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Analysis of the Impact of Bilateral Monetary Agreements and Digital Currencies on International Oil and Gas Trade

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ABSTRACT

International oil and gas trade has traditionally been founded upon the hegemony of the U.S. dollar and the petrodollar system over recent decades. This structural dependency has transformed Western-dominated financial networks into instruments of power projection and has given rise to a phenomenon referred to as weaponized interdependence. The consequence of this condition for independent economies and developing countries has been severe vulnerability to secondary financial sanctions, restrictions on access to international payment systems, and rising settlement costs. Given the existing research gap in presenting an integrated model that simultaneously examines macroeconomic dimensions, commercial applications, security risks, and legal requirements, the primary objective of this study is to analyze the role of disruptive financial technologies and emerging geo-economic alliances in transforming the architecture of energy trade and international settlement systems, with a focus on policy implications for Iran. In terms of purpose, this study is fundamental-applied research, and in terms of nature, it is descriptive-analytical with a qualitative approach. The findings indicate that the establishment of bilateral monetary agreements can substantially reduce transaction costs and enhance economic resilience under sanctions by eliminating intermediary currencies. On the other hand, the utilization of digital currencies, blockchain technology, and smart contracts provides a suitable platform for instantaneous, transparent, and restriction-resistant cross-border settlements. Nevertheless, this transition is accompanied by serious challenges, including legal ambiguities, money laundering risks, tax evasion, cyber threats, and high energy consumption. Ultimately, the study argues that the energy trade system is moving toward a multipolar, multi-currency, and technology-driven financial order, and that these emerging instruments constitute strategic levers for the reconfiguration of power in the global economy, the effective utilization of which requires an intelligent and balanced regulatory approach.

Keywords: *Oil and gas trade, bilateral monetary agreements, digital currencies, financial sanctions.*

Introduction

Over the past decades, the global trade system, and particularly the energy market, has been deeply dependent on the hegemony of the dollar and the petrodollar system. This uncontested monetary dominance has led to the emergence of a phenomenon known as weaponized interdependence; an approach through which Western powers, by instrumentalizing the interconnection of global financial systems and imposing secondary sanctions, expose emerging economies and independent states to systemic risks and paralyzing restrictions. In response to these structural challenges, the transition toward a multipolar financial system is taking shape with remarkable



speed. This transition is supported, on the one hand, by the emergence of new geo-economic alliances such as BRICS and the Shanghai Cooperation Organization and, on the other hand, by the development of disruptive financial technologies such as distributed ledger technology, blockchain, smart contracts, and digital currencies. By facilitating instantaneous, transparent, and cross-border settlements that operate entirely independently of centralized Western financial institutions, these technological innovations have made it possible to bypass traditional financial bottlenecks. Nevertheless, the phenomenon of cryptocurrencies is a double-edged sword; although this decentralized network creates a strategic capacity to neutralize banking sanctions and preserve the foreign trade arteries of countries such as Iran, it simultaneously entails worrying consequences such as the intensification of security threats, including money laundering and tax evasion, complex legal ambiguities at the international level, and environmental and infrastructural challenges arising from the excessive energy consumption involved in the mining process.

Accordingly, the main objective of the present study is to provide a comprehensive explanation and analysis of the role of disruptive technologies and emerging geo-economic alliances in transforming the architecture of energy trade and financial settlement mechanisms, with a particular focus on formulating appropriate practical strategies and policies for the Islamic Republic of Iran in confronting these developments. In pursuit of this ultimate objective, the study seeks to answer the key question of what role digital currencies play in changing the configuration of international trade and what their multidimensional implications are for Iran's national security and economic resilience. To expand this problem, several subsidiary objectives and questions have also been designed, including explaining the distinction and legal nature of cryptocurrencies in relation to traditional money, precisely assessing the efficiency and capacities of decentralized networks in circumventing sanctions structures, conducting an in-depth pathology of security and economic threats, identifying barriers to domestic technological development, and ultimately proposing operational and regulatory solutions for managing and optimizing energy consumption in the mining industry. This further reveals the necessity of adopting an intelligent approach to exploiting opportunities and containing threats.

A review and examination of the research literature indicate that studies conducted in this field have generally been reductionist and one-dimensional. Most previous studies have mainly focused on specific aspects, such as macroeconomic effects (1), purely commercial applications (2), security and cyber consequences (3), or merely legal requirements (4). The fundamental gap in this scientific field is the absence of an integrated analytical model capable of simultaneously assessing the interactions and conflicts between two essential categories: the development of commercial relations under sanctions and security and regulatory requirements. Therefore, the innovation of the present study lies in adopting a systemic and domestically contextualized approach that attempts to combine these seemingly contradictory variables and provide comprehensive policy strategies so that policymakers, through principled regulation, can protect economic and infrastructural security while benefiting from the unique geo-economic potentials of this technology in line with national interests.

Methodologically, this study is organized as qualitative, fundamental-applied research with a descriptive-analytical approach. To enrich the analyses, the present study draws on the theoretical frameworks of new institutional economics and international political economy, particularly by relying on the concepts of neoliberal theory in institutional interdependence. The data collection strategy is based on documentary and library studies and has been carried out through the systematic examination of reference books, credible scientific articles, specialized university dissertations, and the monitoring and analysis of strategic reports issued by international

monetary and financial institutions such as the International Monetary Fund, the Bank for International Settlements, and the Financial Action Task Force. Finally, the extracted data were examined, categorized, and inferred using the qualitative content analysis technique in order to provide a scientific and reasoned response to the issues raised.

Theoretical Foundations and Conceptual Framework

International Political Economy, Monetary Hegemony, and Structural Power

The context of international political economy, from the beginning of its formation as an interdisciplinary field, has been based on the assumption that the economic and financial power of states is reproduced not only at transactional and commercial levels but also within the institutional and monetary structures of the world (5). According to this approach, monetary hegemony is a prominent symbol of structural power; a power that operates within the global financial system and, by shaping rules, institutions, and the direction of capital flows, makes it possible to exercise political will beyond the traditional instruments of power (6). This concept does not regard money merely as a medium of exchange, but rather considers it an instrument for imposing order and control; an order based on a state's ability to determine the value, liquidity, and convertibility of its own currency in the global system (7).

Within this framework, monetary hegemony means a country's capacity to determine international monetary and credit standards; that is, beyond influencing exchange rates or fiscal policies, the country's structural power makes other states and firms inevitably accept and operate within the framework of the hegemonic currency (8). In other words, hegemonic money functions as the backbone of the global political economy, because it determines actors' access to financial resources, credit facilities, and even trade routes (9). More precisely, the structural power arising from such a position goes beyond direct coercive relations and becomes institutionalized at the institutional and discursive levels; in the sense that others adjust their financial and monetary structures in a way that becomes compatible with the logic of the hegemonic currency (10).

The contemporary dynamics of international political economy show that the monetary dominance of the United States, despite emerging challenges from other international currencies, remains a clear example of this structural power. The dollar functions not only as the main global reserve currency, but payment systems, debt structures, and the pricing of strategic commodities are also organized on its basis, thereby systematically ensuring the structural dependency of other countries (11). This dependence on the dollar, while facilitating the political and economic influence of the United States, causes any change in that country's monetary policies to leave broad effects on global financial and inflationary balances (2). Therefore, monetary hegemony can be analyzed as one of the main components in the reproduction of structural power in the global system, because through money as an institutional mechanism, it generates the capacity to regulate and control economic and political flows simultaneously (12).

Thus, an accurate understanding of the connection between international political economy and structural power requires an analysis of the processes through which financial and monetary instruments are transformed into mechanisms of global governance. At this level, monetary hegemony is not merely an indicator of economic capacity, but rather the symbol of a discursive order reproduced through a network of financial, informational, and institutional dependencies (5). Such a global monetary order has a dynamic nature, and the hegemon's position within it is constantly tested against technological and geo-economic transformations; however, its foundation

remains based on the same classical principle: money is the embodiment of structural power in the international system.

The Historical Formation of the Petrodollar System and Its Dominance over the Energy Market

Understanding the current architecture of global energy trade requires examining the historical roots of the petrodollar system, in which revenues from oil exports are priced and settled exclusively on the basis of the United States currency (13). This financial structure was not accidental and is considered the product of strategic engineering in international political economy after the collapse of the Bretton Woods system (13). With the unilateral severing of the link between the U.S. currency and gold in 1971, due to pressures arising from military expenditures and balance-of-payments deficits, this currency became money without physical backing and was exposed to the risk of declining global demand (14).

In response to this hegemonic crisis and with the aim of finding a new backing, policymakers turned to oil, which led to the conclusion of a strategic agreement in the 1970s between Washington and Riyadh (15). Under this agreement, oil sales were conducted only in the U.S. currency, and surplus oil revenues were invested in Treasury bonds to finance budget deficits (15). This financial shift took place in exchange for guaranteeing Riyadh's military security, and with the accession of other oil-exporting countries in subsequent years, the structural dominance of this currency over the arteries of energy was fully consolidated (15).

The formation of this mechanism had profound consequences for the global market and, in addition to creating a permanent structural demand at the international level, turned the U.S. currency into the main and unrivaled reserve currency of central banks (16). Moreover, the recycling of these vast resources into Western financial markets provided extensive liquidity to strengthen the foundations of their financial hegemony (17). Ultimately, this institutionalized monopoly gave the United States an unprecedented ability to use the financial settlement network as a lever of pressure to isolate non-aligned actors, which today has encouraged emerging economies to search for alternative architectures and new monetary agreements (17).

The Concept of De-dollarization and the Geo-economic Motivations of Countries

The concept of de-dollarization refers to a process through which states seek to reduce their dependence on the U.S. dollar in trade exchanges, foreign exchange reserves, payment systems, and international financial contracts, and instead expand the use of national currencies or alternative monetary mechanisms (7). In recent decades, this trend has become one of the most important debates in international political economy, because the dominant position of the dollar has created not only economic dimensions but also broad geopolitical and strategic implications for the structure of global power (12). From this perspective, de-dollarization is not merely considered a monetary or financial policy, but rather part of countries' grand strategy to reduce vulnerability to the structural power of the United States (5).

The dominance of the dollar over the global economy after the collapse of the Bretton Woods system and the consolidation of the petrodollar system enabled the United States to exert influence beyond its conventional economic capacity by controlling financial flows and international payment networks (9). As a result, many countries realized that excessive dependence on the dollar could limit their independent decision-making capacity in the fields of foreign and economic policy (18). For this reason, efforts to reduce the share of the dollar in foreign trade and foreign exchange reserves gradually became part of the geo-economic policies of emerging powers (7).

One of the most important geo-economic motivations of countries in the path toward de-dollarization is countering vulnerability arising from financial sanctions and banking restrictions. Since a large share of global transactions is conducted through the dollar-based financial system, the United States is able, by using its dominant position, to restrict countries' access to financial markets and international payment networks (19). This issue has led many states to seek the creation of independent financial infrastructures, bilateral monetary agreements, and settlement mechanisms based on local currencies in order to reduce their dependence on the dollar-dominated financial system (2).

In addition to security and political considerations, economic motivations also play an important role in the de-dollarization process. Dependence on the dollar causes fluctuations in U.S. monetary policy to directly affect the economies of other countries; in such a way that changes in interest rates or contractionary and expansionary policies of the Federal Reserve can create currency crises, capital outflows, and financial instability in dependent economies (11). Under such conditions, countries attempt to reduce their exposure to U.S. economic policies by diversifying foreign exchange reserves and increasing the share of national currencies in foreign trade (8).

Emerging economic powers, especially China and Russia, regard de-dollarization as part of the project of redefining the global economic order. By developing independent payment systems, concluding bilateral monetary agreements, and strengthening the use of national currencies in energy trade, these countries seek to reduce the monopoly of the dollar in global exchanges (20). In fact, the expansion of financial cooperation among emerging economies can be seen as an effort to gradually transfer part of structural power from the West to new economic centers (5). However, the full realization of de-dollarization faces serious obstacles, because the dominance of the dollar does not arise merely from the economic power of the United States, but also depends on the depth of financial markets, global trust, high liquidity, and its historical role in international trade (6).

Consequently, de-dollarization should be regarded as a gradual, complex, and multidimensional process that has taken shape within the context of contemporary geo-economic rivalries. On the one hand, this trend reflects countries' dissatisfaction with the concentration of financial power in the hands of the United States, and on the other hand, it represents the efforts of emerging powers to rearrange the world's economic and monetary balances (7). Nevertheless, the persistence of dollar dominance shows that change in the international monetary structure requires simultaneous transformation in financial institutions, global trust, and the balance of economic power; a matter whose realization in the short term will face extensive structural constraints (12).

The Mechanism and Function of Bilateral/Multilateral Monetary Agreements

Bilateral and multilateral monetary agreements, as one of the most important instruments of financial cooperation among states, have gained a prominent position in countries' economic and monetary strategies in recent decades. These agreements refer to arrangements under which states or central banks make it possible to use national currencies in trade exchanges, investment, and financial settlement in order to reduce dependence on dominant international currencies (7). The expansion of these mechanisms should be analyzed within the framework of developments in international political economy and the growing geo-economic competition among major powers, because countries seek, through the creation of alternative monetary arrangements, to limit part of the structural power arising from dollar dominance (12).

Functionally, bilateral monetary agreements are based on an agreement between two countries to settle exchanges in national currencies. In this mechanism, the central banks of the two parties establish reciprocal credit

lines so that the need to use an intermediary currency is reduced and direct trade between the two economies is facilitated (9). This process reduces currency conversion costs, limits the risks of fluctuations arising from third currencies, and increases the speed of transaction settlement (8). In fact, such agreements constitute a form of gradual redistribution of monetary power at the international level, because they reduce, to some extent, countries' structural dependence on the dollar-based financial network (5).

Multilateral agreements have more complex and broader dimensions than bilateral agreements and are usually formed within the framework of regional arrangements or among groups of aligned economies. The main objective of these mechanisms is to create regional settlement systems, strengthen monetary stability, and increase collective capacity to confront financial crises (18). In such arrangements, countries attempt to organize part of their foreign exchange reserves or liquidity resources within joint mechanisms so that they can benefit from mutual support in times of financial instability or external pressure (11). In addition to their economic function, these agreements also have political and geo-economic dimensions, because they can lead to the formation of independent financial blocs and reduce the influence of dominant powers in the global monetary system (19).

One of the most important operational mechanisms of these agreements is the establishment of currency swap lines between central banks. In this process, the central bank of one country provides a certain amount of its national currency to the central bank of another country and receives the other party's currency in return, so that liquidity can be supplied for trade and investment (2). This mechanism becomes especially important in times of financial crisis or restricted access to the dollar, because it can reduce part of the pressure caused by foreign currency shortages and preserve the stability of exchanges (7). In addition, the development of independent payment systems and the connection of domestic banking networks among countries play an important role in increasing the effectiveness of these agreements (20).

The expansion of monetary agreements in recent years has been influenced above all by the strategy of emerging powers. By concluding dozens of bilateral monetary agreements and developing the use of its national currency in foreign trade, China has sought to enhance its monetary position in the global economy and reduce the degree of dollar dominance (8). Russia, following the imposition of Western financial sanctions, has also expanded monetary cooperation with regional and Asian partners as part of its strategy to counter economic pressure (19). These developments show that monetary agreements are no longer merely technical instruments for facilitating trade, but have become part of the competition among powers in the arena of rearranging the global economic order (6).

Despite their many advantages, the efficiency of monetary agreements also faces limitations. The most important challenge is economic asymmetry among countries and weak global trust in many national currencies, which prevents their expanded international use (11). In addition, the limited depth of financial markets in some countries, currency volatility, and the absence of advanced banking infrastructures reduce the operational capacity of these agreements (9). Therefore, although monetary agreements can reduce part of the dependence on the dollar-based financial system, they will not be able to completely replace the existing monetary structure in the short term (7).

Overall, bilateral and multilateral monetary agreements should be regarded as one of the most important emerging instruments in the transformation of the global monetary order. At the economic level, these mechanisms facilitate trade and reduce transaction costs, and at the geo-economic level, they make it possible to increase countries' financial independence and reduce the concentration of monetary power (5). However, their success

depends on factors such as economic stability, international trust, the development of financial infrastructures, and countries' capacity to create sustainable regional cooperation (12).

The Nature of Central Bank Digital Currencies and Distributed Ledger Technology

Central bank digital currencies can be regarded as a new form of official money issued by central banks that, by relying on digital infrastructures, makes it possible to transfer, hold, and settle funds without the need for physical banknotes (21). These currencies are in fact the response of monetary systems to financial technology developments, the expansion of electronic payments, and the emergence of cryptographic assets, and their main objective is to preserve the sovereign role of states in the contemporary monetary system (22). In recent years, the increasing concern of governments over declining control of monetary flows and the growing influence of private financial technology companies has led many central banks to place the development of national digital currencies on their agenda (1).

The nature of central bank digital currencies differs fundamentally from conventional electronic money, because these currencies are directly liabilities of the central bank and enjoy full sovereign backing (23). For this reason, unlike many private cryptographic assets that experience severe price volatility, central bank digital currencies are designed on the basis of national currency stability, and their main function is to facilitate exchanges and increase the efficiency of the payment system (21). In fact, these currencies represent an attempt to combine the advantages of digital technology with the stability and legitimacy of the official monetary system (24).

One of the most important analytical dimensions of central bank digital currencies is their relationship with geo-economic developments and monetary competition among states. Many countries do not regard the development of these currencies merely as a technological transformation, but rather consider it part of a strategy to reduce dependence on financial infrastructures dominated by major powers (19). Within this framework, digital currencies can make it possible to settle exchanges directly among countries and reduce dependence on traditional dollar-based payment networks (2). From this perspective, the development of central bank digital currencies should be considered part of the process of rearranging the international monetary structure, in which states seek to strengthen their financial and monetary independence (7).

Distributed ledger technology is the main infrastructure of many central bank digital currencies. This technology operates on the basis of the simultaneous and decentralized recording of transaction information among a set of network nodes and, through cryptographic mechanisms, limits the possibility of changing or manipulating data (25). The main feature of this technology is increased transparency, reduced intermediation costs, and enhanced security in recording financial information (26). In such a structure, transactions are verified and recorded without the need for traditional intermediary institutions, which can significantly increase the speed of financial settlement (3).

Nevertheless, not all central bank digital currencies are necessarily designed on the basis of a fully decentralized model. Many central banks prefer to use hybrid models in which final control of the network remains in the hands of the central monetary authority (1). This issue shows that states seek to benefit from the advantages of distributed ledger technology without relinquishing monetary sovereignty and financial supervision (24). Therefore, contrary to the common perception of blockchain technologies, the application of this technology in official monetary systems does not necessarily mean the elimination of state authority, but can lead to the strengthening of the supervisory and managerial capacities of central banks (23).

One of the most important functions of central bank digital currencies is increasing the efficiency of domestic and cross-border payment systems. Traditional payment systems, especially in international transactions, face problems such as high costs, long settlement times, and dependence on intermediary networks (21). Digital currencies can reduce some of these problems through direct and instantaneous settlement and limit the costs of financial exchanges (22). In addition, the programmability of digital money creates a new capacity for monetary policymaking and supervision of financial flows (3).

At the international level, competition over the development of central bank digital currencies has acquired significant geopolitical and geo-economic dimensions. China is considered one of the main pioneers in this field and pursues the development of its national digital currency as part of its strategy to strengthen financial influence and reduce dependence on the Western financial system (2). Other economic powers, concerned about the consequences of the expansion of foreign digital currencies, have also launched similar projects to prevent the weakening of their monetary sovereignty (19). Consequently, competition over digital currencies can be considered part of the broader competition among powers to shape the future financial order of the world (7).

Despite their broad opportunities, the development of central bank digital currencies is also accompanied by important challenges. Concerns about privacy, cybersecurity, the concentration of financial data, and the possibility of increased state surveillance over economic activities are among the main issues in this field (26). Moreover, if these currencies become widely used, there is the possibility of changes in the structure of commercial banking and a reduction in the intermediary role of banks, which could create important consequences for financial stability (1). In addition, the absence of common international standards and differences in technological infrastructures among countries limit the process of global convergence in this field (21).

Overall, central bank digital currencies and distributed ledger technology should be regarded as part of a fundamental transformation in the monetary and financial structure of the contemporary world. While these technologies increase the efficiency of payment systems and expand supervisory capacities, they have also created new instruments for geo-economic competition and the redefinition of monetary power at the international level (24). However, their success and expansion will depend on the extent to which states can create a balance among technological innovation, financial stability, information security, and the preservation of public trust (22).

Analysis of the Effects of Monetary Agreements and New Financial Technologies on Energy Trade

The Effects of Monetary Agreements on Oil and Gas Trade

Bilateral and multilateral monetary agreements have become one of the important instruments for readjusting economic relations among countries in recent years, particularly in the field of energy trade. Because of the high volume of financial exchanges and historical dependence on dominant international currencies, oil and gas trade has traditionally been conducted within the framework of the dollar-based monetary structure, which has created significant geo-economic consequences for energy-exporting and energy-importing countries (7). Under such conditions, monetary agreements, as mechanisms for using national currencies in the settlement of energy exchanges, provide the possibility of reducing dependence on foreign currencies and increasing countries' financial independence (12).

From the perspective of international political economy, the importance of these agreements in energy trade is not limited merely to economic dimensions, but is also connected to the structure of power in the global financial

system. The concentration of financial infrastructures and payment systems within networks under the influence of major powers has caused oil and gas exchanges to be directly affected by geopolitical considerations (19). Consequently, many countries have attempted, by developing alternative monetary arrangements, to make direct settlement of energy exchanges possible and reduce their vulnerability to external financial pressures (2).

Monetary agreements in the field of energy trade can have multiple functions, the most important of which include reducing transaction costs, managing financial risks, and increasing resilience against sanctions. These functions are strategically important, especially for countries whose foreign exchange revenues depend significantly on oil and gas exports (8). In fact, the expanded use of national currencies in energy exchanges can gradually diversify the financial structure of oil and gas trade and reduce its dependence on dominant currencies (7).

Reducing Transaction Costs, Fees, and Eliminating Traditional Currency Intermediaries

One of the most important effects of monetary agreements on oil and gas trade is the reduction of financial transaction costs. In the traditional energy trade system, payments are usually made through intermediary currencies and international banking networks, which requires the payment of multiple fees and the completion of complex financial settlement stages (9). The use of national currencies within the framework of monetary agreements makes it possible to eliminate part of these intermediary processes and conduct financial exchanges directly between the parties (18).

Reducing dependence on intermediary currencies, in addition to lowering currency conversion costs, also increases the speed of transaction settlement. In energy trade, which is often associated with high-volume exchanges and long-term contracts, reducing settlement time can help improve liquidity flows and increase the efficiency of transactions (11). Furthermore, the use of settlement mechanisms based on national currencies can reduce the costs arising from fluctuations in third currencies and create greater stability in energy contracts (8).

On the other hand, reducing the role of traditional financial intermediaries in this process is one of the most important consequences of monetary agreements. In the traditional structure of the global financial system, many international transactions are conducted through centralized payment networks supervised by Western financial institutions (19). Eliminating or reducing dependence on these intermediaries can lead to greater financial independence for countries in energy exchanges and provide the possibility of more independent management of financial flows (2).

Risk Management, Neutralizing Financial Sanctions, and Increasing the Resilience of Energy Trade

In addition to reducing transaction costs, monetary agreements play an important role in managing financial and political risks in energy trade. Since oil and gas trade is often accompanied by geopolitical tensions and economic pressures, dependence on financial infrastructures dominated by major powers can increase countries' level of vulnerability (12). Under such conditions, the use of national currencies in the settlement of energy exchanges can help reduce risks arising from external financial restrictions (7).

One of the most important dimensions of this issue is the relationship between the international monetary system and financial sanctions instruments. Since many global transactions are conducted through dollar-based payment networks, countries whose access to these networks is restricted will face serious difficulties in conducting foreign exchanges (19). Monetary agreements can reduce some of these restrictions by creating alternative settlement mechanisms and make it possible to continue energy trade even under financial pressure (2).

Moreover, diversifying the currencies used in energy trade can help increase countries' economic resilience. Under conditions in which global energy markets face severe price and financial fluctuations, reliance on a single currency may create systemic risks (11). The use of monetary agreements and settlement in different currencies can reduce risk concentration and increase the flexibility of the financial system associated with energy trade (8).

Overall, monetary agreements in oil and gas trade have gained increasing importance as instruments for reducing transaction costs, increasing financial independence, and strengthening countries' economic resilience. While facilitating energy trade, these mechanisms can gradually diversify the monetary structure governing the global oil and gas market and reduce its dependence on dominant international currencies (7). However, the success of this trend depends on factors such as the volume of trade among countries, economic stability, and trust in national currencies, which determine the effectiveness of monetary agreements in the field of energy trade (12).

Analysis of the Role of Digital Currencies and Blockchain in the Energy Trade Chain

Technological developments in the international financial system, especially the expansion of digital currencies and blockchain technology, have provided the ground for the formation of new patterns in global energy trade. Because of its extensive dependence on international payment systems, banking networks, and complex financial settlement processes, oil and gas trade has always faced high costs, delays in fund transfers, and risks related to transparency and information security (26). Under such conditions, blockchain technology and digital currencies have emerged as instruments for rearranging energy trade mechanisms and influencing traditional exchange patterns (3).

Blockchain is in fact a type of distributed ledger that records transaction information in encrypted and immutable form among network members and makes simultaneous monitoring of data possible (25). This feature has led many companies active in the energy sector, as well as governments, to pay attention to the use of this technology for contract management, shipment tracking, and financial settlement of energy transactions (2). In fact, the combination of digital currencies and blockchain technology can reduce part of the inefficiencies existing in the energy trade chain and provide the ground for greater efficiency and transparency (24).

From the perspective of international political economy, the importance of these technologies is not limited merely to technical aspects, but is also connected to the competition among powers over control of financial and energy infrastructures (19). Countries seeking to reduce dependence on the dollar-based financial system consider digital currencies and blockchain to be instruments for creating more independent financial mechanisms (7). Therefore, the digital transformation of energy trade should be regarded as part of the broader process of rearranging power in the global economy, in which new technologies play an increasing role in determining economic and financial balances (12).

Smart Contracts and Instantaneous Settlement of Oil and Gas Shipments

One of the most important applications of blockchain technology in energy trade is the use of smart contracts to manage and automatically execute commercial obligations. Smart contracts are sets of programmed codes that automatically execute contractual provisions once specified conditions are met and reduce the need for the intervention of traditional intermediaries (3). In oil and gas trade, where contracts are usually complex, long-term, and multi-stage, this technology can facilitate contract execution and financial settlement processes (26).

In the traditional structure of energy trade, financial settlement of oil and gas shipments may take days or even weeks, because document verification, shipment inspection, and the transfer of funds are carried out through multiple banking networks (21). Smart contracts can conduct settlement instantaneously and automatically by connecting transportation information, customs documents, and payment data to a single platform (25). This issue not only reduces transaction time, but also lowers operational and administrative costs and increases the efficiency of energy trade (24).

In addition, smart contracts can increase the level of trust between the parties to a transaction, because the execution of obligations relies on data recorded in the network rather than on human intermediaries (3). This feature is particularly important in international energy trade, where transaction parties may operate in different legal and political environments (26). Consequently, the use of smart contracts can reduce part of the legal and execution risks associated with oil and gas trade and help facilitate cross-border exchanges (2).

Accurate Shipment Tracking, Increased Transparency, and Reduced Corruption in Transactions

Another important effect of blockchain technology in energy trade is increased transparency and the possibility of accurate tracking of oil and gas shipments. In the traditional system, information related to the origin, transportation route, and status of shipments is often recorded in separate systems, which increases the possibility of errors, document forgery, and financial corruption (25). Blockchain, by creating an immutable registry, enables the simultaneous and transparent recording of all stages of shipment transfer (3).

This feature can play an important role in reducing corruption and increasing oversight capacity in energy trade. In many countries, ambiguity in the process of selling and transferring oil and gas has led to the formation of opaque financial networks and informal intermediation (12). The use of blockchain-based systems can reduce the possibility of concealing or altering data and increase transaction transparency by accurately recording transaction information and creating continuous traceability (26).

Moreover, accurate shipment tracking can also help improve the security of the energy supply chain. Recording data related to loading time, transportation route, shipment delivery, and financial settlement on a single platform makes more effective oversight of the trade process possible and reduces the likelihood of commercial disputes (24). This issue becomes especially important under conditions in which the energy market faces geopolitical tensions and trade restrictions (19).

Linking Digital Currencies to Physical Assets

One of the most important developments in the field of digital currencies is the effort to link these currencies to physical assets such as gold, oil, and gas. Unlike many digital assets that lack specific backing and experience high price volatility, digital currencies based on physical assets are designed with the aim of creating stability and increasing trust in exchanges (21). In this model, each unit of digital currency is backed by a certain amount of a real asset, which can increase its usability in energy trade (23).

Linking digital currencies to energy resources can create a new mechanism for settling oil and gas exchanges. Some countries have attempted to develop digital currencies based on oil reserves or natural resources as instruments for reducing dependence on dominant international currencies (2). This trend shows that energy is playing a role not only as a strategic commodity, but also as backing for redefining monetary instruments (7).

From a geo-economic perspective, energy-backed digital currencies can be considered part of countries' efforts to create a multipolar monetary order. Under conditions in which the dominance of international currencies is connected to the structural power of the states issuing those currencies, the creation of new financial instruments based on energy resources can increase countries' economic maneuvering capacity (12). However, the success of these currencies depends on factors such as the level of market trust, the stability of the value of the backing asset, and their international acceptance (24).

Overall, digital currencies and blockchain technology are becoming part of the new infrastructure of global energy trade. Through facilitating financial settlement, increasing transparency, reducing transaction costs, and creating new monetary instruments, these technologies have the capacity to transform the structure of oil and gas trade (3). Nevertheless, challenges such as the absence of common legal standards, cybersecurity concerns, and competition among major powers over control of digital financial infrastructures remain among the main obstacles to the full expansion of these technologies in energy trade (19).

Geopolitical Changes and Case Studies in the Energy Market

Recent developments in the global energy market show that the traditional structure of oil and gas trade is gradually being influenced by geopolitical changes and transformations in the international financial system. The historical dependence of energy trade on a dominant currency has caused many energy exchanges to be conducted through specific financial mechanisms formed within the framework of the structural power of major economies (12). However, increasing competition among economic powers and the growth of emerging economies have led some countries to seek alternative financial and monetary mechanisms for energy trade (7).

Within this framework, the energy market has become an important arena for redefining power relations in the international system. Countries with extensive energy resources or large consumer markets attempt to use their economic capacities to change financial settlement patterns and reduce dependence on dominant currencies (19). This trend is especially visible among emerging economies whose share of global energy production and consumption is increasing (2).

Consequently, geopolitical developments in the energy market can be analyzed as a set of efforts to diversify monetary instruments, create regional financial arrangements, and redefine economic relations between energy producers and consumers. This trend affects not only the financial mechanisms of oil and gas trade, but can also influence the structure of power in the global economy in the long term (12).

The Emergence of the Petroyuan and China's Energy Strategy in the Middle East

China's rapid economic growth in recent decades has led to a significant increase in the country's need for energy resources. This rising demand has made China one of the world's largest oil importers and has increasingly linked its foreign and economic policy to energy security (7). In this regard, China has attempted to strengthen its position in the global energy market by expanding energy relations with oil-producing countries in the Middle East (2).

One of the most important dimensions of this strategy is the effort to use China's national currency in energy exchanges, which is referred to in the economic literature as the petroyuan. The main objective of this approach is to reduce dependence on dominant currencies in oil trade and create greater capacity for the internationalization of China's currency (7). Within this framework, China has attempted to move part of energy exchanges outside the

traditional framework by creating financial markets related to oil transactions and offering financial instruments based on its own currency (2).

The importance of this trend lies in the fact that China, in addition to being a major energy consumer, is gradually becoming one of the main actors in determining the financial rules of energy trade. The use of China's currency in oil transactions can gradually increase the role of this currency in the global financial system and affect the existing balance in the monetary structure of energy trade (19). From this perspective, the petroyuan can be considered part of China's broader strategy to increase its economic and financial influence in the international system (12).

The Approach of BRICS Countries and the Shanghai Cooperation Organization in Creating a New Financial Architecture

In recent years, the member countries of BRICS and the Shanghai Cooperation Organization have attempted to create the ground for the formation of new mechanisms in the international financial system by developing financial and economic cooperation. These countries, which possess a significant share of the world's population, natural resources, and economic output, seek to reduce dependence on traditional financial mechanisms and create more diverse monetary arrangements (7).

One of the most important actions of these countries in this regard is the creation of joint financial institutions and the development of the use of national currencies in trade exchanges. The establishment of the BRICS Development Bank and the increase in financial cooperation among member countries indicate an effort to create alternative financial infrastructures in the global economy (2). These actions are especially important in the field of energy trade, because many members of these groups are among major energy producers or consumers (19).

In addition, financial cooperation within the framework of these groups can provide the ground for creating more independent payment and financial settlement networks. Such a trend allows countries to conduct part of their energy and strategic commodity exchanges outside the framework of traditional financial systems and reduce their dependence on dominant currencies (12). Consequently, the efforts of BRICS countries and the Shanghai Cooperation Organization can be considered part of the trend toward the formation of a multipolar financial architecture in the international system, whose objective is to increase diversity in financial and monetary instruments (7).

Russia's Experience in Ruble-Based Energy Trade after Sanctions

The economic and financial sanctions imposed on Russia in recent years have had a significant impact on the manner in which the country conducts its energy exchanges. Restrictions on Russia's access to certain international financial infrastructures led the country to seek alternative mechanisms to continue its energy exports (19). Within this framework, Russia attempted to increase the use of its national currency in energy exchanges and conduct part of its oil and gas transactions on a ruble-based basis (2).

This policy was designed with the aim of reducing the effects of external financial restrictions and strengthening the role of the ruble in foreign trade. By requiring some energy buyers to pay for gas using rubles, the Russian government attempted to increase demand for this currency and thereby strengthen domestic financial stability (7). Such an action shows that monetary instruments can be used as part of geo-economic strategies in energy trade (12).

Russia's experience also shows that changing monetary mechanisms in energy trade is accompanied by challenges. Acceptance of alternative currencies by buyers, the stability of the national currency's value, and market trust are among the factors that affect the success of such policies (19). Nevertheless, Russia's actions indicate that geopolitical developments can push countries toward reconsidering the financial mechanisms of energy trade and accelerate the trend of diversifying the currencies used in this market (2).

Pathology, Barriers, and Challenges Ahead

Recent developments in the field of energy trade and the international monetary system show that efforts to create alternative mechanisms against dominant financial structures face a set of structural, legal, and economic challenges. Although some countries, in order to reduce dependence on dominant currencies and traditional financial networks, have moved toward the use of national currencies, bilateral monetary agreements, and new financial technologies, the practical implementation of these approaches has been accompanied by limitations that can affect the efficiency and sustainability of these mechanisms (7).

One of the most important limiting factors in this field is the relative instability of many national currencies compared with international currencies, which can create significant financial and commercial risks for actors in the energy market (12). In addition, the absence of coordinated legal and regulatory frameworks at the international level, especially in the field of new financial technologies, has caused the widespread use of new payment instruments to face legal and supervisory ambiguities (3).

On the other hand, the structure of power in the global financial system is also an important obstacle to the formation of alternative financial mechanisms. The dominance of major financial institutions and international payment networks formed within Western economies enables these countries to use economic and financial instruments to preserve their position in the global monetary system (19). Consequently, any effort to redefine the financial rules of energy trade will inevitably face structural reactions and resistance from the dominant actors in the international financial system (2).

Fluctuations in the Value of National Currencies and Liquidity Risks in Bilateral Agreements

One of the most important challenges in using national currencies in energy trade is the fluctuation of their value in global financial markets. Unlike dominant currencies, which enjoy broad economic backing and deep financial markets, many national currencies of developing countries face significant fluctuations that can affect the stability of trade exchanges (7).

Within the framework of bilateral monetary agreements, countries attempt to conduct part of their trade exchanges using national currencies in order to reduce dependence on foreign currencies. However, differences in the level of economic development, trade volume, and financial stability among countries can create imbalances in these agreements and increase financial risks (2). Under such conditions, exchange rate fluctuations may increase transaction costs and reduce the incentives of economic actors to use national currencies in international transactions (12).

Another issue in this field is the limited liquidity of some national currencies in global markets. If a country's currency lacks broad convertibility, trade partners may face difficulties in using it to make international payments (7). This issue, especially in energy trade, where the volume of financial exchanges is very high, can constitute an important barrier to the expanded use of national currencies (19).

International Legal and Regulatory Gaps in the Field of Cryptocurrencies

The expanded use of digital assets and blockchain-based technologies in international trade has created important questions concerning legal and supervisory frameworks. Despite the considerable capacities of these technologies in reducing transaction costs and increasing transparency, a coherent and coordinated legal system has not yet been formed at the international level for regulating activities related to cryptocurrencies (3).

One of the most important challenges in this field is the difference in countries' approaches toward digital assets. Some countries have recognized the use of these instruments and developed specific regulatory frameworks for them, while others have imposed extensive restrictions on their use (25). This divergence in regulatory approaches has caused the use of cryptocurrencies in international trade to be accompanied by legal uncertainties (2).

In addition, issues related to legal liability, cybersecurity, and data protection are other important challenges in this field. The absence of common legal standards for resolving disputes arising from digital transactions can increase legal risks for economic actors (3). Consequently, the extensive development of the use of cryptocurrencies in energy trade depends to a large extent on the formation of transparent and coordinated legal frameworks at the international level (19).

Structural Resistance and Possible Reactions of the United States and Western Financial Institutions

One of the most important obstacles to the formation of alternative financial mechanisms in energy trade is the structural resistance of dominant powers in the global financial system. The dominant position of certain international currencies depends not only on economic factors, but also on a broad network of financial institutions, capital markets, and payment infrastructures that have taken shape over recent decades (12). This institutional network enables the countries that own these infrastructures to exert significant influence over global financial flows (7).

Within this framework, any effort to reduce dependence on dominant financial mechanisms may encounter political and economic reactions. The use of instruments such as financial sanctions, restrictions on access to international payment networks, and political pressure are among the measures that can be used to preserve a superior position in the global financial system (19).

In addition, major financial institutions and capital markets located in Western economies play an important role in determining global financial rules and standards. Through the formulation of regulations, banking standards, and international settlement mechanisms, these institutions can influence the functioning of the global financial system (2). Consequently, changing existing financial structures in energy trade requires the creation of new financial infrastructures and the acquisition of market actors' trust, which is considered a complex and time-consuming process (7).

Overall, the examination of the barriers and challenges ahead shows that although the effort to diversify monetary mechanisms in energy trade is an expanding trend, its full realization depends on a set of economic, legal, and geopolitical conditions. The success of this trend requires creating stability in national currencies, formulating coordinated regulatory frameworks for new financial technologies, and forming new institutional arrangements in the international financial system capable of attracting the trust of economic actors (12).

Discussion and Conclusion

This study analyzed structural transformations in the architecture of international energy trade and showed that the traditional petrodollar system, which had functioned for decades as the backbone of the global political economy, is now facing unprecedented erosion and challenge from two convergent forces: geo-economic alliances and disruptive financial technologies. The findings of the study confirm that the monetary hegemony of the dollar, which has turned into an instrument of “weaponized interdependence” and the imposition of unilateral sanctions, constitutes the main motivation for countries to move toward a multipolar financial order.

In response to the main research question concerning the role of digital currencies and monetary agreements in changing the configuration of international trade, the results show that these mechanisms are not merely tools for facilitating trade, but rather operate as strategic instruments for rearranging power in the global financial architecture. Bilateral/multilateral monetary agreements, by eliminating intermediary currencies and reducing costs, enable countries to optimally manage foreign exchange reserves while increasing their resilience against sanctions shocks and fluctuations in U.S. monetary policies. These agreements, especially within the framework of alliances such as BRICS and the Shanghai Cooperation Organization, are creating a parallel financial network independent of Western institutions.

At the same time, technologies based on distributed ledger technology, blockchain, and digital currencies have accelerated this transition by providing the necessary technical infrastructures. Through the creation of cross-border, decentralized, and censorship-resistant payment channels, these technologies create a unique capacity to circumvent financial sanctions. Smart contracts minimize friction and operational risks in the energy trade chain through automation and instantaneous settlement of transactions, while transparency in shipment tracking has the potential to contain corruption.

However, this study also revealed the dual and complex nature of these technologies. Alongside geo-economic opportunities, serious threats exist, such as facilitating money laundering, tax evasion, severe price volatility, legal-regulatory gaps, and infrastructural and environmental challenges, especially high energy consumption in mining.

The main innovation of this study was the presentation of an integrated analytical framework showing that a successful strategy for a country such as Iran lies neither in absolute acceptance nor in complete rejection of these technologies, but rather in intelligent management and balanced regulation. Effective policymaking must be able to simultaneously exploit the capacities of these instruments for neutralizing sanctions and developing trade while, at the same time, protecting the country’s national and economic security against the threats arising from them through the formulation of precise regulatory, security, and legal frameworks.

Ultimately, the transition from a unipolar monetary order in the energy market is an irreversible reality moving toward a mosaic, multi-currency, and technology-driven financial architecture. For actors such as Iran, which are on the front line of confronting geo-economic pressures, a deep understanding of these transformations and the adoption of a forward-looking and comprehensive approach is not a choice, but a strategic necessity for preserving national interests and strengthening economic resilience in the coming decades. It is recommended that future studies, with a focus on quantitative research, more precisely assess the economic effects of these mechanisms and formulate domestic legal and technical models for their implementation in the country’s energy chain.

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Authors' Contributions

All authors equally contributed to this study.

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Transparency of Data

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