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THE ECONOMIC NATURE OF CRYPTOCURRENCIES AS A DETERMINANT OF MARKET INEFFICIENCY AND THE STRUCTURAL LIMITS OF THEIR VALUE PREDICTABILITY

The article examines how the economic nature of cryptocurrencies creates conditions for market inefficiency and limits value predictability. The study combines conceptual, comparative, structural-functional, and causal analysis. Cryptocurrencies are defined as hybrid digital assets integrating conditional monetary functionality, investment demand, network utility, and technological properties. Production costs, protocol-based scarcity, transactional utility, adoption, and expectations affect prices but do not create a stable valuation anchor. Reflexive pricing, fragmented trading infrastructure, information asymmetry, and limits to arbitrage make market efficiency heterogeneous and time-varying. The proposed framework distinguishes short-term price forecasts from long-term value predictability and supports more cautious assessment of cryptocurrency forecasts and risks.

Keywords: cryptocurrency, economic nature, fundamental value, valuation anchor, market efficiency, price formation, reflexivity, value predictability.

JEL classification: E42, G12, G14, G17.

ЕКОНОМІЧНА ПРИРОДА КРИПТОВАЛЮТ ЯК ДЕТЕРМІНАНТА НЕЕФЕКТИВНОСТІ РИНКУ ТА СТРУКТУРНИХ ОБМЕЖЕНЬ ПЕРЕДБАЧУВАНOSTІ ЇХНЬОЇ ВАРТОСТІ

У статті досліджено взаємозв'язок між економічною природою криптовалют, структурною неефективністю криптовалютного ринку та обмеженою передбачуваністю їхньої ринкової вартості. Актуальність дослідження зумовлена тим, що висока волатильність криптовалют зазвичай пояснюється незрілістю ринку, спекулятивною поведінкою або недосконалістю прогностичних моделей, тоді як її зв'язок із внутрішніми властивостями криптовалют залишається недостатньо систематизованим. Метою статті є теоретичне обґрунтування того, як неповне виконання функцій грошей, відсутність загально визнаного вартісного якоря, залежність від мережових ефектів та очікувань, фрагментація торговельної інфраструктури й обмеження арбітражу спільно визначають механізм ціноутворення та межі передбачуваності вартості. Застосовано теоретико-концептуальний дизайн, концептуальний і порівняльний аналіз, системний та структурно-функціональний підходи, а також причинно-наслідковий синтез. Криптовалюти визначено як гібридні цифрові економічні активи, що поєднують умовну грошову функціональність, інвестиційний попит, мережево залежну корисність і технологічні властивості. Встановлено, що витрати виробництва, протокольно заданий дефіцит, транзакційна корисність, поширення мережі та очікуваний попит можуть впливати на ціну, однак жоден із цих чинників не утворює стабільного й універсального вартісного якоря. Розмежовано витрати, економічну цінність і ринкову ціну, а також короткострокову передбачуваність ціни та довгострокову передбачуваність вартості. Обґрунтовано, що рефлексивна взаємодія між ціною, увагою інвесторів, поширенням мережі та спекулятивним попитом посилюється інформаційною асиметрією, фрагментацією платформ, концентрацією ринкового впливу й обмеженнями арбітражу. Унаслідок цього ефективність криптовалютного ринку є неоднорідною та змінюється в часі. Наукова новизна полягає у розробленні теоретичної моделі, яка пояснює обмежену передбачуваність вартості як ендегенний результат взаємодії вартісного та ринково-структурного каналів. Практична цінність результатів полягає у можливості їх використання для критичного оцінювання криптовалютних прогнозів і вдосконалення підходів до оцінювання ризиків.

Ключові слова: криптовалюта, економічна природа, фундаментальна вартість, вартісний якор, ефективність ринку, ціноутворення, рефлексивність, передбачуваність вартості.

Problem Statement. The expansion of cryptocurrencies has created a distinct segment of the global financial system in which digital assets combine payment, investment, technological, and network functions. Their growing integration into financial infrastructure has increased their relevance for investors, businesses, regulators, and researchers. At the same time, cryptocurrency markets remain characterised by substantial volatility, recurrent speculative cycles, fragmented liquidity, and unstable behaviour across assets and periods.

Cryptocurrency price instability is commonly attributed to market immaturity, speculative trading, regulatory uncertainty, or limitations of forecasting models. Although important, these explanations do not fully consider whether limited predictability arises from the economic properties of cryptocurrencies themselves.

Unlike equities and bonds, cryptocurrencies generally provide neither contractual cash flows nor claims on an issuer's assets. Unlike commodities, most have no direct productive use, while their scarcity is determined by protocol rather than physical constraints. Their monetary functionality is also restricted by volatility, limited acceptance, and the continued denomination of economic transactions in national currencies. Consequently, conventional valuation methods cannot establish a generally accepted benchmark for assessing cryptocurrency prices.

The absence of a stable valuation anchor increases the influence of expectations, network effects, investor attention, and speculative demand. Price appreciation may attract new participants and stimulate adoption, while expanding adoption may generate additional demand. This reflexive relationship makes price formation endogenous and sensitive to market narratives.

These effects are reinforced by fragmented trading across heterogeneous centralised and decentralised platforms. Differences in liquidity, access to information, settlement, and regulation constrain arbitrage and complicate price discovery. Moreover, blockchain records do not reveal the full economic context of exchange activity, off-chain transactions, leveraged positions, or participants' intentions.

Therefore, the scientific problem concerns whether a stable and economically grounded value trajectory can exist when valuation determinants are heterogeneous, expectations are reflexive, and market efficiency changes over time. Addressing this problem requires explaining how the economic nature of cryptocurrencies creates recurring conditions for market inefficiency and structurally limits the reliability of their long-term value forecasts.

Analysis of Recent Research and Publications. The economic nature of cryptocurrencies has been examined from monetary, institutional, asset-pricing, and market-efficiency perspectives. The initial conceptualisation proposed by Nakamoto defined Bitcoin as a peer-to-peer electronic cash system in which transaction validation and monetary issuance are performed through a decentralised protocol rather than by a central intermediary [1, p. 1]. This technological definition, however, does not fully resolve the question of the economic status of cryptocurrencies.

Research addressing their monetary properties

generally emphasises the incomplete correspondence between cryptocurrencies and conventional money. Yermack evaluates Bitcoin against the functions of a medium of exchange, unit of account, and store of value and concludes that its volatility and limited transactional use substantially restrict its monetary capacity [2, pp. 31-43]. Bjerg interprets Bitcoin as a hybrid phenomenon that combines certain properties of commodity, fiat, and credit money without fully corresponding to any of these categories [3, pp. 53-72]. These findings indicate that cryptocurrencies cannot be consistently valued either as conventional currencies backed by monetary institutions or as financial assets generating contractual cash flows.

A related strand of research focuses on the existence of fundamental value. Cheah and Fry identify a substantial speculative component in Bitcoin prices and demonstrate their susceptibility to bubble dynamics [4, pp. 32-36]. Nevertheless, the conclusion that Bitcoin has no fundamental value should be treated cautiously because it depends on the valuation framework applied. Models based on discounted cash flows are poorly suited to cryptocurrencies, whereas network-based approaches associate their value with transactional demand, platform adoption, and network externalities. Cong, Li, and Wang show that token prices may emerge from heterogeneous users' transaction demand and endogenous platform adoption rather than from expected cash flows [5, pp. 1105-1155]. Consequently, the problem is not necessarily the complete absence of economic value but the absence of a stable and generally accepted mechanism for determining it.

Studies of cryptocurrency returns similarly reveal the limited explanatory power of conventional asset-pricing factors. Liu and Tsyvinski find that cryptocurrency returns are associated with network growth, momentum, and investor attention, while production-related factors have considerably weaker explanatory power [6, pp. 2689-2727]. Liu, Tsyvinski, and Wu subsequently identify market, size, and momentum factors capable of explaining a significant part of the cross-sectional variation in cryptocurrency returns [7, pp. 1133-1177]. These results support the proposition that cryptocurrency prices are largely shaped by endogenous market variables and changes in participants' expectations rather than by production costs or traditional macrofinancial fundamentals.

Another research direction examines cryptocurrency markets through the efficient market hypothesis. Urquhart finds that Bitcoin returns do not satisfy weak-form efficiency over the full sample, although the market tends to become more efficient as it matures [8, pp. 80-82]. This result initiated a broader empirical discussion in which market efficiency is increasingly interpreted as time-varying rather than as a permanent state. The systematic review by Almeida and Gonçalves confirms the coexistence of efficiency and inefficiency across cryptocurrencies, time horizons, liquidity conditions, and market phases [9, pp. 1035-1068]. Mokni, El Montasser, Ajmi, and Bouri likewise demonstrate that the efficiency of Bitcoin and Ethereum changes over time and depends on liquidity, volatility, financial stress, money flows, and major market disruptions [10, pp. 1-25].

Market fragmentation provides an additional explanation for persistent pricing discrepancies. Makarov and Schoar document substantial and recurrent price differences across cryptocurrency exchanges, showing that capital controls, settlement frictions, and limits to arbitrage prevent the immediate equalisation of prices [11, pp. 293-319]. The coexistence of centralised and decentralised exchanges further complicates price discovery because these trading systems differ in liquidity, governance, custody, regulation, and pricing mechanisms [12, pp. 1-21]. Thus, blockchain transparency does not automatically ensure market transparency or informational efficiency.

Existing studies therefore explain particular dimensions of cryptocurrency pricing: incomplete monetary functionality, network effects, speculative bubbles, market-specific return factors, time-varying efficiency, and trading-platform fragmentation. However, these dimensions are predominantly investigated separately. Insufficient attention has been paid to the causal relationship between the economic nature of cryptocurrencies and the recurring conditions of their market inefficiency. In particular, the literature has not fully explained how the absence of a common valuation anchor, dependence on network expectations, reflexive interaction between adoption and price, fragmented market infrastructure, and limits to arbitrage jointly constrain the reliability of cryptocurrency value forecasts. Addressing this gap requires an integrated theoretical framework that treats limited predictability not only as a methodological problem of forecasting models but also as an endogenous consequence of the economic and institutional properties of cryptocurrencies.

Purpose of the Article. The purpose of the article is to substantiate the causal relationship between the economic nature of cryptocurrencies, the structural sources of cryptocurrency market inefficiency, and the limited predictability of their market value. The study aims to determine how incomplete monetary functionality, the absence of a generally accepted valuation anchor, dependence on network effects and market expectations, fragmented trading infrastructure, and limits to arbitrage jointly influence cryptocurrency price formation.

Research Methods. The study employs a theoretical-conceptual research design. Conceptual analysis is used to clarify the economic nature of cryptocurrencies and distinguish between their monetary, financial-asset, and network-based properties. Comparative analysis is applied to assess cryptocurrencies against the functional characteristics of conventional money and traditional financial assets. The systematic approach is used to integrate the monetary, institutional, behavioural, and market-microstructure dimensions of cryptocurrency price formation. Structural-functional analysis identifies how the absence of a common valuation anchor, network effects, speculative expectations, fragmented trading infrastructure, and limits to arbitrage contribute to market inefficiency. Causal synthesis is subsequently employed to construct an integrated theoretical framework linking the economic properties of cryptocurrencies with the structural limitations of their value predictability.

Main Research Results. The economic nature of cryptocurrencies cannot be adequately explained within a single conventional category. Their original technological design corresponds to a decentralised payment instrument that enables the transfer of digital units without a central settlement institution [1, p. 1]. Nevertheless, the technical capacity to perform payments does not automatically confer the full economic properties of money. A monetary instrument must not only be transferable but also be sufficiently accepted, stable, and interpretable as a common measure of value.

The distinction between technological design and actual economic use is therefore fundamental. Yermack demonstrates that Bitcoin only partially performs the functions of a medium of exchange, unit of account, and store of value [2, pp. 31-43]. Bjerg consequently characterises it as a hybrid form combining selected properties of commodity, fiat, and credit money without fully reproducing the institutional foundations of any of them [3, pp. 53-72]. The economic identity of a cryptocurrency is thus determined not exclusively by its protocol but also by the way market participants use and value it.

From this perspective, cryptocurrencies combine four interrelated components. First, they have monetary properties, since they may be transferred and accepted as payment. Second, they have investment-asset properties, because holders acquire them in anticipation of future price appreciation. Third, they operate as network goods, whose utility depends on adoption, infrastructure, and the number of potential counterparties. Fourth, they have technological properties, including protocol-defined issuance, cryptographic verification, and distributed transaction recording. The relative importance of these components differs across cryptocurrencies and may change over time.

Empirical patterns of use support this interpretation. Baur, Hong, and Lee find that Bitcoin has been used predominantly as a speculative investment rather than as a medium of exchange [13, pp. 177-189]. This does not eliminate its potential monetary function but indicates that actual demand may diverge from the purpose embedded in its original design. Moreover, the monetary classification proposed by Bech and Garratt shows that digital currencies can be differentiated by issuer, accessibility, form, and transfer mechanism [14, pp. 55-70]. Privately issued decentralised cryptocurrencies consequently occupy a position distinct from cash, commercial bank money, and central bank digital currencies.

Accordingly, a cryptocurrency should be understood as a hybrid digital economic asset that combines conditional monetary functionality, protocol-based scarcity, network-dependent utility, and investment demand. This definition explains why its market price cannot be derived from one valuation principle. It may simultaneously reflect expected transactional utility, anticipated network expansion, perceived scarcity, speculative expectations, and changes in market confidence. The heterogeneity and instability of these determinants constitute the first structural precondition for the absence of a generally accepted cryptocurrency value anchor (Fig. 1).

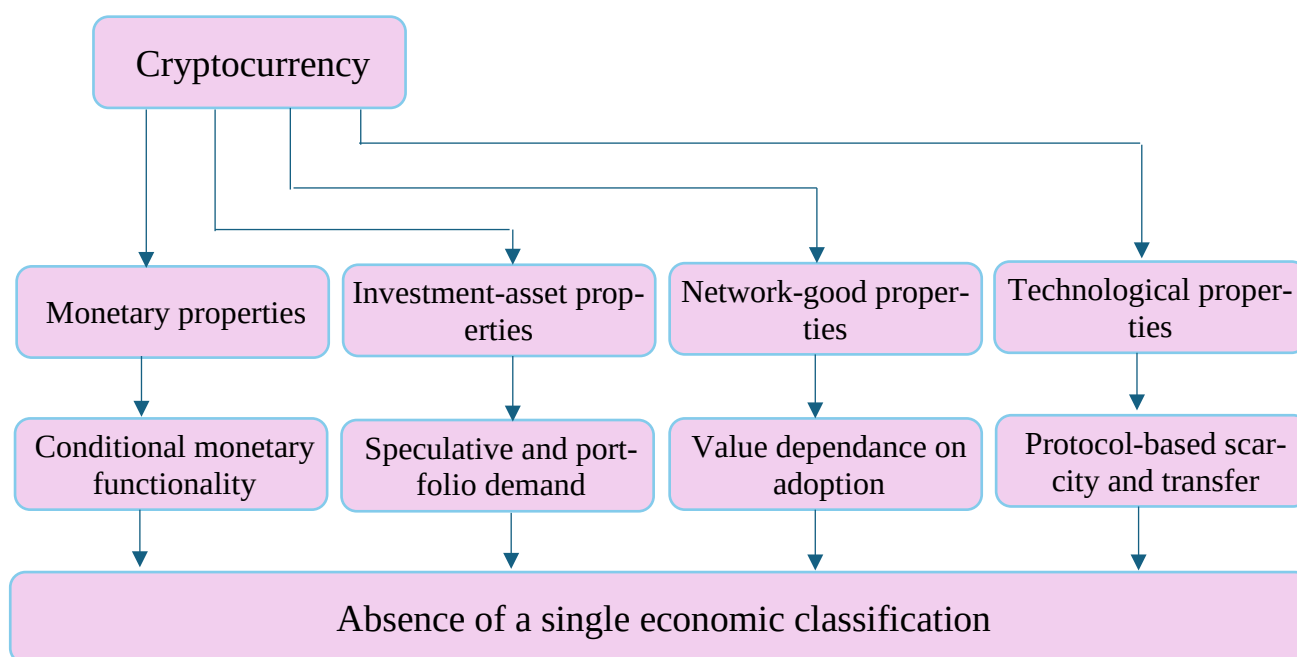


Figure 1. Hybrid Economic Nature of Cryptocurrencies.

Source: developed by the author based on [1-3; 13-15].

The hybrid economic nature of cryptocurrencies becomes particularly evident when their capacity to perform the classical functions of money is examined. An asset may be technically transferable without becoming a generally accepted medium of exchange, a stable unit of account, or a reliable store of value. Therefore, the monetary status of cryptocurrencies should be assessed according to their actual economic use rather than their technological designation.

As a **medium of exchange**, cryptocurrencies enable direct digital transfers without a central clearing institution [1, pp. 1-2; 15, pp. 213-238]. However, their practical use remains constrained by limited acceptance, differences in transaction speed and fees, exchange-rate volatility, and the continued dependence of many transactions on intermediaries such as exchanges, wallets, and payment processors. Moreover, evidence that Bitcoin is predominantly held for investment purposes indicates that its transactional function remains secondary to speculative demand [13, pp. 177-189]. Its capacity to mediate exchange is therefore technically established but economically conditional.

The function of a **unit of account** is even more restricted. Goods, services, financial results, and contractual obligations are generally denominated in national currencies, while cryptocurrency amounts are recalculated according to current exchange rates. This means that cryptocurrencies normally represent the object of valuation rather than the common standard through which the value of other goods is expressed. High price volatility further limits their ability to provide a stable basis for economic calculation [2, pp. 31-43].

Cryptocurrencies also perform the function of a **store of value** inconsistently. Protocol-based scarcity can limit the expansion of supply, but scarcity alone does not ensure stable purchasing power. The ability to preserve value depends on future demand, market liquidity, technological

continuity, and participants' confidence. Consequently, the same cryptocurrency may be perceived as a long-term store of value by some holders and as a high-risk speculative asset by others [3, pp. 53-72; 13, pp. 177-189].

Thus, cryptocurrencies perform monetary functions selectively rather than comprehensively. Their monetary capacity varies across assets, users, jurisdictions, and market conditions. This conclusion does not exclude their use as money but indicates that such use lacks the stability and universality characteristic of established monetary systems. As a result, the monetary function cannot provide a sufficient and consistent basis for determining their market value. This limitation shifts the analytical focus from the formal supply of cryptocurrency units to the heterogeneous sources of demand and the problem of identifying a reliable valuation anchor.

The limited monetary functionality of cryptocurrencies makes the identification of their fundamental value particularly problematic. In conventional financial analysis, a valuation anchor is a relatively stable economic variable against which the observed market price can be assessed. For equities, such an anchor is associated with expected cash flows; for bonds, with contractual payments; for commodities, with productive utility, scarcity, inventories, and replacement costs. Cryptocurrencies generally provide neither contractual income nor a legally enforceable claim on an issuer's assets. Their valuation therefore cannot be directly derived from the standard discounted-cash-flow approach.

Several alternative foundations of cryptocurrency value can nevertheless be identified. The first is **production cost**, including electricity, specialised equipment, and other resources required for mining. Hayes demonstrates that mining costs and protocol characteristics can explain part of Bitcoin's value formation [16, pp. 1308-1321]. However, production costs should not be interpreted as an autonomous source of market value. When the cryptocurrency

price increases, mining becomes more profitable, new computational capacity enters the network, and mining difficulty may rise. Conversely, a price decline forces less efficient miners to leave. Thus, production costs partially adjust to market conditions and cannot independently determine the equilibrium price.

The second potential foundation is **protocol-based scarcity**. A predetermined issuance path limits the supply of certain cryptocurrencies, particularly Bitcoin [1, p. 4]. Yet scarcity creates value only if demand for the scarce object persists. A technically limited supply does not establish either the scale or stability of future demand and therefore cannot provide a complete valuation anchor.

The third foundation is **transactional and network utility**. The usefulness of a cryptocurrency may increase with the number of users, merchants, applications, and available exchange channels. Cong, Li, and Wang demonstrate that token value may be generated through transactional demand and endogenous platform adoption [5, pp. 1105-1155]. Bolt and van Oordt similarly distinguish between actual payment use, speculative positions, and expectations of future adoption as components of virtual-currency value [17, pp. 835-862]. Network-based

valuation is therefore economically meaningful, but it remains sensitive to changing expectations, competing technologies, and shifts in user activity.

The fourth foundation is **speculative demand**. Expectations of future price appreciation may generate current demand even when transactional use remains limited. In this case, the observed price incorporates not only expected economic utility but also beliefs about the willingness of subsequent buyers to acquire the asset. This mechanism helps explain why cryptocurrency prices may substantially diverge from estimates based on current use [4, pp. 32-36; 6, pp. 2689-2727].

These approaches show that cryptocurrencies are not necessarily devoid of economic value. The central problem is that their potential value determinants are heterogeneous, mutually dependent, and unstable. Production costs react to market prices, scarcity depends on continuing demand, network utility depends on adoption, and adoption itself may respond to price appreciation. Consequently, no single factor provides a generally accepted benchmark for distinguishing justified value changes from speculative price movements (Table. 1).

Table 1

Valuation Anchors of Conventional Assets and Cryptocurrencies

Asset	Principal valuation anchor	Nature of the holder's economic claim	Main valuation limitation
Equity	Expected corporate cash flows	Residual claim on corporate income and assets	Uncertainty of future earnings
Bond	Contractual interest and principal payments	Contractual claim on the issuer	Credit and interest-rate risks
Commodity	Productive utility, scarcity, inventories, and replacement cost	Ownership of a usable or consumable resource	Cyclical demand and supply shocks
Fiat currency	Purchasing power, monetary policy, taxation, and institutional credibility	Institutionally supported payment capacity	Inflationary and policy uncertainty
Cryptocurrency	Network utility, scarcity, production conditions, and expected future demand	Control over transferable digital units	Absence of a common and stable valuation anchor

Source: developed by the author based on [4-6; 16; 17].

Accordingly, the difference between cost, economic value, and market price is decisive. Cost reflects the resources used to produce or maintain a cryptocurrency; economic value reflects the expected benefits attributed to its ownership or use; market price represents the exchange outcome produced by current supply and demand. These categories may interact but are not equivalent. Their frequent conflation creates the misleading assumption that mining expenditure, algorithmic scarcity, or network growth alone can establish an objectively justified cryptocurrency price. The absence of such a stable relationship shifts price formation towards expectations, narratives, and reflexive market behaviour.

The absence of a stable valuation anchor changes the mechanism through which cryptocurrency prices are formed. In conventional asset markets, expectations are constrained, although never completely determined, by observable economic variables such as income, contractual payments, inventories, or productive use. In cryptocurrency markets, these constraints are weaker. Consequently,

expectations about future demand become an independent component of current demand.

Cryptocurrency price formation can therefore be represented as a reflexive process. An expected price increase stimulates purchases; the resulting demand raises the observed market price; price appreciation attracts public attention and new participants; and their entry generates additional demand. The price does not merely reflect expectations but also changes the information environment in which subsequent expectations are formed. This produces a feedback relationship between price, attention, adoption, and market activity.

Empirical research supports the existence of such interactions. Kristoufek shows that the relative importance of economic, transactional, technical, and speculative Bitcoin price drivers varies across time and analytical horizons [18, pp. 1-15]. This instability limits the possibility of identifying a permanently dominant explanatory factor. Garcia et al. reveal feedback cycles connecting Bitcoin prices with information searches, word-of-mouth

communication, and user-base growth [19, pp. 1-8]. Liu and Tsyvinski likewise establish that investor attention and time-series momentum contain predictive information for cryptocurrency returns [6, pp. 2689-2727].

Network effects intensify this mechanism. A larger number of users may increase transactional opportunities and the perceived utility of the cryptocurrency, thereby supporting a higher price [5, pp. 1105-1155; 17, pp. 835-862]. At the same time, an increase in price may itself stimulate adoption by signalling profitability, legitimacy, or growing public acceptance. It is therefore difficult to separate the effect of network growth on price from the effect of price growth on network participation.

Speculative demand does not necessarily imply irrational behaviour. Given the absence of a common valuation benchmark, market participants may rationally use observable price dynamics, trading volume, public attention, and the behaviour of other participants as informational signals. However, when the same signals influence a large proportion of market participants, individual responses become mutually reinforcing. Momentum and herding may then amplify price movements beyond changes in current transactional utility.

This mechanism explains why the determinants of cryptocurrency prices are endogenous and regime-dependent. A factor may predict returns during one market phase but lose explanatory power after participants adapt, market infrastructure changes, or a new narrative becomes dominant. Accordingly, short-term statistical predictability can coexist with fundamental valuation uncertainty. A forecasting model may capture a temporary relationship between past prices, attention, and returns without establishing a stable causal benchmark for long-term value.

Thus, cryptocurrency price formation is characterised by a circular rather than strictly linear relationship between economic utility, expectations, market attention, adoption, and price. The resulting reflexivity increases sensitivity to changing narratives and external information and creates conditions under which price movements may become partially detached from current economic use. When combined with fragmented trading infrastructure and unequal access to market information, this mechanism becomes a structural source of cryptocurrency market inefficiency.

Reflexive price formation alone does not prove market inefficiency. A market may remain informationally efficient even when prices are volatile, provided that available information is rapidly and adequately incorporated into prices. Cryptocurrency market inefficiency should therefore be associated not with volatility itself but with systematic conditions that delay, distort, or unevenly distribute the incorporation of information.

The first condition is **market fragmentation**. Cryptocurrencies are traded continuously across numerous centralised and decentralised platforms that differ in liquidity, participant structure, regulation, settlement procedures, and access to banking services. Makarov and Schoar document persistent cross-exchange price differences and show that limits to capital movement and arbitrage prevent their immediate elimination [11, pp. 293-319]. Consequently, a cryptocurrency does not always have one

simultaneously observable market price; instead, several platform-specific prices may coexist.

The second condition is **information asymmetry**. Public blockchain records increase the traceability of transactions but do not provide complete information about their economic purpose or the identities and intentions of market participants. Moreover, trades executed within custodial platforms may be recorded in internal databases rather than individually reflected on-chain. Over-the-counter transactions, derivatives positions, leveraged exposure, and the aggregation of users' funds in common wallets further weaken the correspondence between blockchain activity and actual market demand. Blockchain transparency should therefore not be equated with full market transparency.

The third condition is the **concentration of market influence**. Large holders, exchanges, stablecoin issuers, mining pools, developers, and information intermediaries may affect liquidity, expectations, and transaction flows. Griffin and Shams identify a specific historical episode in which Tether-denominated purchases were associated with substantial Bitcoin price increases during the 2017 boom [20, pp. 1913-1964]. This finding should not be generalised as evidence that all cryptocurrency price movements are manipulated. It nevertheless demonstrates that concentrated transaction flows can materially affect prices when liquidity and market depth are limited.

The fourth condition concerns **trading mechanisms and limits to arbitrage**. Differences between centralised exchanges and decentralised platforms include custody arrangements, order-execution models, regulatory requirements, and liquidity formation [12, pp. 1-21]. Price discrepancies may persist when arbitrageurs face transfer delays, withdrawal restrictions, transaction costs, counterparty risk, or uncertainty regarding platform solvency. Forced liquidations of leveraged positions can additionally amplify price changes without corresponding changes in the current economic utility of the cryptocurrency.

These conditions do not imply that cryptocurrency markets are permanently inefficient. Empirical evidence indicates that their efficiency varies over time and depends on liquidity, market maturity, volatility, and external shocks [8, pp. 80-82; 9, pp. 1035-1068; 10, pp. 1-25]. However, fragmentation, incomplete information, concentrated influence, and limits to arbitrage reproduce an environment in which deviations from informational efficiency can recur. Market development may reduce particular inefficiencies without eliminating their structural sources.

Thus, cryptocurrency market inefficiency should be understood as heterogeneous, time-varying, and structurally reproducible. This interpretation avoids treating every price fluctuation as evidence of inefficiency while recognising that the institutional and infrastructural organisation of cryptocurrency trading limits uniform price discovery. When these market characteristics interact with the absence of a stable valuation anchor and reflexive expectations, the reliability of value forecasting becomes fundamentally constrained.

The structural characteristics identified above require a distinction between **price predictability** and **value**

predictability. Price predictability refers to the ability of a model to forecast market-price movements over a specified period. Value predictability concerns the possibility of determining an economically justified trajectory based on relatively stable fundamental variables. These forms of predictability are not equivalent.

The existence of momentum, investor-attention effects, network indicators, or other statistically significant predictors demonstrates that cryptocurrency returns may be partially forecastable under particular market conditions [6, pp. 2689-2727; 7, pp. 1133-1177; 18, pp. 1-15]. However, such relationships are historically contingent. Their magnitude and direction may change when market participants adapt their strategies, liquidity conditions shift, regulation changes, or new technologies and trading platforms emerge. A model may therefore achieve short-term predictive accuracy without identifying a stable determinant of long-term economic value.

This limitation arises from the interaction of three mechanisms. First, cryptocurrencies lack a common

valuation anchor capable of constraining market expectations. Second, their price determinants are endogenous: adoption influences price, while price simultaneously influences adoption, attention, and speculative demand. Third, fragmented market infrastructure creates unequal information, platform-specific prices, and recurring limits to arbitrage. These mechanisms jointly make the data-generating process unstable.

Accordingly, forecast errors cannot be attributed exclusively to methodological deficiencies. More complex models may improve predictive accuracy within a given sample but cannot eliminate structural breaks, changing market regimes, or the emergence of previously unavailable information. The problem is therefore not an absolute impossibility of forecasting. It is the absence of a stable economic relationship that would ensure the transferability of estimated patterns across periods and market conditions.

The resulting theoretical relationship between the economic nature of cryptocurrencies, market inefficiency, and limited value predictability is presented in Figure 2.

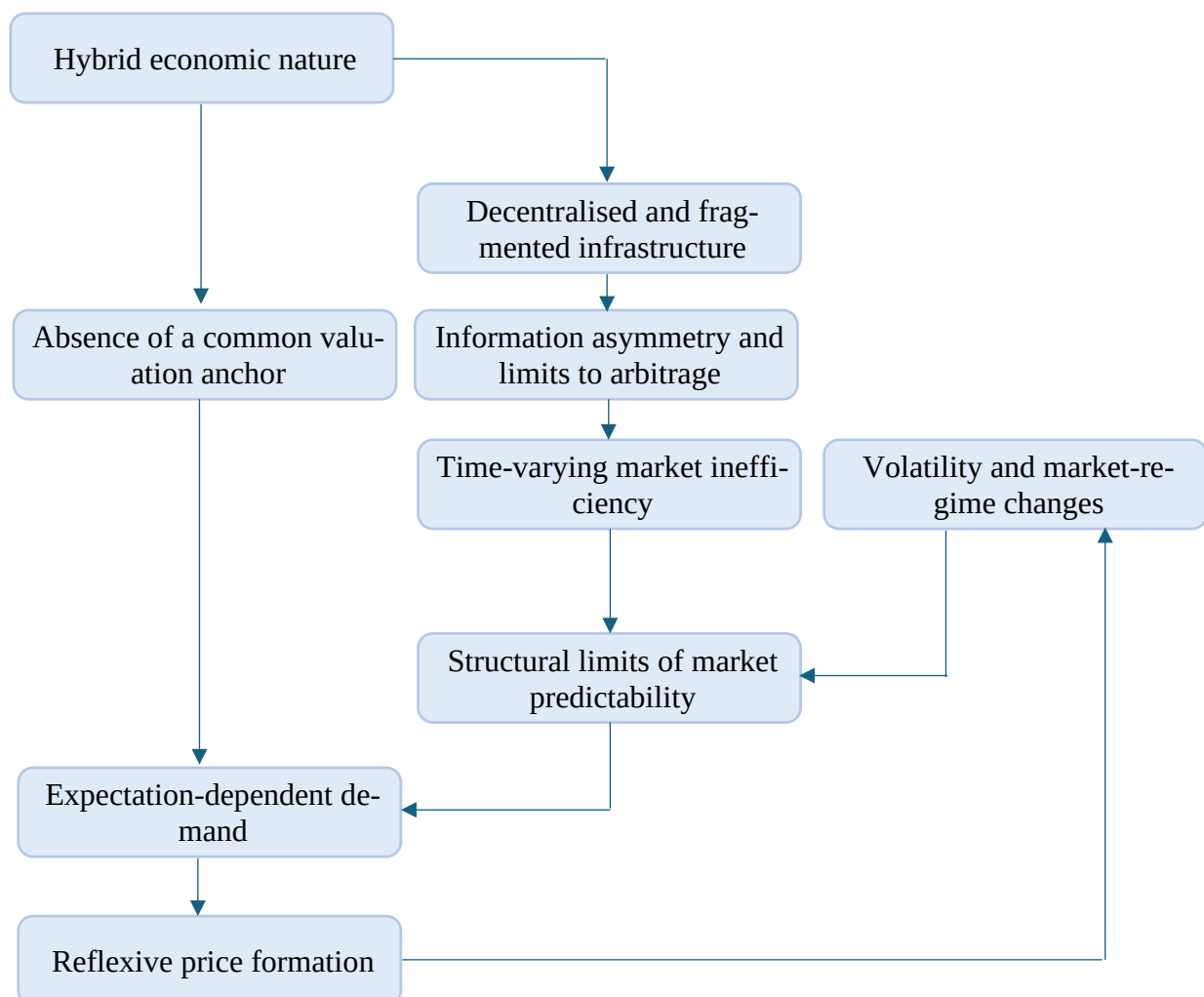


Figure 2. Theoretical Framework of the Structural Limits of Cryptocurrency Value Predictability.

Source: developed by the author based on [5-12; 16-20].

The framework contains two interconnected causal channels. The **valuation channel** links the hybrid economic nature of cryptocurrencies to the absence of a common valuation anchor, expectation-dependent demand,

reflexive pricing, and changing market regimes. The **market-structure channel** connects decentralised infrastructure with information asymmetry, limits to arbitrage, and time-varying inefficiency. Both channels converge in the

structural limitation of value predictability. The feedback from predictability limitations to expectations reflects the fact that uncertainty itself affects participants' behaviour and demand.

The proposed framework does not imply that all cryptocurrencies are equally unpredictable or that forecasting models are devoid of practical value. Predictability may differ according to liquidity, adoption, protocol design, market maturity, and forecast horizon. Nevertheless, the absence of stable valuation foundations and the endogenous evolution of market conditions prevent temporary predictive relationships from being interpreted as universally reliable laws of cryptocurrency value formation.

Therefore, the limited predictability of cryptocurrency value is not merely a temporary consequence of market immaturity. It is partly endogenous to the economic nature of cryptocurrencies and the institutional organisation of their markets. This conclusion constitutes the principal theoretical result of the study.

Conclusions. The study demonstrates that the limited predictability of cryptocurrency value is not determined solely by market immaturity or the insufficient accuracy of forecasting methods. It is partly rooted in the economic nature of cryptocurrencies and reinforced by the institutional and infrastructural organisation of their markets.

Cryptocurrencies represent hybrid digital economic assets that combine conditional monetary functionality, investment demand, network-dependent utility, and technological properties. Although they can perform certain functions of money, their use as a medium of exchange, unit of account, and store of value remains selective and unstable. Consequently, their monetary utility cannot provide a sufficient basis for determining market value.

The analysis also shows that cryptocurrencies do not necessarily lack economic value. Their price may reflect production conditions, protocol-based scarcity, transactional utility, network adoption, and expected future demand. However, these factors are heterogeneous, mutually dependent, and variable over time. Production costs respond to market prices, scarcity requires persistent demand, and network adoption is simultaneously a cause and consequence of price changes. Therefore, none of these factors independently creates a stable and generally accepted valuation anchor.

In the absence of such an anchor, cryptocurrency price

formation becomes increasingly dependent on expectations, investor attention, momentum, market narratives, and reflexive feedback between price and adoption. These mechanisms interact with market fragmentation, information asymmetry, concentration of influence, and limits to arbitrage. As a result, cryptocurrency market efficiency is neither permanently absent nor consistently present; it is heterogeneous, time-varying, and structurally vulnerable to recurring disruptions.

The proposed theoretical framework distinguishes short-term price predictability from long-term value predictability. Statistical models may identify temporary relationships and produce accurate forecasts within particular periods. Nevertheless, changes in market regimes, participant behaviour, technology, liquidity, and regulation restrict the transferability of these relationships across time. Thus, improvements in forecasting techniques cannot fully eliminate uncertainty generated by an unstable valuation structure.

The scientific contribution of the study lies in integrating the economic nature of cryptocurrencies, their valuation determinants, reflexive price formation, and structural sources of market inefficiency within a single causal framework. The framework explains limited value predictability as an endogenous outcome of interacting valuation and market-structure channels.

The results may be used to interpret cryptocurrency forecasts more cautiously, develop risk-assessment approaches that account for regime instability, and avoid treating algorithmic scarcity or mining costs as sufficient measures of fundamental value. Further research should examine whether the proposed relationships differ across payment-oriented cryptocurrencies, platform tokens, stablecoins, and other cryptoassets and should empirically test the stability of the identified causal channels across market cycles.

Declaration on the Use of Artificial Intelligence.

During the preparation of this article, the author used the generative artificial intelligence tool ChatGPT (GPT-5, OpenAI, 2026) to assist with structuring the manuscript, synthesising the literature, and improving the clarity and linguistic consistency of the English text. All AI-assisted content was critically reviewed, revised, and verified by the author. The author takes full responsibility for the scientific validity, accuracy, originality, and integrity of the article.

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