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Money as Information: Economical and Philosophical Implications for the Quantity Theory of Money

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Abstract

This paper develops a novel theoretical framework that reconceptualizes money as information, extending the classical Quantity Theory of Money through information theory. By substituting Shannon's entropy equation for the traditional quantity of money variable in Fisher's equation of exchange, we establish a new analytical framework for understanding monetary phenomena. Our approach yields three primary contributions. First, we demonstrate how monetary systems can be analyzed through their informational properties, with particular attention to limit cases where informational entropy approaches zero (analogous to gold standard systems) or infinity (corresponding to hyperinflationary scenarios). Second, we explore how this informational perspective provides new insights into monetary stability and policy effectiveness, especially relevant for digital currencies and modern financial systems. Third, we examine the philosophical implications of viewing money as information, engaging with questions of ontology, phenomenology, and ethics in monetary systems. The framework proves particularly valuable for analyzing contemporary monetary phenomena, including cryptocurrency systems and digital central bank currencies. Our findings suggest that monetary stability depends not merely on quantitative factors but on the quality and reliability of information transmission within the economic system, offering new perspectives for monetary policy and financial system design.

Keywords: monetary theory, information theory, Shannon Entropy, digital currency, philosophy of money

1. Introduction

This paper develops the money demand equation in informational terms. The proposal aims to encourage new perspectives on money demand through an interdisciplinary approach, engaging with mathematical information theory. The informational approach to money demand enables us to understand money as a means of storing and transmitting economic information, clarifying how money demand can be influenced by uncertainty and expectations regarding future economic events.

The paper's primary objective is to present the resulting equation and discuss the model's main implications *a priori*. This proposal is justified by the importance of considering factors that influence people's preference for holding money relative to other financial assets, as well as by the increasing migration of monetary phenomena to the digital world, where money exists as pure information.

The digitalization of money and the increasing complexity of monetary systems call for new theoretical frameworks to understand monetary phenomena. This paper advances an information-theoretic approach to monetary analysis, building on previous theoretical work, as that of Hayeck (1945) who argued that prices and money serve as communication mechanisms in a market economy. Sathler (2020) explored the relationship between money and information theory, launching conceptual bases for the assumption that money is information, through the work of Petty, Quesnay, Adam Smith, David Ricardo, Marx, Walras, Pareto, Marshall, Schumpeter, Samuelson, Tobin, Sargent and Wallace, Hicks, Keynes and Friedman.

The main objectives are develop an information-based monetary equation and analyses its economical and philosophical implications for monetary theory. In order to do so, we examine limit cases and their practical relevance and derive policy implications for modern monetary systems.

The conceptualization of money as information raises fundamental epistemological questions that deserve exploration. The informational view of money connects directly to contemporary epistemological debates about the nature of knowledge in social systems. Just as Goldman (1999) argues that social practices and institutions shape knowledge acquisition, monetary systems can be understood as epistemological frameworks that structure our understanding of economic value. Hayke's insights about market prices as information carriers can be reinterpreted through the lens of social epistemology, where money serves as a distributed knowledge system enabling collective economic understanding. This epistemological framework helps explain why monetary stability depends not just on quantitative factors, but on the quality and reliability of the knowledge transmission system itself. When monetary information becomes unreliable, as in cases of hyperinflation, we witness what might be termed an 'epistemological crisis' in the economic system.

Our informational reinterpretation of the Quantity Theory represents what Kuhn (1962) would term a paradigm shift in monetary theory. By replacing quantity with information as the fundamental variable, we are not merely modifying existing theory, but proposing a new framework for understanding monetary phenomena. This paper presents a groundbreaking theoretical framework that fundamentally reconceptualizes money as information by integrating Shannon's entropy equation into Fisher's equation of exchange. Unlike previous works that metaphorically describe money as information, this research provides a rigorous mathematical foundation for understanding monetary phenomena through information theory. The novel substitution of the traditional quantity of money variable (M) with information entropy (I) enables a more nuanced analysis of monetary systems, particularly in examining limit cases where informational entropy approaches zero (analogous to gold standard systems) or infinity (corresponding to hyperinflationary scenarios).

The research's unique value lies in its interdisciplinary bridging of information theory, monetary economics, and philosophy, offering new analytical tools for understanding contemporary monetary phenomena. By demonstrating how monetary stability depends on the quality and reliability of information transmission within economic systems, the paper provides fresh insights into digital currencies, central bank policies, and financial system design. The framework proves particularly valuable for analyzing modern monetary systems where money exists primarily as information, offering central banks and policymakers a new paradigm for understanding how monetary information flows affect economic stability. This theoretical advancement is especially relevant as economies increasingly shift toward digital currencies and complex financial instruments, where traditional quantity-based analyses may prove insufficient.

2. Theoretical Framework

Our approach integrates classical monetary theory with information theory, providing a framework particularly suited to analyzing digital currencies and modern monetary systems. The use of Shannon's entropy in monetary theory allows us to capture the uncertainty inherent in economic agents' behavior. Just as entropy in communication theory measures the unpredictability of a message, in monetary theory it can be used to measure the unpredictability of value signals, thus providing a quantitative way to assess monetary stability.

Sathler (2020) provides an extensive discussion of the possible relationships between money and mathematical information theory, drawing from various economists and schools of economic thought, combining them with philosophers as Plato, Aristoteles, Dennett, Simmel, Lévy, Baudrillard, Kurz. Money, traditionally viewed as a medium of exchange, store of value, and unit of account, can be reinterpreted as an information system that transmits value signals between economic agents. This approach aligns with economists such as Friedrich Hayek (1945).

The proposal also aligns with Keynes's (1936) perspectives on money. Keynes (1936) argued that information and economic agents' expectations play a fundamental role in determining economic outcomes. He maintained that in contexts of uncertainty, agents' expectations would play a crucial role in economic decision-making, such as investment and spending decisions. When information about an economic event is scarce, uncertainty is higher, and expectations have a more significant impact on decisions. Conversely, when there is greater clarity and predictability about an event, expectations have less influence.

The relationship between increasing income (Y) and decreasing information quantity or surprise relates to the idea that as information becomes more available and reliable, economic agents can make decisions with greater certainty and less surprise regarding expected outcomes. This, in turn, affects economic behavior, such as investment and spending, according to Keynes's general theory. Thus, we observe the relationship between Keynes's notion of uncertainty and Shannon and Weaver's (1963) concept of surprise in mathematical information theory. Keynes acknowledges that information available to economic agents is limited and imperfect. Therefore, as the probability of an event increases or decreases, the quantity of information and surprise associated with that event can also be perceived by economic agents. In rational expectations theory, economic agents form decisions based on available information and future expectations. If money is information, this reinforces the importance of expectations regarding money's value, as agents react not only to the current state of the economy but also to future information that money may carry.

This view is already partially reflected in economics, where money velocity can be interpreted as the frequency with which this information is used. Thus, the quantity of money can be reinterpreted as the quantity of information circulating in the economy, directly relating to the idea that money's purchasing power is a matter of perception and confidence, as discussed by Keynes. The advantage of this treatment is that, as in information theory, money demand can be influenced by uncertainty and expectations regarding future economic events.

Under greater uncertainty or expectations of unforeseen events, money demand may increase as people seek to maintain greater liquidity to protect against possible contingencies. As information plays an important role in economic decision-making, money demand reflects the valuation of information. Understanding money as a means of storing and transmitting economic information, facilitating the exchange of goods and services, we can assume that money's reliability plays a fundamental role, just as the quality of the communication channel and transmission reliability are important in the information transmission process. In other words, confidence in stability and money acceptance influence its demand, as people tend to seek money that is reliable as a medium of exchange and store of value.

Furthermore, this idea engages with Milton Friedman's contributions to the Quantity Theory of Money, which argues that the quantity of money in circulation is fundamental to price and economic system stability. In his money demand model, Friedman (1969) emphasizes the relationship between money demand and macroeconomic variables, such as income and interest rates. For Friedman, money demand is a function of real income and interest rates. Individuals desire to maintain sufficient money for their normal transactions but also consider interest-earning opportunities when deciding how much money to hold relative to other assets.

In the context of monetary economics, considering the idea that "money = information" essentially implies viewing it as a way of transmitting data about value, confidence, purchasing power, and expectations among economic agents. Money thus ceases to be seen merely as a physical asset (like paper money) or digital asset (like a bank account balance), to be understood as a symbolic language that carries essential information about the economy.

When considering money as information, money's value ceases to be seen as an intrinsic characteristic (as in the classical view of gold or paper money) and comes to be understood as something completely relational and subjective. Money acquires value because it transmits information that is accepted by all market participants. This implies that money acceptance is based on economic agents' confidence in the validity of the information it transmits. Money's value can be more sensitive to agents' perceptions and expectations, as any change in the underlying "information" (such as monetary policies, inflation rumors, or crises) affects its acceptance and value.

In terms of supply and demand, the dynamics can be viewed as a matter of information access and control. Central Banks and other financial institutions would be seen as information managers controlling the data flow that defines money's value and purchasing power. Monetary policies would be comparable to managing an "information system," where changes in interest rates, money issuance, or exchange rate interventions would alter the quantity and quality of circulating information.

The literature on monetary theory has evolved significantly, incorporating elements of information theory to explore the dynamic role of money in modern economies. Groundbreaking works, such as the microfoundations of monetary theory, laid the groundwork for understanding the disequilibrium aspects of monetary systems (Plassard, 2017). Contemporary advancements further this integration, as illustrated by the Lagos-Wright model, which employs search theory to analyze monetary dynamics and policy implications in decentralized economies (Liu, 2016). These frameworks highlight the necessity of examining monetary mechanisms through the dual lenses of economic uncertainty and informational flows, contributing to a nuanced understanding of monetary systems in a globalized financial landscape.

Modern Monetary Theory (MMT) also provides a critical perspective on monetary policy's interaction with fiscal decisions and macroeconomic stability. As highlighted by Visser (1991), recent developments in monetary theory examine issues such as crowding out, currency substitution, and the breakdown of stable money demand functions (Visser, 1991). These analyses align with ongoing discussions about central banks' roles in managing informational trust and navigating post-Bretton Woods monetary challenges. Moreover, research on monetary integration has emphasized the necessity of robust institutional frameworks to manage exchange rate mechanisms and financial stability in multi-currency unions (Trautwein, 2005).

The informational perspective is particularly critical in understanding the mechanisms of digital currencies and decentralized financial systems. Studies have shown that cryptocurrencies, such as Bitcoin, operate as pure informational constructs, relying on cryptographic validation and trust within distributed networks (Liu, 2016). These insights complement foundational research by Goodhart, who argued that monetary phenomena could only be fully understood within the context of information asymmetries and associated market uncertainties (Goodhart, 1977).

The paper's theoretical framework builds upon recent developments in monetary economics, particularly the growing body of research examining the informational properties of monetary systems. Recent work by Brunnermeier et al. (2019) on the "digitalization of money" and its implications for monetary policy provides crucial context for understanding how information flows affect modern financial systems. This connects well with Agur et al. (2022)'s analysis of digital currency design and its impact on monetary transmission mechanisms, highlighting how the paper's information-theoretical approach can illuminate contemporary policy challenges.

The research intersects with emerging scholarship on the role of expectations and information in monetary policy effectiveness. Coibion et al. (2022) have provided empirical evidence on how households' inflation expectations respond to different types of monetary information. These findings support the paper's theoretical premise that monetary phenomena can be understood through an informational lens. Additionally, Bordalo et al. (2023)'s work on diagnostic expectations in macroeconomics offers important insights into how economic agents process monetary information, complementing the paper's information-theoretical framework.

Recent research on central bank communication and monetary policy transparency provides another relevant context for the paper's contributions. Blinder et al. (2022) have examined how central bank communication strategies affect market expectations and monetary policy transmission, while Hansen et al. (2019) have analyzed the informational content of monetary policy statements using natural language processing techniques. The paper's theoretical framework offers new ways to understand these communication dynamics through its integration of information theory with monetary economics.

The growing literature on cryptocurrency and decentralized finance also provides important context for the paper's theoretical innovations. Allen et al. (2023) have analyzed how digital currencies affect monetary sovereignty and financial stability, while Uhlig and Xie (2020) have examined the informational efficiency of cryptocurrency markets.

3. Money as Information

The paper's methodological foundation rests on a mathematically rigorous transformation of Fisher's equation of exchange, where the traditional quantity of money (M) is substituted with Shannon's information entropy equation (I). This substitution is not merely symbolic but represents a fundamental reconceptualization supported by extensive theoretical groundwork linking monetary theory with information theory. By integrating Shannon's entropy equation into Fisher's classical equation of exchange, the study develops a novel analytical framework that quantifies money's informational properties. This substitution is methodologically justified by the parallels between entropy in information theory and the uncertainty inherent in monetary systems. The framework captures critical aspects of monetary phenomena, such as stability, diversity of use, and the effects of economic agents' expectations, which traditional models often overlook. The methodology's robustness is demonstrated through its systematic analysis of limit cases ($I \to 0$ and $I \to \infty$), which provides testable predictions about monetary behavior in extreme scenarios such as gold standard systems and hyperinflationary environments. The mathematical framework is further validated by its ability to explain historical monetary phenomena and its consistency with established economic theories, including Keynesian uncertainty and rational expectations.

However, the paper acknowledges certain methodological limitations that warrant further research. While the theoretical framework provides insights into monetary phenomena, empirical testing of the model's predictions requires the development of specific metrics for measuring monetary entropy in real-world economic systems. Additionally, the relationship between informational entropy and velocity of circulation (V) could benefit from more detailed mathematical exposition, particularly in cases where the information content of money changes rapidly. Future research could strengthen the methodology by developing quantitative methods for measuring monetary entropy in digital currencies and traditional financial systems, thereby providing empirical validation of the theoretical framework's predictions.

Money traditionally serves three functions: medium of exchange, store of value, and unit of account. We reinterpret these functions through an informational lens, viewing money as a system that transmits value signals between economic agents. This approach aligns with Hayek's (1945) view of prices and money as communication mechanisms in market economies. And our framework also builds on Keynesian uncertainty and expectations; Friedman's monetary analysis; and rational expectations theory.

We propose that monetary dynamics can be better understood by considering money's informational content rather than just its quantity. This perspective is particularly relevant in digital economies where money exists primarily as information.

The Quantity Theory of Money was extensively advocated by Milton Friedman (1969); Friedman and Schwartz (1963), who argued that "inflation is always and everywhere a monetary phenomenon." Friedman based his analysis on Irving Fisher's (1911) equation of exchange to demonstrate that money supply growth has direct effects on prices when money velocity and output are constant. Fisher's equation of exchange is traditionally expressed as:

$$M \times V = P \times Y, \quad (1)$$

where:

- M is the quantity of money;
- V is the velocity of circulation;
- P is the general price level;
- Y is real output (or real GDP) of the economy.

In this analysis, we propose substituting M with information (I), then:

$$I \times V = P \times Y. \quad (2)$$

This substitution represents the core element of our proposal. We understand that this assumption depends on deeper conceptual issues. It is not merely a variable substitution but a fundamental reinterpretation of money's nature. While (M) represents a physical or nominal quantity, (I) captures money's informational dimension, allowing for the incorporation of qualitative aspects of the monetary system that the traditional approach cannot capture.

Substituting (I) with Shannon's Information equation (which, in information theory, effectively measures entropy):

$$\mathrm{I} = -\sum_{i=1}^{n} p_i \log p_i \quad (3)$$

where p_i represents the probability of money use in different forms or transactions. This substitution leads to a new form of the exchange equation:

$$\left(-\sum_{i=1}^{n} p_i \log p_i\right) \mathrm{x}\, V = P \,\mathrm{x}\, Y \quad (4)$$

This requires a reinterpretation of the components:

I = entropy, or information quantity, represents the uncertainty or diversity of money use in the system. Higher entropy means money is being used in various ways, with a more uniform distribution. (M)0 is now interpreted as the total quantity of economic information available to economic agents in a given period. In this sense, (M), now as (I), represents the quantity of value signals circulating in the economic system, rather than just physical or digital money. This monetary information includes the value that money communicates about purchasing power, confidence, and future price expectations.

V = velocity of circulation is understood as the frequency of monetary information processing or the frequency with which value information is processed or used in transactions. Rather than referring to the number of times a unit of money is exchanged, (V) can be interpreted as the speed at which economic agents assimilate, interpret, and use the information contained in money to make decisions.

P = the general price level continues to represent the cost of goods and services in the system. It represents the final result of value communication between economic agents. If money is information, (P) can be viewed as a measure of precision or clarity of this information. Inflation, for example, can be interpreted as a loss of clarity or precision in the information transmitted by money, causing distortions in how prices reflect the real value of goods and services.

Y = real output is the result of interaction and efficient use of information in the economic system. It is the outcome of economic interactions based on information transmitted by money and reflects economic agents' capacity to use monetary information to produce and exchange goods and services.

Considering the prediction of more uniform distribution in money use (assuming all probabilities p_i are equal, meaning money use is equally distributed among different forms of transactions or economic events), we can simplify the equation. In this case:

$$p_i = \frac{1}{n}, \text{ for all } i. \quad (5)$$

Thus, entropy (I) reaches its maximum value, and the equation can be simplified as:

$$I = -\sum_{i=1}^{n} \frac{1}{n} \log\left(\frac{1}{n}\right) = \log n \quad (6)$$

from which:

$$logn \times V = P \times Y \quad (7)$$

where *n* represents the number of possible forms of transaction or economic events. The larger *n* is, the greater the entropy, i.e., the quantity of information transmitted by money.

3.1 Analysis of Limit Cases

From the proposed transformation, we can explore two important limit cases: when entropy tends to zero (I→0) and when entropy tends to infinity (I→∞).

3.1.1 Zero-Limit Case (I→0)

When I→0, it means that the probability distribution p_i concentrates on a single event or use of money. In this case, money use is highly predictable, and there is low uncertainty in the economic system. The resulting equation is:

$$0 \times V = P \times Y \quad (8)$$

This implies that, to maintain equilibrium, P×Y must tend to zero. This situation can be associated with the gold standard. Under the gold standard, the quantity of money in circulation (typically represented by notes or coins) is directly backed by the quantity of gold held by the government or central bank. This creates a fixed and highly predictable relationship between money and gold, limiting the amount of money that can be issued. Under the gold standard, money is used predictably, and the money supply cannot be rapidly adjusted to economic changes, resulting in deflationary pressure. Milton Friedman (1969x) criticized the gold standard for its rigidity, arguing that more flexible monetary systems are necessary to accommodate modern economic fluctuations.

As a result, the economic system has characteristics similar to the zero-entropy limit. As money is used very predictably, there is little uncertainty. Money is not subject to large value variations due to changes in monetary policy. The quantity of money in circulation is determined by gold availability, which restricts the use of instruments such as money issuance or expansionary monetary policy, reducing the diversity of scenarios in which money can be used.

The perspective of zero money demand dialogues with the situation envisioned by Shannon and Weaver (1963), where, when a message is highly probable, the information value is very small (almost zero), or a situation of "total form". According to the authors: "in the limiting case where one probability is unity (certainty) and all the others zero (impossibility), then H is zero (no uncertainty at all – no freedom of choice – no information" (Shannon & Weaver, 1963, p. 15). Similarly, zero entropy would mean that money use concentrates on a single event or form of use, with probabilities p_i practically equal to zero for all other uses. This reflects a highly controlled and predictable system.

One expected effect in a low-entropy system is that prices (P) remain stable or even tend to zero (deflation). As money supply is limited, monetary supply growth cannot keep pace with production growth (Y), leading to deflationary pressures. Money has a stable value, but prices fall relative to production increases. This behavior can be associated with chronic deflation, where economic growth is not accompanied by flexible money supply, resulting in a general price decline.

Another interpretation is that real output (Y) could tend to zero or grow slowly. The gold standard, by restricting the quantity of money available in the economy, limits the financial system's and monetary policy's ability to support economic growth. This can lead to economic stagnation or very limited growth, as money cannot be expanded to facilitate increased economic activities.

This limitation was one of the main criticisms of the gold standard. Economies adopting this system frequently faced difficulties in rapidly expanding their economies, especially in times of financing needs, such as during wars or economic crises.

Historically, the gold standard was associated with deflationary periods, especially during the late 19th and early 20th centuries. As economies grew, gold supply could not keep pace with money demand, leading to a relative scarcity of money and falling prices. Deflation was one of the main factors that led many countries to abandon the gold standard, as it prevented the flexibility needed to deal with economic crises or finance expansions.

In the context of entropy tending to zero, deflation would be interpreted as the result of an excessively rigid monetary system, where information flow (entropy) is practically nonexistent, and money is used predictably, without flexibility to respond to changes in economic conditions.

Compared to modern monetary systems, where central banks have the ability to manipulate the quantity of money in circulation (as in fiat money systems), the gold standard appears closer to the $I \to 0$ limit. In a fiat system, money has a more dynamic function, capable of being influenced by monetary policies, which increases entropy (uncertainty and diversity of uses). This contrast reflects the difference between a predictable and rigid system (gold standard) and a more flexible and dynamic system (fiat money).

The analysis reveals how low-entropy systems, such as the gold standard, are associated with stability but also economic rigidity, which can generate deflation and difficulties in promoting economic growth in times of need.

3.1.2 Infinite Limit Case ($I \to \infty$)

When $I \to \infty$, monetary entropy is maximal, meaning that money is used in an extremely diversified manner, with all forms of transactions having equal probabilities. The equation transforms into:

$$\infty \times V = P \times Y \tag{9}$$

For the equation to remain balanced, $P \times Y$ must also tend to infinity. This may indicate a hyperinflationary scenario, where uncertainty about money's value is so high that prices increase rapidly. This phenomenon aligns with Friedman's argument that uncontrolled money supply growth, without corresponding production of goods and services, leads to galloping inflation.

When the informational entropy associated with money tends to infinity, there is a scenario of great uncertainty and diversity in money uses or perceptions. This condition aligns with characteristics observed during periods of hyperinflation, where money's value becomes extremely unstable and unpredictable (as in Germany' 1920s and Brazil's 1980s).

$I \to \infty$ means that monetary entropy tends to infinity, which can be interpreted as a situation of maximum uncertainty regarding money's value. Economic agents lose confidence in money as a store of value and stable medium of exchange. There is an extreme increase in price diversity and alternative transaction forms (for example, substitution of national currency with foreign currencies or physical assets).

When monetary entropy tends to infinity, there are two ways of situation development. First, through a price explosion, given the exponential growth of entropy, as extreme uncertainty about money's value leads economic agents to constantly adjust prices upward. The higher the entropy (uncertainty), the more money's nominal value loses meaning, forcing continuous price increases. Alternatively, through a reduction in real output, as a response to currency devaluation and collapse of confidence. Producers may reduce their production due to uncertainty about their costs or inability to price products stably. The lack of a stable unit of value prevents the productive sector from functioning normally, contributing to the hyperinflationary spiral.

In information theory, high entropy means maximum uncertainty—a state where money's value does not transmit clear information about purchasing power. In hyperinflation, money loses its role as a unit of account, as prices become volatile and unpredictable. People resort to alternative currencies or commodities to store value.

When $I \to \infty$, monetary entropy is maximal, and this can be seen as an indicator of monetary collapse. In practical terms, infinite entropy suggests that money has become completely unpredictable and useless as a medium of exchange or store of value. Infinite entropy reflects a situation where the monetary system reaches a point of collapse, where money is substituted or completely loses its value. Price diversity and loss of confidence reach such levels that the monetary system needs to be reformed, as historically happens in extreme cases of hyperinflation (for example, monetary reform, dollarization, or creation of a new currency).

The association of the entropy limit tending to infinity with hyperinflation is an innovative interpretation that offers a new way of viewing the phenomenon. In hyperinflation, infinite entropy captures the complete loss of value and reliability of money, characteristics observed in economies facing severe monetary crises. Developing methods to measure monetary entropy and use it as an economic policy indicator could provide a valuable tool for anticipating and mitigating risks of monetary collapses in high-inflation scenarios.

3.1.3 Application to Special Cases

a. Stagflation Situations

Stagflation occurs when an economy simultaneously experiences high inflation and low economic growth (or even recession). This phenomenon is problematic because typical monetary policies to combat inflation (such as interest rate increases) can further aggravate low economic growth.

Monetary entropy can provide insights into the stagflation phenomenon. In stagflation, the economy faces high uncertainty about currency value and prices, without resulting in economic growth. In terms of informational entropy, uncertainty about currency value increases during times of stagflation, especially when there are external factors (such as supply shocks, commodity price increases) that make prices volatile. This high entropy reflects the unpredictability of currency value, which can affect consumer and business confidence.

In a stagflation scenario, increased entropy does not result in more active currency circulation to stimulate growth. Instead, money becomes uncertain in value, and both consumers and businesses reduce consumption and investment, reinforcing low growth.

b. Keynes's Liquidity Trap Situation

A liquidity trap, a situation described by John Maynard Keynes, occurs when interest rates are so low that monetary policy loses effectiveness. Even if central banks try to stimulate the economy, economic agents prefer to hold money rather than spend or invest, creating an economic blockage.

In the liquidity trap, monetary entropy can manifest in a unique way. Normally, monetary entropy increases with uncertainty, but in the liquidity trap, economic agents tend to avoid using money, increasing its retention. In informational entropy terms, we can interpret the liquidity trap as a reduction in monetary entropy. When agents prefer to hold money and not spend, the diversity of money use decreases, reducing entropy. Instead of freely circulating in the economy, money is held as a reserve because agents have low confidence in productive investments and prefer liquidity.

Therefore, there is a loss of money's function as information. In the liquidity trap, money doesn't function as a transmitter of economic information because excessive retention means that prices and market signals don't reflect reality. The lack of diverse use of money reduces its ability to communicate value, further harming economic activity.

4. Philosophical Implications

The transformation of money into information raises fundamental questions about its ontological status. While Searle's (1995) account of institutional facts provides a starting point, our informational reinterpretation suggests a more radical ontological shift. First, monetary information exists in a distinct ontological category from physical currency or institutional declarations. It represents what Floridi (2011) terms a "Level of Abstraction" - a systematic way of observing and interpreting reality. This suggests that monetary systems are fundamentally informational structures rather than physical or institutional ones. Second, the ontological status of monetary information has implications for monetary stability. If money is fundamentally informational, then its stability depends on maintaining the integrity of information flows rather than backing by physical commodities or government authority. This helps explain why digital currencies can function effectively despite lacking physical form. Third, the informational ontology of money suggests that monetary crises are fundamentally crises of information rather than crises of substance. Hyperinflation, for instance, represents not just a loss of value but a breakdown in the ontological structure of monetary information.

The phenomenology of monetary value, drawing from Husserl's analysis of consciousness and meaning, offers insights into how economic agents experience and interpret monetary information. When money is understood as information, its value becomes a matter of intentional experience rather than intrinsic worth. This phenomenological perspective helps explain why monetary stability depends crucially on collective confidence – the shared intentional experience of value must remain coherent across economic agents. Hyperinflation can thus be understood as a breakdown in the phenomenological coherence of monetary value. The informational view of money connects to theories of extended and distributed cognition (Clark & Chalmers, 1998). Monetary systems can be understood as cognitive extensions that enhance human capability to process economic information and make decisions. This perspective suggests that monetary stability isn't just about maintaining value but about preserving the cognitive infrastructure that enables economic calculation and coordination.

Drawing from philosophical work on semiotics (Peirce, 1931-1958), money can be analyzed as a sign system that communicates economic value. The transformation of money into pure information highlights its fundamental nature as a symbolic system. This semiotic perspective helps explain why monetary stability depends on maintaining the clarity and reliability of economic signification – when money's capacity to signify value breaks down, economic coordination becomes impossible

There is also another connection with the work of Luciano Floridi's (2011). Within Floridi's framework, money can be understood as an 'informational object' that structures economic reality. As he argues, information is not just about reality (semantic information) but constitutive of reality itself (constructive information). Applied to monetary theory, this suggests that money doesn't merely represent economic value but actively constructs it through informational processes. This aligns with our transformation of the Quantity Theory, where monetary dynamics are understood primarily through informational rather than quantitative mechanisms

The reconceptualization of money as information raises crucial ethical questions that extend beyond traditional monetary ethics. If money is fundamentally informational, access to monetary systems becomes an issue of informational justice rather than merely economic justice. This perspective aligns with Floridi's (2011) information ethics framework, where informational entities have intrinsic moral worth. Several ethical dimensions emerge, as the one about Informational Justice: the distribution of monetary information becomes a matter of fundamental justice. Information asymmetries in monetary systems represent not just economic inefficiencies but ethical failures. If money functions as a cognitive extension for economic calculation, access to monetary systems becomes a matter of cognitive rights. This connects to discussions of cognitive enhancement and distributed cognition in contemporary philosophy of mind.

If money is fundamentally information, then information asymmetries in monetary systems become ethical rather than merely technical problems. Drawing from Rawls's (1971) theory of justice, we might ask what principles should govern the distribution of monetary information in a just society. The ability to access and process monetary information becomes a crucial component of economic justice. The maintenance of monetary information quality becomes a collective ethical responsibility. This raises questions about the ethical obligations of central banks, financial institutions, and individual economic agents. These ethical considerations suggest that monetary policy should be evaluated not just in terms of economic efficiency but also in terms of informational justice and cognitive rights.

5. Economic and Policy Implications

The analysis of limit cases suggests that a balance between diversity and predictability in money use is crucial for a stable economy. Low-entropy systems, such as the gold standard, can be associated with deflation and slow growth, while high-entropy systems, as in hyperinflationary scenarios, can lead to economic instability.

For modern economies, especially in the context of cryptocurrencies and digital economies, the processing speed of monetary information (represented by entropy) will become increasingly important. Financial crises, such as hyperinflation or currency collapses, can be viewed through a new lens: as communication failures or breakdowns in trust in the information that money transmits.

Inflation, traditionally viewed as a general increase in prices, can be interpreted as a dilution of the quality of information contained in money. High inflation means that money transmits less precise information about value, creating greater informational entropy in the economic system. Anti-inflationary policies, therefore, would be attempts to reduce this entropy and restore the clarity of information that money should transmit. Hyperinflation, therefore, would be the degradation of monetary information to the point where agents no longer trust money's ability to reflect value stably, generating irrational behaviors of flight to other assets.

If money is a form of information, traditional monetary policies must be rethought from the perspective of informational trust management. Central banks, when intervening in the economy, would, in practice, be manipulating the flow of information that agents receive about the economy's future. Measures such as quantitative easing could be seen as a way of flooding the market with more "monetary information," attempting to influence agents' perceptions and expectations. The Central Bank effectively acts as a manager of a complex informational system, whose main task is to ensure that money continues to transmit accurate information about value and purchasing power.

In terms of rational expectations, the effectiveness of forward guidance depends on both the entropy level of current monetary information and the credibility of entropy-reducing signals from monetary authorities. Therefore, monetary policy operates not just through changing interest rates or money supply, but through managing the entropy of monetary information in the system. Central Bank credibility can be reinterpreted as the ability to maintain optimal entropy levels that balance flexibility and predictability.

In traditional rational expectations theory, economic agents are assumed to use all available information efficiently to form expectations about future economic variables. When we introduce the concept of monetary entropy, this process can be formalized more precisely (with entropy [I] affecting the total quantity of information available to economic agents in a specific moment).

The idea of money as information is particularly applicable to digital economy and cryptocurrencies. Digital currencies, like Bitcoin, are essentially information protocols that use cryptography to ensure integrity and trust in information (money). In this context, digital money is the purest example of "money = information," as there is no associated physical form; value is entirely based on encoded information and trust in the validation system (blockchain). The rise of cryptocurrencies can be seen as a natural evolution of monetary economics toward a more informational view of money, where decentralized trust becomes an essential tool for ensuring value. If money is essentially information, trust in the information transmission system, whether it be a central bank, government, or decentralized technology, becomes the most crucial factor for monetary stability.

6. Conclusion

By substituting money quantity with Shannon's entropy equation, we reimagine the Quantity Theory of Money as a model that incorporates the information transmitted by money. This approach offers a novel perspective on money's role in modern and digital economies, enabling a richer analysis of how diversity and uncertainty in money use affect price levels and real output.

The limit cases, particularly the association between low entropy and the gold standard, reveal the importance of managing monetary entropy to ensure economic stability. Simultaneously, economies with excessive entropy may face challenges of hyperinflation and instability. Money, as an information system, must be managed in a way that preserves the clarity of information it transmits, maintaining a balance between predictability and flexibility. The **perception management** and expectations of economic agents would be as important as, if not more important than, traditional money supply control mechanisms.

Considering that **money = information** provides a powerful way to reimagine money's function in the economy. This perspective emphasizes the **communication of value and trust** among economic agents and suggests that monetary management is, in fact, management of information trust. Such an approach can be especially useful in an increasingly digital and interconnected world, where technologies like blockchain and cryptocurrencies gain relevance, and where monetary stability increasingly depends on agents' perceptions and expectations.

Exploring the limit cases for monetary entropy as information reveals that **extremes of predictability or uncertainty** in money use can lead to significant economic instabilities. Both the **lack of diversity** in money use (gold standard) and **extreme diversity** (hyperinflation) can have disruptive effects on the economic system, whether through deflation and stagnation or through hyperinflation and excessive complexity. These analyses suggest that balance in money use—neither too concentrated nor too dispersed—is crucial for a stable and healthy economy.

Competing Interests

The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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