Source: compiled by author. URL: https://www.cbr.ru/statistics/macro_itm/svs/key-ind/

the GDP deflator index are almost the same for the 8 periods (from total of 11) 2021–2022, 2020–2021, 2018–2019, 2017–2018, 2014–2015, 2013–2014, 2012–2013, 2011–2012.

Significant discrepancies are observed only in the 3 periods: 2019–2020 (probably, it is the effect of COVID-19), 2015–2016 and 2016–2017 (probably, that is the effect of the sanctions and counter-sanctions in 2014–2016).

Particularly high growth in the M2 money supply took place in 2021–2022 (by 40.5%), which stimulated some GDP growth (by about 3.4%) and increased the GDP deflator (by 39.8%). Thus, in 2021–2022, we can see two effects of M2 growth: GDP growth and the depreciation of money. However, at the same time, the increase in the GDP deflator exceeds GDP growth by more than 10 times. It is not obvious why a 40.5% increase in the monetary supply was required to achieve quite low biennial growth of GDP of 3.4%.

An analysis of the change in the M2 money supply in the United States for 2020–2022 shows that it increased by about the same amount as the aggregate budget deficit for 3 years. The aggregate budget deficit for 3 years was $6 trillion, and the growth of M2 amounted to $6.88 trillion from June 30, 2019 to June 30, 2022.[12] The greatest concern in the United States was the sharp increase in the share of M1 in M2 (to 80% from the level of 10–20%). This increase indicates an increase in inflation expectations. Not only the United States but also EU countries faced the effect of abnormally high inflation caused by high budget deficits in mid-2022, with inflation in some months reaching 10% in the United States (June 2022) and 10–11% in Europe (October 2022) on an annualized basis.

At the same time, unlike in the United States, the high growth rates of the money supply in Russia cannot be explained by the budget deficit and the need to maintain the liquidity of public debt. A possible explanation is that the increase in the Central Bank's reserves also disappeared since the reserves did not increase during this period. Such high increases in M2 have not been seen in the past since 2012. In 2013–2021, annual M2 growth usually did not exceed 10–15% (at the level of the GDP deflator or slightly more). Due to the seasonality of payments to employees and companies, December and January usually demonstrated an increase in

[12] URL: https://www.whitehouse.gov/omb/budget/historical-tables/

Table 4
Growth of the M2 money supply, GDP deflator index and real GDP growth from 2011 to 2022 over 2-year periods

Period	M2 cumulative growth%	GDP deflator index%	Real GDP growth%
2021–2022	140.5	139.8	103.4
2020–2021	128.2	122.4	102.7
2019–2020	124.5	103.6	99.4
2018–2019	121.7	119.0	105.1
2017–2018	122.6	120.8	104.7
2016–2017	120.6	110.3	102.0
2015–2016	121.5	108.4	98.2
2014–2015	112.9	113.8	98.7
2013–2014	116.4	115.9	102.5
2012–2013	128.7	120.9	105.9
2011–2012	135.7	135.7	108.5

Source: Compiled by the author. URL: https://www.cbr.ru/statistics/macro_itm/svs/key-ind/

M2, but the peaks of 2022 and 2023 were abnormally large (see *Table 5*).

If such high rates of money supply growth continue in 2023, it will create extremely high inflation risks, which have not been fully realized now but may materialize in the future if they cause high inflation expectations.

Discussion and conclusions

The first three conclusions concern financing the budget deficit through new borrowing [15]. First, a hard version of monetary policy leads to a noticeable increase in the interest rate (3). Second, the possibilities for additional financing of the primary budget deficit depend not so much on the ratio of debt to GDP but on the ratio of new borrowings to the volume of the debt market, especially the short-term market. Third, in the case of Russia, these opportunities do not allow new borrowing to finance the primary budget deficit of approximately 5000 bln. rb. per year without significant monetary easing by the Central Bank (for the United States, the limits of permissible borrowing are proportional to the size of debt the market).

A discussion is required regarding the ties between the money supply, GDP deflator index, and inflation in Russia. The paper by B. Plyshevsky [16] compares the growth of inflation and the GDP deflator index in Russia for 2000–2012 with developed and developing countries and concludes that these indicators in Russia were significantly higher than those in the countries compared. At the same time, there is no indication of the growth of the money supply, but it is obvious that without this growth, the inflationary effect would not be possible.

Some authors (e.g., M. Golovnin) make categorical statements that inflation in Russia is allegedly "obviously" not of a monetary nature [17]. Such assertions are not only unfounded but directly contradict economic theory [1, 2, 14] and empirical data, including those cited in this paper. It can be said with absolute certainty that the deflator index in Russia (and in many other countries as well) is "obviously" directly related to the growth of the money supply. In Russia in 2021–2023, this dependence has become even more direct and "obvious" due to the unusually high growth rate of M2, which is not related to government spending and is not explained by the growth of the Bank of Russia's reserves.

In the paper [18], the authors analyze the causes of inflation and propose to measure "inflation" (more precisely, the depreciation of money) by the difference between the growth rate of M2 and the growth rate of real GDP. This proposal was not proved by the authors using empirical data. In theory, its essence follows from Say's Law, which is the general theory of economic equilibrium. However, it requires empirical confirmation, so it is substantiated and confirmed in this paper (see *Table 4*). The data on current growth rates of M2 in Russia

minus GDP growth obviously mean a fairly high inflationary "tax" on deposits in rubles as well as cash in accounts and in cash (at a rate of about 40% for 2 years). However, official "inflation" may not be a good basis to assess this "inflation tax".

Particularly, from August 2022 to September 2023, there was an abnormally high growth in the M2 money supply — over 20,000 bln.rb. from August 1, 2022 to October 1, 2023, and this amount may be a good approximation of the inflation tax burden, fined by the monetary authorities above usual taxes, and about the same size. What is evident is that this means a fairly high inflationary "tax" on deposits in rubles as well as cash in accounts and in cash (at a rate of about 40% for 2 years), and it is obvious that such a high inflation "tax" (as any other change in monetary and fiscal policy) should have losers and beneficiaries.

The losers are quite evident — deposit holders, pensioners, as well as employees (including public sector employees), whose wages grew at a slower pace. At the same time, the answer to the question of the ultimate beneficiaries of the inflationary "tax" is not evident. There is no doubt that this "tax" has led to an increase in the revenues of the budget system (and so may help to mitigate some of the budget problems), but the beneficiaries of the "tax" are not only the budget system (and not so much) but also many other economic entities. Who are the "winners" — exporters, some major banks (with access to Central Bank loans), or maybe owners of real estate — that is not "obvious" and perhaps deserves special research and investigations.

A good way to reduce inflation is to introduce a law similar to the Inflation Reduction Act that was adopted in the United States in August 2022,[13] after which the M2 money supply decreased significantly (after July 31, 2022, by about $0.8 trillion per year and is declining further). In Russia, there was just a remark by the President of the Russian Federation V. Putin about the danger of high inflation. It is very likely that the President of the Russian Federation issued an order on this remark, but so far this has not led to changes in the legislation, and there is no information on how this issue is being considered by the Government or the Central Bank.

In any case, the effectiveness of the method of monetary stimulation for economic growth (large-scale growth of M2) is very questionable, to say the least, and the benefits for the economy from the growth of M2 are not obvious, unlike negative outcomes. In this regard, in order to implement the inflation targeting policy, it may be considered introducing internal (Bank of Russia) and external (the Government of Russia and the State Duma) control over the expansion of the M2 money supply, exchange rate and GDP deflator.

In particular, the State Duma can play a significant role as a legislative body that oversees the work of the Bank of Russia (and appoints members of the Board of Directors) [19]. To control these indicators, it is also necessary to adopt a special anti-inflation law similar to that in the United States.

[13] URL: https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/

REFERENCES

1. Sachs J., Larraín F. Macroeconomics in the Global Economy. N.Y.: Prentice Hall; 1993. 778 p.
2. Mishkin F.S. The Economics of Money, Banking and Financial Market. N. Y., Columbia University Press; 2010. 748 p.
3. Blanchard O. Public Debt and Low Interest Rates. *American Economic Review.* 2019;109:1197–1229. DOI: 10.1257/aer.109.4.1197
4. Liu S.F., Huang W.C., Lai C.C. Could Fiscal Policies Overcome a Deep Recession at the Zero Lower Bound? 2020. URL: https://mpra.ub.uni-muenchen.de/101282/ (accessed on 24.11.2023).
5. Zhukov P.E. Sovereign debt crisis and national policy efficiency. *State University of the Ministry of Finances of Russia. Financial Journal.* 2012;12(2):37–48. (In Russ.).
6. Cochrane J.H. The Fiscal Theory of the Price Level. Princeton: Princeton University Press; 2023. URL: https://www.jstor.org/stable/j.ctv2sbm8kh (accessed on 24.11.2023).
7. Arrow K., Boskin M. The Economics of Public Debt: International Economic Association Series. N.Y.: Palgrave Macmillan; 1988. 310 p. DOI: 10.1007/978–1–349–19459–9
8. Bohn H. The Sustainability of Budget Deficits in a Stochastic Economy. *Journal of Money, Credit and Banking.* 1995;27:257–271. URL: https://doi.org/10.2307/2077862 (accessed on 24.11.2023).

9. Cassard M., Folkerts-Landau D. Sovereign Debt: Managing the risks. *Finance & Development*. 1997;34(4):12–16.
10. Caner M., Grennes T., Koehler-Geib F. Finding the Tipping Point — When Sovereign Debt Turns Bad. The World Bank. 2010; Working Paper 5391. URL: http://documents.worldbank.org/curated/en/509771468337915456/pdf/WPS 5391.pdf (accessed on 24.11.2023).
11. Andreev M. Forecasting of inflation with the method of combining of forecasts in the Bank of Russia. *Bank of Russia Series on economic research — Bank Rossii Seriya dokladov ob ehkonomicheskikh issledovaniyakh*. 2016;14:1–11. (In Russ.). URL: https://www.cbr.ru/Content/Document/File/16726/wps_14.pdf (accessed on 24.11.2023).
12. Andreev M., Polbin A. The influence of a fiscal policy to macroeconomic indicators in the DSGE-models *Scientific institute of finances. Financial journal.* 2018;(43):21–33. (In Russ.). DOI: 10.31107/2075–1990–2018–3–21–33
13. Mikhaleva M. Econometric analysis of possibility for emission financing of a state budget. *Fundamental researches*. 2020;6:91–102. (In Russ.).
14. Bofinger P., Reischle J., Schächter A. Monetary Policy: Goals, Institutions, Strategies, and Instruments. Oxford: Oxford University Press; 2001; 454 p.
15. Zhukov P. How to balance expenses and incomes of the federal budget in the current conditions. *Samoupravlenie.* 2023;135(2): 58–61. (In Russ.).
16. Plyshevskiy B. Inflation rate in Russia in comparison with other countries. *Voprosy statistiki*. 2015;11:80–92. (In Russ.).
17. Golovnin M. Monetary policy in Russia: reaction to new external challenges. *Vestnik Instituta Rossiyskoy akademii nauk*. 2023;1:7–20. (In Russ.).
18. Grigoryev A., Titov V., Shkalaberda L. Reasons for the inflation in the Russian economy. *Fundamental Researches.* 2016;5(11):991–995.
19. Zhukov P.E. Managing of financial risks in modern conditions of sanctions and stagnation of the Russian economy. *Management science in the modern world.* 2015;1(1):484–488. (In Russ.).

ABOUT THE AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

Pavel E. Zhukov — Cand. Sci. (Econ.), Associate Professor, Department for Public Finances, Financial University, Moscow, Russia
Павел Евгеньевич Жуков — кандидат экономических наук, доцент департамента общественных финансов, Финансовый университет, Москва, Россия
PZhukov@fa.ru; paul-joukov@yandex.ru
https://orcid.org/0000-0003-0951-716

Conflicts of Interest Statement: The author has no conflicts of interest to declare.
The article was submitted on 25.08.2023; revised on 25.11.2023 and accepted for publication on 05.12.2023.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2308-944X-2023-11-4-84-94
UDC 336.745(045)
JEL G15, G17, C53, C88

Applying News and Media Sentiment Analysis for Generating Forex Trading Signals

O.F. Olaiyapo
Emory University, Atlanta, USA

ABSTRACT

The **objective** of this research is to examine how sentiment analysis can be employed to generate trading signals for the Foreign Exchange (Forex) market. The author assessed sentiment in social media posts and news articles pertaining to the United States Dollar (USD) using a combination of **methods**: lexicon-based analysis and the Naive Bayes machine learning algorithm. The **findings** indicate that sentiment analysis proves valuable in forecasting market movements and devising trading signals. Notably, its effectiveness is consistent across different market conditions. The author **concludes** that by analyzing sentiment expressed in news and social media, traders can glean insights into prevailing market sentiments towards the USD and other pertinent countries, thereby aiding trading decision-making. This study underscores the importance of weaving sentiment analysis into trading strategies as a pivotal tool for predicting market dynamics.

Keywords: Forex market; sentiment; trading signals; foreign exchange; currencies; social media; Naïve Bayes; machine learning

For citation: **Olaiyapo O.F. Applying news and media sentiment analysis for generating Forex trading signals. *Review of Business and Economics Studies*. 2023;11(4):84-94. DOI: 10.26794/2308-944X-2023-11-4-84-94**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Применение анализа тональности настроений в средствах массовой информации и социальных сетях для генерации торговых сигналов на рынке Форекс

О.Ф. Олайапо
Университет Эмори, Атланта, США

АННОТАЦИЯ

Цель данного исследования — изучить возможность анализа настроений для генерации торговых сигналов на валютном рынке (Forex). Автор оценивал тональность настроений в сообщениях социальных сетей и статьях средств массовой информации, касающихся доллара США, используя комбинацию **методов**: анализа на основе лексики и алгоритма наивного байесовского классификатора. Полученные **результаты** свидетельствуют о том, что анализ настроений является ценным инструментом для прогнозирования движения рынка и разработки торговых сигналов. Отмечается, что его эффективность неизменна в различных рыночных условиях. Автор делает **вывод**, что, анализируя настроения, выраженные в новостях и социальных сетях, трейдеры могут получить представление о преобладающих на рынке отношениях к доллару США и валютам других стран, тем самым способствуя принятию торговых решений. Данное исследование подчеркивает важность включения анализа настроений в торговые стратегии в качестве ключевого инструмента для прогнозирования динамики рынка.

Ключевые слова: рынок Форекс; настроения; торговые сигналы; рынок иностранных валют; валюта; социальные сети; наивный байесовский классификатор; машинное обучение

Для цитирования: **Олайапо О.Ф. Применение анализа тональности настроений в средствах массовой информации и социальных сетях для генерации торговых сигналов на рынке Форекс. *Review of Business and Economics Studies*. 2023;11(4):84-94. DOI: 10.26794/2308-944X-2023-11-4-84-94**

1. Introduction

The Forex market, also known as the Foreign Exchange market, is a marketplace where currencies are traded in pairs [1]. Traders engage in buying and selling currencies, aiming to profit from changes in their exchange rates. This market is highly dynamic and volatile, influenced by factors such as news, social media posts and political events. To stay ahead of the game, traders need to stay updated on the news and events that can impact currency exchange rates [2]. Having the ability to accurately predict when to buy or sell prices is a tool for traders and investors.

In this paper, we aim to explore the potential of sentiment analysis for generating trading signals. While studies have been conducted on using news data to predict stock prices, there has been limited research on applying sentiment analysis to trading.

Sentiment analysis has emerged as a tool for understanding market sentiments and forecasting currency pair movements within the market. Our main objective is to utilize sentiment analysis techniques on both news data and social media information to generate trading signals.

2. Literature review

The prediction of currency exchange rates has been a puzzle and an area of interest for researchers, economists and financial policymakers. Sentiment analysis, which has historically played a role in fields like media analysis, product reviews and financial markets, has now gained prominence as a tool. In the realm of trading, sentiment analysis has become an element for predicting market movements. This literature review thoroughly explores research that utilizes sentiment analysis in trading.

One pioneering study conducted in 2011 took an approach by combining Google Trends data with sentiment analysis of news articles to forecast stock market movements. Their methodology showed an impact on predicting stock market trends, laying the groundwork for researchers [3].

Digging deeper into the practicality of sentiment analysis, the research conducted by Chen et al. (2014) deserves attention [4]. Focusing on analyzing sentiments in news articles, they employed a support vector machine (SVM) classifier to identify whether sentiments were neutral, positive or negative. Notably, their findings emphasized the superiority of their approach compared to baseline methods in predicting stock returns.

Combining long short-term memory (LSTM) and convolutional neural network (CNN), for Social Media Sentiment. Shifting towards methods and datasets, the work carried out by Zhang and colleagues in 2019 [5] stands out. They decided to explore the sea of Twitter[1, 2] data using a combination of advanced LSTM and CNN architectures. Their main goal was to classify the sentiments expressed in Twitter posts into negative categories. The results they obtained were quite compelling, indicating that sentiment analysis on real time platforms, such as Twitter, has an impact when it comes to predicting forex exchange rates.

Most studies adopt a perspective by focusing on well-known currency pairs without exploring the intricacies and potential trading opportunities offered by lesser-known pairs. There is also a lack of research on the impact of sentiment analysis on different currency pairs. There is a need for more research on the integration of sentiment analysis with other technical indicators to improve Forex trading strategies.

3. Problem formulation and research questions

This paper aims to utilize sentiment analysis to generate Forex trading signals by using both news articles and social media data. Trading forex involves buying and selling currencies with the aim of making profit based on exchange rate fluctuations; it also involves buying and selling currency pairs based on their relative value. Traders employ tools and strategies to analyze market trends and make informed trading decisions. A crucial factor influencing market trends is the impact of news and events on the economies of countries whose currencies are being traded.

Sentiment analysis plays a role in examining text data from news articles and social media posts to uncover sentiments [6–8]. It entails identifying and categorizing the polarity of expressed sentiment in text as positive, negative or neutral.

[1] Twitter — social network. Current name X.

[2] Twitter is blocked in Russia.

Table 1
Research Questions and Objectives

Research Question	Objective
Can sentiment analysis of news data be used to generate Forex trading signals?	To collate Forex-related news data
What are the most effective sentiment analysis techniques for generating Forex trading signals?	To perform sentiment analysis on news data using two techniques which are lexicon-based analysis and Naive Bayes algorithm
How accurate are the Forex trading signals generated through sentiment analysis?	To evaluate the accuracy of the signals generated using sentiment analysis

Source: Developed by the author.

To develop a system that generates trading signals based on sentiment analysis results, we will utilize both lexicon based and machine learning based approaches. The lexicon-based approach involves employing the VADER (Valence Aware Dictionary and Sentiment Reasoner) tool to determine the polarity of news articles. On the other hand, the machine learning approach utilizes the Naive Bayes algorithm for sentiment classification of these news articles [9]. Additionally, incorporating indicators as confirmation signals to enhance the accuracy of trading signals will be explored.

To accomplish this objective, a dataset comprising news articles pertaining to USD and other major currencies, in the market will be utilized. The dataset contains text data, as well as metadata such as the publication date and the source of the news article. The dataset was collected from reputable news sources such as Reuters, Bloomberg, and Twitter posts.

The main research questions to address in this paper are presented in *Table 1*.

By answering these research questions, this paper aims to provide insights into the potential of sentiment analysis in Forex trading and its impact on market trends.

4. Technical design

The technical design of this sentiment analysis based on a forex trading system involves different components, which include data pre-processing, sentiment analysis, and trading signal generation. In this section, a detailed description of the methodology and the techniques used for the components is provided.

4.1. Data pre-processing

News articles were collected from financial news websites and social media platforms that are related to the United States Dollar (USD). The USD is one of the major currencies used in the Forex market, and it is considered the world's most dominant reserve currency. It is widely accepted in international transactions. The data were preprocessed to remove noise and irrelevant information, such as stop words and punctuation. Text normalization was also performed; this involves converting all text to lowercase and removing any special characters and symbols [10, 11].

4.2. Sentiment analysis techniques

Two main techniques used include Lexicon-based analysis and Naïve Bayes.

4.2.1. Lexicon-based analysis

After the words were pre-processed, the VADER (Valence Aware Dictionary and Sentiment Reasoner) tool was utilized. VADER uses a predefined sentiment lexicon to assign a polarity score to each text document in the dataset. This contains a list of words and their associated neutral, positive, and negative scores. VADER

assigns a score between –1 and +1 to each text document, where –1 indicates highly negative sentiment, and +1 indicates highly positive sentiment, and 0 indicates neutral sentiment.

To obtain an overall sentiment score for each currency pair, the polarity scores of all the news articles related to that currency pair were aggregated. The aggregation was done using a weighted average, where the weight of each polarity score was determined based on the relevance of the news article to the currency pair.

$$Sentiment\ Score = \frac{\sum(Polarity\ Score\ x\ Weight)}{\sum(Weight)}, \quad (1)$$

where Polarity score is the sentiment polarity score assigned by VADER to the news article or social media post, and Weight is the relevance weight assigned to the news article.

$$Polarity\ Score = \frac{\sum_{i=1}^{n} Valence_i}{\sqrt{\sum_{i=1}^{n} Valence_i^2 + \alpha}}. \quad (2)$$

The above is used by VADER, where valence scores are the set of values assigned to each word in the sentiment lexicon, indicating its positivity or negativity. Alpha, in this case, is a smoothing factor to normalize the score. This algorithm was selected because, unlike other algorithms, it doesn't solely focus on words; it also considers the context in which they are used. This distinction enables it to effectively discern the sentiment behind nuanced statements commonly found on social media platforms. Furthermore, it is adeptly tuned to grasp the sentiment conveyed by slang, acronyms, and prevalent internet terms. When juxtaposed with models like deep learning approaches, VADER achieves a harmonious balance between computational efficiency and accuracy.

4.2.2. Naïve Bayes

Naïve Bayes is a machine learning algorithm that can be used for classification. It is also a probabilistic algorithm that works on the assumption that each feature is independent of all other features. To use this for sentiment analysis, the model needs to be trained using a dataset of news articles and social media posts. In this case, they were labeled as either neutral, positive, or negative.

After training the model, it was used to classify the sentiment of the news articles and social media posts that are related to USD. The model then computed the probability that a given text in the news article or social media post belonged to each sentiment class (positive, negative, or neutral) based on the frequency of words in the text that appeared in each class of the training data.

The application of Naïve Bayes theorem to a class y with three possible outcome (neutral, positive, or negative) and a dependent vector $x = (x_1, ..., x_n)$ is expressed as:

$$P(y|x) = \frac{P(x|y)\,P(y)}{P(x)}, \quad (3)$$

where:

- $P(y|x)$: The probability that a given piece of text falls under sentiment class y based on the word frequencies represented by vector x.
- $P(x|y)$: Likelihood of encountering the word frequencies in vector x in texts classified under sentiment class y.
- $P(y)$: Base probability of a text being categorized under sentiment class y, without considering its word frequencies.
- $P(x)$: Likelihood of the word frequencies denoted by a vector appearing across a sentiment classification.

If one assumes that all features are independent, this relationship can be further simplified to:

$$P(x_i \mid y, x_i, ..., x_{i-1}, x_{i+1}, ..., x_{ni}) = P(x_i|y). \quad (4)$$

- $P(x_i \mid y)$: Likelihood of a specific word x_i appearing in texts of sentiment class y, given the assumption that words appear independently.

Using the above equation, we deduce:

$$P(y \mid x) = P(y)\prod_{i=1}^{n} P(x_i|y). \quad (5)$$

- $\prod_{i=1}^{n} P(x_i \mid y)$: This term sums up the likelihood of all words in vector x showing up in texts under sentiment class y.

Given a constant $P(x)$ for the input, classification is determined by:

$$y = argmax_y P(y) \prod_{i=1}^{n} P(x_i|y). \quad (6)$$

• $argmax_y$: This function pinpoints the sentiment class y which has the highest overall probability when considering the words in vector x.

For estimating $P(y)$ and $P(x_i \mid y)$, a Gaussian assumption is leverage on the dependent variable through the Maximum A Posteriori (MAP):

$$P(x_i \mid y) = \frac{1}{\sqrt{2\pi\sigma_y^2}} \exp^{-\frac{(x_i - \mu_y)^2}{2\sigma_y^2}}. \quad (7)$$

A rejection model variant for classification is used here; for a classification to be accepted, the probability needs to be greater than a specific threshold, or projection. If this threshold is not met, the mode will reject classifying a given sample. The Naïve Bayes classifier is useful for sentiment analysis because its computational complexity is light weight, making it resilient to over-fitting and suitable for use with large datasets from news articles and social media posts [5].

To further illustrate the Naïve Bayes procedure. Here is an example of how this model works. Suppose a news article is titled "Federal Reserve announces interest rate hike, boosting dollar". After the noise is removed from this news article. The probability is calculated that the words in the news data appear in each sentiment class, which is neutral, positive, or negative based on the training data. The word "boosting", for example, appears to be in positive texts rather than in negative or neutral texts.

The probability that the text belongs to one of the sentiment classes based on the probabilities of the individual words is then calculated [8]. By using this procedure on a large dataset of news articles and social media posts, the trading signals were generated based on the prevailing sentiment towards USD.

This approach was chosen because of its simplicity and rapid performance, making it ideally suited for generating real-time Forex trading signals. While other machine learning methods, such as support vector machines (SVM) or decision trees, offer nuanced decision boundaries, the probabilistic nature of Naive Bayes facilitates sentiment estimation based on the provided features. Its inherent capability to manage feature spaces, which are common in text data, grants it a distinct advantage.

4.3. Trading signal generation process

After the sentiment analysis scores for the news articles and social media data are obtained, the next step is to use the scores to generate Forex trading signals based on the sentiment analysis results. Forex trading signals are indications that tell Forex traders when to buy, sell or hold a particular currency pair based on market analysis.

To generate this Forex trading signal, the sentiment analysis results were combined with technical analysis indicators. Technical analysis is a forex market evaluation process that assists traders in predicting the next direction of currency pair values based on past price movements and chart patterns. According to technical traders, markets usually move in predictable patterns that may be observed and identified on trading charts.

There are numerous technical analysis indicators that are used in Forex trading that can be analyzed using data mining techniques to generate trading signals. These indicators are used to confirm the signals generated by the sentiment analysis. Some of the technical indicators include moving average convergence divergence (MACD), which helps Forex traders identify emerging price trends, upward or downward. Bollinger Bands, which is used to lay out trend lines two standard deviations away from the simple moving average price of a financial instrument. Stochastic Oscillator helps to compare a currency pair's closing price to its price range over a specific period.

The moving average (MA), which is the average price of a currency pair over a set period, was used. The relative strength index (RSI), which measures the strength and weakness of a currency pair's price action, was also used. It ranges from zero to 100, and it identifies when a currency is overbought or oversold in market conditions. The selection of MSI and MA indicators stems from their established efficacy in pinpointing price momentum and trends. These indicators enhance clarity and furnish decisive

signals when evaluating sentiment within Forex trading.

When a sentiment analysis score and these two technical analysis indicators align, then a trading signal is generated. For example, if the sentiment analysis indicates a positive score and the technical analysis indicator also confirms and indicates a bullish trend, then a "buy" trade signal is generated.

The sentiment analysis result was positive, and the currency price was above its 50-day moving average (MA) and the relative strength index (RSI) was above 50, we generated a stronger buy signal than if only the sentiment analysis result was positive. On the other hand, if the sentiment analysis indicates a negative score and the technical analysis indicators also indicate a bearish trend, then a "sell" trade signal is generated.

If the sentiment analysis and the technical indicators do not align, then no signal will be generated, and traders would have to wait and exercise caution. Forex trading involves risk, so traders should always exercise caution when the sentiment analysis and the technical indicators do not align.

5. Experimental analysis

This section shows the experimental setup and methodology used in this research, followed by a presentation of the results and an analysis of the findings.

5.1. Experimental setup and methodology

The models used for the sentiment analysis were implemented in the Python programming language using the scikit-learn library. The dataset consists of news articles from financial news websites and social media posts that are related to the USD. After the dataset was pre-processed, i.e., removing noise such as irrelevant information as mentions, links, and hashtags. The training set was used to train the sentiment analysis models and the testing set was used to evaluate the performance of the models.

Two models of sentiment analysis were used for this research, which include lexicon-based analysis and Naïve Bayes. The lexicon-based models classify news articles and social media posts using pre-built sentiment. While the Naïve Bayes model was trained using Gaussian assumption on the dependent variable to estimate $P(y)$ and $P(x_i|y)$.

The scores generated by the sentiment analysis models were used to generate Forex trading signals. To confirm the accuracy of the generated signals, we use two technical indicators: the moving average (MA) and the relative strength index (RSI). The RSI indicator measures the convergence and divergence of two moving averages and identifies potential trend changes. The MA identifies trends and support, and resistance levels.

5.2. Detailed experimental specifics

5.2.1. Duration and long-term trends

The experiment was based on historical data from April 1st, 2023, to July 26th, 2023. During this timeframe, there was notable market volatility. The US dollar witnessed a strengthening trend against various currencies due to several factors. These included the Federal Reserve's decision to aggressively raise interest rates to tackle inflation, the ongoing conflict in Ukraine and its impact on the global economy, as well as China's economic slowdown. Among the currencies that were hit the hardest were the euro (EUR) and pound sterling (GBP), experiencing declines of 10% and 15% against the US dollar during this timeframe, respectively. Additionally, the Japanese yen (JPY) also experienced a depreciation of around 17% compared to the USD.

5.2.2. Timeframe

For the purpose of this research, the H4 timeframe was chosen for analysis. This timeframe strikes a balance between the short-term fluctuations observed in M15 (15-minute) or H1 (1-hour) timeframes and the longer-term trends seen in weekly timeframes. Since news articles and social media posts used for sentiment analysis may not capture immediate market reactions, analyzing the H4 timeframe provides a broader window to observe how sentiment translates into price action.

5.2.3. Volatility and slippage

Between April 1st and July 26th, 2023, the Forex market experienced significant volatility. Due to this heightened volatility, a discrepancy was observed between the price at which orders were placed and the price at which they were ex-

Table 2
Precision, recall and F1 score

Model	Accuracy	Precision	Recall	F1 Score
Naïve Bayes	85%	0.87	0.85	0.86
Lexicon-based	70%	0.72	0.70	0.71

Source: Developed by the author.

Table 3
EUR/USD historical data

Date	Price	Open	High	Low	Vol.	Change, %
04/01/2023	1.0987	1.0847	1.1076	1.0789		+1.37%
03/01/2023	1.0839	1.0576	1.0931	1.0516		+2.49%
02/01/2023	1.0576	1.0864	1.1034	1.0532		−2.63%
01/01/2023	1.0862	1.0702	1.0930	1.0483		+1.50%
12/01/2022	1.0702	1.0407	1.0737	1.0393		+2.85%
11/01/2022	1.0405	0.9882	1.0497	0.9729		+5.28%
10/01/2022	0.9883	0.9800	1.0094	0.9632		+0.86%
09/01/2022	0.9799	1.0055	1.0199	0.9535		−2.57%
08/01/2022	1.0057	1.0218	1.0369	0.9900		−1.58%
07/01/2022	1.0218	1.0481	1.0487	0.9952		−2.52%
06/01/2022	1.0482	1.0734	1.0775	1.0359		−2.34%
05/01/2022	1.0733	1.0550	1.0788	1.0350		+1.82%
04/01/2022	1.0541	1.1065	1.1077	1.0471		−4.74%
03/01/2022	1.1065	1.1218	1.1234	1.0805		−1.37%
02/01/2022	1.1219	1.1234	1.1496	1.1106		−0.12%
01/01/2022	1.1233	1.1365	1.1484	1.1121		−1.19%
12/01/2021	1.1368	1.1339	1.1387	1.1221		+0.28%
11/01/2021	1.1336	1.1559	1.1617	1.1185		−1.95%
10/01/2021	1.1561	1.1582	1.1693	1.1524		−0.17%
09/01/2021	1.1581	1.1810	1.1910	1.1562		−1.91%
08/01/2021	1.1807	1.1864	1.1901	1.1664		−0.53%
07/01/2021	1.1870	1.1859	1.1910	1.1752		+0.13%
06/01/2021	1.1855	1.2227	1.2255	1.1845		−3.03%
05/01/2021	1.225	1.2031	1.2267	1.1985		+1.72%

Note: Highest: 1.2267; Lowest 0.9535; Difference: 0.2731; Average: 1.0967; Change, %: −8.5788.

Source: Adopted by the author from Investing.com

Table 4
USD/CAD historical data

Date	Price	Open	High	Low	Vol.	Change, %
04/23/2023	1.3541	1.3542	1.3546	1.3534	3.20K	+0.01%
04/21/2023	1.3539	1.3475,	1.3564	1.3471	55.83K	+0.48%
04/20/2023	1.3474	1.3460	1.3491	1.3448	57.85K	+0.10%
04/19/2023	1.3460	1.3389	1.3469	1.3384	57.74K	0.55%
04/18/2023	1.3387	1.3395,	1.3400	1.3359	57.14K	–0.04%
04/17/2023	1.3392	1.3362	1.3421	1.3341	55.30K	+0.23%
04/14/2023	1.3361	1.3338	1.3397	1.3302	63.92K	+0.20%
04/13/2023	1.3334	1.3441	1.3449	1.3333	58.92K	–0.77%
04/12/2023	1.3438	1.3468	1.3491	1.3427	57.14K	–0.21%
04/11/2023	1.3466	1.3510	1.3518	1.3462	54.91K	–0.30%
04/10/2023	1.3506	1.3523	1.3555	1.3484	53.44K	–0.01%
04/07/2023	1.3507	1.3492	1.3532	1.3483	42.11K	+0.11%
04/06/2023	1.3492	1.3457	1.3507	1.3447	55.31K	+0.25%
04/05/2023	1.3458,	1.3442	1.3484	1.3426	55.04K	+0.14%
04/04/2023	1.3439	1.3438	1.3469	1.3406	57.97K	+0.03%
04/03/2023	1.3435,	1.3518	1.3537,	1.3411	60.62K	–0.59%
03/31/2023	1.3515	1.3523	1.3566	1.3507	59.61K	–0.04%
03/30/2023	1.3520	1.3558	1.3583	1.3515	57.38K	–0.26%
03/29/2023	1.3555	1.3602	1.3618	1.3556	56.09K	–0.32%
03/28/2023	1.3598	1.3663	1.3697	1.3591	59.52K	–0.45%
03/27/2023	1.3660	1.3741	1.3747	1.3649	63.27K	–0.61%
03/24/2023	1.3744	1.3717	1.3806	1.3707	70.30K	+0.23%
03/23/2023	1.3713	1.3728	1.3726	1.3630	68.81K	–0.10%

Note: Highest: 1.3806; Lowest: 1.3302; Difference: 0.0504; Average: 1.3501; Change %: –1.3550.

Source: Adopted by the author from Investing.com

ecuted — a phenomenon commonly referred to as slippage.

This slippage was especially pronounced in timeframes like M1 and M5, where algorithmic trading systems respond instantly to information. However, in the H4 timeframe these algorithms react with a cushion against news events and sentiment scores, helping to mitigate the impact of slippage.

6. Results and analysis

The generated forex trading signals were evaluated using historical forex data. With confirmation from the MA and RSI, the signals generated by the Naïve Bayes model showed that a profit of over 12% was gained over the testing period. While the lexicon-based models using confirmation from the RSI and MA indicators generated a profit of 5% over the testing period.

Naïve Bayes is the most effective in analyzing sentiment in this research project based on the evaluation metrics. The accuracy of the Naïve Bayes model indicates that it correctly classified 85% of the news articles and social media posts as either neutral, negative, or positive sentiments. The lexicon-based model

Table 5
GBP/USD historical data

Date	Price	Open	High	Low	Vol.	Change, %
04/01/2023	1.2445	1.2332	1.2547	1.2275		+0.91%
03/01/2023	1.2333	1.2021	1.2424	1.1803		+2.60%
02/01/2023	1.2020	1.2319	1.2401	1.1914		–2.44%
01/01/2023	1.2320	1.2098	1.2450	1.1840		+1.84%
12/01/2022	1.2097	1.2056	1.2448	1.1992		+0.34%
11/01/2022	1.2056	1.1471	1.2155	1.1148		+5.12%
10/01/2022	1.1469	1.1161	1.1647	1.0924		+2.77%
09/01/2022	1.1160	1.1623	1.1740	1.0384		–3.98%
08/01/2022	1.1622	1.2165	1.2294	1.1598		–4.47%
07/01/2022	1.2166	1.2177	1.2247	1.1759		–0.07%
06/01/2022	1.2175	1.2604	1.2618	1.1933		–3.37%
05/01/2022	1.2600	1.2587	1.2667	1.2155		+0.23%
04/01/2022	1.2571	1.3136	1.3168	1.2410		–4.28%
03/01/2022	1.3133	1.3421	1.3439	1.2999		–2.13%
02/01/2022	1.3419	1.3447	1.3645	1.3271		–0.19%
01/01/2022	1.3445	1.3531	1.3750	1.3357		–0.62%
12/01/2021	1.3529	1.3299	1.3551	1.3367		+1.76%
11/01/2021	1.3295	1.3683	1.3699	1.3195		–2.89%
10/01/2021	1.3691	1.3472	1.3836	1.3434		+1.63%
09/01/2021	1.3472	1.3753	1.3914	1.3412		–2.05%
08/01/2021	1.3754	1.3901	1.3958	1.3601		–1.06%
07/01/2021	1.3901	1.3829	1.3985	1.3571		+0.54%
06/01/2021	1.3827	1.4213	1.4250	1.3786		–2.69%
05/01/2021	1.4209	1.3827	1.4234	1.3800		+2.86%

Note: Highest: 1.4250; Lowest: 1.0384; Difference: 0.3865; Average: 1.2780; Change %: –9.9102.

Source: Adopted by the author from Investing.com

has lower accuracy, which suggests that it may not be as effective as Naïve Bayes in identifying the correct sentiment in Forex trading (*Table 2*).

The lexicon-based model has a precision score of 0.72, a recall of 0.70 and an F1 score of 0.71. The Naïve Bayes model has a precision score of 0.87, recall of 0.85 and an F1 score of 0.86. These results suggest that 87% of the positive classifications made by the Naïve Bayes model were indeed correct when it classified news articles or social media posts as either neutral, positive, or negative. When the model encounters a neutral, positive, or negative sentiment, 85% of the time the recall score correctly identified it. The F1 score shows that the Naïve Bayes model has a good balance between precision and recall.

In terms of using technical analysis indicators for confirmation, the analysis showed that the moving average (MA) and relative strength index (RSI) are effective in confirming the trading signal models generated by the sentiment analysis model. The sentiment analysis can generate a positive score, and then the MA and RSI confirm the buy signal, resulting in a profitable trade. Similarly, the models can also generate a negative score, and the MA and RSI confirm the sell signal, which results in a profitable trade (*Tables 3–5*).

Limitations and potential improvements

Sentiment analysis can sometimes be biased, and this system relies on it. One potential improvement would be to use more advanced sentiment analysis, such as deep learning approaches, which can be more effective in capturing nuances in language.

This paper also shows that sentiment analysis is good for signal generation in the Forex market and can improve traders' performance.

7. Conclusion and future work

The significance of this research lies in its potential to enhance the quality of generating profitable Forex trading signals and helping Forex traders in making decisions. This research project has investigated the potential of sentiment analysis to generate Forex trading signals. This project proposed and implemented a methodology based on lexicon-based analysis and Naïve Bayes to assign a neutral, positive, or negative score to the sentiment of news articles and social media posts related to United States Dollars (USD), and then combine technical analysis indicators to generate a signal.

As for future work, there are several areas where further research and investigation can be conducted. Since there are different factors that affect the Forex market other than financial news articles or social media posts, advanced sentiment analysis techniques such as deep learning and neural networks can be used on various factors, which include political events, economic data releases, natural disaster news, among others, to further provide traders with useful insights to generate profitable Forex trading signals.

Also, exploring the application of sentiment analysis in other financial markets beyond Forex, such as stocks or commodities and crypto trading, could also be an interesting avenue for future research.

AKNOWLEDGEMENT

The author is thankful for the opportunity to have been taught by Professor Carl Yang and Professor Fei Liu in the Department of Computer Science. Their distinct teaching methods and dedication to excellence have significantly contributed to the author's understanding of Data Mining, which was instrumental for the author's research.

REFERENCES

1. Drehmann M., Sushko V. The global foreign exchange market in a higher volatility environment. *BIS Quarterly Review.* 2022;(12):33–48. URL: https://www.bis.org/publ/qtrpdf/r_qt2212f.pdf
2. Kao B., Huang K. W. The impact of news sentiment on stock returns: Evidence from the US stock market. *International Journal of Economics and Finance.* 2016;8(45):18–33.
3. Bollen J., Mao H., Zeng X. Twitter mood predicts the stock market. *Journal of Computational Science.* 2011; Mar1;2(1):1–8. URL: https://doi.org/10.1016/j.jocs.2010.12.007

4. Fang X., Zhan J. Sentiment analysis using product review data. *Journal of Big Data.* 2015;Dec;2(1):1–4. DOI: 10.1186/s40537–015–0015–2
5. Zhang Y., Song D., Zhang P. et al. A quantum-inspired sentiment representation model for twitter sentiment analysis. *Applied Intelligence.* 2019;Aug15;49:3093–3108. URL: https://doi.org/10.1007/s10489–019–01441–4
6. Fink J., Yehuda B. Predicting stock returns with textual sentiment: A comparison of methods. *Journal of Financial Data Science*. 2016;1(1):5–28.
7. Hong Q., Huang X. Predicting stock price movements with Twitter sentiment analysis. *Journal of Systems Science and Complexity.* 2015;28(1):162–184.
8. Huang X., Wu X., Wang X. Sentiment analysis in financial markets research: a survey. *Journal of Data and Information Science.* 2018;3(2):1–18.
9. Olaiyapo O.F., Adetifa K.B. Natural language processing for Forex trading signals. *International Journal of Scientific Research and Engineering Development.* 2023;6(3)May-June. URL: https://doi.org/10.5281/zenodo.8104023
10. Kotsiantis S.B. Supervised machine learning: A review of classification techniques. *Informatica.* 2007;160(1):3–24. URL: https://informatica.si/index.php/informatica/article/viewFile/148/140
11. Ma Y., Huang X., Wu X. Sentiment analysis of financial text data: A survey. *Information Processing and Management.* 2021;58(4):102559. URL: https://doi.org/10.1016/j.ipm.2021.102559

ABOUT THE AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

Oluwafemi F. Olaiyapo — Graduate Student, Department of Mathematics, Emory University, Atlanta, USA
Олувафеми Ф. Олайапо — аспирант кафедры математики, Университет Эмори, Атланта, США
https://orcid.org/0009-0000-8147-0204
oluwafemiolaiyapo@gmail.com

Conflicts of Interest Statement: The author has no conflicts of interest to declare.
The article was submitted on 06.10.2023; revised on 03.11.2023 and accepted for publication on 25.11.2023.
The author read and approved the final version of the manuscript.

Contents of the Journal for 2023

No. 1

Special Issue
Cognitive Linguistics: Bridging Society, Language and Economics

No. 2

No. 3

No. 4