Chapter 1

The Evolution of Payment Systems: Structural Transformation from Physical Cash to Digital Payment Ecosystems

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Abstract

This study conceptually examines the evolution of payment systems from physical cash-based structures to digital payment ecosystems through the lens of digital economy and governance. Payment systems are treated not merely as technical fund transfer mechanisms, but as institutional infrastructures that organize power relations among money, banks, platforms, and markets.

Historically, although cash-based systems offered advantages such as anonymity, universal acceptance, and technological independence, they faced increasing transformation pressures due to rising transaction costs and scalability limitations. Electronic and card-based payment systems represented the first stage of digitalization within a centralized banking architecture, where trust remained largely bank-centered. Mobile and platform-based payment systems, however, shifted control over user interfaces and data flows, integrating payment processes into the broader digital platform economy. This transition has led to the evolution of payment systems from isolated infrastructures into multi-actor, network-based, and data-intensive digital ecosystems.

The chapter further analyzes the shift of trust from institutional structures to coded systems, the challenges of data ownership and algorithmic governance, and the structural tensions emerging from cashless society debates. It argues that the transformation of payment systems is not merely a technological progression, but a structural reconfiguration of financial intermediation, platform power, and governance architectures within the digital economy..

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1. Introduction: A Conceptual Approach to the Evolving Architecture of Payment Systems

The functioning of the financial system is shaped not only by the supply of money, credit mechanisms, or capital markets, but also by the ways in which value is transferred among these components. The institutional and technical framework that enables this transfer is provided by payment systems. At their most basic level, payment systems can be defined as infrastructures that facilitate the settlement of obligations and the transfer of value. However, this definition should not lead to the perception that payment systems are merely technical transfer mechanisms. On the contrary, payment systems constitute institutional arrangements that organize the relationships among money, banks, markets, and the state, influence financial stability, and ensure the continuity of economic activity (BIS, 2012).

Historically, payment systems have evolved from structures based on physical cash to electronic and card-based systems, and subsequently to mobile and platform-based arrangements, eventually developing into multi-actor digital ecosystems. This evolution represents not merely a process of technological innovation but a structural transformation in which financial intermediation, trust mechanisms, and the organization of economic activity have been fundamentally redefined. Today, payment systems perform functions that extend beyond simple fund transfers, encompassing multiple layers such as data generation, risk analysis, and the integration of financial services.

The process of digitalization has played a decisive role in the transformation of payment systems. Speed, scalability, traceability, and integration capacity have become defining characteristics of modern payment infrastructures. In particular, the rise of network-based digital platforms has extended payment transactions beyond the traditional boundaries of the banking system, giving rise to a complex ecosystem involving interactions among FinTech companies, BigTech platforms, and regulatory authorities. Consequently, payment systems have evolved beyond their role as financial infrastructures and have become one of the key organizational backbones of the digital economy.

However, this transformation does not bring opportunities alone. The shift of trust from institutional structures to coded digital systems has raised important debates concerning data ownership and privacy, while cyber risks and systemic vulnerabilities have made new governance mechanisms increasingly necessary. Moreover, although the trend toward a cashless economy holds the potential to enhance efficiency and financial inclusion, it may also produce paradoxical outcomes such as digital exclusion and heightened surveillance risks. For this reason, the transformation of payment systems should not be

approached from a purely technological determinist perspective; rather, it should be examined within a holistic framework that incorporates institutional, economic, and societal dimensions.

This study aims to examine the historical evolution of payment systems and the structural transformation they have undergone in parallel with the process of digitalization within a conceptual framework. In this context, the institutional characteristics and structural limitations of payment systems based on physical cash are first explored. Subsequently, the emergence of electronic and card-based systems, as well as mobile and platform-based payment models, is analyzed, and the way in which this transformation has evolved into multi-actor digital payment ecosystems is discussed.

In the following sections, issues related to trust, data, and governance, together with debates surrounding the concept of a cashless society, are addressed in order to evaluate the financial and societal implications of payment systems. Finally, the future of payment systems is discussed within the framework of hybrid structures and multi-actor governance perspectives.

The evolution of payment systems reflects not only the development of financial technologies but also the redefinition of the relationship among money, banks, and society. For this reason, the transformation of payment systems constitutes a central field of inquiry in contemporary approaches to finance, offering both theoretical and practical significance.

2. Cash-Based Payment Systems: A Strong Tradition with Growing Structural Limitations

Cash-based payment systems constitute the historical and institutional foundation of the modern financial architecture. Cash is not merely a medium of exchange; it also represents the material embodiment of state sovereignty, monetary authority, and social trust. In this context, payment extends beyond a simple technical transfer process and signifies the settlement of an obligation and the final transfer of value. The finality of payment implies that a transaction is irreversible and concluded without the need for an additional reconciliation process. Physical cash is one of the rare instruments capable of fulfilling this settlement function without requiring the involvement of a financial intermediary (Ingham, 2004).

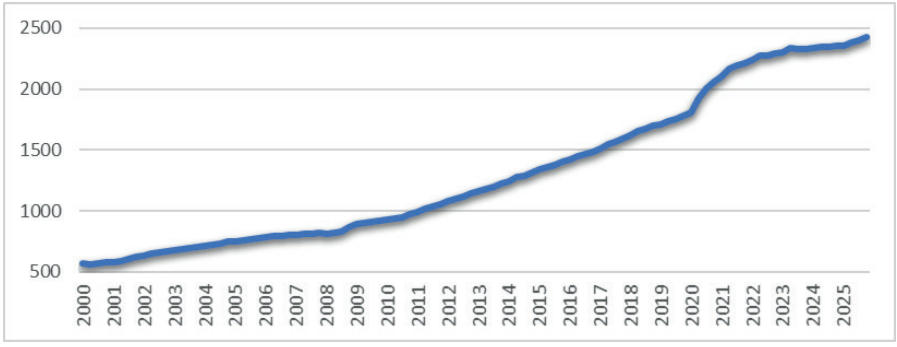
In this respect, cash performs both economic and political functions within the financial system. The physical form of money serves as a symbol of monetary sovereignty and appears as a liability on the balance sheet of the central bank. Consequently, cash is directly linked to the credibility of the state (Goodhart, 1988).

2.1. The Institutional and Political Economy Role of Cash

Cash is closely linked to the state's capacity to generate revenue through the mechanism of seigniorage. This connection transforms payment systems from being merely market-based instruments into matters that also concern public finance and sovereignty. Monetary sovereignty, in this sense, reflects the state's regulatory and symbolic power over the economic sphere (Goodhart, 1998).

During periods of crisis, the tendency toward a flight to cash illustrates that cash functions as a source of trust outside the formal financial system. For example, during the 2008 global financial crisis and the 2020 pandemic period, an increase in the amount of cash in circulation was observed in many countries. Data from the United States indicate that the stock of currency in circulation tends to rise during times of uncertainty, demonstrating that cash is often demanded as a reliable store of value outside the financial system.

Figure 1. Currency in circulation (United States, Billions of U.S. Dollars)



(Source: Federal Reserve Bank of St. Louis. (2026). Monetary base: Currency in circulation. FRED, Federal Reserve Economic Data. https://fred.stlouisfed.org/graph/?g=B4gn)

This phenomenon demonstrates that cash is not only a medium of transaction but also a trusted asset that individuals tend to prefer in times of uncertainty.

2.2. Advantages of Cash

Cash-based payment systems possess three key structural advantages:

- **Anonymity** refers to the ability of cash payments to be conducted without requiring identification. This feature plays an important role in protecting individual privacy. Cash transactions that leave no digital

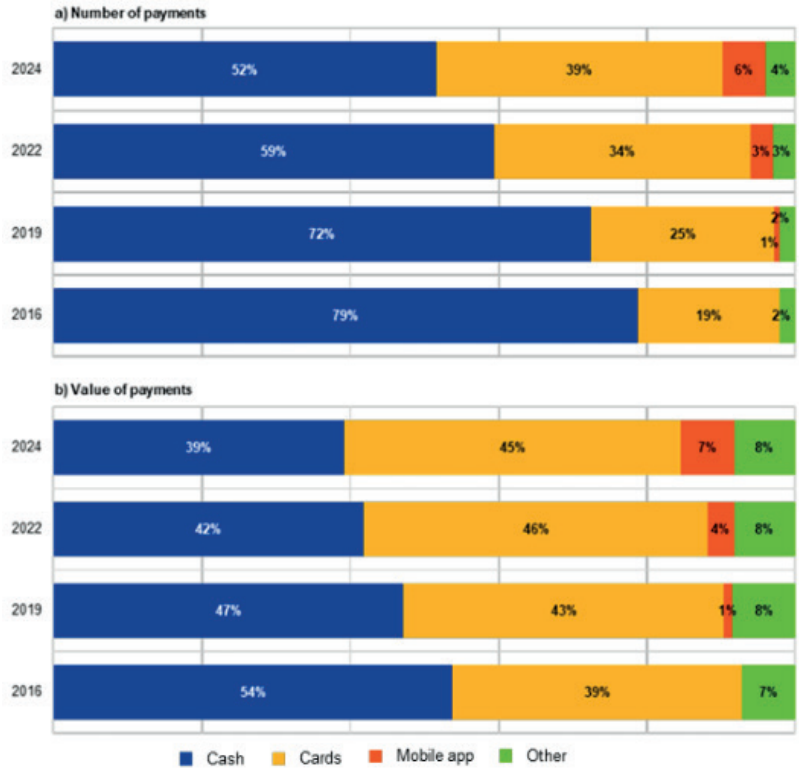
trace prevent third parties from monitoring personal spending behavior, allowing monetary transactions to occur without generating data.

- **Universal acceptance** derives from the legal tender status of cash. Being recognized as legal tender means that economic actors are obliged to accept cash as a means of payment. This characteristic constitutes a significant institutional feature that distinguishes cash from other payment instruments.
- **Technological independence** refers to the ability of cash transactions to be carried out without requiring infrastructure such as electricity, internet access, or digital systems. Particularly in regions with limited technological infrastructure or during systemic disruptions, cash plays a critical role in maintaining economic continuity..

These three advantages help explain why cash has historically remained a strong and resilient payment instrument. However, in the context of digitalization, these advantages have begun to face new challenges, accelerating debates surrounding the transition toward cashless economies.

A consumer payment preferences survey conducted by the European Central Bank (2024) shows that, despite the widespread adoption of digital payment instruments, cash continues to maintain a notable share in everyday transactions. This finding indicates that cash still retains functional importance as a means of payment.

Figure 2. Share of payment instruments used at the POS, euro area



Source: European Central Bank. (2024). Study on the payment attitudes of consumers in the euro area (SPACE) 2024. Frankfurt: ECB. https://www.ecb.europa.eu/stats/ecb_surveys/space/shared/pdf/ecb.space2024~19d46f0f17.en.pdf

2.3. Operational Costs and the Scalability Problem

Cash-based systems generate significant operational costs. The printing, transportation, security, and storage of physical currency create substantial cost components. In addition, cash management imposes additional operational burdens on both the retail sector and the banking system. As transaction volumes increase, these factors limit the scalability of cash-based payment systems (Humphrey, Pulley & Vesala, 1996).

Moreover, the expansion of globalization and international trade has placed greater emphasis on the speed and integration capacity of payment systems. Systems based on physical cash are not well suited to transactions that extend beyond geographical boundaries. Consequently, the process of global financial

integration has made the limitations of cash-based systems increasingly visible (Claessens, Glaessner & Klingebiel, 2001).

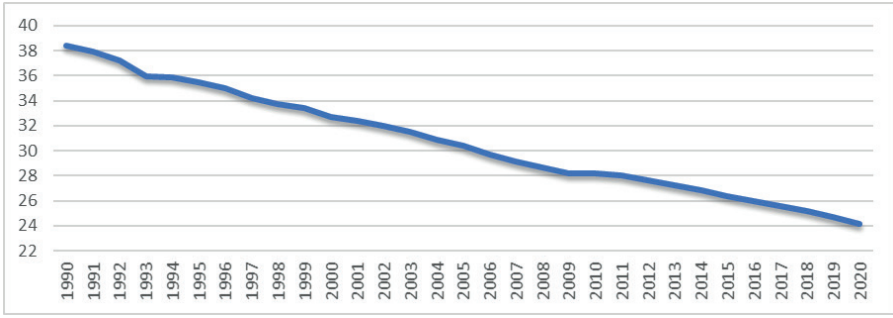
2.4. Informal Economy and the Traceability Problem

While the anonymous nature of cash transactions provides an important advantage in terms of individual privacy, it may also create public risks related to tax losses, money laundering, and the financing of illegal activities. The limited traceability of cash reduces the capacity of public authorities to monitor and tax economic activities, which has led to the frequent association between cash usage and the informal economy. Rogoff (2016) particularly emphasizes the connection between large-denomination banknotes and illicit economic activities, highlighting the limitations of cash in terms of financial transparency.

However, the size of the informal economy cannot be explained solely by the use of cash; it is a multidimensional phenomenon shaped by various structural factors. Elements such as institutional capacity, the effectiveness of the tax system, regulatory frameworks, financial inclusion, and the level of economic development also play a decisive role. Comprehensive analyses conducted by Medina and Schneider (2018) reveal that in many countries the informal economy constitutes a significant share of GDP. These findings indicate that the issue is linked not only to the choice of payment instruments but also to the quality of governance and institutional structures.

In the case of Türkiye, the long-term trajectory of the informal economy has often been evaluated in relation to structural reforms, fiscal discipline policies, and transformations within the financial system.

Figure 3. The Share of the Shadow Economy in GDP in Türkiye (%)



Source: World Bank. (2024). Informal Economy Database (database). The World Bank. https://www.worldbank.org/en/research/brief/informal-economy-database

Within this framework, cash is defended on the one hand as an instrument of freedom and privacy, while on the other hand it is regarded as a contested tool from the perspectives of public finance and financial regulation. Therefore, the sustainability of cash-based payment systems is not solely a matter of technological transformation; it also lies at the center of broader debates concerning fiscal capacity, governance, and institutional effectiveness.

2.5. The Pressure of Digitalization and the Threshold of Structural Transformation

The limitations of cash-based systems create disadvantages compared with digital systems, particularly in terms of speed, integration, and data generation. In today's financial ecosystem, payment transactions serve not only as mechanisms for transferring value but also as infrastructures for data production, risk analysis, and the integration of financial services. By their very nature, however, cash systems do not generate this data layer.

Digitalization in payment systems has evolved beyond a simple technological innovation and has become a process of structural transformation. Increasing transaction volumes, the expansion of global trade, the growing need for financial monitoring, and requirements for cost optimization have given rise to a financial architecture in which cash-based systems alone are no longer sufficient. Nevertheless, this transformation does not imply the complete disappearance of cash. Cash continues to retain its role as a safe haven and a final settlement instrument, particularly during periods of crisis. Therefore, physical cash systems should be understood not as structures that are disappearing in the digitalization process, but rather as systems that are being functionally repositioned.

3. Electronic and Card-Based Payment Systems: The Construction of Centralized Digitalization

The limitations of cash-based payment systems in terms of scale, speed, and traceability triggered a structural transformation in payment infrastructure beginning in the second half of the twentieth century. Increasing transaction volumes, the expansion of global trade, and the deepening of financial integration made the digitalization of payment processes inevitable. In this context, electronic and card-based payment systems represent the first major digital turning point in the architecture of payments.

However, this transformation did not lead to a decentralized and pluralistic structure, as is often assumed; rather, it resulted in a form of centralized financial digitalization. Electronic payment systems established a digital record

architecture centered on the banking system. This period can therefore be conceptualized as an era of centralized digitalization in payment systems.

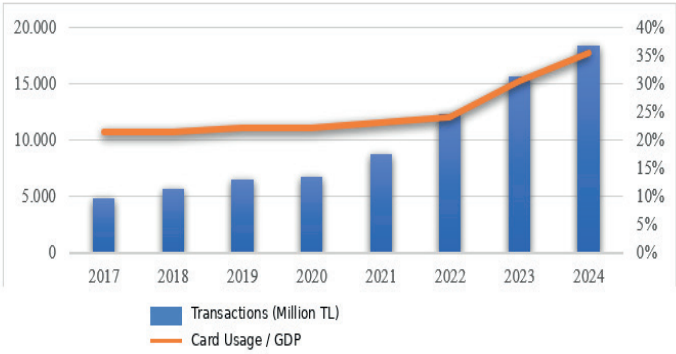
3.1. The Emergence of a Bank-Centered Payment Architecture

The rise of electronic payment systems has progressed in parallel with the increasing information-processing capacity of the banking sector. Debit and credit cards have transformed payment from a process of physical value transfer into one based on the reconciliation of accounts and the updating of digital records. This transformation has made visible the representational and accounting-based nature of money, rather than its material form. Payment no longer refers to money physically "changing hands," but to simultaneous adjustments in the balance sheets of banks. In this sense, payment systems have moved to the center of financial intermediation.

The widespread adoption of card-based systems has also transformed payment infrastructure into a multi-sided structure. Three-party (cardholder–merchant–bank) and four-party (cardholder–merchant–issuing bank–payment network) models are commonly analyzed within the framework of the two-sided markets literature. Rochet and Tirole (2003) define payment networks as two-sided platforms and demonstrate that network effects play a decisive role in the functioning of these systems. Therefore, card-based payment systems represent not only a technical innovation but also the beginning of a platform-based financial architecture. However, this platformization has taken place within a structure that remains controlled and regulated by the banking system, where trust continues to rely largely on banks and other financial institutions.

In the case of Türkiye, the fact that credit card debt payments and mobile banking transaction volumes have reached billions of Turkish lira in recent years illustrates that payments increasingly occur not as physical transfers of value but as updates to accounting records within the banking system.

Figure 4. Card Payment Transaction Volume and the Ratio of Card Usage to GDP in Türkiye



Source: Bankalararası Kart Merkezi (Interbank Card Center). (2026). Dönemsel bilgiler. BKM. https://bkm.com.tr/raporlar-ve-yayinlar/donemsel-bilgiler/ ve Türkiye İstatistik Kurumu (TurkStat). (2026). TÜİK Veri Portalı. https://veriportali.tuik.gov.tr/tr/statistical-themes

3.2. Account-Based Abstraction and the Deepening of Financial Intermediation

Electronic payment systems have transformed the payment process into an account-based abstraction. This transformation has expanded the scope of financial intermediation. Payment is no longer a direct exchange between parties; rather, it has become a process of balance-sheet coordination conducted through the settlement infrastructures of financial institutions.

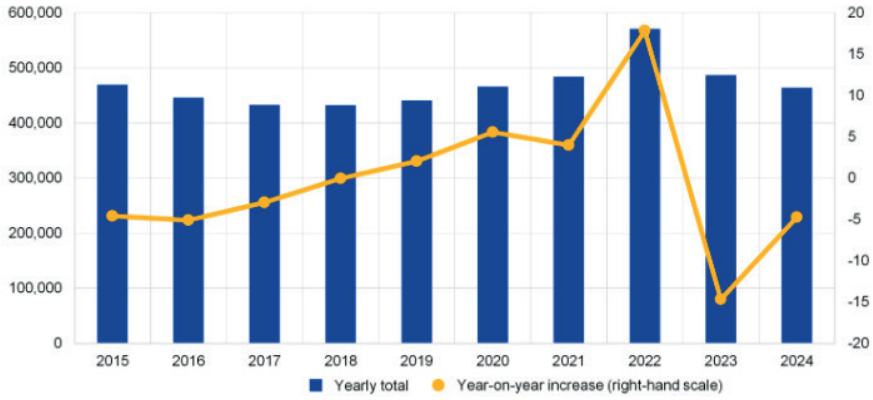
Kahn and Roberds (2009) emphasize that payment systems constitute a fundamental infrastructure for financial stability. Electronic payment systems require trust among banks as well as coordinated liquidity management. In particular, Real-Time Gross Settlement (RTGS) systems—developed for large-value payments—represent central bank innovations aimed at reducing systemic risk.

The significance of electronic payment systems for financial stability becomes particularly evident in the scale of central bank settlement infrastructures. In the Eurozone, the RTGS system T2 (formerly TARGET2) processes transactions amounting to hundreds of trillions of euros annually. This volume demonstrates that payment processes are no longer based on the transfer of physical currency but instead operate through balance-sheet coordination among banks. The magnitude of these transactions reveals that liquidity

flows are managed in real time and on a gross basis through central bank infrastructure, confirming that payment systems function as a core stability mechanism within the financial system.

Therefore, electronic payment infrastructures should not be viewed merely as a technological innovation; rather, they operate as an institutional framework of trust and settlement that ensures the continuity of the financial system.

Figure 5. Annual Transaction Volume of the TARGET2 System (Billion Euros)



Source: European Central Bank. (2024). T2 statistics: Turnover and transaction data. https://www.ecb.europa.eu/paym/target/t2/facts/html/index.en.html

3.3. Centralization and the Institutional Foundations of Trust

Electronic and card-based payment systems represent the first phase of digitalization; however, they have not produced a radical shift in the structural source of trust. Trust continues to be provided by the banking system, payment networks, and regulatory institutions. Within this system, users' confidence in payment transactions relies less on technical codes and more on institutional guarantees.

Anthony Giddens (1990) argues that in modern societies trust increasingly takes the form of confidence in abstract systems. Electronic payment systems constitute a typical example of this type of systemic trust. Users generally do not need to understand the technical details of payment processing; instead, they rely on the institutional integrity of banks and payment networks. In this sense, the era of electronic payments can also be interpreted as a period of institutional centralization of trust.

At the same time, however, this centralization has intensified systemic risks. Technical failures within large payment networks or disruptions arising from financial crises can lead to large-scale economic disturbances.

3.4. Scale, Speed, and Standardization

One of the most significant contributions of electronic payment systems is the increase in scalability and speed. Digital record infrastructures have the capacity to process growing transaction volumes at lower marginal costs. The work of Humphrey and colleagues (1996) demonstrates that electronic payment instruments reduce per-transaction costs in the long run and generate economies of scale. As a result, payment systems have been transformed not only technologically but also in terms of their cost structures.

Standardization has further accelerated global financial integration. Global payment networks such as Visa Inc. and Mastercard have enabled cross-border payments by bringing banking systems from different countries under common technical protocols and settlement standards. Consequently, payment systems have evolved beyond national infrastructures into a global network architecture. However, this network structure has not developed as a fully distributed or autonomous system; rather, it has taken shape around centralized platforms controlled by financial institutions and private payment networks (Bolt & Schmiedel, 2013).

The fact that 233.8 billion transactions were processed through the Visa Inc. network in 2024, reaching a total transaction volume of USD 15.7 trillion, illustrates that global payment trust has become concentrated around a small number of major platforms (Visa Inc., 2024). This scale demonstrates that the era of electronic and card-based payments represents not only the beginning of digitalization but also a stage in which platformization and centralization have become institutionalized within the global payment ecosystem..

Table 1. Number of Transactions Processed Through the Visa Network and Total Transaction Volume

Year	Number of Transactions (Billion)	Total Transaction Volume (Trillion USD)
2022	192.5	14.1
2023	212.6	14.8
2024	233.8	15.7

Source: Visa Inc. (2024). Annual report 2024 (Form 10-K). https://investor.visa.com

4. Mobile and Platform-Based Payment Systems: The Shift Toward the Transaction Experience

Electronic and card-based payment systems abstracted payment processes from physical cash and transferred them into account-based digital records; however, this transformation largely occurred within a bank-centered architecture. Mobile and platform-based payment systems have taken this structure a step further by transforming payment from a purely technical transfer process into an integral part of user experience, data generation, and platform participation.

This stage represents a shift in payment systems from centralized digitalization toward user-centered platformization. The transformation is not merely a technological advancement but also a structural change in the organization of financial intermediation. Payment is no longer simply an accounting process operating in the background of the financial system; instead, it has become a visible component of the user experience positioned at the forefront of the digital platform economy.

4.1. Mobile Wallets and the Redesign of the Payment Process

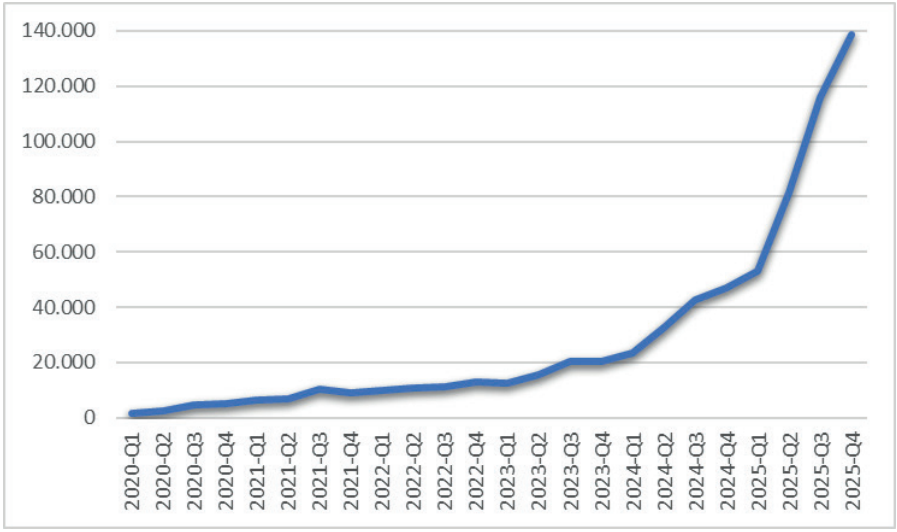
The widespread adoption of smartphones has fundamentally transformed the architecture of payment systems. Mobile wallets have transferred bank and credit cards from their physical form to digital interfaces, while technologies such as QR codes, contactless payments (NFC), and biometric authentication have reduced both transaction time and transaction costs. These systems allow users to perform financial transactions through a single device within an integrated experience (Dahlberg, Guo, & Ondrus, 2015).

However, the primary innovation of mobile payment systems lies not only in technology but also at the architectural level. Payment transactions now occur not through banking interfaces but through the user interfaces of digital platforms. While banks increasingly function as background infrastructure actors responsible for settlement, the user experience is designed and controlled by the platform. This shift has led to a redistribution of visibility and control within the financial value chain (Gomber, Koch, & Siering, 2017).

This process has introduced a new stage that can be described as the "invisibilization" of financial services. Users often complete payment transactions without consciously perceiving them, as payment functions are embedded within e-commerce, transportation, digital content, and social media applications. Consequently, payment systems become integrated into the data-driven business models of the platform economy, and financial transactions turn into components of user behavior generation.

The widespread adoption of mobile payment infrastructures and the shift of user behavior toward digital platforms have led to a significant increase in the volume of transactions conducted through mobile devices. The following figure illustrates the temporal evolution of this trend (Langley & Leyshon, 2017).

Figure 6. Payment Transactions Conducted via Mobile Devices (thousand units)



Source: Türkiye Bankalar Birliği (2025). Statistical Reports – Mobile banking data. Türkiye Bankalar Birliği. https://www.tbb.org.tr/istatistiki-raporlar/11238

4.2. Platformization and Network Effects

Mobile payment systems exhibit the typical characteristics of the platform economy. Platforms create value by bringing together different user groups—such as consumers, merchants, financial institutions, and third-party developers—within the same digital infrastructure. The central dynamic of this structure is network effects. Michael L. Katz and Carl Shapiro (1985) emphasize that network effects—where the value of a product or service increases with the number of users—are particularly decisive in digital platforms.

In mobile payment platforms, network effects operate both directly and indirectly. As the number of users increases, the system becomes more acceptable and trustworthy for consumers, while the expansion of the merchant acceptance network increases the platform's value for the other side of the market. From the perspective of the two-sided market framework developed by Jean-Charles Rochet and Jean Tirole (2003), mobile payment systems

exhibit a growth dynamic in which interdependent user groups mutually reinforce each other. In this way, the platform generates a self-reinforcing economy of scale.

This process can also lead to market concentration. Scale advantages and data accumulation increase the competitive strength of large platforms and raise barriers to entry. Consequently, mobile payment systems represent not only technical innovations but also platform strategies that reshape the structure of competition.

As of 2025, several platforms in the mobile wallet market have reached a remarkable scale. According to industry data, Apple Pay has approximately 744 million users, while Google Wallet has around 200–250 million users. Globally, the number of digital wallet users exceeds 5 billion (Emewulu, 2025). This magnitude indicates that mobile payment systems have evolved from being alternative payment methods into globally standardized digital infrastructures. The breadth of the user base increases platforms' capacity to collect data, and this accumulation of data facilitates the integration of financial services into platform ecosystems.

4.3. User-Centricity and the Experience Economy

With the emergence of mobile payment systems, the concept of payment has become an integral part of the experience economy. Speed, convenience, intuitive design, and integration capacity have become key determinants in the adoption of payment instruments. In this context, payment systems compete not only on the basis of technical reliability but also on the quality of the user experience they provide (Kim, Shin, & Kim, 2010).

The ability to complete payments within seconds, ensure security through biometric authentication, and digitally track transaction histories has transformed user behavior. Payment is no longer merely an economic necessity; it is increasingly becoming a natural and embedded extension of digital life. Financial transactions are gradually becoming invisible within user interfaces, as payment functions are integrated into e-commerce, transportation, and various digital service applications.

This transformation has also increased the data generation capacity of payment systems. Digital payment and mobile transaction data are playing an increasingly significant role in credit risk assessment processes. For individuals with limited traditional credit histories, alternative data sources—such as mobile payment histories, bill payment regularity, digital wallet usage, and account activity shared through open banking frameworks—serve as complementary indicators in evaluating creditworthiness. Open banking and API-based data-

sharing frameworks enable financial institutions to conduct more behavior-based and dynamic risk analyses (World Bank, 2024).

These developments demonstrate that payment systems are no longer merely transaction infrastructures; they have also become mechanisms for the production of financial information. Consequently, mobile payment data is evolving into a strategic input for credit scoring, financial inclusion, and the design of data-driven financial products.

4.4. From a Bank-Centered Structure to the Platform Economy

While trust and control in electronic payment systems largely rely on the banking system, in mobile payment systems the visible layer of the value chain has increasingly come to be managed by technology platforms. This shift signifies a transfer of interface control in financial intermediation from banks to digital platforms.

John Zysman and Martin Kenney (2016) argue that digital platforms have emerged as new institutional structures that organize economic activities. Payment systems have likewise become part of this new organizational form. While banks continue to operate within the layers of settlement, liquidity provision, and regulatory compliance, the user experience, data flows, and customer relationships are increasingly designed and controlled by platforms.

This transformation reflects three major shifts in power::

- The transfer of interface control from banks to digital platforms
- The concentration of data ownership and data accumulation within technology companies
- The embedding of financial services within broader platform ecosystems

However, this stage does not yet represent a fully multi-actor and distributed ecosystem. Rather, it can be interpreted as an intermediate phase in which bank-centered centralization is gradually replaced by platform-centered centralization. In this sense, the era of mobile payments represents a transitional period in which the architecture of power and control within the financial system is being fundamentally reshaped.

5. From Payment Systems to the Digital Payment Ecosystem: The Rise of Multi-Actor Network Structures

Electronic and mobile payment systems have transferred payment processes into the digital environment, creating platform-based structures centered on user experience. However, this transformation alone is not sufficient to

explain the organizational and institutional complexity that characterizes modern payment structures. Today, payment systems are no longer merely technical infrastructures or isolated platforms; rather, they have evolved into multi-actor, network-based digital ecosystems that generate value through interdependent relationships among diverse participants.

This stage represents not merely a technological advancement but a structural turning point in the historical evolution of payment systems. The organization of financial intermediation has fundamentally changed: payment is no longer a service provided by a single institution but has become a process of value creation that emerges from the simultaneous and coordinated interaction of multiple actors (Evans & Schmalensee, 2016).

5.1. From System to Ecosystem: A Conceptual Framework

While the concept of a "payment system" refers to transactions carried out through a specific infrastructure or institutional arrangement, the concept of an "ecosystem" describes a modular and dynamic organizational structure in which interdependent actors jointly create value. James F. Moore (1993) explains business ecosystems as structures in which firms operate not in isolation but within networks of interacting actors. This perspective provides a fundamental theoretical framework for understanding the transformation occurring in the field of payments.

Although the concepts of platform and ecosystem are often used together, there is an important structural distinction between them. Platforms function as centralized digital infrastructures that bring together different user groups and coordinate their interactions. Ecosystems, by contrast, represent a broader value architecture that may include platforms but extends beyond them by organizing complementary actors in a modular structure. For this reason, the digital payment ecosystem should not be understood as a closed network built around a single platform, but rather as a layered structure in which different specialized actors operate together.

Michael G. Jacobides, Carmelo Cennamo, and Annabelle Gawer (2018) define ecosystems as systems in which complementary actors jointly create value within a modular structure. The fragmentation of the value chain and the increasing functional specialization observed in the digital payments field closely align with this definition.

In this context, the core characteristics of digital payment ecosystems can be summarized as follows:

- Multi-actor participation

- Modular and layered infrastructure
- Data-driven value creation
- Coordination through platforms
- Systemic interdependence

This structure differs significantly from the traditional bank-centered hierarchical financial architecture.

5.2. Core Actors of the Ecosystem

The organizational architecture of the digital payment ecosystem is shaped by four main groups of actors positioned at different layers of the value chain.

Banks: The Infrastructure and Institutional Trust Layer	FinTech Companies: Actors of Modular Innovation	BigTech Platforms: Network Power and Data Concentration	Regulators: Designers of the Ecosystem
•Banks continue to play a central role in settlement, liquidity management, and regulatory compliance. However, they are increasingly moving away from being the actors that design the payment experience. Within the ecosystem, banks are evolving toward roles primarily focused on trust provision, regulatory compliance, and infrastructure support. This transformation is redefining the position of banks within the financial value chain.	•FinTech firms bring dynamism to the ecosystem by developing innovative interfaces, alternative credit assessment methods, and user-centered designs. These actors integrate into the ecosystem through modular innovation and often create value by collaborating with banks.	•Large technology companies have gained a strong position within the payment ecosystem due to their extensive user bases and data capabilities. By integrating payment services into social media, e-commerce, and digital service platforms, these firms embed financial transactions directly into everyday digital life. As a result, payment systems have become not only an economic domain but also a strategically significant one.	•Central banks and regulatory authorities play a critical role in ensuring the stability and security of the ecosystem. Through instruments such as open banking regulations, data-sharing standards, and payment licensing frameworks, the institutional architecture of the ecosystem is shaped and defined. In this sense, regulation functions not only as a mechanism of oversight but also as a design force shaping the structure of the ecosystem.

5.3. Cooperation and Competition

Digital payment ecosystems are hybrid structures in which cooperation and competition occur simultaneously. The concept of coopetition, introduced by Adam M. Brandenburger and Barry J. Nalebuff (1996), demonstrates that firms can act as both competitors and partners at the same time. Within ecosystem structures, value creation depends less on pure competition and more on the capacity for coordination among actors.

In the payments sector, the relationships between banks and FinTech companies clearly illustrate this dynamic. Banks may invest in FinTech startups or provide infrastructure services, while simultaneously continuing to compete within the same customer segments. Similarly, BigTech platforms often rely

on banking infrastructure, yet they can achieve strategic advantages through control over user interfaces and data flows. As a result, competition is no longer shaped solely by price or market share; it increasingly revolves around data control, architectural positioning, and network effects (Adner, 2017).

5.5. The Ecosystem Nature of Modern Payment Systems

Modern payment systems are no longer closed structures dominated by a single actor. Instead, they have evolved into multi-layered, modular digital ecosystems operating through relationships of mutual interdependence. This transformation is redefining both the distribution of power and the mechanisms of value creation within the payments domain.

The transition from bank-centered centralization to platform-centered structures, and subsequently to multi-actor network ecosystems, reflects a structural reconfiguration of the financial architecture. Payment systems are no longer merely financial infrastructures; they have become one of the organizational backbones of the digital economy. However, this expansion also introduces new areas of debate, including issues related to data ownership, the concentration of algorithmic power, systemic risk, and governance gaps. For this reason, the next section examines the dimensions of trust, data, and governance within modern payment ecosystems.

6. Trust, Data, and Governance: New Risks and New Safeguards in Digital Payments

The widespread expansion of digital payment ecosystems has transformed payment systems from purely technical and economic infrastructures into matters of governance and ethics. Trust has always been a central concept in the historical evolution of payment systems; however, the source of this trust has changed over time (Vives, 2019).

During the era of physical money, trust relied primarily on state monetary sovereignty and the tangible existence of currency. In the period of electronic payments, trust was largely constructed through institutional banking structures and regulatory frameworks. In digital payment ecosystems, however, trust increasingly depends on software protocols, algorithmic verification mechanisms, and data security infrastructures. This shift indicates that the foundation of trust is moving from institutional structures toward technical architectures. Consequently, trust is no longer solely a legal guarantee; it is becoming a coded and continuously updated system design.

6.1. The Shift of Trust from Institutions to Coded Systems

In modern societies, trust emerges as a form of abstract confidence in the functioning of complex systems (Giddens, 1990). Individuals act on the basis of trust in systems whose technical details they do not fully understand. Digital payment systems represent one of the most visible examples of this form of abstract trust. Users complete payment transactions without having knowledge of the encryption algorithms, data transmission protocols, or server architectures operating behind the system.

According to Niklas Luhmann (2018), trust functions as a mechanism that reduces uncertainty and enables decision-making within complex social systems. In digital payment systems, this uncertainty-reducing function is institutionalized through technical tools: strong encryption protocols, two-factor authentication, biometric recognition systems, and real-time fraud monitoring mechanisms form the technical architecture of trust.

Within this framework, trust becomes less a normative expectation and more a designed property of the system itself. However, the technologization of trust also generates a structural tension: as systems become more complex, the range of potential vulnerabilities expands. Cyberattacks, data breaches, and software vulnerabilities continuously test the security architecture of digital payment systems.

At the global level, data breaches in the financial services sector provide concrete evidence of these vulnerabilities. A report by Verizon Communications (2025) indicates that a significant portion of data breaches in the financial sector originate from system intrusions and social engineering attacks.

6.2. The Authentication–Surveillance Paradox

In digital payment systems, the shift of trust from institutional structures to coded infrastructures has placed authentication at the center of the payment process. While anonymity was a dominant feature during the era of physical cash, digital systems rely on mechanisms such as Strong Customer Authentication (SCA), biometric verification, and multi-layered security protocols as primary sources of trust (Contini et al., 2011).

Although these technical tools aim to reduce fraud risk, they also narrow the scope of anonymity. Digital payment systems continuously process users' identity, location, and spending data, thereby generating a structural tension between security and privacy. As security increases, the traceability of financial transactions also expands, giving rise to what can be described as a "surveillance paradox" within the architecture of digital payments.

Therefore, authentication should not be understood merely as a technical security tool; it should also be considered a design choice that redefines the boundaries of individual freedom and privacy within digital financial systems.

6.3. Data Ownership, Platform Power, and Economic Value

Digital payment transactions represent not only the transfer of funds but also the production of data. The data generated through these transactions increasingly serves as a strategic input for credit risk analysis, consumer behavior modeling, marketing strategies, and algorithmic decision systems.

As Shoshana Zuboff (2019) argues, within the digital platform economy data has become a new source of power. Payment data helps shape users' economic identities and can create opportunities for financial inclusion. At the same time, however, it also introduces risks related to profiling, discrimination, and behavioral manipulation.

Control over the collection, processing, and sharing of data plays a decisive role in shaping the distribution of power within the payment ecosystem. Regulatory initiatives such as open banking frameworks and data portability principles can be interpreted as institutional efforts aimed at limiting data concentration and fostering competition. Nevertheless, the growing concentration of data control within platform companies signals the emergence of a new form of power centralization within the financial system.

6.4. Cyber Resilience and Systemic Risk

The network-based structure of digital payment ecosystems increases the risk of operational vulnerability. In architectures characterized by multiple actors and mutual interdependence, a disruption in one infrastructure component can create a domino effect across the entire system (Allen & Gale, 2000).

Cyberattacks, ransomware incidents, and data breaches threaten payment systems not only at the level of individual users but also at the level of macro-financial stability. For this reason, payment infrastructures are increasingly classified as critical financial infrastructures.

Central banks and regulatory authorities now treat cyber resilience and operational continuity as integral components of financial stability policies. In this context, trust is defined not only through micro-level mechanisms such as authentication and security protocols but also through the system-wide resilience of the financial architecture.

6.5. Algorithmic Governance and the Normative Framework

Governance in digital payment systems requires not only technical security measures but also normative and institutional design principles. Multi-actor structures can lead to the dispersion of responsibility and create challenges related to accountability. For this reason, regulatory frameworks must extend beyond security standards to include issues such as data ownership, transparency, and fairness (Arner, Barberis, & Buckley, 2016).

In particular, algorithmic models used in credit scoring and risk assessment processes require careful scrutiny in terms of decision-making transparency and the risk of discrimination. At this stage, trust depends not only on technical protection mechanisms but also on the integrity of legal and ethical design frameworks.

Therefore, in digital payment ecosystems, trust is grounded not only in coded security protocols but also in normative and legal design principles. Governance thus requires a multi-layered regulatory framework that integrates technical, ethical, and institutional dimensions.

7. Toward a Cashless Society: Opportunities, Risks, and Structural Tensions

The widespread expansion of digital payment ecosystems indicates that the financial system is gradually evolving away from a cash-based structure toward one in which cash is used less frequently. The concept of a cashless society refers to a system in which economic transactions are conducted largely through digital instruments and physical money plays a secondary role. However, this transformation is not merely a technological advancement; it represents a multi-layered restructuring with economic, social, and political dimensions (Arvidsson, 2019).

Digital payment systems reduce transaction costs, accelerate economic coordination, and facilitate liquidity management through real-time settlement infrastructures. Digital traceability also provides public authorities with important tools for combating the informal economy and improving tax collection. From the perspective of public finance, therefore, the move toward cashless systems can produce a more transparent and auditable economic structure.

At the same time, digital payment infrastructures have the potential to enhance financial inclusion. Mobile wallets and digital identity solutions offer alternative financial channels for individuals with limited access to the traditional banking system. However, this potential depends heavily on levels

of digital access and financial literacy. Limited internet access, lack of device ownership, and insufficient technological capabilities may create new forms of digital exclusion. Consequently, the transition toward cashless systems embodies a dual dynamic of both inclusion and exclusion.

While physical cash provides anonymity, digital payments generate transaction data. In a cashless society, a large share of economic activity leaves digital traces, potentially transforming payment systems into infrastructures of data surveillance. As transparency increases, the scope of privacy may simultaneously shrink, giving rise to a new search for balance between security and individual freedom. Achieving this balance requires not only technical security measures but also careful consideration of data ownership regimes, regulatory frameworks, and fundamental rights.

Moreover, cashless systems depend on electricity, internet connectivity, and digital infrastructures. Operational disruptions or cyber threats may therefore generate new vulnerabilities that affect the resilience of the financial system. Physical cash, by contrast, can function as an alternative safe asset during crises due to its independence from technological infrastructure. For this reason, the transition toward cashless systems should be understood not as a complete substitution but as a transformation requiring hybrid architectures.

The debate on the cashless society has gained an additional dimension with the emergence of central bank digital currencies (CBDCs). CBDCs are often viewed as attempts to transfer state monetary sovereignty into the digital domain, with the potential to provide public digital payment infrastructures, balance platform concentration, and support financial inclusion. At the same time, they may increase risks related to state surveillance and data centralization. Consequently, the design of CBDCs requires a careful institutional balance between privacy and financial stability. In this respect, CBDCs represent one of the most visible manifestations of the cashless paradox at the state level (Auer & Böhme, 2020).

At the center of the debate on the cashless society lies a structural paradox: digitalization simultaneously produces outcomes that are both empowering and potentially destabilizing. While digital payment infrastructures enhance economic efficiency and traceability, they may also reduce privacy, increase technological dependence, and redefine systemic risks. Therefore, the transition toward a cashless society should not be interpreted as a linear progression but rather as a multi-dimensional transformation in which opposing effects coexist.

This paradox demonstrates that the cashless society is not an inevitable destination but a dynamic process shaped by policy design, regulatory choices,

and societal balances. Accordingly, the future of payment systems should not be viewed as a one-directional evolution toward a fully cashless structure; instead, it represents the deliberate design of a multi-layered financial architecture in which digital and physical payment instruments may coexist and evolve together within governance frameworks.

8. Conclusion

This study has examined the evolution of payment systems within a conceptual framework, tracing their transformation from structures based on physical cash to electronic and card-based systems, and subsequently to mobile and platform-based architectures, ultimately culminating in multi-actor digital ecosystems. This historical trajectory reflects not merely a process of technological advancement but a multi-layered transformation in the institutional, organizational, and societal structure of the financial system.

During the era of physical cash, payment functioned as a material exchange and a final settlement instrument backed by state authority. Electronic and card-based systems transferred this structure into digital records, yet trust remained largely centered on the banking system. Mobile and platform-based payment systems, by contrast, placed the user experience at the forefront and enabled financial services to become embedded within everyday digital life. In doing so, payment transactions have become increasingly invisible, fluid, and data-generating processes. Ultimately, digital payment ecosystems have emerged as multi-actor network structures characterized by interdependent relationships among banks, FinTech firms, BigTech platforms, and regulatory authorities.

One of the most critical aspects of this transformation is that payment systems are no longer merely infrastructures for fund transfers. Modern payment systems function as strategic gateways for data production, risk analysis, credit evaluation, and the design of financial services. Value creation is no longer generated solely by individual institutions but increasingly through network-based interactions and complementarities among ecosystem participants. In this context, payment systems have evolved from being technical financial infrastructures into organizational backbones of the digital economy.

However, this expansion also generates new responsibilities and vulnerabilities in the domains of trust, data, and governance. The shift of trust from institutional structures to coded systems has placed technical security infrastructures at the center of payment architectures. At the same time, new risks have emerged in the form of cyber threats, data breaches, and algorithmic biases. While the transition toward cashless systems offers opportunities for

efficiency and financial inclusion, it may also produce paradoxical outcomes such as digital exclusion, loss of privacy, and increasing systemic dependence on technological infrastructures.

Therefore, the evolution of payment systems should not be interpreted as a linear or one-directional process of progress. The vision of a cashless society should be understood not as an inevitable end state but as a governance challenge shaped by regulatory choices, technological design principles, and societal values. In this respect, hybrid models—where cash and digital instruments coexist—continue to play an important role in maintaining financial resilience and inclusivity.

This study conceptualizes the evolution of payment systems not merely as a technological progression but as a transformation in which the distribution of power and the governance architecture of the digital economy are being reconfigured. By positioning payment systems not only as infrastructures for fund transfers but also as organizational backbones of the platform economy, it extends the predominantly technical and financial focus of existing literature. Moreover, by analyzing the shift of trust from institutional structures to coded systems, the study places the governance dimension of digitalization at the center of its analytical framework. It also highlights how the process of platformization in payment systems leads to data concentration and the centralization of power, thereby linking the redefinition of financial intermediation to the dynamics of platform power.

In conclusion, the future of payment systems will be shaped not by technological determinism but by the distribution of power, data ownership regimes, and public design choices. Digital payment ecosystems should therefore be understood not only as arenas of financial innovation but also as strategic governance domains situated at the intersection of institutional responsibility, ethical design, and the pursuit of public balance.

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