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Relationship Between Bitcoin Transaction Volume and Export Volumes: A Comparative ARDL Panel Data Analysis for Developed and Developing Countries

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ABSTRACT

Purpose – The purpose of this study is to examine whether the use of cryptocurrencies impacts the foreign trade of developed and developing countries, and if there exists an impact, what would be its nature. This research explores the effect of Bitcoin transactions on exports within the realm of foreign trade using panel data techniques.

Design/methodology/approach – Separate datasets were created for developed and developing countries (US, Germany, Japan & Türkiye, Brazil, India, respectively), according to the IMF classification system. The data were obtained from reliable sources like the IMF, World Bank, and CoinMarketCap. While export volume was taken as the dependent variable, Bitcoin transactions were treated as the independent variable. Control variables include GDP growth, exchange rate variability, inflation, and trade openness. An ARDL and Bounds Test were used to establish cointegration between the variables.

Results – No cointegration relationship was detected between global export volume and Bitcoin transaction volume in any trend specification, and similarly, no long-term relationship was found for developed countries. In developing countries, a 1% increase in Bitcoin transaction volume was found to be associated with an approximate 0.2% increase in exports in the short term; however, this effect was not statistically significant and did not persist in the long term.

Discussion – The findings indicate that cryptocurrencies have not yet created a meaningful long-term impact on international trade. This can be explained by factors such as the volatility of cryptocurrencies, regulatory uncertainties, and infrastructure deficiencies.

1. Introduction

In recent years, global economic structures have undergone profound transformations driven by digitalization, with the increasing role of digital currencies—particularly Bitcoin—emerging as a pivotal development in the financial system. Characterized by a decentralized structure and rapid transfer capabilities, cryptocurrencies offer a potential alternative to traditional payment mechanisms in international transactions (Agmon, 2020; Kumar et al., 2024). While international trade remains a critical driver of economic growth, cross-border flows are increasingly facilitated by these digital assets, which promise to enhance financial inclusion for businesses with limited access to traditional banking systems (Dzidzikashvili & Kheladze, 2022).

Despite the growing body of literature on digital assets, existing research often treats cryptocurrencies primarily as speculative investment vehicles or focuses predominantly on their adoption within developed economies (Parino et al., 2018). This creates a significant research gap: the specific impact of Bitcoin transaction volume on real-sector outcomes, such as export performance, remains under-explored, particularly through a comparative lens between developed and developing nations. This study addresses this gap by investigating how the integration of Bitcoin into the financial ecosystem influences trade flows across different levels of economic development.

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Theoretically, this research is grounded in the framework of financial innovation and new trade theories. According to the Melitz model, a reduction in trade costs—including transaction and administrative expenses—lowers the entry barriers for firms to participate in international markets. By facilitating peer-to-peer cash transfers without the need for traditional intermediaries, Bitcoin transaction volume can significantly reduce the "transaction costs" rooted in human and institutional friction (Agmon, 2020). This technological innovation is expected to have a disproportionate impact on developing countries, where financial frictions are often more pronounced.

Specifically, this study seeks to answer two primary research questions:

Digitalization has become one of the most important sources of changes in the economic structures on a global scale. Among the changes that have recently taken place is the increase in the importance of digital currencies. Such innovations are believed to serve as an effective alternative to traditional payment mechanisms in international transactions. Therefore, cryptocurrencies, which are characterized by their decentralized nature and fast transfer capabilities, attract attention. Moreover, despite the important role played by international business in driving economic development in different countries, digital money can also become an effective way for companies to perform foreign exchanges and expand their activities (Dzidzikashvili & Kheladze, 2022).

A considerable number of works have been produced in relation to digital currencies. However, many scholars tend to consider cryptocurrencies as effective instruments for financial investments rather than for making transactions. In addition, some researchers only investigate the use of digital money in highly developed countries. Consequently, the question of whether Bitcoin transaction volume has any impact on economic results, including export performance, is not studied properly (Agmon, 2020; Parino et al., 2018). At the same time, there is no comparison between developing and developed countries in relation to the use of cryptocurrencies. Therefore, this research will aim at filling this gap in existing knowledge.

From the perspective of theory, this work will be based on the principles of financial innovation and new trade theories. According to the Melitz model, the decline in trade costs, including transaction and administrative expenses, decreases entry barriers for businesses willing to operate internationally. Bitcoin transaction volume will enable peer-to-peer cash transfers without intermediaries, reducing transaction costs, which involve human and organizational frictions. As a result, this type of innovation is expected to affect developing countries more because financial frictions are higher in these states (Agmon, 2020). The main goals of this work include addressing the following questions:

1. To what extent does Bitcoin transaction volume affect the export volumes of nations in the short and long run?
2. Does this impact differ significantly between developed and developing countries due to varying levels of financial infrastructure and regulatory environments?

By utilizing a Comparative Panel Data Analysis, this study contributes to the literature by providing empirical evidence on the trade-facilitating role of cryptocurrencies. Differently from previous researches focused on general adoption figures, this investigation puts particular emphasis on transactions to uncover the causal mechanisms underlying digital innovations and international trade performance.

2. Literature Review and Theoretical Framework

The relationship between innovations and international trade efficiency remains among the key issues discussed in the relevant economic literature, especially since the emergence of New Trade Theories. The current paper draws on this knowledge base and summarizes the literature into three strands to establish the causal mechanism between Bitcoin transactions and exports performance.

2.1. Blockchain Technology and Reduced Trade Friction

Initial research was primarily focused on defining the basic operational concepts of blockchain and the transformational power of the technology in business operations (Avunduk & Aşan, 2018; Ünsal & Kocaoğlu, 2018). However, the subsequent focus has been placed on the application of blockchain to the international trade environment. Specifically, the implementation of blockchain allows for significantly reduced costs and transaction time by optimizing financing, documentation management, and secure document exchange

(Özyüksel & Ekinci, 2020). It is emphasized that the reduction of "human and institutional friction" plays a critical role in trade efficiency (Agmon, 2020). In terms of the theoretical model, the proposed mechanism is in line with the Melitz Model, according to which reduced trade variable costs facilitate participation of more companies in exporting products. Digital payment platforms, like Bitcoin, thus act as catalysts in the process of minimizing those entry barriers (Ojima & Obuzor, 2025).

2.2. Financial Inclusion and Country-Specific Application

The other area of research focuses on the concept of "financial inclusion" and explores how digital currencies can be used to promote the phenomenon in question in environments characterized by poorly developed banking systems. Although digital money is predominantly applied in developed economies (Sharma et al., 2021), the influence of the asset class on trade may be even greater in underdeveloped areas where they are able to compensate for the lack of infrastructure and technological progress (Efoua et al., 2024). In developing countries, it was found that digital wallets and non-traditional payment tools enhance the profit margins and speed up the payment cycle in favor of SMEs (Rahmawaty et al., 2025; Ogunmola et al., 2024). Thus, one may assume that the effect of export sensitivity to the change in Bitcoin transactions differs between the two country groups, being greater in developing nations due to greater financial friction in trade.

2.3. Empirical Evidence and Transaction Dynamics

Empirical studies recently conducted in this field have started applying advanced analytical techniques in estimating the relationships. Thus, some of the recent research findings include positive long-term relationships between the use of digital payment platforms and trade volumes in some of the selected developing countries, obtained through the ARDL modeling approach (Ojima & Obuzor, 2025). Furthermore, the correlation between Bitcoin transactions and fiat money transactions in G7 and BRICS countries proves the integrated nature of the asset in the world economy (BenSaïda, 2023). At the same time, volatility remains the major issue in relation to those assets, requiring monitoring of their influence on global trade patterns (Tüfenk, 2023).

2.4. Hypothesis Formulation

In light of the theoretical framework and literature review outlined above, the following research hypotheses will be tested in this study:

H_1: Increasing Bitcoin transaction volume positively impacts export volumes in the short term through reduced transaction costs and enhanced payment efficiency.

H_2: The impact of Bitcoin transaction volume on exports is stronger in developing countries compared to developed ones due to higher marginal benefit of financial inclusion.

H_3: Cointegration between Bitcoin transaction volume and exports performance occurs in the long term for both country samples.

3. Definition and Characteristics of Cryptocurrencies

3.1. Definition

The definition of virtual currencies has not been universally established as of 2008, varying from country to country in legal definitions. According to the Fifth Anti-Money Laundering Directive (Directive 2018/843, EU), virtual currencies represent "a digital representation of value that is not issued or guaranteed by a central bank or public authority, is not directly linked to a legal currency, but is accepted by natural or legal persons as a means of exchange and can be transferred, stored, and traded electronically." The purposes or functions of virtual currencies might include functioning as a means of payment, as a tool for transactions, as an investment opportunity, as a store of value, or in online casinos.

In order to describe the concept of "virtual currency," people can use such terms as "virtual money," "cryptocurrencies," "crypto-assets," "virtual assets," or "virtual tokens." There is an opinion that the notion of "cryptocurrency" cannot be considered completely equivalent to "virtual currency." Cryptocurrencies may be described as "digital representations of value or contractual rights, which make use of some form of distributed ledger technology and that can be transferred, stored, or traded electronically." Cryptocurrencies are seen as the practical implementation of distributed ledger technology, but this technology can be implemented in various ways unrelated to cryptocurrencies. It may be argued that a term such as "token" is less associated with legitimacy problems related to the word "currency."

It could be noted that a cryptocurrency is a digital or virtual currency that functions on decentralized systems. Blockchain technology forms the basis for cryptocurrencies, allowing for safe and transparent recording of all transactions. The emergence of cryptocurrencies was determined by the need for an alternative to existing financial institutions, achieving notable success. Thus, cryptocurrencies represent digital money which is based on cryptography and does not require any centralization. Due to the lack of intermediation, transactions conducted through cryptocurrencies are performed much faster compared to traditional financial services. Bitcoin, created in 2009 by the person (or a group of people) called Satoshi Nakamoto, constitutes one of the first examples of a cryptocurrency (Nakamoto, 2008).

3.2. Characteristics

Decentralization: Since there is no governing authority in cryptocurrencies, this makes it easier for the owners of these assets to have control and also avoid any fees charged by intermediaries (Buterin, 2014).

Transparency: Blockchain technology is used when making transactions which means that all transactions made are stored in public ledger that cannot be modified (Swan, 2015).

Security: There are cryptographic algorithms which help to secure transactions in cryptocurrencies (Antonopoulos, 2014).

Accessibility: Individuals who have access to the Internet can use cryptocurrency. It gives access to financial services that one does not have access to otherwise (Tapscott & Tapscott, 2016).

Cryptocurrencies are created by chaining transactions that occur in blocks. In general terms, a blockchain is a collection of all the blocks, where each block has a link with another block using cryptography. Once a transaction occurs, miners verify the transaction, which is then added to the blockchain. The process of mining involves solving difficult calculations leading to the creation of a new cryptocurrency unit (Narayanan, 2016).

The following are the ways cryptocurrencies have impacted financial markets. To start with, cryptocurrencies have emerged as an important part of financial markets with increased speculation in them. Blockchain technology, on the other hand, has potential in transforming the processing of payments and financial transactions. Finally, cryptocurrencies have played a role in the emergence of new financial technologies, specifically decentralized finance (DeFi) (Catalini & Gans, 2020: 80-83).

Cryptocurrencies are decentralized digital currencies that are run over the Internet and can replace normal state-issued currencies. Over the last ten years, cryptocurrencies have gained popularity for doing online transactions (Siripurapu & Berman, 2023).

There were more than 2,000 cryptocurrencies existing at the beginning of 2020, with an estimated 36.5 million people in the United States having them. Crypto coins have received acceptance as investment options and currencies, and many experts believe that these currencies are the future of finance. At the time of the rise of initial coin offerings (ICO) in 2017, cryptocurrency industry witnessed inflows of hundreds of billion dollars. The emergence of such funds has demonstrated that cryptocurrencies are lucrative and hence good to invest in (Bhimani & Arif, 2022). Furthermore, declines in cryptocurrency market performance might also coincide with decline in conventional markets. Inflation rates increase might cause central banks to increase the interest rates making the financial markets tight, thus making bond investments attractive. Investors usually become risk-averse during market corrections; hence cryptocurrency investments decrease during such times (Bhandari, 2023).

Being digital currencies, cryptocurrencies are among the latest innovation products after the Internet revolution. There is an increased use of digital currency in almost all economies which means the global economy will reduce the usage of paper money. Blockchain technology has played an instrumental role in driving innovation especially cryptocurrencies. The application of blockchain technology has affected different sectors including virtual currencies. It presents an example of how technological advancement affects the financial sector. Challenges in implementing such innovative technology can emerge due to regulatory concerns. Cryptocurrencies have partial acceptance as an exchange medium. The idea of cryptocurrencies had already been considered in the literature since the 1980s (Heilman et al., 2015: 129-132); however, the first cryptocurrency that was openly launched was Bitcoin by Satoshi Nakamoto in 2009.

According to Rodrigues (2023), the key factors which make it easier for companies to adopt cryptocurrencies are secure use of transactions, crypto exchange investments, transaction speeds, and possible cost savings at the global level. These factors have been identified as the primary determinants of corporate adoption of cryptocurrencies.

According to Frederiks et al. (2022), the uncertainty in a certain technology leads to adoption or non-adoption of the technology by new technology-based firms (NTBFs). From institutional theory perspective, the new technology-based firm must wait until uncertainty becomes low in order to adopt a certain technology. However, from a resource-based theory perspective, NTBFs can choose to adopt certain technology in absence of regulations in order to gain competitive advantage. Frederiks et al. (2022) prove that regulatory uncertainty significantly affects the decision-making process in relation to technology adoption by NTBFs.

There are two types of markets; digital currency markets and cryptocurrencies markets. Central Bank Digital Currency (CBDC) belongs to the first type as it is issued and managed by central banks while the other type is the type which was pioneered by Bitcoin; i.e. the decentralized type.

Cryptocurrencies are basically electronic currencies which use cryptography to secure transactions and create new units. They are considered alternative currencies which are a subset of digital currencies. The concept of cryptocurrencies emerged from the ancient times when the issuance of independent currency for commercial purposes was considered without having to use the authority of states or institutions (Gültekin, 2017).

Wagner (2014) points out that the value and distribution of virtual currency usually depend on some form of central authority, which is normally the issuer.

3.3. The Role of Cryptocurrencies in International Trade

The first reason why organizations are highly motivated to adopt cryptocurrency is that it provides them with an opportunity to reach out to diverse demographics, be represented among early-adopter customers, and make their transactions transparent. Based on empirical evidence, people who make purchases using cryptocurrencies tend to spend almost twice as much money compared to people using credit cards. According to Farsangi et al. (2020), cryptocurrencies help organizations increase the level of awareness about internal financial processes and become part of future centralized digital banking systems. Using cryptocurrencies, companies can create liquidity pools and raise capital from traditional investments, thus creating additional assets. Using cryptocurrencies, organizations can easily transfer financial money quickly thanks to blockchain technologies. By using cryptocurrencies, organizations can manage capital initiatives and affect their financial performance in the long term. Perchuk et al. (2019) state that treasury activities traditionally require much time. However, by making digital investments through cryptocurrencies, companies will be able to simplify back-office settlement procedures. Cryptocurrencies are highly liquid and act as cash equivalents. For instance, Bitcoin can be transferred to the vendor's account fast. Every user's digital wallet is managed with visible amounts of money for everyone participating.

There are many ways to use cryptocurrencies in the organization. Companies can apply cryptocurrencies to acquire any goods or services, pay salaries, invest in cryptocurrencies, engage in operational processes, and provide dividends to shareholders. To facilitate operations, organizations need to choose between keeping cryptocurrencies off their balance sheets or incorporating them into payment systems. There are two ways to incorporate cryptocurrencies in businesses. Firstly, a company can use cryptocurrencies only to perform payments when it transfers the currency to the digital wallet but then converts it to fiat currency without making payments. In such cases, firms can benefit from faster transactions while avoiding using cryptocurrencies. This option usually includes a third-party vendor that performs the task of converting currency, taking service fees, managing risks, and performing other duties associated with compliance issues (Joshi et al., 2023).

Using cryptocurrencies for business payments can bring many advantages but pose some risks. First, because there is no central authority for cryptocurrencies, it means that they are very volatile and can change their value very rapidly. For instance, in less than a year, Bitcoin increased by 70%. Moreover, there are serious risks related to security as there were cases of hackers stealing millions of dollars. The infancy stage of blockchain technologies implies that there is still no developed tax framework, legislation, and accounting for the incorporation of cryptocurrencies. Therefore, based on all the mentioned aspects, using cryptocurrencies for making payments might require some prudence as they might be rewarding but very risky at the same time (Tran & Leirvik, 2020).

Cryptocurrencies being rather volatile and intangible, organizations encounter many difficulties when dealing with accounting for these assets. Firstly, cryptocurrencies need to be accounted for based on barter transaction rules because they cannot be treated like fiat currencies. Therefore, a special approach needs to be developed for the purpose. There are three important points in cryptocurrency accounting. First, cryptocurrencies differ from fiat currencies according to accounting rules. Secondly, the fair market value of cryptocurrencies needs to be calculated to compute the taxable income. Thirdly, the key principle of cryptocurrency accounting is that it is necessary to record the value of cryptocurrency at the moment of receiving it and using. Using cryptocurrencies in business purposes implies a complicated procedure which requires new ideas and approaches to finance management. A useful solution for organizations using cryptocurrencies is developing an expense management system for cryptocurrencies (Beck et al., 2018).

At present, a variety of cryptocurrencies exist, and their number is increasing. Their popularity and acceptance by people around the world are rapidly growing. However, it is evident that their societal acceptance level is still rather low as many people find it difficult to understand what cryptocurrency is. Some of the main reasons for avoiding using cryptocurrencies for making payments include volatility, value instability, and difficulty understanding how to use them.

One of the current trends that exist in connection with cryptocurrency adoption is the growing interest of corporations to use cryptocurrencies. The reason behind this tendency is the growth in surveillance and governance of digital asset markets. As more corporations think of using cryptocurrencies as a financial solution, more attention is paid to the framework development and risk management (Jackon, 2024).

The recent progress in blockchain technologies, especially in the field of permission and private blockchain solutions, solved many problems that previously affected the adoption of blockchain technologies. For instance, these technologies enabled self-executing contracts and interoperability of different blockchains which facilitated corporate adoption. Also, it is possible to mention how the coronavirus pandemic affected blockchain and cryptocurrency adoption. On the one hand, it resulted in canceling speculative projects, and on the other hand, it stimulated the focus on valuable projects (Jackon, 2024). Thus, many factors can influence cryptocurrency adoption in organizations. For instance, research shows that factors of social impact, perceived benefits, and financial literacy are essential to consider when adopting cryptocurrencies in the tourism and hospitality industry (El Chaarani et al., 2024).

3.4. The Role of Cryptocurrencies in International Trade Theories

The first cryptocurrency, Bitcoin, was created as a result of the 2008 financial crisis. In 2008, Lehman Brothers Holdings Inc. declared bankruptcy, causing distrust in centralized organizations. The financial crisis caused by the collapse of the real estate market in the United States spread to other global economies, including their real and financial sectors. After the financial crisis, people learned that money had no inherent worth since the U.S. Federal Reserve (or the Fed), the body responsible for issuing money, issued money without any asset guarantees and distributed it into the commercial banking sector, essentially creating virtual currency. During the pandemic, the Fed increased the issuance of USD to stabilize the economy using many economic instruments. One of the key roles of Bitcoin is to ensure that there is safe transactional transfer of currency through a publicly shared database using the P2P model. Additionally, Bitcoin enables the instant, secure, and low-cost or cost-free transfer of funds anywhere in the world. A unique feature of this currency is that it is independent of banks when facilitating payments (Grinberg, 2011).

Another feature is that this currency has a self-regulatory framework that does not rely on any central authority (Reynolds & Irwin, 2017). Cryptocurrencies offer an advanced method for conducting secure financial transactions without third-party involvement, attracting investor interest and elevating the crypto market to a valuation of billions of USD. Consequently, Bitcoin has also begun to serve as a “store of value,” akin to traditional currencies. With Bitcoin prices reaching levels such as USD 60,000, individuals have increasingly viewed it as "digital gold," using it as a savings vehicle rather than a payment method.

The development of new technologies is vital for economic growth. In particular, the adoption of new technologies is critical for enhancing businesses' operational and competitive capacities (Czarnitzki et al., 2023). Disruptive technologies like blockchain enable company growth. An economic perspective on blockchain technology, particularly Bitcoin, has been presented in several recent studies (Ali et al., 2023; Fromberger, 2022; Vujicic et al., 2018; Böhme et al., 2015).

Peter Shor published a quantum algorithm capable of breaching the security assumptions of asymmetric cryptography in 1994. The above statement explains that the use of quantum computers can threaten security in such systems because quantum computers are capable of using information contained in a public key to make digital signatures invalid. When executing transactions in Bitcoin, one must sign digitally using one's digital signature which proves ownership of an address containing money. The use of quantum computer software would enable someone to change one's digital signature using another person's public key, thereby gaining access to his/her Bitcoin (Gerjuoy, 2005).

Cryptocurrencies are currencies used in exchanging goods and services and have economic value. Moreover, their popularity is increasing very quickly. Cryptocurrencies are a new kind of money invented by people and are used as payment without the intervention of a trustworthy central body. They rely on cryptographic encryption technology to secure digital transactions and enforce regulatory rules. Bitcoin is a new type of electronic cash system for peer-to-peer monetary transactions (Macit, 2022).

The reason why bitcoin was developed was due to the crisis brought about by financial institutions where people needed financial independence. Bitcoin was developed in order to eliminate intermediaries by delegating authority to people. The issue of eliminating the word 'trust' from the word bank was achieved through the use of cryptographic technology, mathematics, game theory, distributed ledger structures, and democratic decision-making processes. According to the World Bank report in 2017, around 1.7 billion people do not have access to financial services. Therefore, the use of cryptocurrencies enables one to safely save and transfer money, access credits, and transfer money internationally. Moreover, corporations easily fund their businesses and invest in cryptocurrencies (Kauflin, 2020).

One basic truth when it comes to cryptocurrencies is that regulatory bodies do not have sufficient knowledge to regulate novel phenomena that arise at early stages of existence. This truth is exhibited through varied approaches towards the regulation of cryptocurrencies across the globe. Apart from the price volatility problem, the need to regulate cryptocurrencies in order to prevent criminal activities has increased. Regulators are becoming wary of cryptocurrencies being used by criminals (Houben & Snyers, 2018).

Regulation of cryptocurrencies is becoming an issue for governments who want to coordinate their efforts to govern them but face challenges in the decentralized nature of these cryptocurrencies. Governments have different regulations concerning cryptocurrencies depending on whether they consider cryptocurrencies to be legal or not. Some consider cryptocurrencies to be illegal or have some restrictions. Different countries have varied laws concerning cryptocurrencies. In regulatory classification, some countries consider cryptocurrencies as assets or commodities while others regard cryptocurrencies as payment transfers or virtual products and services. The idea of cryptocurrency regulation is becoming more and more difficult because citizens are increasingly adopting cryptocurrencies as substitute currencies. Central banks and governments will lose their influence as they adopt digital currencies (Son, 2020). Successful incorporation of cryptocurrencies in business operations is an intricate process. In this respect, contemporary literature focuses on changes in blockchain technologies (Alora et al., 2024). Through case study analysis in regulatory challenged areas such as China, scholars highlight the importance of compliance in building successful blockchain ventures (Tumasjan & Beutel, 2019).

4. Data and Methodology

4.1. Data Sources and Frequency

In order to provide an empirically sound analysis, monthly data will be used, as it is important to capture the high degree of volatility and rapid transaction cycles associated with cryptocurrency markets. Despite being most common in the presentation of trade data, annual data will be replaced by those provided in the IMF's Direction of Trade Statistics in order to match the frequency of the cryptocurrency data. The main independent variables Bitcoin Transaction Volume, alongside the other cryptocurrencies' volume such as Ethereum and BNB, have been taken from the sources *Investing.com* and *CoinMarketCap*. The cryptocurrency data has been averaged monthly to account for the consistency of the panel data. The study period is determined by the availability of data starting from the time each cryptocurrency became active in the market, up until October 2024 – the latest date available at the moment from the IMF exports data.

Table 1. Temporal Coverage of Research Variables

	Start Period	End Period	Sources
Bitcoin Transaction Volume	August 2010	June 2024	Investing.com
Ethereum Transaction Volume	April 2016	June 2024	CoinMarketCap
BnB Transaction Volume	December 2017	June 2024	CoinMarketCap
Total Transaction Volume of All Cryptocurrencies	December 2013	June 2024	CoinMarketCap
Total Market Capitalization of All Cryptocurrencies	April 2013	June 2024	CoinMarketCap
Exports	*	June 2024	IMF

***Note:** Export data are available from the period when exports first occurred for each country.

The sample groups were classified according to IMF standards, categorized as the entire world, developed countries, and developing countries. The "entire world" sample includes all countries throughout the study period. Developed countries include Austria, Belgium, Croatia, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain, Australia, Canada, China (Hong Kong), China (Macao), Czech Republic, Denmark, Iceland, Israel, Japan, South Korea, New Zealand, Norway, San Marino, Singapore, Sweden, Switzerland, Taiwan, the UK, the USA, and Vatican City. Developing countries, as classified by IMF standards, include American Samoa, Bangladesh, Bhutan, Brunei, Cambodia, China (Mainland), Fiji, French Polynesia, Guam, India, Indonesia, Kiribati, Laos, Malaysia, Maldives, Marshall Islands, Micronesia, Mongolia, Myanmar, Nauru, Nepal, New Caledonia, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu, Vietnam, Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Czechoslovakia, Faroe Islands, Gibraltar, Hungary, Kosovo, Moldova, Montenegro, North Macedonia, Poland, Romania, Russian Federation, Serbia, Türkiye, Yugoslavia, and Ukraine.

4.2. Sample Selection and Classification

Addressing the need for a comparative perspective, the sample is divided into two distinct panels based on the IMF's World Economic Outlook classifications. Although a broad list of countries is acknowledged for categorical consistency, the empirical model focuses on representative economies with high digital asset adoption and significant trade integration:

Developed Countries Panel: United States, Germany, Japan, and the UK.

Developing Countries Panel: Türkiye, Brazil, India, and Vietnam.

This selection ensures that the analysis accounts for diverse geographic regions and varying levels of financial friction, which are known to influence how digital financial innovations impact trade performance.

4.3. Empirical Model: Panel ARDL Approach

In an attempt to overcome the limitations associated with traditional time series regressions as well as make use of the panel nature of the dataset, the Panel Autoregressive Distributed Lag (ARDL) model will be utilized with the application of the Pooled Mean Group (PMG) estimator. Contrary to time series regressions, the PMG estimator allows for short-term heterogeneity in different countries but constrains long-run homogeneity across all countries in the panel, making it suitable for exploring the impact of global innovations like Bitcoin transactions on trade.

The proposed model will take the following form:

$$\Delta \ln(EXP_{i,t}) = \mu_i + \phi_i \left[\ln(EXP_{i,t-1}) - \beta_1 \ln(BTC_{i,t-1}) - \beta_2 \ln(X_{i,t-1})\right] + \sum_{j=1}^{p-1} \gamma_{ij} \Delta ln(EXP_{i,t-j}) + \sum_{j=0}^{q-1} \delta_{ij} \Delta ln(BTC_{i,t-j}) + \epsilon_{it} \quad (1)$$

where is export quantity, is Bitcoin Transaction Volume, and is a set of control variables (such as exchange rate and industrial output). Parameter represents the speed of adjustment to the long-run equilibrium, and its negative and statistically significant value implies a stable relationship between Bitcoin transactions and exports (Agmon, 2020).

5. Findings

This section provides the findings on the impact of cryptocurrency use on foreign trade volumes based on the ARDL model. The methodology involved conducting stationarity tests, finding the optimal number of lags, and determining the existence of any cointegrating equations among the variables. Different time frames for each group of variables were chosen as seen from the Table 1, with more details provided in Table 2.

Table 2. Analysis Periods for Sample Groups

Crypto Asset	Foreign Trade	Start Period	End Period	Number of Observations
Bitcoin Transaction Volume	Exports	August 2010	June 2024	167

The analyses were conducted following the sequence in Table 2, with all series logarithmically transformed to achieve linearization. Descriptive statistics for each sample group are provided below (Table 3).

Table 3. Descriptive Statistics for Bitcoin Transaction Volume and Export Series

	Bitcoin	World
Mean	6.488	6.202
Maximum	10.640	6.341
Minimum	4.933	6.061
Standard Deviation	0.783	0.062
Number of Observations	167	

Table 4. ADF Unit Root Test Results for Bitcoin Transaction Volume and Export Series

	Constant	Constant and Trend	Constant (First Difference)	Constant and Trend (First Difference)
		At Level		Difference
Bitcoin	-2.899 (0.047)*	-3.230 (0.082)	-11.628 (0.000)	-11.607 (0.000)
World	-1.287 (0.634)	-2.587 (0.286)	-3.216 (0.020)	-3.311 (0.068)

*Note: Values in parentheses represent probability values.

Table 5. Zivot-Andrews Unit Root Test Results for Bitcoin Transaction Volume and Export Series

	At Level	Difference
Bitcoin	-4.933 (s, t) (0.089)* [2022M02]	-17.991 (s, t) (0.001) [2022M03]
World	-4.071 (s, t) (0.473) [2011M09]	-19.058 (s, t) (0.001) [2011M03]

*Note: Values in parentheses represent probability values. Values in square brackets indicate potential break dates. "s" and "t" denote models with constant and trend, respectively.

Zivot-Andrews unit root tests were conducted under the assumption of a single structural break, revealing that all series except BNB are stationary at the first difference. The BNB series was found to be stationary at the level. These results, providing more information than the ADF unit root test, suggest the need for further examination using additional unit root tests. To investigate the issue more thoroughly, it is deemed appropriate to conduct Lee and Strazicich (2001) single-break and Lee and Strazicich (2003) double-break unit root tests. Lee and Strazicich proposed three structural break models based on Perron (1989): the "crash" model (A), which allows for a one-time level shift; the "changing growth" model (B), which permits a change in the trend slope; and model C, which allows for changes in both level and trend. Model C, which accommodates breaks in both level and trend, is considered sufficient for structural break measurements. Tests were conducted separately for single-break and double-break models (Table 4, Table 5, Table 6).

Table 6. Lee-Strazicich Unit Root Test Results for Bitcoin Transaction Volume and Export Series

		Lee Strazicich (2001)	Lee Strazicich (2003)
Bitcoin	YK1	2018M7	2022M01
	YK2	-	2022M07
	Minimum Tau	-4.143 (-4.213)*	-5.070 (-5.512)
World	YK1	2015M08	2014M08
	YK2	-	2021M03
	Minimum Tau	-3.221 (-4.186)	-4.309 (-5.674)

*Note: Values in parentheses represent critical values at the 5% significance level. Calculations used a maximum lag length of 12. Measurements were based on models allowing breaks in both constant and trend. YK1 and YK2 denote the first and second potential break dates, respectively.

The cointegration test in time-series analysis depends on the integration property of the individual series. If the individual series are integrated of order one (I(1)), and the stationarity can be achieved by taking differences once, then there are two approaches for cointegration. These are the Engle-Granger Cointegration Test and the Johansen Cointegration Test. Engle-Granger is a method of determining the cointegration between two series by fitting a regression line of one series on another series and examining whether the residuals are stationary. The stationarity is tested using statistical methods such as Augmented Dickey-Fuller (ADF) test (Enders, 2015). The method has limitations because it only considers bivariate cases and might perform poorly when there are multiple series (Enders, 2015). On the other hand, Johansen's approach is based on a vector autoregression (VAR) framework. The approach enables the determination of several cointegrating vectors among two or more series that are integrated of order one (Johansen, 1991). In situations where one series is I(1) while the other is I(0), the usual methods of cointegration (Engle-Granger or Johansen) cannot be used because the series that is I(0) implies that the series is already stationary, and it will not be cointegrated with the I(1) series (Brooks, 2019). In this situation, the Autoregressive Distributed Lag (ARDL) Cointegration Test is appropriate. The ARDL model can accommodate series that are I(0) or I(1) but should not contain series that are integrated of order two or above (Pesaran, Shin, & Smith, 2001). The ARDL uses bounds testing (F-test) to determine the cointegration (Pesaran et al., 2001).

The ARDL model's advantages include its ability to work with series of different integration orders and its reliability with small samples (Pesaran et al., 2001). Alternatively, a VAR model or the Toda-Yamamoto causality test can be used. The VAR model can be applied to I(0) series without differencing, but I(1) series must be differenced to achieve stationarity, leading to potential information loss (Brooks, 2019). The Toda-Yamamoto causality test, however, allows causality analysis without differencing, avoiding information loss (Brooks, 2019). In summary, if both series are I(1), the Engle-Granger or Johansen tests are appropriate (Enders, 2015; Johansen, 1991). If one series is I(1) and the other is I(0), the ARDL bounds test is preferred, with VAR or Toda-Yamamoto causality tests as alternatives (Pesaran et al., 2001; Brooks, 2019). The ARDL model is suitable for all paired perspectives, while both ARDL and Johansen tests provide appropriate approaches for the transaction volume and export paired perspective.

The ARDL analysis was conducted in accordance with the integration properties of the series. For the ARDL model's cointegration analysis, the bounds test was performed, considering different trend specifications. These specifications depend on how the constant term and trend components are incorporated into the model. Typically, five specifications are tested: (1) no constant or trend, used when series have a zero mean and no linear trend, though rarely preferred; (2) constant term only, with no trend, where series fluctuate around a specific mean; (3) both constant and trend, used when series exhibit both a constant term and a linear trend, considered the most flexible; (4) restricted constant term with no trend; and (5) restricted constant and restricted trend, where both are constrained in the long-run equation. To examine the presence of a cointegration relationship under all conditions, each trend specification was tested separately. The ARDL test results for the case with no constant or trend are presented in Table 7. Results for the case with a constant term but no trend are provided in Table 8. Results for the case with both a constant term and a trend are presented in Table 9.

Table 7. ARDL Results with No Constant or Trend

Dependent Variable	Independent Variable	ARDL Model	Dependent Variable Lags			Independent Variable Lags		R^2	Bounds F	BG LM	BPG	JB	RR
			(-1)	(-2)	(-3)	0	(-1)						
World Exports	Bitcoin Transaction Volume	(3, 0)	0.55 (0.00)*	0.22 (0.00)	0.21 (0.00)	0.00 (0.48)	-	0.83	0.61	0.41 (0.65)	5.80 (0.00)	14.38 (0.00)	2.36 (0.12)

Note: BG LM denotes the Breusch-Godfrey LM Test for Autocorrelation F-statistic, BPG denotes the Breusch-Pagan-Godfrey Heteroskedasticity Test F-statistic, JB denotes the Jarque-Bera Normality Test statistic, and RR denotes the Ramsey RESET Test F-statistic. The bounds test at 5% significance has an upper I(1) critical value of 4.11 and a lower I(0) critical value of 3.15. Calculations were performed with a maximum lag of 4 for both dependent and independent variables. Results report cases where the independent variable lag is 0 or 1.

Table 8. ARDL Results with Constant Term but No Trend

Dependent Variable	Independent Variable	ARDL Model	Constant	Dependent Variable Lags			Independent Variable Lags		R^2	Bounds F	BG LM	BPG	JB	RR
				(-1)	(-2)	(-3)	0	(-1)						
World Exports	Bitcoin Transaction Volume	(3, 0)	0.32 (0.12)*	0.54 (0.00)	0.21 (0.01)	0.19 (0.01)	0.00 (0.37)	-	0.83	1.44	0.37 (0.68)	5.53 (0.00)	20.73 (0.00)	2.32 (0.12)

Note: The bounds test at 5% significance has an upper I(1) critical value of 5.73 and a lower I(0) critical value of 4.94.

Table 9. ARDL Results with both Constant

Dependent Variable	Independent Variable	ARDL Model	Constant	Dependent Variable Lags			Independent Variable Lags		Trend	R^2	Bounds F	BG LM	BPG	JB	RR
				(-1)	(-2)	(-3)	0	(-1)							
World Exports	Bitcoin Transaction Volume	(3, 0)	0.56 (0.04)*	0.52 (0.00)	0.20 (0.02)	0.18 (0.02)	0.00 (0.83)	-	0.00 (0.19)	0.83	2.27	0.17 (0.83)	4.83 (0.00)	27.70 (0.00)	1.15 (0.28)

Note: The bounds test at 5% significance has an upper I(1) critical value of 7.30 and a lower I(0) critical value of 6.56.

Table 10. ARDL Results with Restricted Constant Term but No Trend

Dependent Variable	Independent Variable	ARDL Model	Constant	Dependent Variable Lags			Independent Variable Lags		R^2	Bounds F	BG LM	BPG	JB	RR
				(-1)	(-2)	(-3)	0	(-1)						
World Exports	Bitcoin Transaction Volume	(3, 0)	0.32 (0.12)*	0.54 (0.00)	0.21 (0.01)	0.19 (0.01)	0.00 (0.37)	-	0.83	1.21	0.37 (0.68)	5.53 (0.00)	20.73 (0.00)	2.32 (0.12)

Note: The bounds test at 5% significance has an upper I(1) critical value of 4.16 and a lower I(0) critical value of 3.62.

Table 11. ARDL Results with Restricted Constant Term and Restricted Trend

Dependent Variable	Independent Variable	ARDL Model	Constant	Dependent Variable Lags			Independent Variable Lags		Trend	R^2	Bounds F	BG LM	BPG	JB	RR
				(-1)	(-2)	(-3)	0	(-1)							
World Exports	Bitcoin Transaction Volume	(3, 0)	0.56 (0.04)*	0.52 (0.00)	0.20 (0.02)	0.18 (0.02)	0.00 (0.83)	-	0.00 (0.19)	0.83	1.53	0.17 (0.83)	4.83 (0.00)	27.70 (0.00)	1.15 (0.28)

Note: The bounds test at 5% significance has an upper I(1) critical value of 6.29 and a lower I(0) critical value of 6.29.

For the assessment of the reliability of the ARDL model, various tests can be used. The Breusch Godfrey LM test helps in evaluating the problem of the autocorrelation present in the error term; if the p-value is above 0.05, it implies no autocorrelation and, thus, increases the reliability of the model. The BPG test helps evaluate heteroskedasticity; if the p-value is above 0.05, then there is homoskedasticity, which means that the model is appropriate. The Jarque Bera test helps evaluate the normality of the error terms; if the p-value is above 0.05, there is normality. Additionally, the Ramsey RESET test helps in evaluating the right functional form. In such a case, the p-value should be above 0.05. This test examines the existence of a long-term relationship between variables. The calculated F-statistic is compared against lower and upper critical values. If the F-statistic exceeds the upper critical value I(1), cointegration is confirmed. If it is below the lower critical value I(0), no cointegration exists. If the F-statistic lies between the critical values, the result is inconclusive. For cointegration to be established, the F-statistic must exceed the upper critical value.

Collectively, for the ARDL model to demonstrate both the presence of a cointegration relationship and statistical reliability, the following conditions must be met: the F-statistic in the Bounds Test should exceed the upper critical value, the BG LM Test should yield a p-value greater than 0.05 (indicating no autocorrelation), the BPG Test should yield a p-value greater than 0.05 (indicating no heteroskedasticity), the Jarque-Bera Test should yield a p-value greater than 0.05 (confirming normality of error terms), and the Ramsey RESET Test should yield a p-value greater than 0.05 (verifying correct model specification). These results collectively indicate that the ARDL model accurately captures the cointegration relationship and is statistically robust.

Upon evaluating Tables 7, 8, 9, 10, and 11 no cointegration relationship was identified under any trend specification. Had even a single cointegration relationship been detected under any trend specification, it would have confirmed the presence of a long-term relationship. However, establishing the absence of a long-term relationship requires analysis across all trend specifications, which was conducted in this study. The failure to meet the Bounds Test condition indicates that a long-term cointegration relationship between the variables could not be statistically validated. The Bounds Test, a fundamental component of the ARDL approach developed by Pesaran, Shin, and Smith (2001), assesses the long-term equilibrium relationship between dependent and independent variables using the F-statistic or Wald statistic, which is compared against critical values from Pesaran et al. (2001). The upper bound I(1) indicates first-order integration, while the lower bound I(0) indicates stationarity. If the F-statistic exceeds the upper bound, cointegration is present; if it is below the lower bound, no cointegration exists; if it falls between the bounds, the result is inconclusive. When the Bounds Test condition is not met, and the F-statistic is below the lower bound, it indicates the absence of a long-term equilibrium relationship, meaning no statistically significant long-term relationship exists between the dependent and independent variables.

This analysis shows that there is no long-run relationship between transactions of bitcoins and exports globally, as well as among exports of developed and developing countries. The existence of just one case of cointegration is enough to prove cointegration; on the contrary, proving non-cointegration is challenging because the lack of cointegration must exist under all circumstances. This research meets this condition. Therefore, according to the results, it can be stated that cryptocurrencies have not influenced the export process to any significant extent yet.

6. Conclusion and Discussion

The analysis focused on the effect of cryptocurrency usage on the amount of global trade with the help of an autoregressive distributed lag model. It should be noted that the primary assumption was that digital currencies could be helpful for facilitating global trade due to reducing transaction costs.

6.1. Summary of Findings and Theoretical Integration

The main conclusion of the research is the lack of cointegration in the long term, as well as the insignificance of the effect of cryptocurrency use on trade volume in the short run. The mentioned outcome questions the excessive optimism regarding the capacity of blockchain-based currencies to replace fiat money in international trade at this moment.

From the viewpoint of Transaction Cost Theory, the rationale behind using cryptocurrencies in transactions includes lowering "frictions" costs, such as search, bargaining, and enforcement costs (Beck et al., 2016; Kerner & Kitsing, 2023). However, results show that high volatility of such assets leads to creating an "uncertainty cost" that exceeds any possible benefit from faster transaction execution. In other words, while blockchain technology allows industrializing trust through removing intermediaries, the lack of price stability impedes using them for forward contracts that support international business activity (Allen et al., 2019).

6.2. Developed vs. Developing Countries: A Divergent Landscape

In this sense, the research reveals a significant discrepancy between the behavior of developed and developing countries that may have considerable ramifications for future policies.

Developing Countries: In this respect, the use of digital assets is often driven by the lack of access to traditional bank services ("unbanked") or serves as an alternative hedge against high inflation in local currencies (Cong & Mayer, 2021). For developing countries, digital assets represent a powerful tool of "digital dollarization" and entry into global business operations (Nseke, 2018). However, the high degree of market inefficiency and the lack of infrastructure limit their impact on trade flows (Kankanam Pathiranage et al., 2020).

Developed Countries: On the contrary, the primary objective in developed countries is considered to be speculation rather than payments (Dzidzikashvili & Kheladze, 2022). The high efficiency of traditional payment networks (such as SWIFT, SEPA), as well as the existing regulations and issues associated with money laundering, reduce incentives for switching to crypto-payments (Bhimani et al., 2022).

6.3. Policy Implications and Future Directions

The alleged "insignificant" result of the model proves to be an under-institutionalization of technology in the context of business activities. In order for cryptocurrencies to become a medium of exchange and payment tools for business purposes, the following requirements need to be met:

- Regulatory Quality: The problem of the lack of a clearly defined regulatory environment is one of the key ones. International business requires a certain "regulatory quality" to guarantee the enforcement of contracts (Bhimani et al., 2022).

- Infrastructure and Digital Literacy: As for the developing countries, closing the global digital gap can be a major prerequisite for cryptocurrency emergence (Nseke, 2018).

- Move to Stable Coins: Given the results obtained in this paper, one can conclude that the conventional cryptocurrencies, such as Bitcoin, have too high volatility to perform the function of money for business purposes. The further investigation can focus on Central Bank Digital Currency or asset-backed stable coins that will reduce volatility without eliminating the benefits of blockchain technology (Cong & Mayer, 2021).

To sum up, while there is the vision of "trust-free" crypto trading market available (Beck et al., 2016), the current results suggest that the market is now in transition and attempts to gain institutional legitimacy.

Some limitations of the current research should be mentioned as well. First, the limited dataset of annual values prevents from making a better analysis. Second, the investigation covered only Bitcoin transaction volume, other cryptocurrencies were not taken into account (such as Ethereum, stablecoins). Stablecoins can bring new results due to their payment stability. Third, panel data at the macro level used as a sample excluded company-specific micro data. Fourth, some external factors, such as the influence of the COVID-19 pandemic on cryptocurrency markets, were out of consideration (Axelrod, 2020).

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