



(Research/Review) Article

Literature Review on Market Efficiency and Its Impact on Digital Financial Innovation

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Abstract: This study examines the relationship between market efficiency and digital financial innovation in the context of global financial transformation over the past decade, when fintech, cryptocurrency, and Decentralized Finance (DeFi) have significantly altered price formation and information dissemination mechanisms. The main issue raised is whether the Efficient Market Hypothesis (EMH) theory remains relevant in the face of digital market dynamics characterized by high volatility, speculative behavior, and regulatory uncertainty. The objective of this study is to assess the impact of digital innovation on information efficiency, price transparency, and the stability of modern financial markets. The study used the Systematic Literature Review (SLR) method, examining 15 scientific articles published between 2015 and 2025 from various academic databases. The findings indicate that digital technology increases access and speed of information distribution, but does not always result in consistently efficient markets. Crypto and DeFi markets have been shown to exhibit fluctuating efficiency due to price anomalies, information asymmetry, and weak regulation. Overall, the literature synthesis confirms that market efficiency in the digital era is dynamic and influenced by the interaction between technology, investor behavior, and governance quality. This study concludes that the EMH remains relevant as a basic framework, but needs reinterpretation to suit the complex and rapidly changing characteristics of digital markets.

Keywords: Cryptocurrency; DeFi; Digital Finance; Fintech; Market Efficiency

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1. Introduction

Over the past decade, the global financial world has undergone a major transformation due to digitalization driven by advances in financial technology (fintech), cryptocurrencies, and decentralized finance (DeFi). These innovations have transformed the way people interact with the financial system, from payments and investments to financing. According to Ozili (2022), global financial digitalization has expanded financial access, reduced transaction costs, and created new business models that are more efficient than traditional systems. Fintech, for example, enables high-speed, low-cost cross-border transactions, while blockchain introduces transparency and security that are difficult to achieve with conventional systems (Ozili, 2022). Furthermore, the emergence of crypto assets and DeFi challenges the traditional financial market structure, which relies on intermediaries such as banks or stock exchanges. Makarov and Schoar (2022) explain that DeFi introduces an automated intermediation system through smart contracts on the blockchain, enabling financial transactions without third parties and reducing dependence on central institutions. This creates opportunities for greater market

efficiency, but also raises new challenges in the form of price volatility and the risk of market manipulation. Meanwhile, research by FinTech, Cryptocurrencies, and CBDC (2022) shows that innovations such as China's Central Bank Digital Currency (CBDC) have accelerated the integration of technology into the national financial system, while increasing efficiency and information transparency in financial markets.

These changes also impact the price formation mechanisms and information dissemination in financial markets. Technologies such as distributed ledgers and big data analytics allow for faster access and dissemination of financial information, thus supporting the creation of more efficient markets. However, this efficiency is not always stable. A study by the Global Finance Journal found that crypto markets exhibit a dynamic level of efficiency, with periods of high volatility often followed by declining efficiency due to speculative behavior and regulatory limitations (The Dynamics of Market Efficiency of Major Cryptocurrencies, 2023). This is reinforced by research by Momtaz (2024), which highlights that DeFi markets, particularly Initial Coin Offerings (ICOs), still face search frictions and information asymmetries that can hinder price formation efficiency. Therefore, it can be concluded that the phenomenon of global financial digitalization not only drives increased information and transaction efficiency but also poses new challenges to market stability and transparency. Therefore, a literature review on the relationship between market efficiency and digital financial innovation is crucial for understanding how technology can influence the balance between efficiency and risk in the digital financial era.

In the era of digital finance, the relevance of the Efficient Market Hypothesis (EMH) proposed by Fama (1970) is increasingly being questioned. The EMH states that asset prices in the market reflect all available information, so no investor can consistently earn abnormal returns based on publicly available information. However, the development of fintech, crypto, and DeFi has put pressure on this basic assumption. For example, research on the Indonesian crypto market found that the Bitcoin market exhibits high volatility and strong sensitivity to domestic and global issues, indicating that prices do not always adjust quickly to all information, an indication of weak market efficiency (Kurniawan et al., 2023). Furthermore, there is empirical evidence of market anomalies in the context of digital assets. A concrete example in the Indonesian stock market is the study "Semexamining the Information Efficiency of the Indonesian Equity Market: Evidence from Earnings Announcements," which showed post-earnings announcement drift and abnormal returns following financial report announcements, contradicting the semi-strong form of the EMH because the market does not immediately produce a perfect response to public information (Nainggolan, 2024). Similarly, in the crypto market, a recent international study found more pronounced size anomalies, momentum, and abnormal returns in micro-coins during bull markets, suggesting that information and prices do not always converge efficiently under all market conditions (Cryptocurrency Anomalies and Economic Constraints, 2024).

In addition to anomalies, the phenomenon of speculation in digital assets also poses an empirical challenge to the EMH. Crypto prices are often influenced by investor sentiment, rumors, social media hype, and external factors unrelated to fundamentals, leading to large price fluctuations and sometimes irrational market responses. For example, a national study on cryptocurrency volatility in Indonesia using the GARCH and Value at Risk models found that risk and volatility are heavily influenced by external factors and inadequately controlled by traditional market mechanisms (Tumaggor & Prayogi, 2022). Regulatory challenges also deepen doubts about the relevance of the EMH in the digital age. Digital asset regulations in many countries including Indonesia are still relatively new, unclear, or ineffective in regulating crypto trading, NFTs, and other DeFi instruments. Studies on the legal challenges of digital assets in Indonesia reveal a regulatory vacuum and legal ineffectiveness that is unable to address the risks of market manipulation, data security, and legal certainty for investors (Wildan et al., 2022).

The phenomenon of global financial digitalization over the past decade has fundamentally changed the information and price formation mechanisms in financial markets. The development of financial technology (fintech), cryptocurrencies, and Decentralized Finance (DeFi) has created a faster, more efficient, and more transparent financial system, but has also introduced new challenges in the form of extreme volatility, speculation, and regulatory uncertainty. These changes have created an urgent need to revisit the relevance of the classical Efficient Market Hypothesis (EMH) proposed by Fama (1970), which assumes that asset prices in the market rationally reflect all available information. In the digital era, phenomena such as price anomalies in crypto assets, algorithmic trading, and speculative behavior by retail investors demonstrate that market efficiency cannot always be maintained as assumed in

traditional models (Kurniawan et al., 2023; Rizal & Umardi, 2021). Although numerous studies on market efficiency have focused largely on conventional stock markets and traditional financial instruments. Empirical studies on market efficiency in the context of digital finance are still limited, particularly in developing countries like Indonesia. Research by Rizal and Umardi (2021) found that Bitcoin's exchange rate against the Rupiah and the Dollar is inefficient in either weak or semi-strong forms, but failed to link this to digital financial innovations that shape market information dynamics. Similarly, Kurniawan et al. (2023) examined Bitcoin's efficiency in Indonesia without delving deeply into how blockchain and DeFi technologies are changing information dissemination mechanisms. This situation highlights a research gap between classical market efficiency theory and the reality of rapidly evolving digital markets.

The novelty of this research lies in its integrative effort to revisit the EMH theory in the context of modern digital finance through a literature review of the last 10 years (2015–2025). This research seeks to bridge the classical market efficiency theory with the dynamics of digital financial innovation, including fintech, cryptocurrency, and DeFi, which influence information structure, investor behavior, and price transparency in financial markets. Furthermore, this approach also highlights the context of Indonesia as a country with a financial system undergoing digital transformation, which has rarely been studied comprehensively in academic literature. Thus, this research provides new theoretical and conceptual contributions to understanding the relationship between market efficiency and digital financial innovation in the era of technological disruption. Based on this description, this study aims to review the relationship between market efficiency and digital financial innovation through a review of the latest literature during the period 2015–2025. Specifically, this study aims to: (1) identify the influence of fintech, cryptocurrency, and DeFi developments on financial market efficiency; (2) analyze the extent to which digital innovation influences the mechanisms of information and price formation in the market; and (3) developing a conceptual framework that describes the relationship between market efficiency and financial technology innovation in the context of global digital economic transformation.

2. Literature Review

2.1. Market Efficiency

The concept of market efficiency is rooted in the Efficient Market Hypothesis (EMH) proposed by Fama (1970), which states that asset prices reflect all available information in the market. In its strong form, this theory assumes that no investor can consistently earn abnormal returns because all information, both public and private, is fully reflected in asset prices. However, with advances in financial technology and the digitalization of the economy, the basic assumptions of the EMH have begun to be questioned. Apergis (2023) in the *Journal of Behavioral Finance* asserted that market efficiency is no longer static, but is highly dependent on the speed of information distribution and the technological capacity used by market participants. This means that market efficiency in the digital era must be understood as a dynamic process that continues to change as the complexity of the global financial system increases.

Several studies have shown that market efficiency in the digital financial era has undergone significant shifts. Nainggolan (2024) found that the Indonesian stock market still exhibits post-earnings announcement drift, indicating that the semi-strong form of the EMH is not yet fully applicable. These results align with research by Rizal and Umardi (2021), which revealed that Bitcoin's exchange rate against the Rupiah and the Dollar is inefficient in both its weak and semi-strong forms, as digital asset prices often react slowly to changes in fundamental information. This suggests that although information is now more readily accessible through digital technology, the process of its absorption into market prices is not always efficient.

International research also provides evidence that financial digitalization has created new, partial forms of efficiency. The *Dynamics of Market Efficiency of Major Cryptocurrencies* (Global Finance Journal, 2023) found that crypto market efficiency fluctuates; during periods of high volatility, the market becomes inefficient due to the dominance of speculation, while during periods of relative stability, the market exhibits greater efficiency. This phenomenon is confirmed by Momtaz (2024), who showed that the Decentralized Finance (DeFi) market faces search frictions and information asymmetry, where investors with access to advanced technology tend to achieve greater returns than conventional investors.

Based on a review of various previous studies, it can be concluded that the Efficient Market Hypothesis (EMH) theory remains the primary foundation for understanding market efficiency. However, its application in the digital finance era requires adjustments to the dynamics of technology and modern investor behavior. The development of fintech, cryptocurrency, and Decentralized Finance (DeFi) has changed the distribution patterns and speed of information, so that market efficiency is now relative and fluctuating. Recent studies show that price efficiency is determined not only by the availability of information, but also by technological capacity, investor literacy, and the stability of digital regulations. Therefore, market efficiency in the digital era needs to be understood as a dynamic process that continuously evolves with the advancement of financial innovation, rather than as a static condition as assumed in Fama's (1970) classical theory.

2.2 Digital Financial Innovation (Financial Innovation / Digital Finance)

Research conducted by Ozili (2022) shows that financial digitalization has had a transformative impact on the global financial system by expanding public access to formal financial services (financial inclusion). In his study, Ozili highlighted the crucial role of financial technology (fintech) in opening access to communities previously excluded from the traditional banking system. Through digital platforms, people can now conduct cross-border transactions more quickly and efficiently at significantly lower costs than conventional mechanisms. Furthermore, the use of digital technology enables the collection and analysis of large-scale financial data, enabling financial institutions to more accurately assess credit risk and accelerate the decision-making process. These findings reinforce the view that digital financial innovation not only creates transaction efficiency but also increases equity in access and economic participation across all levels of society.

Meanwhile, research by Makarov and Schoar (2022) provides a more in-depth perspective on the emergence of Decentralized Finance (DeFi) as a form of structural innovation in the financial system. Both highlight how blockchain technology and smart contracts are creating new intermediation models that operate without the involvement of third parties such as banks or clearing houses. In this system, transactions are executed automatically based on a mutually agreed-upon algorithm, thereby reducing transaction costs while increasing transparency and security. However, the study also warns that the lack of centralized oversight introduces new risks, such as algorithmic manipulation, cyberattacks, and potential system failures due to coding errors. Thus, DeFi offers new efficiencies difficult to achieve in traditional financial systems, but it also poses significant challenges to regulatory mechanisms and market stability.

Research published in the *Global Finance Journal* (2023) provides a more critical look at the stability of market efficiency amidst the emergence of digital assets. The study, "The Dynamics of Market Efficiency of Major Cryptocurrencies," found that crypto markets exhibit fluctuating levels of efficiency over time. During periods of high volatility, markets tend to be inefficient because crypto asset prices are more influenced by speculative sentiment and external factors such as government policies or geopolitical issues. Conversely, during periods of relatively stable markets, efficiency increases due to better functioning information mechanisms. These findings confirm that digital market efficiency is highly dependent on investor behavior and external conditions that influence risk perception.

Based on these three studies, it can be concluded that digital financial innovation has brought fundamental changes to the structure and efficiency of the global financial system. Ozili's (2022) findings indicate that digitalization through fintech improves transaction efficiency and expands financial inclusion, while Makarov and Schoar (2022) assert that Decentralized Finance (DeFi) creates a new, efficient but risk-laden intermediation model because it operates without centralized oversight. On the other hand, a study by the *Global Finance Journal* (2023) revealed that the crypto market is dynamic, with market efficiency increasing or decreasing depending on price volatility and investor speculative behavior. Overall, recent literature suggests that digital financial innovations enhance market efficiency by accelerating information flow and reducing transaction costs. However, they also pose new challenges in the form of regulatory risks, security risks, and market instability, which must be managed adaptively in the modern financial era.

3. Proposed Method

This study uses the Systematic Literature Review (SLR) method. According to Cahyono (2019), a Systematic Literature Review is a scientific process that produces a comprehensive

report based on the collection, evaluation, and synthesis of relevant literature to answer a specific research question or issue. This method allows researchers to deeply examine the results of previous research in a structured and transparent manner. Furthermore, Rusdin, Supriadi, and Rahayu (2023) explain that the SLR process includes three main stages: planning, implementation, and synthesis of research results, which are carried out systematically to ensure the reliability and objectivity of the study results. The data used in this study are secondary data obtained from scientific publications in the form of national and international journals. The literature search process was conducted through several academic databases, including Mendeley, Google Scholar, and ScienceDirect, with a publication period between 2015 and 2025. Keywords used in the search include: "Market Efficiency," "Digital Finance," "Fintech," and "Cryptocurrency." Researchers selected 15 articles that met the following inclusion criteria: (1) articles published by reputable national or international scientific journals, (2) published between 2015 and 2025, and (3) discussing the relationship between market efficiency and digital financial innovation, both conceptually and empirically. The selected articles were then analyzed to identify patterns, findings, and trends in research results relevant to the study theme. The results of this synthesis are presented in the form of an integrated thematic narrative in the literature review and discussion sections.

4. Results and Discussion

Research findings from a systematic literature review indicate that digital financial innovations, including fintech, cryptocurrency, and Decentralized Finance (DeFi), have had a significant impact on changes in the information structure and efficiency of financial markets over the past decade. The analyzed literature confirms that digitalization increases the speed of information flow and lowers transaction costs, theoretically supporting the creation of more efficient markets. Research by Ozili (2022) demonstrates that fintech can expand financial inclusion, increase transparency, and accelerate the risk assessment process, thus supporting information efficiency. Similarly, Makarov and Schoar (2022) demonstrate that DeFi introduces new efficiencies through the elimination of traditional intermediation and the use of smart contracts that automate transactions.

However, other findings in the literature indicate that market efficiency in the digital era is not always stable and often fluctuates. A study from the *Global Finance Journal* (2023) found that crypto markets are only efficient during periods of price stability, while during periods of high volatility the market becomes highly inefficient due to the dominance of speculative sentiment. Empirical evidence from research by Kurniawan et al. (2023) and Rizal & Umardi (2021) support this conclusion, stating that the Bitcoin market in Indonesia does not meet the criteria for weak or semi-strong form efficiency because prices often do not optimally reflect fundamental information. Furthermore, market anomalies such as momentum, size anomalies, and abnormal returns found in crypto assets (2024) indicate that the basic assumptions of the Efficient Market Hypothesis (EMH) do not always hold in the modern digital environment.

The research also confirms that digital innovation brings new risks that can hinder market efficiency. Information asymmetry, search frictions, and market manipulation remain significant challenges in the digital financial ecosystem. Momtaz (2024) points out that the DeFi and ICO markets still face issues of intermediation and unequal distribution of information, allowing investors with superior technological access to gain disproportionate profits. In the Indonesian context, the literature indicates that regulatory uncertainty, as described by Wildan et al. (2022) and Fajar & Sugiyono (2023), exacerbates the risk of market manipulation, increases volatility, and reduces price transparency.

When compared to the current state of global digital financial market development, the findings of this study are increasingly relevant. In recent years, the widespread adoption of AI-based trading, the increased use of blockchain by financial institutions, and the introduction of Central Bank Digital Currencies (CBDCs) by countries such as China and Europe have accelerated information distribution and increased transparency. However, recent findings from international financial institutions indicate that crypto volatility remains high, DeFi platforms remain highly vulnerable to hacking, and global regulations remain unharmonized. This situation reinforces the study's conclusion that while digital innovation accelerates information processing, markets do not automatically become more efficient. Instead, new technologies often create new forms of inefficiency previously unseen in traditional markets. Thus, this study makes a measurable contribution by affirming that efficiency in the digital

era must be understood as a dynamic phenomenon that constantly changes with technological developments, investor behavior, and regulatory readiness.

Overall, the research indicates that digital financial innovation does not automatically create ideal market efficiency as described by the classical EMH theory. Although technology enhances information flow and accelerates transactions, investor behavior, digital asset volatility, and regulatory lag remain major obstacles. Thus, market efficiency in the digital era is better understood as a dynamic condition influenced by the interaction between technology, investor behavior, systemic risk, and the quality of governance and regulation.

6. Conclusions

Based on a literature review conducted over the period 2015–2025, this study concludes that digital financial innovation plays a significant role in reshaping information mechanisms, market behavior, and the dynamics of global financial market efficiency. Innovations such as fintech, cryptocurrency, and DeFi have been shown to increase financial access, lower transaction costs, and accelerate the dissemination of information, which theoretically support increased market efficiency. However, various empirical findings indicate that this efficiency is not permanent and often fluctuates depending on market conditions, digital asset volatility, and the level of regulatory maturity in a country.

The Efficient Market Hypothesis (EMH) proposed by Fama (1970) remains relevant as a basic framework, but it is no longer able to fully explain the realities of digital markets rife with speculation, information imbalances, and the risk of manipulation. Price anomalies, abnormal returns, and irrational investor behavior found in crypto assets demonstrate that market efficiency in the digital era is not absolute but depends on price stability and the quality of regulatory infrastructure. This situation demonstrates that modern market efficiency requires a more flexible and contextual approach, especially in a rapidly changing digital environment.

Based on the research findings, it is recommended that financial authorities strengthen the regulatory framework to reduce the risk of manipulation and enhance the security of digital transactions. Developing digital financial literacy among the public is crucial to reduce the dominance of speculative behavior that can undermine market stability. Furthermore, further research is recommended to explore the link between artificial intelligence (AI), algorithmic trading, and digital market efficiency, given the increasing role of these technologies in modern investment decision-making processes.

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