Deep Science Publishing
https://doi.org/10.70593/978-93-49910-78-2_1

# Chapter 1: The evolution of global payment systems and digital finance infrastructure

## 1.1. Introduction

Payment systems are vital for the functioning of today's economy, from retail transactions through to the settlement of interbank final payment obligations. Even with the increasing migration to electronic money transfers from the dominance of cash and checks, the basic aspects of payment systems are broadly similar to when the Bank of England was established to provide a facility for banks to convert their notes and settle interbank obligations. Fundamental concepts in payment systems are risk transfer from payer to payee, and relinquishing control over resources by the payer.

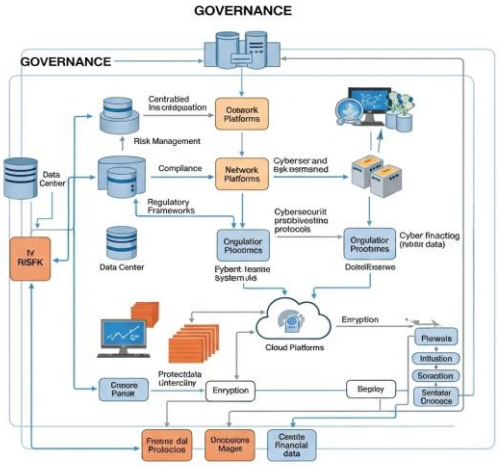


**Fig 1 :** Governance Framework

There are two broad categories of payments. Hard payments are payments of some form of property that exhaust the payment proceeds and rely on private rules of restitution in the event of error or fraud. The payer is not owed any further claim against the payee. Soft payments are payments that create a claim against the payee for further performance after payment. Soft payments rely on information and formal procedures available to a financial intermediary, such as banks, for creating sufficient barriers to bounce a payment on errors or fraud.

In the real world, the distinction is somewhat blurred by procedural safeguards such as notification of receipt, rules on irrevocability and confidentiality, or the use of an intermediary with formal banking rules governing the transference of property, and these rules help shape risk layerings allocating liabilities between intermediaries, payers, and payees in the event of error or fraud. Our focus in what follows is generally on bank-related payment systems, except where specified. We start with some basic concepts on payments, risks, and risk allocation, before outlining how risk layers evolve in the development of real time gross settlement systems, other core national payment systems, and cross-border payment systems. Payment systems are not just there as value-added luxuries for high-value transactions. Electronic stores of value are backed by reserves at central banks. Banking regulation imposes capital requirements conditional on the instability of the bank deposit liability that backs the account (Nakamoto, 2008; Buterin, 2013; Tapscott & Tapscott, 2016).

### 1.2. Historical Overview of Payment Methods

An analysis of modern systems of transferring value provides an insight into how systems are both similar to and different from old systems. An examination of outdated systems provides evidence of how the purpose of these payment systems has remained the same, but that the means and infrastructure used to satisfy these purposes have changed. Financial flows are a basis of any economy's infrastructure and as such a traditional means of measuring economic activity is based on the idea of calculating the speed of money. The speed of money is the movement of money through the economy, or more simply the ease of transferring money.

In its earliest known format, economic activity consisted of barter, a simple means of satisfying the purpose of enabling the exchange of goods, in which two parties directly exchange goods of roughly equal value. However, finding two parties simultaneously demanding each other's goods has always been problematic, and to overcome the inefficiencies of barter, people began accepting certain objects of acceptable and reproducible form as commodities of worth. For example, in ancient Rome, salt was a highly traded commodity, and is where the term salary comes from. In other places, such commodities included cattle, shells, and other materials of public acceptance. As trade

grew, the limitations of commodity money seeking alternative means meant that paleolithic tribes transacting property only occasionally began transferring pieces of valuable metals.

These metals, usually gold, began to be shaped into standardized coinages. The first mention of currency, or coins, dates back to 700BC in Lydia. They were stamped into metals of certain weights for public acceptance, thus further expediting the means of exchange. The introduction of coinage provided a standard of payment and an accounting format that soon made the arithmetical basis for payment possible. However, the need for large amounts of weighty coinage, especially during international trade, soon necessitated the further development of the banking system for coin storage and transfer. Subsequently, banks issued paper receipts, which were later directly accepted as invoices for service or goods transactions, until the eventual elimination of coins took place and balances alone became the acceptable form of settling debts.

### 1.2.1. Barter and Commodity Money

The function of money is not without controversy, and there are numerous definitions of both money and payment systems. The broadest definition of money is anything that is used to settle a debt for goods and services. In practice, however, this definition would allow many different goods to function as money, from cigarettes to wine. It may be more practical to define money as something that is issued by the state and accepted by society in a transaction. This definition prioritizes what is known as fiat money, such as coins and paper currency, and it more or less excludes barter systems. However, a significant part of global economic activity today is transacted without the use of fiat money. Money is also important in different ways. What we are often interested in is the function of money in its role as a liquid asset, which is available for carrying out future transactions. This function of money facilitates economic exchange and is the primary focus of this essay. Prior to the introduction of money, the exchange of goods and services took place through barter, which relied on the double coincidence of wants – two parties both having what the other wished to exchange. Under barter, the only form of trade is frictional trade – demanders incur some transaction costs in satisfying their needs. Some of these costs could also be called considerations, in the sense that they preempt consumption to create future wants to trade for opportunities. Barter could only result in economic growth through the development of specializations in tradeable goods. Under barter, the comparison of value between different types has to be made at the exchange point. But with the introduction of money, exchange becomes a marketplace function. The reduction in transactions costs because of the introduction of money also facilitates savings and investment, which further fosters economic growth.

### 1.2.2. The Introduction of Currency

Currency is an essential system when it comes to asset exchange. It is a commodity, the value of which someone else wants when he will have a need to use it. The main difference with the barter system is that with currency you do not have the constraint of a double coincidence of wants at this very moment. In practice, a commodity is something for which anybody is ready to pay in order to spend it later. Generally, metals are preferred because they are small and light, long-lasting, have different values by unit volume, and are easily divisible. This system should have been the first introduction of a currency system. Later on, banks started to issue negotiable debts or other types of documents. Finally, the last innovations are made by governments with the ability to sustain inequity rates without going bankruptcy, issuing unbacked paper currency.

At first, precious metals were the only currencies accepted and used in transactions, but they also carry costs as they are physical, heavy, could be run out. Hence, more modern commodities were invented to be the first forms of currency. Precious metals backing, such as gold or silver, has been the second stage in the invention of the current currency process. Then non-redeemable paper Money entered into the race and just met with success. Their story cannot be divided into specific distinct periods: it is more a question of a gradual process where some innovations have been generalized much more easily than others, without in principle, any specific order. The reasons are that different economy players do not all have the same constraints and needs, and that the alternatives created by innovations followed these needs and constraints.

### 1.2.3. The Rise of Banking Systems

On the other hand, the institution that provides the basic structure of today's world economy, banks, emerged at the same time as permanent, organized and wealthy states. Banks are the only institution capable of channeling a high fraction of available savings into investments of various types and periods, unlike the other traditional institutions that evolved earlier, especially family and temple. Thanks to large-scale investments and the constant development of mechanisms to guarantee the collection of those investments, banks allow the lending of large, long-term sums without affecting the liquidity of savers. They act not only through a perfect redistribution of illiquidity over time, but also by intermediating information, selecting risk for investors, as well as channeling insustainable risk through financial diversification. In this context, the first banks appeared in Italy during the Renaissance to appear in other European nations and in the American colonies at the service of commerce and agriculture of those times by providing accounts, deposit and transfer services, as well as loans for consumer and business spending. However, the rapid growth of demand and trade exchange, especially after the Industrial Revolution, led to the creation and expansion of many other banks,

whose gradual over expansion, especially after the Gold Standard, required controls by the corresponding states for reasons of financial stability as well as to ensure the exclusive use of currency and deposits in their respective economies.

### 1.3. Technological Advancements in Payment Systems

Perhaps the most important driver of payment innovation over the last few decades is technology, which has addressed many of the shortcomings of payment systems outlined above. The technological infrastructure that supports the internet has been one of the great breakthroughs of the last fifty years, and it has enabled a wide range of changes in the way transactions are executed and settled. Following the commercial introduction of the world wide web in 1995, financial markets came to be populated with new companies that turned the process of settling transactions in markets or products like travel planning or eBay into a digital experience. Payments, however, were until then not usually part of the online experience; just as the vast majority of commerce was still "brick and mortar" rather than "online," the vast majority of payments were not executed over the internet. Consumers more or less needed to leave their computers in order to convert screens into shopping and to pay with cash or credit or debit cards.

**Fig 2 :** The integration of blockchain, cryptocurrency, biometric verification, and mobile transactions into the financial infrastructure of smart cities.

Mobile payment technologies. Only with the introduction in 2007 of smartphones, and the consequent use and spread of mobile commerce, did payments become an integral part of the experience of transacting over the internet. Smartphones are handheld devices with powerful capabilities, including fast wireless access to the internet, the ability to combine the functionalities of cameras, microphones, GPS networks, and the inherent functions of phones. Numerous companies introduced apps that allowed consumers to execute transactions securely using their mobile devices, including payment apps that allowed them to tie their payment instruments into their mobile devices. This demonstrated that consumers commuted more than they went to work; they moved around within their interconnected world, and this called for new, fast, and low-cost innovative payment solutions to meet the rising demand. This desire for new mobile payment solutions became the key catalyst of change.

### 1.3.1. The Impact of the Internet

Following the establishment of the foundations of the payment system and digital internet infrastructure, the proliferation of public internet networks enabled unprecedented technological innovation in key industries capitalizing on these new capabilities, in particular, the dot-com boom of the late 1990s. These developments would not only revolutionize finance; they would also transform entire economies and make the world more interconnected than ever. Within finance, private market players began offering new services that facilitated information, goods trading, and access to credit. An entirely new asset class was also popularized through the creation of the first exchange-traded funds and index mutual funds.

The more apparent effects of the internet's impact on finance would take shape in the area of banking services. The giants of so-called "shadow banking" rapidly proliferated, creating platforms to facilitate a broad range of financial activities. Digital assets, payments, and new intermediation models would enable a radically transformed finance sector, and even more radical changes would follow. Yet the primary impact of all these developments would initially be relegated to providing transitional or supplementary access solutions layered on top of legacy, existing infrastructure. The first brokers began offering digital access to stock markets but by no means dominated the flows. Within a decade, however, advances in computing technology would transform both physical and functional models of securities, payments, storage, and settlement, and risk management and capital requirements would also be transformed. In particular, risk and capital requirements would be expanded, and the business models for key elements of financial dance would be seriously challenged.

### 1.3.2. Mobile Payment Technologies

The emergence of mobile payment methods has changed the way customers interact with merchants. The mobile wave has collected the technologies created by the Internet, and the change of culture has allowed new players to deal with issues that legacy financial institutions had stunted or forced to evolutionary timeframes. These innovations allow for the first time customers and merchants to interact in retail that is programmable, can be made visible and auditable, and are settled in real-time. Mobile devices and applications form the foundation for billions of customers to gain access to digital finance, but only a handful of applications have become popular. The mobile payment is an example of the ATM. Whilst over 10 million ATMs have been installed in the world, only three models became successful, defined broadly as cash disbursal devices. The models are bank tokens, independent tokens with a line of credit, or biometric devices. The network and security required before customers will use applications and merchants will accept transactions at scale is enormous – fast access to the financial network, access to liquidity, and protection against fraud.

There are four types of mobile payment services. Firstly, there are remote payments for goods and services purchased on Internet merchants, through dedicated mobile applications or Web browsers, and mobile wallets. These payments are best executed using credit cards, and account for one-third of the credit cards indirectly connected to payments. Mobile wallets account for 72 percent of payments, provided mainly by domestic players, but also others. 22 percent of the values were settled using electronic bank transfers, which settled more than 1 billion transactions in value from its launch until 2020.

### 1.3.3. Blockchain and Cryptocurrencies

In January 2009, the world witnessed a technological breakthrough, namely Bitcoin, a Peer-to-Peer Electronic Cash System. Bitcoin is a decentralized digital currency that allows anyone to send or receive money over the Bitcoin network without the need of a trusted third party. Because transactions are verified by network nodes through cryptography and recorded in a public distributed ledger called a blockchain. As such, cryptocurrencies are a specific type of digital tokens that make use of blockchain technology and its existent characteristics. Over the years, other blockchain-based systems focusing on different applications and use cases have extended the original vision. Bitcoin was quickly followed by several alternative cryptocurrencies such as Peercoin, Litecoin, Namecoin, and PPCoin, commonly referred to as Altcoins.

The aim of these cryptocurrencies was to serve as a store of value and as a medium of exchange, and to support fungible P2P transactions around the globe. While these

Altcoins have seen several successful applications, more often than not they have also been the targets of multiple hacking incidents, Ponzi schemes, and other criminal activities and have featured substantial losses over the years. Around 2014, increasing development activity around the Ethereum platform initiated a wave of digital tokens that exceeded the original intent to function exclusively as a medium of exchange. Emerging applications of blockchain technology include digital identity and reputation system management, real estate title management, transport and logistics, insurance, and recruitment and cohort management. In summary, cryptocurrencies are digital tokens secured by cryptography based on blockchain technology.

## 1.4. Global Payment System Frameworks

Payment systems have large-scale operations and various players, all of which produce the fundamental plumbing if a payment has to be made. At the top level are the operators and schemes who establish the rules of the game — settlement mechanisms, currencies in terms of which payments are made, payment value ceilings. National or global payment systems include real-time gross settlement systems, interbank clearinghouses, clearinghouses for stored value, specialized credit or value transfer services, and risk intermediation services. Yet this type of organization is often missing from discussions on Digital Finance, while not providing the entire picture. Digital Finance players focus more on financial institutions utilizing payment networks. However, large players operate globally and store value, intermediate risk. In many jurisdictions, they operate outside the central banking framework.

A typical area not covered is the structure of value transfer flows and information networks. One major fortification of a payment system is anti-money laundering regulations. The area is typically dominated by a system that settles payments between participating banks. However, alternatives, mainly regional in focus, are starting to appear, increasingly able to offer lower costs than the dominant system.

### 1.4.1. SWIFT and International Transactions

In modern, integrated world markets, international payments account for considerable transactional volume. As the value of gross international payments flows exceeds world GDP, and this is expected to remain the case, an efficient, integrated international payments system is as essential for the continued smooth operation of these markets, as it is for their domestic counterparts. The messaging service links banks around the world in a secure fashion to facilitate the exchange of messages detailing requests to debit or credit particular accounts for specified amounts, say in ten days, gross of swap payments and at an agreed date reference price.

Other than the compulsory use of protocols and codes in messaging its transactions, it does not participate in the clearing or settlement of payments between accounts, nor does it guarantee the payments it facilitates. Furthermore, in summary form, it cannot provide record of clearance or settlement through a particular account with a central bank, which can only be done for individual transactions by the banks at the start and end of each payment. It provides these services at a marginal cost close to zero. For international payments incorporated into larger transaction flows, and provided there are no sanctions on particular jurisdictions or banks, the low servicing costs relative to account management benefits available from netting payments through one or two correspondent banks, or groups of correspondent banks facilitate international integration. As a result, an estimated 220 million of transactions are coded, cleared, and settled using the messaging system for transactions accounting for around 104 trillion of payments in 2011, accounting for over two-thirds of total cross-border payments value.

### 1.4.2. Regional Payment Networks

Along with applicable regulations, regional payment networks simplify international payment processing and reduce transaction costs. With dedicated transaction networks, they also reduce risks associated with international transfers with effects facilitated through large, global payment networks. Regional payment networks promote financial integration and greater currency use among countries within designated regions. Member countries mutually establish rules that enable more efficient, lower-cost settlement of trade and other transactions.

Bilateral trade and investment partnerships between two countries are the basis for many regional payment networks. Countries that share a long border often wish to facilitate trade and investment flows along it and establish payment networks in their national currencies. In the 1970s, Argentina and Brazil joined financial networks that permitted the settlement of selected trade transactions in one another's national currencies. Shortly thereafter, other South American countries, primarily Chile and Uruguay, established similar payroll and trade arrangements in their own currencies.

The European Payments Union was an early example of a multilateral payment network. It established rules and procedures to facilitate trade among member countries. Bilateral payment offsets were established to facilitate settlement of the net balances among member countries. Trade normalization among members was made possible through temporary arrangements to finance deficits. The advent of the euro ended the EPU and transformed intra-European payments. However, intra-European payment activity among countries not adopting the euro-multilateral and bilateral payment networks-remain active, particularly in connection with trade activities.

### 1.4.3. Central Bank Digital Currencies (CBDCs)

CBDCs are an innovation constructed by countries across the world to diversify and modernize current payment systems. They are designed as secure digital currencies that can be utilized for everyday transactions. The functions of a CBDC align closely with those of banknotes or coins, satisfying roles as a unit of account, a store of value and a medium of exchange. Like notes or coins, CBDCs are a direct liability of the central bank and do not involve credit or liquidity risk. The main attributes of CBDCs include token or account-based access in a retail or wholesale format, the use of convenient digital wallets and real-time access via the Internet, amongst other additional possibilities. Furthermore, CBDCs differ from private stablecoins in some important respects: they are generally longer-lasting, do not carry credit risk and can help central banks enforce monetary policy. They also help prevent disruptions from deposit shifts to private stablecoins, help reduce illicit use of payment systems, cannot create more debt in the economy, can offer central banks important data on market needs and allow banks to focus on credit creation.

CBDCs are a product of the convergence of technological innovation, globalization and shifts in consumer, industry and capital market preferences. By using the collective digital tools developed in the modern economy, these five forces are creating a new digital financial infrastructure in which CBDCs will play a substantial role for retail transactions, while carrying out important services for wholesale financial transactions. Aside from a few countries that have launched pilot programs for retail CBDCs, many more countries are focused on the implications of the adoption of a retail CBDC for their economies and financial systems. Substantial progress on this policy agenda is likely in the upcoming two years, as many central banks expect to commence pilot programs. Central banks are also focused on the risks that the adoption of CBDCs could pose to financial markets, given that at present, financial markets are currently served by interbank payment services operated by private firms.

## 1.5. Regulatory Environment and Compliance

Creating a digital financial infrastructure that works for everyone requires implementing regulatory policies that do not represent a barrier to entering an innovative global payment ecosystem. Different jurisdictions take different approaches to regulatory environments. Some are permissive, while others expect compliance with a complex set of requirements. It is essential to understand the risk environment not only because non-compliance can lead to severe consequences, but also because a failure to meet the specific regulatory needs of a jurisdiction may prevent a service from being used by consumers in that jurisdiction. The digital finance community continues to push for

global interoperability concerning global payment systems and financial infrastructure more broadly.

Notably, there are several important global regulatory organizations whose purview extends beyond existing legislation. For example, an intergovernmental organization develops policies to combat money laundering and terrorist financing and reviews the compliance of its member countries. Importantly, while the recommendations developed by this organization are not legally binding, member countries are expected to implement laws and regulations based on those recommendations to the organization's standards. In addition, an intergovernmental organization dedicated to fostering economic progress and world trade has developed data protection initiatives, review standards, and a code of conduct for the protection of privacy and transborder flows of personal data.

Both remittance services and the banking system are subject to AML requirements, which can vary considerably between jurisdictions. This generally involves implementation of Know Your Customer (KYC) policies and transaction monitoring procedures to detect suspicious behavior. AML compliance and enforcement has become significantly more complicated for the digital finance sector given the nature of cryptocurrencies and the fact that cryptocurrency users cannot be reliably identified. Cryptocurrency services in several jurisdictions are required to follow a set of regulations concerning KYC and transaction monitoring. However, because of the perceived risk of anonymity associated with cryptocurrency wallets, some companies have opted to forego the cryptocurrency sector altogether.

### 1.5.1. Global Regulatory Bodies

Since the launch of cryptocurrencies and blockchain technology, a number of initiatives have sought to regulate this new industry from establishing taxation laws on digital asset income, taxation of digital assets, to blockchain and cryptocurrency-related businesses. A wide range of regulations that cover the entire market, from ICO issues to taxation of digital assets, are set to come into play around the globe.

In this paragraph, we will discuss some of the organizations involved in the process of digital economy regulations. The G20 is a collective body representing a large part of the global population, which meetings have put pressure on governments to implement regulations that improve the robustness of digital finance and prevent possible mishaps that could affect the digital economy and, more importantly, the traditional financial market. The International Organization of Securities Commissions was created after the Global Finance Crisis with the mission to protect investors from shocks to the financial system that could arise from dishonest individuals. As for the Banking industry, the Basel Committee on Banking Supervision is an organization created by the G10 that

comprises representatives from the central banks and supervisory authorities of 28 countries, including the European Union.

Another committee that has functioned as a collector of rules and treaties regulating the Digital Economy is the Financial Action Task Force, which was created after the Global Terrorism crisis to impose laws and regulations that act as safeguards against cyber terrorism. Additionally, organizations such as the Financial Stability Board of the G20, which promotes the stability of the global financial system, and the International Monetary Fund are also looking into Digital Economy operations in an effort to avoid a repeat of the Global Financial Crisis collapse from bad asset management.

### 1.5.2. Anti-Money Laundering (AML) Policies

Money laundering enables criminals to conceal illicit money, earning enormous profits from their criminal enterprises. Civil society and political leaders in all nations, especially in the United States and Europe, benefit greatly when the countries in which these crimes are committed and the countries in which the extraterritorial financial transactions occur coordinate their efforts to prohibit and prevent money laundering. No country wants to be the venue for foreign criminals to deposit and transfer money to conceal their criminal efforts or to return laundered funds to their headquarters. To limit the ability of criminals to launder money for their criminal enterprises from locations outside their home country, especially to deposit and transfer funds from their criminal enterprises to pockets in their home country, the United States has implemented a regime of legislation, regulations, and enforcement tools.

After the September 11 attacks, the United States increased its anti-money laundering investment. On October 26, 2001, Congress enacted the USA PATRIOT Act, expanding the sanctions regime created by the Bank Secrecy Act and the Money Laundering Control Act of 1986. Specifically, new legislation added reporting requirements for banks and other financial institutions to prevent and detect money laundering. Banks must file Suspicious Activity Reports (SARs) for a variety of suspicious transactions involving possible money laundering and terrorist financing. In addition to currency transaction reports (CTRs) for currency transactions over $10,000, banks must report all transactions involving the transfer of foreign checks and deposit accounts performed remotely. They must also implement customer due diligence procedures aimed to obstruct bad actors, especially foreign criminals, from using the bank's services to launder money.

### 1.5.3. Data Protection Regulations

While providing clarity, understanding, and insight into how regulators oversee their markets, compliance with regulations also has the potential to stifle innovation by creating barriers to entry. Technological advancement creates new possibilities for systems to share consumer data and other sensitive information. Yet, exploration of those advancements—the very innovations that will define the coming decades—could be shackled if the wrong policy decisions are made regarding data access and protection. Bad regulation at this stage could mean thousands of lost opportunities to create better tools and resources to keep both individual and market confidence high. The United States, European Union, and United Kingdom are effectively leading the way in digital finance regulation provision. While any system of regulation could leave huge loopholes for bad actors to find and exploit, the present goal is to create regulation that, instead of stifling innovation, enables the creation of products and services that will take FinTech to the next level, providing services to businesses and empowering consumers with greater choice and autonomy over their funds. Consequently, both public sector stakeholders and regulation-minded private sector players are collaborating to create a robust framework to address the opportunities ahead and help lift the burdens of compliance associated with those regulations. Additionally, the US, EU, and UK are aligning toward the common goal of addressing responsible use cases of data in digital finance. They seek to not just streamline compliance but also educate all players on the value of compliance to the system at large.

## 1.6. Digital Finance Infrastructure

Infrastructures for digital finance are focused primarily on digital payment capabilities that often include authentication and fraud prevention. Digital finance infrastructure is critical because it connects digital financial activity in the real economy to a central bank's balance sheet. The structure and policies that govern these infrastructures influence user access, competition, and efficiency — sometimes determining whether or not an integrated global economy is a reality. The early phases of digital finance with email, first-generation Internet and mobile payments emphasized user experience and social connections, but ultimately hand-off to bank balance sheets that provided finality and legitimacy. Newer digital payment systems emphasized new forms of private-sector risk-taking, replacing an intermediary with atomic settlement, combined with the convenience of existing digital payment infrastructures with digital wallets tied to bank accounts. As these systems have developed, an underlying theme is the group dynamics and security from double spending derived from centralization and collaboration.

Digital finance boasts a variety of firms that specialize in providing backend support for payment processing. Payment gateways handle the transfer of data between payment

processors and the front-end payment channels, usually a merchant's website or mobile app. Merchants send transaction data via the gateway for approval, the gateway encrypts the data, and sends it to the payment processor, enabling rapid processing of transactions from anywhere in the world utilizing the internet. Payment processors, with the aid of underwriting banks known as sponsors, are the infrastructure service providers that manage the handling of transactions. To authorize the transaction, payment processors connect to credit card and debit card network infrastructures. In some cases, the payment processor is both the gateway and the processor, creating an all-in-one solution for transaction processing.

### 1.6.1. Payment Gateways and Processors

Payment gateways and payment processing software become the de facto middlemen in the digital payment lifecycle. Their services are crucial in establishing the electronic connection between retailers' and payment cardholders' banks through either the payment card networks or alternative bank transfer directives in the case of ACH. Creating the technology to ensure that funds flow from merchant accounts to consumers' accounts securely, efficiently, and cost-effectively is a highly specialized niche within the fintech industry. A select number of firms have captured the majority of market share using addressable market-building scale and technological product evolution. Any discussion of fintech would know them well.

Adding new features that facilitate commercial acceptance of digital payment technology is common. For example, large merchants preferred to keep complicated databases of customer card profiles to manage subscription billing for digital services. Payment gateways needed to evolve to include profiles and key management. Increased market forces to avoid fraud and bank chargebacks required highlights in security features for customers. The transition from brick-and-mortar to online shopping created the need for touch-less point of sale solutions, which also needed to be incorporated into payment gateway features. As the volumes and dollar values of card-not-present transactions increased exponentially, chargebacks related to customer fraud became a significant disincentive for retail banks to provide card-based services to merchants. This facilitated the growth of chargeback management startups that offered small and mid-sized merchants sophisticated tools to assess consumer performance against merchant rules and to file the requisite documentation to banks to win against baseless chargebacks.

### 1.6.2. Security and Fraud Prevention

In the first few years of the e-commerce boom, a major point of skepticism among customers was security. Credit card fraud is often too easy in a card-not-present transaction. For a CNP payment, the merchant does not have any additional identification of the user; the only sources of verification are the address provided by the customer and the credit card data. Many aspiring e-commerce businesses quickly learned that it was important to have as few customers who had their packages shipped to a different address than the billing address on the card used. Because this was considered the largest user of fraudulent transactions, many merchants required their customers to sign up for a service that enabled verification of the address using a simple check.

It was also common for merchants to call the customer and check to ensure that the transaction being placed was legitimate. As with many things in life and business, the more secure the checkout process, the more friction is added for the user, and friction often equates to lost sales. This meant that, more often than not, the payment processor absorbed the credit card fraud associated with a transaction. While many merchants eventually began to realize that they indeed had liability for the fraud, they viewed it as simply a cost of doing business, and they were reluctant to add the friction associated with improving the underlying security because it would likely lead to fewer sales. The increasing incidents of attacks led various authorities to regulate security in the online payment space.

### 1.6.3. User Experience in Digital Payments

The unprecedented growth of online shopping has rippled through its associated economies of delivery and logistics, spreading shopper expectation and habits. The emergence of alternative payment mechanisms which allowed for one-click transactions has created a user preference for simple, rapid digital payments. Acceptance of credit cards and in a latter stage debit cards on ecommerce platforms has paved the way for transaction solutions providers who allow customer websites to offer user-friendly, secure digital payment options. From a retailer perspective, any friction in the UX will mean lower conversion rates, either because customers will abandon their transactions or demand other payment options. Retailers risk incursions by competitors offering ease in the transaction process. Payment facilitators have evolved towards user-centric solutions. “In-office” payment terms have disappeared in postmortem auctions to attorneys and accountants. The ubiquitous presence of mobile phones has made access to each individual constant, even during events and news which used to be off-limits to discussions in one’s pocket. No one is offline in the new digital landscape. This merging of – along with the massive growth in efficiency and lowered costs of transfer between parties across a payment system, fintechs have had to remain on their toes. Digital

wallets and mobile payments have sped seamlessly into new efficiencies, improving the UX for all parties. User families have learned to onboard their children in digital payment systems and wallets so that they can make occasional purchases. Resale platforms have created a whole new multigenerational user base for online sales and resale of everything – including apparel, electronics, and collectibles. The slightest friction in a UX has the potential of either preventing a purchase or leading to abandonment of an ongoing transaction or sale.

### 1.7. Emerging Trends in Digital Finance

The emergence of numerous new innovative financial technologies are transforming the digital finance ecosystem. A multitude of fintech innovations using new technologies, notably blockchain, machine learning and artificial intelligence, promise to disrupt existing players in digital finance, expand the dimensions of the digital finance ecosystem and increase access to financial services to the unbanked and underbanked. Specifically, new fintech innovations are transforming the very nature of retail and commercial banking through next-generation digital banking, removing intermediaries in debt and equity finance mechanisms and offering innovative solutions to wealth and asset management.

Specifically, fintech innovations are redefining retail banking through next-generation, cloud-based, digital-only banks with banking-as-a-service platforms and marketplaces; enabling e-KYC and Open Banking; transforming payments through digital wallets and payment gateways; expanding the financial inclusion mandate to the unbanked and underbanked through alternative services like BNPL, remittances, micro-lending and cashless payments; redefining the borrowing and investing experience through P2P lending and equity crowdfunding platforms; disrupting wealth management with robo-advisors; democratizing wealth management and investing through fractional ownership and tokenization; offering simplified insurance purchasing and underwriting solutions through Insurtechs; improving compliance through Regtech; enhancing capital market offerings through decentralized finance; revolutionizing business operations through Invoicing and BNPL Payments; and reshaping the crypto ecosystem through OCOs, Digital Custodians, Crypto Lending Platforms and Crypto Exchanges. Global investment in fintechs reached $173 billion in 2022. Innovations in fintech combine the genius of best-in-class functional services and infrastructure with the ambition to deliver an unparalleled customer experience.

Peer-to-Peer lending gained initial popularity in the aftermath of the Bankruptcy of Lehman Brothers when the world was still ravaged by the Financial Crisis. Default rates on consumer loans at banks were rising steadily but demand for unsecured consumer loans was growing as banks tightened lending standards. Banks were living up to the

reputation of being the liquidity drainers in a crisis. Given the exorbitant interest rates charged by credit card companies to consumer borrowers, a small group of internet entrepreneurs decided to create a more efficient and less expensive market mechanism leveraging the power of the internet to connect consumers in need to willing lenders. Since then, there has been a proliferation of P2P lending platforms that allow consumers to post loan requests stating how much they want and for how long at what interest rate. The loan request is then assigned a risk rating, same as with consumer loans originated by banks.

### 1.7.1. Fintech Innovations

Data and analytical methods that manage big data at scale are perhaps the most often discussed innovation areas in the Fintech space, and sometimes they are listed more generally as one of the three Ts: Technology. When analyzing financial transactions, and looking for investment or other trading opportunities, sophisticated pattern recognition algorithms that rely on artificial intelligence, machine learning, or deep learning techniques can add incredibly useful tools to our quiver. But today's tools cannot replace human judgment in portfolio management or trading, because when things go wrong, it is humans who are going to enter the financial War Room and take action. The end effect of the big data revolutions and the advanced data analysis techniques is that we, the financial services firms and banks, will, in the future, have a much more intimate understanding of consumers and businesses with a much better ability to serve them. Rather than creative new products or services, financial services companies will be obsessed with understanding the uses, wants, fears, or dreams of customers and designing services around this empathy. We will know our customers as they are known in other industries.

Cloud computing is not only a prophetic statement of a senior executive at a major technology company, nor just what the Internet of Things, but also a very powerful and revolutionary shift in how we use technology and building on the openness of the Internet and broadband networks that causes financial services companies to be much more focused on operational improvements and efficiency than their IT systems. In fact, it is the bloodline of the IT revolution in financial services, perhaps more central than other trends; and it applies more powerfully to some areas of financial services than to others. On the one hand, companies in the securities business have virtually no capital expenditure in technology and are already using cloud services.

### 1.7.2. Peer-to-Peer Lending Platforms

Peer-to-peer (P2P) lending platforms represent the burgeoning digital finance space's initial foray into lending via the digital infrastructure. Traditional banks have centered lending on their exclusive portfolios, inviting developers to create marketplaces for allowing individuals and or businesses to borrow money directly from other individuals. The distinctive feature of these P2P lending platforms is the tech firm's role as just an intermediary connecting lender and borrower approved by its proprietary rating system. Large numbers of borrowers have been attracted to P2P platforms by their relatively low transaction costs compared to banks, as well as lower rates and shorter maturities than typically available from informal lenders.

P2P lending standouts largely facilitate short-term consumer loans owing to online demand. The banks prefer pledging the higher-cost, long-term mortgages to their branches, creating a niche for P2P lenders offering better conditions for their less creditworthy customers. In practice, P2P's relative advantage is in securing lower rates for less-risky consumer borrowers, with their debts typically paid off in 12 to 36 months. Defaults are not uncommon, owing to the absence of collateral. The P2P space has drawn considerable venture capital funding, and P2P lending growth rates have been nevertheless impressive, at 150 percent annually since its inception, making it one of the fastest-yielding asset classes.

The dominance in this arena is noteworthy, with about 37 percent market share. Expansion abroad has come through acquisitions. P2P lending thus offers tantalizing opportunities to deal in credit default swaps, but misses on not diversifying from the loan area, subprime lending having produced the heftiest defaults. If treated as a credit risk-management strategy, P2P lending thus has considerable niche appeal.

### 1.7.3. Robo-Advisors in Wealth Management

The emergence of robo-advisory services has had a profound influence on the wealth management industry. Although the first robo-advisors appeared in 2008, it was not until the following decade that such services garnered significant interest and began to proliferate. The investment services provided by these robo-advisors have flourished due to three principal factors: reduced barriers to investing provided by low trading commissions and no minimum investment thresholds; cost savings from the lower management fees associated with passive index fund investing; and strong investment performances in the years following the financial crisis. The utilization of algorithms and artificial intelligence to reconstruct a portfolio, perform tax loss harvesting, and monitor investment performance on a rapid, 24/7 basis has further accelerated the popularity of these platforms. Robo-advisors in the financial services industry remain

focused on providing broad-based investment management services. By automating routine portfolio management and exploiting technology to control transaction costs, many of the larger robo-advisory companies are maintaining expenses that are substantially lower than those on traditional wealth management platforms. Such research suggests that providing investment management services at lower costs has resulted in younger, first-time investors selecting robo-advisors to manage their portfolios. While COVID-19 did have a negative impact on many traditional wealth management firms, the opposite was true in the case of robo-advisors who experienced a surge in new customers in the wake of the pandemic. In fact, while traditional wealth managers were slowing or halting recruitment hires at their firms, leading robo-advisors were ramping up their hiring to keep pace with the demand for their services. The increasing demand for low-fee investment strategies has propelled automated investment management services into the spotlight. Robo-advisory services have expanded the investment landscape, leading to the rise of a new online advisory category. While its primary target was initially the millennial cohort, robo-advisors are diversifying their offerings so as to make them appealing to other investor age and wealth demographics. Indeed, the services provided by robo-advisors have become sophisticated enough that they are now extending automated investment management services to high-net-worth investors, family offices, and even pensions, endowments, and foundations. Thus, it is without surprise that the wealth management market is expected to capture the impact that robo-advisors have had on the financial services industry.

### 1.8. Impact of Global Events on Payment Systems

Humans, and societies, have always faced unexpected events that marked a before and after in their lives and in the structure of economies. In some cases, these events have been wars, others, famines, and still others, diseases that have ravaged whole societies. Such events usually have a long-lasting impact, which, as in the case of wars, modifies the existing structure and leads us to a postwar period, which suggests an order that emerges from that disorder. The pandemic was one more of those unplanned events that deeply marked the evolution of daily life, affecting millions of people around the world. Everything changed, from how we connect and travel to how we study, enjoy entertainment, and carry out financial transactions. One of the most relevant areas of change was that of financial transactions, especially considering the speed of adoption of alternatives to cash. It would mean a landmark in the evolution of payment systems if we were able to compare, unfortunately in time, the pattern of adoption of cashless alternatives to the impact of the pandemic.

However, sometimes, the change of state is not necessarily due to a disease that alters the very structure of society, but rather, as was the case of September 11 in New York,

it has to do with human actions that go against humanity itself. This event altered, among many other aspects, the whole structure of international security and, as a consequence, the way we travel and move around the world. The measures adopted not only modified how long it takes for a flight to be carried out, but in many cases, they also meant the end of a trip, of a vacation, of a work life, of a family reunion. This essay proposes to analyze whether such events affect how transactions are carried out and whether they leave changes that are permanent over time. Have we learned from the events, or do we go back to the previous patterns once they have faded? Is the post-event order different from the disorder that preceded it?

### 1.8.1. COVID-19 Pandemic Effects

The COVID-19 pandemic had significant effects on global digital finance infrastructure. The pandemic's spread and related physical distancing measures influenced people's access to settlement infrastructures directly. Those notoriously checking paper settlement payment and settlement statements, bank clerks or similar, plus the usual

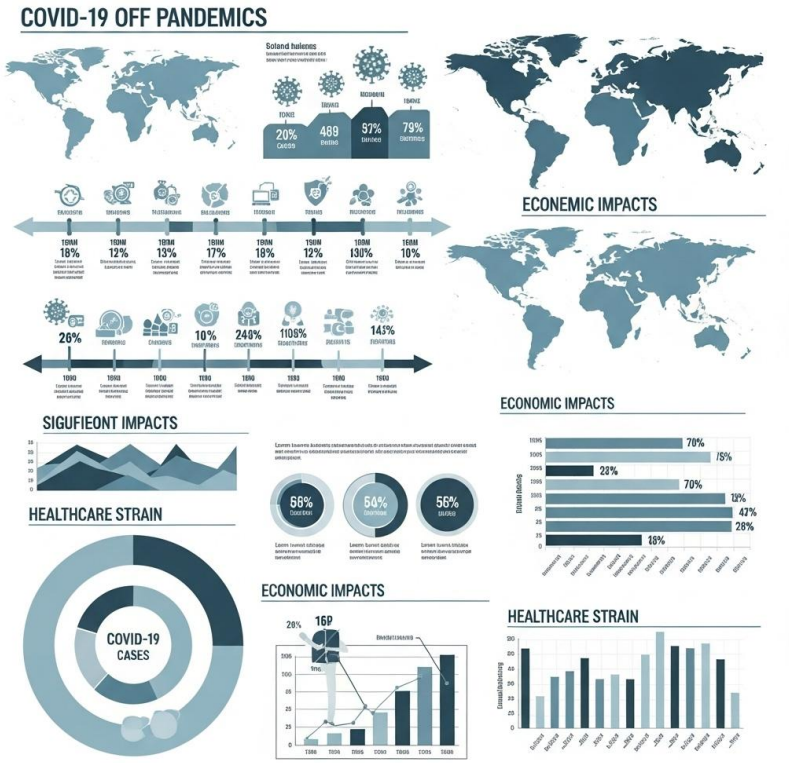


**Fig :** Visual summary of COVID-19 pandemic effects, including timeline, spread, and socioeconomic impacts.

paper physical flow, were halted, leading quickly to rapid pressure for acceleration of somewhat to virtualized alternative payment infrastructures in real time. Settlement activity shifted during the pandemic from banks to the electronic payment networks, perhaps because of greater difficulties for businesses to borrow during the pandemic. The relative mix of various electronic payment systems shifted. The pandemic surge for electronic commerce, plus the virtual alternative to in-person charitable donations, taxed the existing automated clearing house with fast payment systems and forced the initially previously planned launch date of the real-time payment systems to be hastened to handle existing current demand.

The pandemic, in initially occurring phases, measurably lessened bank branch transactions. Graduated branches in areas or countries deemed low pandemic transmission risk gradually reopened. The next-found wave in pandemic transmission risk forced closures in some countries, tapering down from those previously in demand. Post-pandemic, especially in the United States and Canada, debit card transactions reached new volumes, while traditional in-person check and cash transactions have returned to prior value comparatives at a much slower rate. The pandemic pushed automating a lot more transactions into electronic goods, typically via commercial websites, partly necessitated by government-ordered physical distancing mandates but by consumer choice partly now fuelling the growth in additional demand for cashless transaction methods after last observing major crisis.

### 1.8.2. Geopolitical Influences

The last century has seen the emergence and shift of global powers guiding the economic, financial, and technological development of the world towards distinct objectives and principles. While in the late 20th Century, the post-WWII agreements led many countries into a unipolar world dominated by the US and its allies. After the collapse of the Soviet Union and the opening of China's economy allowing it to join the world's trading, financial, and technological fabric, the geopolitical confrontation started a historical shift with multi-polar ramifications. While aiming to exploit the benefits of a single global market, these multi-polar powers are led by opposing philosophies, either promoting a democratic free-market approach or a centralized authoritarian model.

Global power politics affect payment and digital finance systems. Questions about the traceability of transactions incentivized adopting a new private currency with high levels of anonymity and privacy, stability, and democratizing access to finance and payments: Bitcoin. Initially embraced by libertarians and the anti-system, its appeal has widened as it has preserved its anti-inflation value alongside criticism of traditional finance. Against inflationary monetary policies around the world, demands to have easier and lower-cost access to global payments increased, especially in inflation-wrecked emerging markets.

If at first, Bitcoin was only an alternative to speculation with hedge characteristics, it has become a needed alternative to central-bank digital currencies and other fiat currencies, a sort of crypto-Gold renaissance.

### 1.8.3. Economic Crises and Recovery

Shifts in global payment dynamics are often propelled by economic crises leading to increased innovation and further development of the financial infrastructure. For example, significant changes in payment mechanisms along with the collapse of the gold standard further strengthened payment systems based on fiat currencies. During the Great Depression of 1929, special measures imposed restrictions on consumers to hold cash as a preventive measure, yet innovated the payment mechanism development globally. An invention of a Central Bank Settlement Coin gave rise to the accelerating development of digital currencies during the pandemic. Notably, economies in recovery from crises have cited future innovation in and investments conceptualizing consumer trust as further payment innovation catalysts.

The original economic crisis of the Great Depression along with stagnant recessions in the 1970s jolted the Federal Reserve Board to further innovate the development of the world's most important payment system. Economic crises worldwide have seemingly acted as a tailwind against backward development of the global payment system further propelling the strength of the digital payments infrastructure. Development of the payment system infrastructure brought employment, productivity, and economic growth that aided recovery from economic crises which led to further payment system infrastructure development. Losses of confidence in the existing payment systems after a crisis have further catalyzed steps for a more efficient and well-distributed payment system like the work of Reserve Banks to modernize check payments, the work of the Treasury, Central Banks, and the World Bank to encourage remittances or payment systems to avoid capital flight from fragile economies after an economic crisis.

## 1.9. Future Directions in Payment Systems

America's economic and financial infrastructure has always been the envy of the world. From an efficient payment system allowing round-the-clock and near-instant exchanges to one of the most innovative banking sectors leveraging the efficiencies created by the payments system and enormous pools of savings, the American financial system has long been the key not only to the United States' economic success and expansion, but to the success of many other economies around the world. But the American payments system is being challenged on several fronts. It has always been an area of innovation, with the next "better idea" just around the corner. But what comes next? How will these

infrastructure changes shape the future of payments and other shaped sectors? The text looks at some of those challenges facing America's economic infrastructure, listing three specific areas of growth and efficient future payments infrastructure involving artificial intelligence and machine learning in payments, the growing role of big data in payment systems, and the importance of sustainability in financial systems of the future and the role of finance in overall sustainable economic growth. The reason for these choices is simple. Artificial intelligence is quickly changing the technological landscape, as it affects everything we do and think. And big data and sustainability are specific areas of focus from the government and key areas of research focus going forward. These focus areas will likely provide the foundation for research foundations looking into the future of our economic, payment, and banking infrastructure. Whether it be initiatives or government and academic partnerships focusing on the use of technology in creating a more sustainable society, enhanced use of technology has become a global initiative, one that the United States is positioned to lead.

### 1.9.1. AI and Machine Learning in Payments

Artificial intelligence (AI) is used to supplement human judgment by clustering, matching, recognizing patterns, or mining large amounts of data to enhance human intelligence and automate repetitive tasks. Its application will supplement and automate processes across all aspects of payments, from back-end functions like fraud detection, customer service, risk management, compliance, cybersecurity, and anti-money laundering (AML) to front-end functions such as customer onboarding, marketing, and user experience design. AI and machine learning (ML) power the prediction algorithms that predict how, when, and what a customer will buy next, enhancing UX/UI and product design in payments.

AI is being applied to expand the scope and speed of helping companies comply with regulations on AML, know your customer (KYC), payment card industry (PCI) standards, watch lists, policies, transaction record-keeping requirements, electronic funds transfer security requirements, and data protection rules. AML compliance typically requires large teams of employees reviewing millions of transactions over lengthy, manual processes, and AI is being used to screen large amounts of data in the first steps of processing these transactions. The infrastructure is a scalable, automated process that deploys AI-powered models to help prioritize cases requiring human-level investigation under the guidance of an AML expert. AI models flag transactions performed by a business for further review if corroborative evidence is not identified, reducing the need for human resources on the project. AI can also be used to improve KYC in customer onboarding. The traditional way has been slow and tedious, requiring

manually screening hundreds of lists and reviewing substantial amounts of data collected during the onboarding process and over the customer's life.

### 1.9.2. The Role of Big Data

Analytically supported decisions are crucial to the smooth running of any company. Thus, the gathering and analysis of data are now considered an integral part of a company's core business and are widely used to enhance its marketing effectiveness, optimize its operations, increase efficiency and reduce costs. Big data and optimal comorbidity prediction can provide the financial services industry with opportunity and cost improvements. Yet the value of valuable data cannot be disregarded. Using massive datasets of financial approval or denial behavior is one way to develop robust predictive models. Another result involves the use of unsegmented ordinary course transaction flow data by a transactional bank. Such data is used to fine-tune behaviors and alter merchant pricing. The analysis of digital transactions also makes it possible to identify more subtle factors driving payments growth.

Before the era of big data model risk was narrowly defined: a model was used as a glass-bottomed vessel to navigate through obscure waters. Such a crude mechanism was bound to fail, as models would be outdated or irrelevant due to structural changes that produce radical shifts in the behavior of both data and the parameters of models. The concentration of model risk in the one or two models that an institution has to use at any branch is bad enough. It is always best to have different models tailored to specific groups of customers, transactions, markets, or branches. Models should only give guidance to human bankers, and fit within a comprehensive portfolio management framework; only rarely are data discipline and full automation found in the decisions actually implemented by banks. Still, interpretable machine learning is advancing agnostically, and simplifying model space might yet be achievable for tasks involving large data, particularly with regard to the requirements of pre-qualification.

### 1.9.3. Sustainability in Digital Finance

Digital finance and payment systems will have to face the increasing demands of the international community in favor of sustainable development. Economic and financial activity are responsible for a large part of carbon emissions and the aim is to achieve net-zero emissions by 2050. In this context, the financial industry will play an important role by monitoring the activities aiming to reduce carbon footprints, financing green projects with long-term views, and establishing the adequate incentive schemes. However, the transition of the planet to a zero-carbon economy is an enormous undertaking that will

require funding of around $100tn by 2050, and cannot be done through traditional ways. Digital finance can provide a cost-effective and fast way for these financings.

Digital finance has huge potential to help fund the transition to sustainable development in several ways. Digital finance can channel funds to green projects by allowing a broader base of eligible investors for climate-related investment opportunities. Digital finance can underpin initiatives aimed at decarbonizing the economy, while creating the real-time data to inform, assure, and enable productive investment at scale. Sustainable green and social issues are currently a dynamic segment of global capital markets. Digital finance can design and implement front-to-back solutions for issuing, activating, and managing 'impact' products. Digital finance can also provide remote participation, access to deep pools of demand, and cost-efficient pricing for investors.

## 1.10. Conclusion

The material presented requests for conclusions. Clearly, central bank digital currencies constitute a totally new infrastructure. Focusing upon any efficiency, access or consumer welfare justification will tell you that interoperability will need to be inbuilt and designed in. If done right, one could expect this standard technological layer to hold out new and efficient avenues of finance in most countries. Countries and regions that they put their faith in will benefit from economics of specialization, of sales, of low cost through greater knowledge across the value and trade networks that are assembled. The differentiation with banks is the monetary side of the banks intermediation activities, shifting the risk of bank intermediation back to private actors – and distinguishing between lending and savings products, beyond money. Why would one do this? Money and payment services are public services of any economy, and yet: at the moment they are still being provided at cost by the social networks. Many observers consider that the efficiency on the means of payment guarantees their neutrality in the transfer of values – but we are left with no control upon quality, size or speed of their evolutions. The development of the ultimate layer of the digital economy should help us equip citizens with tools of better equality and prevention of insularity – just as the past centuries were punctuated by workers creating tools of historical initiative that led the way as seminal discussions on some who dared ask for access to money as monopolies of the richest were discussed. This is the real question for the CBDC world: not whether they will happen – but in what conditions and who will design and decide how they will work.

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