MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
KYIV NATIONAL ECONOMIC UNIVERSITY
NAMED AFTER VADYM HETMAN

Faculty of International Economics and Management
Department of International Economics

BACHELOR DEGREE PROGRAM	**"INTERNATIONAL ECONOMICS"**
FIELD OF KNOWLEDGE	**05 Social and behavioural sciences**
MAJOR	**051 "Economics"**

Form of education: *full-time*

BACHELOR

***Title* "Cashless payments in the global payment system"**

by Polina Kamenchuk

(Signature)

Academic Supervisor Doctor of Economics, Professor of the Department of International Economics
_____*Tsymbal L.*
(Signature) (Name, Surname)

Bachelor Thesis has been approved for defense at Attestation Examination Commission (EC)

Head of the Department of International Economics Dr.of science, Professor
_____Y. Stoliarchuk
(Signature)

KYIV 2025

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LIST OF ABREVIATIONS

ACH – Automated Clearing House

ATM – Automated Teller Machine

BIS – Bank for International Settlements

CBDC – Central Bank Digital Currency

ECB – European Central Bank

EMV – Europay, MasterCard, Visa

e-commerce – electronic commerce

e-money – electronic money

IDP – Internally Displaced Person

IMF – International Monetary Fund

ISO – International Organization for Standardization

KYC policy – Know Your Customer policy

MICR – Magnetic Ink Character Recognition

NBU – National Bank of Ukraine

NFC – Near Field Communication

NGO – Non-Governmental Organization

OECD – Organization for Economic Cooperation and Development

PIN – Personal Identification Number

POS – Point of Sale

PSP – Payment Service Provider

Riksbank – the central bank of Sweden

SEK – Swedish Krona

SEP – System of Electronic Payments

INTRODUCTION

The topic of the bachelor's thesis is devoted to cashless transactions in the global payment system and covers theoretical foundations, historical development, classification, current trends and their factors, future prospects, cases of the most successful low-cash economies, as well as an analysis of the state, prospects and problems of Ukraine in this context.

Due to continuous innovations in financial technologies, including blockchain and digital platforms, the cashless economy is undergoing extremely dynamic changes. Effective management of these trends requires a deep understanding of their underlying fundamentals. In Ukraine, which is actively developing digital services – from the state-owned Diia to mobile banks such as Monobank – cashless payments are becoming increasingly important. The support of the National Bank of Ukraine, including the hryvnia pilot project, creates favourable conditions for the introduction of new non-cash instruments. A cashless economy helps to increase financial inclusion, fight the shadow economy, and strengthen economic resilience, which is especially important in the post-war recovery.

Modern studies of the cashless economy generally focus on several key areas. In particular, World Bank, Deloitte, Raya J. M. and Vargas C., Worldpay analyse in detail the trends of declining cash turnover, globalisation of payments, and the growth of P2P transfers, emphasising the role of transparent banking and open APIs in improving the efficiency of payment services [1; 2; 3; 4; 5]. At the level of international institutions, the Bank for International Settlements monitors cashless transaction statistics in its annual report, outlining the opportunities and risks of digitalising the payment infrastructure [6; 7; 8]. The IMF, in its working papers, pays special attention to electronic money and e-banking as tools for financial inclusion, analysing their structure, necessary reforms, and the introduction of digital currencies by central banks in different countries using a comparative approach [9; 10; 11]. The Organisation for Economic Co-operation and Development explores current trends in digital payments, e-commerce, and digitalisation of financial services, while emphasising the importance of preserving cash in circulation to avoid financial exclusion of vulnerable groups of society [12; 13; 14]. The European

Central Bank, in its research on the future of money and financial infrastructure, among other things, focuses on reducing the cost of transactions and developing digital financial instruments, explores the possibilities of innovative payment systems, and actively promotes the concept of the digital euro as an integral part of the future European financial infrastructure [15; 16; 17; 18]. As for central bank digital currencies, this topic has gained considerable popularity both in the global academic community and in the institutional environment [19; 20; 21; 22; 23; 24; 25]. Most studies focus on the benefits of CBDCs: strengthening central banks' monetary policy, expanding financial inclusion for the unbanked, reducing transaction costs, stimulating innovation, and expanding financial market opportunities. At the same time, recent research has drawn attention to potential side effects, including the risk of disintermediation of the banking sector. At the same time, Ukrainian scholars are thoroughly researching the evolution of payment systems and current trends in the domestic context [26; 27; 28]. However, less attention is paid to comparative analysis of international experience and a detailed study of the impact of non-cash instruments on post-war economic recovery in the context of Ukraine. Thus, despite a significant body of theoretical and practical work, there is a lack of a comprehensive comparative overview of global cashless economy models with an in-depth analysis of their applicability in Ukraine – this is the gap that this bachelor's thesis aims to fill.

The research purpose is to identify key areas for optimising non-cash transactions in Ukraine's national payment system to support its post-war reconstruction and enhance its financial stability.

Research objectives:

1. To systematise the theoretical foundations and current trends of the global cashless economy.

2. Analyse the experience of countries with a high level of “cashlessness” and identify the factors of their success.

3. To assess the current state, prospects, and challenges of cashless payments in Ukraine.

4. To identify the benefits and risks of introducing cashless instruments in the context of post-war reconstruction.

5. To develop recommendations for improving the infrastructure and practices of cashless payments in Ukraine.

The object of the study is the process of global transformation of the payment system towards a low-cash (cashless) economy, including historical background, development of theoretical concepts, technological innovations, and institutional changes.

The subject of this study is the system of modern non-cash payment instruments and key trends in their implementation – from the decline in cash turnover and the growth of P2P transfers to open banking and central bank digital currencies – as well as statistical indicators, challenges and prospects for their adaptation and optimisation globally (based on the example of leading countries, including Sweden) and in the national payment system of Ukraine.

The following methodological background has been used to achieve the aim of the study. Historical, logical, and qualitative analysis of the literature for different periods allowed us to build a chronological timeline of key technological innovations and identify the stages of payment system development. The method of concept construction and classification analysis based on various sources was applied, which helped to identify and systematise the terminological differences between cashless, electronic and digital payments, as well as to form a clear classification of payment instruments. The collection and aggregation of indicators from international and national sources was accompanied by the construction of graphs, tables, and correlation matrices using RStudio and Excel. This made it possible to confirm the growth trends in the share of non-cash transactions and to identify the relationship between digitalisation indices and the level of "cashlessness" in the economies of different countries. A case study of Sweden and an analysis of Riksbank reports and academic publications provided a deep understanding of the factors behind the successful transformation of a low-cash economy. Based on the analysis of international practices, the researchers have developed a schematic model of a possible CBDC architecture that reflects the interaction between the central bank, payment institutions, and users. A case study of Ukraine, including a review of official

publications of the NBU and other government agencies, as well as an analysis of domestic statistics, allowed us to assess the current state of cashless payments in Ukraine, identify key challenges, and potential areas for improvement.

The theoretical and methodological significance of this work includes the generalisation and codification of definitions of non-cash, electronic and digital payments, unifying the terminology of domestic and international literature and creating a basis for further research in this area. In addition, the developed classification of payment instruments and the conceptual model of different CBDC architectures can be used as a methodological framework for analysing and comparing innovations in different countries. The results of the statistical analysis showed that in Ukraine, the share of non-cash transactions reached 94.6% by number in 2024 and 64.5% by value. This indicates that the payment infrastructure is ready for further digitalisation. An analysis of the leading cases of transformation to a cashless economy, as well as an assessment of the benefits and challenges along the way, can lay the groundwork for further research and practical modelling of pilot projects and scenarios on cashless transaction methods, innovative payment infrastructure, and CBDCs.

Structure of the study. The paper consists of a list of abreviations, an introduction, two main chapters, conclusions, list of references. The first section examines the evolution of cashless payments and conceptualises key terms. The second section begins with an empirical analysis of global trends in cashless transactions, followed by a comparative clustering of countries and case study of Sweden. A separate paragraph is devoted to an assessment of the current state, challenges and prospects of cashless payments in Ukraine. The conclusions summarise the key findings of the study and formulate practical recommendations for improving the national payment system.

CHAPTER 1. THEORETICAL FOUNDATIONS OF CASHLESS TRANSACTIONS FOR INDIVIDUALS

1.1. Evolution and technological advancements in digital payments

Cashless transactions have a long and impressive history. They have evolved over time, dating back to ancient times and the early Middle Ages, marking an important period of paper cheques and clearing-house settlements in the 17th century and transforming into modern smartphone-based wallets, cryptocurrencies, and CBDCs. In the 21st century, they have become super-technological, instant payment solutions that allow you to transfer funds between cities, countries, and even continents in seconds (Fig. 1.1).

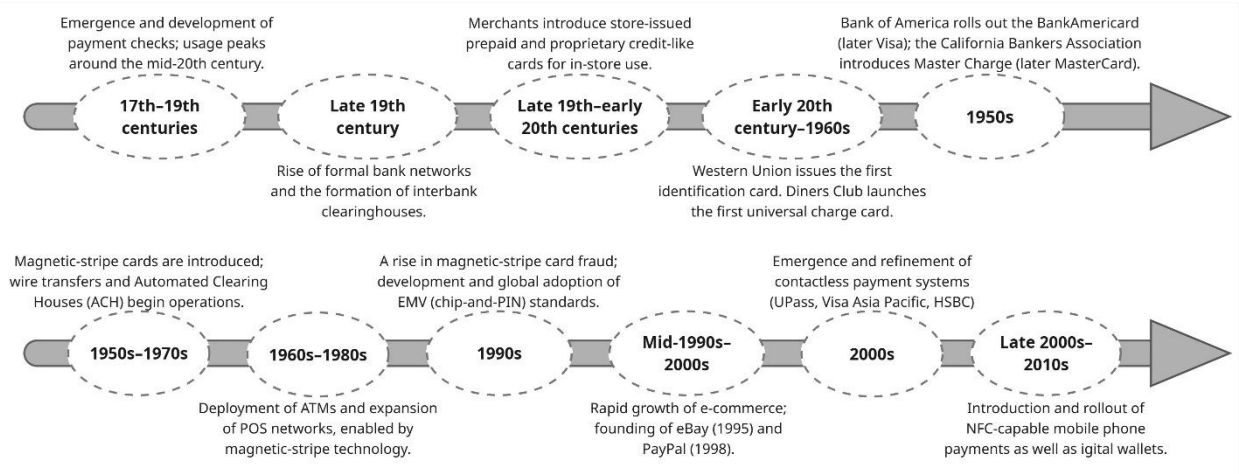


Figure 1.1 – Milestones in cashless payment evolution

Source: Compiled by the author based on sources [27; 29 to 58]

The first tool for cashless payments was paper orders to banks, which were written by hand. Such orders were intended to facilitate long-distance trade. One of the reasons for the idea of documents that we now know as cheques was the difficulty of transporting cash in trade. Coins made of precious metals (gold and silver) were heavy, inconvenient to carry, and attracted robbers. This created a need for safer ways to make payments, which led to the emergence of cheques. In the 17th and 18th centuries, it was English

banks that pioneered the use of pre-printed forms – standardised documents intended for non-cash payments and transfers between accounts [29; 30; 31]. At the same time, in the 17th and 19th centuries, banks in Europe began to network based on geographical location and existing trade and financial ties. This led to the emergence of the central clearing of bank transactions, which reduced the transaction costs of processing cheques, as there was no need to transport large volumes of paper over such long distances, and also accelerated the processing of cheques [29; 30; 32].

The British brought the idea to their colonies, in particular to America, which later became a leading centre for the development of cheque payments. Banking there was developing rapidly due to significant trade volumes. It was during this period that standardised pre-printed cheque forms and a cross-checking mechanism appeared in England and America, which increased the reliability and security of cheque payments [27; 29; 32; 33].

In the 19th century, the cheque processing infrastructure began to take shape. Interbank networks and clearing houses were rapidly developing. Initially, these were informal arrangements, but later they evolved into formal institutions that handled the exchange of cheques and balance sheets. With the development of transport and communications, cheques became easier and faster to deliver. In the 20th century, the use of cheques peaked. By the mid-twentieth century, cheques were widely used in business, the public sector, and among private consumers [29; 30; 32; 33].

In the late 19th and early 20th centuries, the first prototypes of modern payment cards began to appear. In some department stores, store owners issued special tokens for their regular, loyal customers [30; 33]. These tokens contained information about the customer and were linked to their account. The customer could make a purchase by presenting the token, and the amount was recorded in his account–payment could be made later. These were the so-called ‘store-issued cards’–tools that worked exclusively within one store [33; 34; 35]. Later, at the beginning of the 20th century, oil companies and large retail chains began to use similar cards for customer identification. They were valid only within a specific network [27; 30; 34].

In 1914, Western Union issued the first paper card that had the function of identifying the user and linking telegraph messages to his or her account [30; 33; 36]. In 1950, Diners Club launched the first universal card that worked in a restaurant chain. The user was authorised with the card and received an invoice for all of their payments at the end of the month [27; 34]. In 1958, American Express issued its first plastic card, which worked on the same principle – you buy during the month and pay once at the end [27; 36]. In 1959, Bank of America introduced the BankAmericard (latter Visa), the first true credit card that allowed purchases in many places. In 1966, a banking co-operative in California created Master Charge (later MasterCard) as a competitor to BankAmericard. Unlike previous tools, Master Charge and BankAmericard were the first universal means of payment accepted in a variety of stores and services [30; 36].

In the 1960s and 70s, the first ATMs began to appear. Barclays Bank installed the world's first ATM in London (1967), followed by Chemical Bank's ATM in New York (1969). [31]. The mechanisms allowed users to withdraw cash and make transfers even outside of bank hours. The first ATMs used paper cheques and cards equipped with magnetic strips. Most of the early ATMs were available for use exclusively by customers of the bank in question. In the next ten to twenty years, the first joint ATMs appeared, where consumers could use another bank's ATM to withdraw funds from their accounts, and the allowed transaction soups gradually increased with improved security [37; 38]. Shared networks not only reduced per-transaction costs through economies of scale but also became strategic tools for branches to gain local market share [18].

With the invention of MICR in the 1950s and 1960s, magnetic stripe was introduced to cards, allowing for automated payment processing and making card verification faster, safer and more affordable for small merchants. The first prototype of a magnetic stripe was developed in the 1960s by an American inventor. In the 1960s and 1970s, magnetic strips were standardised and widely adopted [27; 33; 39; 40; 41]. By 1971, the International Organisation for Standardisation (ISO) adopted these stripe specifications as ISO 7811, ensuring that cards and readers from different vendors and countries were compatible-paving the way for global card payment networks. It was thanks to magnetic strips on cards that a significant breakthrough was achieved, as in the 1970s and 1980s,

this invention served as the basis for the development of national and international ATM and point-of-sale (POS) networks, enabling real-time transaction processing and centralised clearing rather than batch reconciliation of vouchers [33; 36]. The use of mag-stripe cards peaked in the 1990s, and the technology's low cost and ease of deployment sustained its dominance into the early 2000s [35; 36]. However, magnetic ink recognition technology was not very reliable, and static data storage made cards vulnerable to skimming and counterfeiting. For this reason, in the late 1980s and 1990s, fraud concerns prompted research into more secure technologies such as smart chips (EMV) and eventually contactless NFC solutions. Historically, credit and debit cards only used a magnetic stripe to manage cardholder data. The cardholder would then sign a receipt at purchase. This system did not provide a high level of security. In the 1990s, some solutions to the problem of card transaction security began to emerge. However, none of the solutions were successful because they were not widely used, and if a particular payment instrument was accepted locally, but not on a mass scale, the installation of the necessary infrastructure would be too expensive, which is why certain innovations failed [39; 40; 41; 42; 43; 46].

By the 1990s, ATMs had proliferated worldwide, with newer machines offering services beyond cash withdrawal, such as deposits, fund transfers, and bill payments [45].

Already in the 1960s, German engineers Helmut Gröttrup and Jürgen Dethloff first came up with the idea of chip-based payment using MOS memory chips for secure data storage. In the 1980s, chip-based systems appeared in France and Germany. However, they lacked at least a global distribution to be successful. The breakthrough came when in 1993, Europay, Mastercard, and Visa agreed to develop a common global standard for chip-based payment cards to combat escalating magnetic-stripe fraud. Throughout the 90s, EMV issued several releases of these standards, each time with additional security improvements. The EMV Chip Specifications detailed requirements for interface requirements, security, application, and terminal interactions. EMV also developed and managed a certification system. One of the most important innovations from EMV was that Point-of-sale terminals that meet EMV standards typically require the cardholder to use a personal identification number (PIN) instead of a signature, as was the case with

magnetic stripe cards. Thanks to this, EMV has managed to overcome about 70% of counterfeit card fraud cases over the past decade. In the late 1990s – 2000s, EMV was founded by EMVCo, which was later joined by such global payment systems as China UnionPay, Discover and others [30; 43; 46].

In the 21st century, ATMs have become integral to the broader "Fintech 2.0" wave, complementing digital banking channels and further extending services such as bill payment and cash recycling [45; 46].

The next important step in the development of payment systems was the emergence of contactless payments. This innovation was first used in South Korea, when a public transport provider launched the UPass for commuter fares programme-using simple RFID technology to speed up boarding and reduce cash handling [47]. The initial EMV-compliant contactless payment systems emerged in 2003 when Mastercard initiated a trial of PayPass, which utilized the same chip technology and transaction processing methods but relied on radio-frequency communication instead of a direct contact interface, allowing users to simply tap their cards instead of swiping [46; 48]. Two years later, HSBC began issuing debit cards with PayPass technology, which helped spread this innovation among users [49]. In 2004, Visa Asia Pacific introduced its payWave contactless cards. Users could simply wave their cards over the terminal, allowing for a transaction in less than 500 milliseconds without requiring PINs if the amounts were below established local thresholds [50].

Back in 2002, Sony and a company called NXP Semiconductors invented a new technology called near field communication, which allowed the use of radio waves to read information from one device and transmit this data to another. This NFC technology was and is used not only for payments, as one might mistakenly believe, but also for transferring messages, text, images, music, files and other kinds of information. In 2004, major mobile phone companies such as Nokia, Sony and Philips embraced the idea of integrating NFC into their production to improve security and usability. A few years later, Mastercard and Visa built NFC technology into their payment systems, enabling data to be transferred from a device, i.e. a card, to a terminal [47; 51; 52; 53].

Initially, contactless payment cards were used mainly to pay for public transport and in fast food outlets due to the small amounts of payments [47]. The leading countries were Japan, the United Kingdom, France, and later the United States of America. Gradually, with the improvement of technology and security in the 2000s, the number of available payments with NFC contactless payment cards increased, and the technology itself began to be used in other service areas. In particular, its use spread to POS systems. In the 2000s, wearable devices began to appear, with chips embedded in them that worked based on NFC technology and allowed for payment [34; 53]. In 2007, Nokia in collaboration with Visa launched the first phone that allowed users to pay for purchases using a mobile device. Payment was made via a SIM card or other chips, without the need for physical contact with a terminal [52; 54]. In the 2010s, the first digital wallets appeared Already in 2011, Google launched Google Wallet and Android Pay, electronic wallets that allow for real-time contactless payments not using bank cards but via smartphones. In 2014, Apple announced the launch of Apple Pay, and in 2016, Google Pay and Samsung Pay appeared [55; 56; 57]. This is how contactless payments moved to the level of mobile phones and eventually transformed into the modern forms we use today.

Another important cornerstone in the development of cashless payments has been the widespread use of the Internet. In fact, as the Internet becomes more accessible to ordinary users, faster and cheaper, it gradually leads to the emergence of e-commerce. In America, an e-commerce platform called eBay was launched. Initially, payments were made by cheques or postal orders. This inconvenience led to the emergence of an innovative company called Confinity, which was later renamed to the world-famous PayPal. The company worked on digital payment solutions for both consumers and businesses. It created the world's first digital payment platform. The partnership with the US-based eBay was a turning point: it provided a significant increase in the number of users for both PayPal and eBay due to the convenience and speed of payments. In the 2000s, PayPal expanded rapidly, entering new markets outside the US. The company began to provide not only payment services for goods and services, but also P2P transfers, deferred payments, etc. Thus, PayPal has become one of the pioneers and drivers of electronic payments on a global scale [58].

Cashless payments have evolved from handwritten bank orders and 17th-century cheques – with the advent of centralized clearing houses to avoid hauling heavy coins – to 20th-century automation via MICR and ACH systems. Mid-century saw the rise of charge and credit cards, followed in the 1960s–70s by magnetic-stripe cards powering global ATM and POS networks. Late-20th-century fraud concerns drove the EMV chip standard and PIN-based authentication, setting the stage for secure, contactless NFC payments in the early 2000s. Meanwhile, the Internet and e-commerce spawned digital wallets and platforms like PayPal, Google Wallet, and Apple Pay, which enabled instant consumer and P2P transactions worldwide. Today, real-time cross-border solutions and CBDCs represent the latest frontier, reflecting an ongoing trajectory toward faster, more secure, and universally accessible digital payment services.

1.2. Definition and classification of cashless payments

In day-to-day life, we are constantly faced with transactions and payments, both in our everyday routine and in the business environment. They can be both mundane (e.g., buying groceries) and large-scale, covering international investment, trade between countries, lending, etc. A payment can be defined as an obligation of one of the parties to transfer a certain value, often money or its equivalent, from their possession to the possession of another party. The party that transfers funds is called the payer, and the party that receives them is called the payee or beneficiary. Funds are transferred between participants through specialised channels that form the payment system. (Developed by the author based on the definitions in Table 1.1). At the same time, a transaction is a broader and more complex concept. It involves any economic action that results in a change in the parties' financial positions. In other words, a transaction includes a payment as one of its components, but also covers the transfer of ownership of certain goods (goods, services, capital, labour, etc.) from one party to another.

Table 1.1 – Glossary of Payment and Transaction Definitions

Definition	Source
Payment	
"In a strict sense, a payment is a transfer of funds which discharges an obligation on the part of a payer vis-à-vis a payee. However, in a technical or statistical sense, it is often used as a synonym for 'transfer order'. Transfer order is an order or message requesting the transfer of assets (e.g. funds, securities, other financial instruments or commodities) from the debtor to the creditor."	European Central Bank [59]
"Payments are the transfer of funds between parties via established payment systems – mechanisms that settle transactions in goods, services, and financial obligations. This paper emphasizes that payment systems, whether cash or non-cash based, are critical for monetary policy and financial stability."	Scientific article [60]
"Payment is the voluntary transfer of money, equivalent, or other valuable items from one person to another in exchange for goods or services received or to meet a legal obligation. The person who gives the money is often called the payer, while the person who gets the money is called the payee."	News article [61]
"Payment is the transfer of money, goods, or services in exchange for goods and services in acceptable proportions that have been previously agreed upon by all parties involved. A payment can be made in the form of services exchanged, cash, check, wire transfer, credit card, debit card, or cryptocurrencies."	Encyclopaedia [62]
"Payment is the performance of an obligation to pay money. A person under such an obligation is called a debtor, and a person to whom the obligation is owed is called a creditor. The obligation may arise in various ways, but it is most commonly the result of a commercial transaction or contract between the parties."	Dictionary [63]
Transaction	
"An economic flow that reflects the creation, transformation, exchange, transfer or extinction of economic value and involves changes in ownership of goods and/or financial assets, the provision of services, or the provision of labour and capital"	European Central Bank [59]
"A transaction could be a payment or a funding or a defunding, or a reservation or a combination of the previous (e.g., a payment that requires a defunding)."	European Central Bank [64]

In modern economic systems, all payments are conventionally divided into cash and non-cash payments depending on the form of means of payment used. Cash refers to physical money, such as banknotes and coins, which are used to pay for goods and services. At the same time, there are non-cash transactions, i.e. all other forms of payment that do not involve the physical movement of money.

Although the definition of cash and non-cash payments is quite simple, it has gradually changed and acquired new meanings as new technologies and innovations have emerged. At the beginning of the history of cashless payments, paper cheques were considered to be paper-based payments that were transmitted and processed in paper form. Later, with the introduction of magnetic strips and ACH, cashless payments remained paper-based in nature, but the exchange of information was automated, eliminating the need to transport cash between banks.

In the 1980s and 1990s, the focus of the literature shifted to the development of payment cards, first with magnetic strips and later with embedded chips [65]. During this period, electronic money transfer systems were hailed and their potential to transform payment flows was predicted. The 1990s also saw the emergence of ATMs and electronic banking, which expanded the concept of cashless payments. By the turn of the 2000s, cheques were losing their relevance, except in the United States, as various types of cards, electronic banking and e-commerce gained popularity. Thanks to the spread of the Internet and e-commerce, more and more attention was paid to contactless payments via NFC and new payment devices. It was at this time that the concepts of "electronic money" and "electronic banking" were established in the official terminology [66].

In the 2010s, cashless payments became a common extension of banking services: cards, electronic transfers and mobile payments dominated. Paper cheques were increasingly rarely counted in ECB statistics, and in 2016 the BIS made a clearer distinction between cash and non-cash transactions [15; 66].

At the same time, "cashless payments" were increasingly being equated with "electronic payments", as most transactions were already being carried out via digital media. Since 2008, with the creation of Bitcoin [67], the literature has been actively discussing cryptocurrencies – their benefits, risks and prospects. The 2010s also saw the emergence of mobile wallets (Apple Pay, Google Pay, etc.) [68] and various wearable devices for contactless payments. In the fintech discourse of the 2020s, the focus is on CBDCs, new payment providers and services, and inclusion and security in digital payments. A non-cash payment, unlike a cash payment, is a transfer of a certain amount of funds between the parties that is made without the physical use of cash (Table 1.2).

Table 1.2 – cashless payment perceptions across decades

Decade	Document source	Cashless payments concept
1970s	Scientific article [66]	This article describes how socialist countries used a "law on cashless payments" to take full control over the financial markets, marking an early use of the term "cashless payments" in official analysis.
1980s	BIS [65]	Studies early adoption of automated data-processing in clearing/settlement across G10 countries. Highlights new electronic funds transfer techniques and banking automation beginning to replace purely paper-based cashless payments.
2000s	IMF [9]	Defines e-money as "any electronic payment media carrying stored value". Emphasizes that "credit cards, bank account deposits, and even truncated cheques qualify as e-money, distinguishing e-banking innovations from traditional banking".
2000s	OECD [14]	Surveys internet payment methods, explicitly including "electronic money" (e.g. prepaid cards, e-wallets) alongside credit/debit cards and online banking. Recognizes e-money as a mainstream online payment instrument.
2010s	ECB [15]	Lists common cashless retail instruments (payment cards, credit transfers, direct debits, cheques) and discusses efforts like SEPA to harmonize them. Emphasizes reducing reliance on cash by promoting these electronic alternatives.
2010s	World Bank [1]	Differentiates "cash" vs. "cashless" instruments. Notes that electronic payment methods have "evolved as the preferred cashless instrument", whereas traditional cashless tools like cheques remain paper-based. Highlights mobile and digital payments as leading cashless trends.
2020s	ECB [16]	Introduces the digital euro (CBDC) as central bank money in digital form for retail payments. Frames it as a complement to cash, ensuring citizens have access to a secure, cash-like digital payment instrument.
2020s	IMF [69]	Distinguishes two digital payment innovations: (i) CBDCs (public digital currency) and (ii) private e-money (bank or fintech-issued electronic money). Treats both as "moneys" with fixed value, differing mainly in their redemption guarantees, signaling a shift in focus to digital-payment taxonomy.
2020s	OECD [19]	Observes that the declining role of cash "questions the future of money and payment infrastructure". Discusses stablecoins and CBDCs as emerging private/public digital currencies, marking a conceptual shift toward programmable, cross-border digital money.

There is a wide variety of non-cash payments that can be divided into two subgroups: digital payments and non-digital payments. Digital payments are a type of payment in which funds are transferred electronically, through digital channels or devices. Such payments may be partially, predominantly or entirely digital. They rely to some extent on

electronic or digital instruments, means of transfer and digital networks to enable transactions. These include, among others, bank transfers, mobile transactions, mobile banking, QR codes, various cards, etc. In turn, cashless non-digital payments are those forms of money transfers that, although they do not involve cash, also do not use digital technologies. They are typically processed manually or on the basis of paper documents, without the use of electronic channels. The most common example is paper cheques, which are still widely used, particularly in countries such as the United States. Such payments involve the physical creation, transmission, and processing of documents, which significantly reduces their efficiency compared to digital analogues.

Many sources automatically equate cashless payments with digital or electronic payments. This often leads to confusion between the terms cashless and digital payments, as the lines between them are sometimes blurred. Table 1.3 summarises the concepts of cashless and digital payments to compare the understanding of their meaning.

Table 1.3 – Comparative definitions of cashless, digital, and electronic payments

Cashless Payments	Digital Payments	E-Payments
Cashless transactions are the transfers of funds from payers' accounts to recipients' accounts, including transfers by payment service providers of cash deposits made by payers, to recipients' accounts [70].	Digital payments are all payments made without cash or cheques, processed through digital channels; credit transfers initiated on paper are included due to their small share and digital processing. CBDC payments are excluded [73].	E-payments refer to cash and associated transactions implemented using electronic means [82].
		An e-payment is a financial exchange that takes place online between the seller and the buyer [75].
Cashless transactions are payments executed by transferring funds from a payer's account to a creditor's account in banks without using banknotes [71].	The global digital payments market encompasses the electronic exchange of money and transactions conducted via digital channels and platforms, including mobile payments, online transfers, e-wallets, digital currencies, and other electronic payment systems [9].	E-payments are payments by electronic transfer of credit card details, direct credit, or other electronic means other than payment by cheque and cash [72].
		An e-payment is a retail payment practice where a merchant retrieves payment information for goods and services and places it in an electronic template for processing over the network [76].

A cashless payment is a transaction where physical cash is not exchanged, typically executed using cards, mobile wallets, or bank transfers [72].	Digital payments are the transfer of value from one payment account to another using a digital device or channel; this includes bank transfers, mobile money, QR codes, and payment instruments such as credit, debit, and prepaid cards [74].	An e-payment is a form of interconnections between organisations and individuals, aided by banks and inter-switch houses, that enables monetary exchange electronically [18].
	Digital payments are electronic monetary transactions that replace cash with secure, fast, and cost-effective digital channels, resulting from the integration of information and communications technology into payment systems [86].	An e-payment is any transfer of electronic value from a payer to a payee through an e-payment channel that allows customers to remotely access and manage their bank accounts and transactions over an electronic network [77].

At the same time, such terminological confusion may be justified in terms of actual practice. The most widespread payment instruments in the world today are those that are simultaneously cashless, digital and electronic. Other variants that do not meet all three criteria at once make up such a small share of the total volume of transactions that they can be considered a statistical error. Finally, the construction of a terminological apparatus is always a simplification of reality for research purposes. There is no universal division that would take into account all the nuances, and in academic practice, some deviations have to be ignored in order to preserve the integrity and usefulness of the analytical model.

Payments are the transfer of value that settles an obligation between a payer and a payee, whereas transactions encompass any economic action that alters parties' financial positions, with payments as one component. In modern systems, means of payment split into cash and non-cash methods, the latter further divided into non-digital and digital payments. Over time, paper-based transfers gave way to magnetic-stripe and chip cards, ATMs and online banking in the 1980s–2000s, followed by NFC, mobile wallets and cryptocurrencies in the 2010s–2020s, and most recently CBDCs. Cashless payments today are almost synonymous with digital or electronic methods, as purely manual non-digital forms have become negligible. This evolution reflects both technological innovation and the need to simplify terminology, even if some nuances are smoothed over for analytical clarity.

1.3. Key payment methods in modern economy

In order to make any payment, a complex system is needed where the banks serving the payer and the beneficiary can interact with each other. A set of such interactions is called payment systems, which are integral complexes of instruments, procedures, infrastructure elements, technical means, legal rules and intermediaries [45]. All these components ensure efficient, secure and reliable movement of funds between parties in financial transactions.

Financial transactions are conducted via payment systems. An analysis of this procedure reveals the following sequence. The payer commences a transaction by selecting a preferred payment method and employing a corresponding payment instrument. For instance, when a customer makes a payment at a POS, they present their payment card to the terminal. In the case of online transactions, a payment gateway captures and encrypts the payment data. This gateway serves as an intermediary linking the payer with the payment processor. The payment processor is the mechanism that facilitates communication between the issuing bank and the acquiring bank to authorize the transaction. The issuing bank verifies whether the payer possesses adequate funds or credit. Upon approval, it transmits an authorization back through the payment processor to the merchant. Once authorization is granted, the funds are moved from the payer's account to the merchant's account. This operation encompasses several phases. The initial phase is clearing: The payment processor relays the transaction information to the card network (e.g., Visa, Mastercard). Subsequently, settlement occurs, wherein the card network aids in the transfer of funds from the issuing bank to the acquiring bank. Essentially, this intermediary functions as a communicator, relaying to the issuing bank a directive to debit the payer's account and conveying a directive to the receiving bank to credit the payee's account [78; 79].

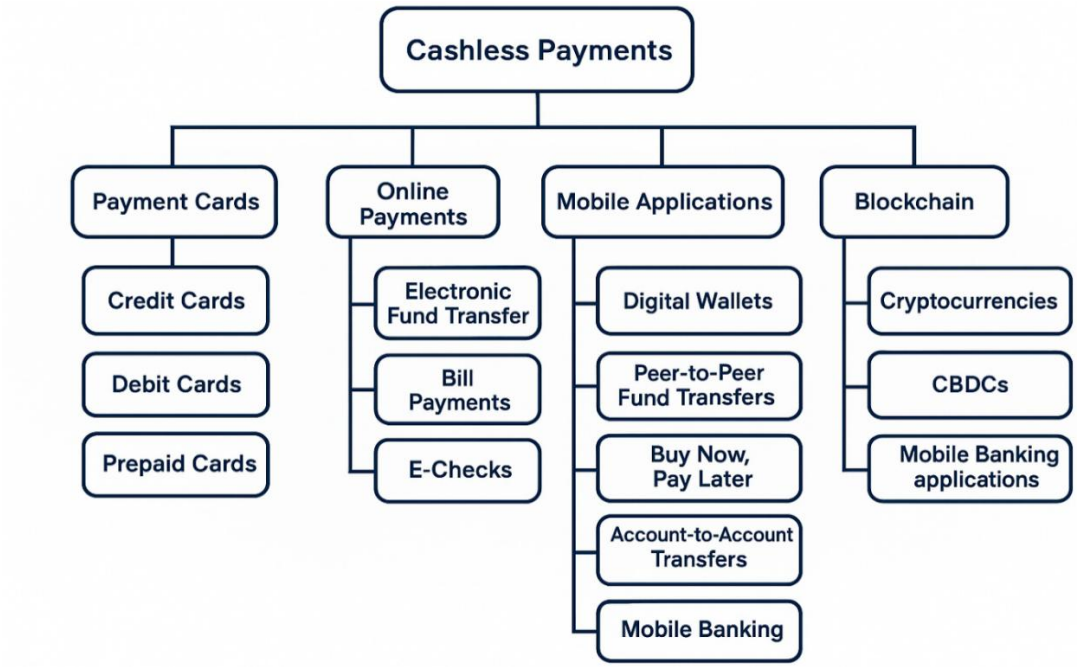


Figure 1.3. – Overview of cashless payment channels

Source: Compiled by the author based on sources [5; 80; 81; 82; 84; 85; 86]

Numerous payment methods are available for executing cashless transactions (Fig. 1.3). Cash is known to be a traditional payment method. Nowadays, the popularity of cash payments is gradually decreasing, although cash is still an important means of payment [80]. Cash also plays an important role in storing value, in particular for storing savings, even as digital alternatives grow [81]. It is important for consumers to always have the option of paying in cash, even if they use a card more often: they value the option to switch to cash whenever they need or want to. For example, according to the European Central Bank, in 2024, 62% of consumers said that the ability to pay in cash was critical to them [80]. According to research, cash is a common means of small payments. Cash is more popular in countries where there are fewer EFT terminals at points of sale [82]. There is also a correlation when the share of cash turnover in a country's GDP increases with the number of ATMs per capita [80].

Bank cards are the next most frequently used means of payment for transactions. Bank cards are generally divided into three main types: credit cards, debit cards and prepaid cards. This payment method has experienced significant growth in recent years due to modern technology. Payment cards account for 52% of all non-cash transactions in the European Union. Overall, the share of card payments is 45%. This means that it is

the dominant payment instrument among all payments. In stores, 55% of purchases are made by card, and in online payments, 48% of transactions are made by card [80].

Another extremely popular means of cashless payments is digital and online payments. These include digital wallets, which are mobile applications or online services that store customer payment information and allow payments to be made online. As of 2023, more than half of e-commerce payments were made using digital wallets, with the leading services being Apple Pay, Google Pay, PayPal, and others, depending on the region [83]. Bank cards and digital wallets dominate both POS and small-value transactions. POS transactions account for only 7% of total payments, while online payments account for 29% [80]. In addition, the largest share of online and digital wallet payments is among the 18–40-year-olds.

The share of digital payment instruments continues to grow, especially in terms of value. In 2024, bank transfers accounted for 22% of all non-cash transactions in the EU by number and 93% by value [80]. There is also a tendency for medium and large amounts of money to be transferred via bank transfers [82]. A2A (account-to-account) transfers and real-time payments. Account-to-account transfers, including traditional bank transfers and those emerging on instant-payment rails, constitute around 7% of global online payments with real-time processing [83; 84]. Payments via mobile apps or platforms or QR codes are also widely used, as well as online banking – through bank platforms and services that allow you to manage your finances online [84].

In the 2000s, a new financial instrument, cryptocurrencies, began to emerge, starting with the emergence of Bitcoin in 2008. However, cryptocurrencies cannot be considered a means of payment at present, as their use for payment is very limited, especially in Europe and in the case of payments at Point-of-Sale [85]. Thus, cryptocurrencies are used more as a means of storing savings in crypto wallets, P2P transfers, etc., rather than as a payment instrument [86]. Instead, central banks in various countries are now actively exploring the issue of digital currencies as a complement to cash – retail CBDCs – to keep up with current trends.

Although not a separate payment method or instrument, a group of payments known as fast payments can be identified (Table 1.4). These are payments that happen instantly,

taking only a few seconds, in real or near real time. They can also be made 24/7. Although such payments account for the largest share of transactions, they are quite small in terms of volume. In other words, as of 2023, fast payments accounted for about 80% of all transactions globally. However, in terms of volume, most payments are not made by fast payments, but by Batch Payments. Batch payments are useful when transactions take place at a certain fixed time – with a clear frequency and time interval. This is the case with payroll, social benefits, and tax payments. Also, cross-border payments are often batch payments, as it is necessary, firstly, to check compliance with compliance regulations, and secondly, to standardise the format (for example, through correspondent banks or SWIFT). Batch payments are also useful for large transactions involving significant amounts, as countries set limits by law, and large payments (real estate sales, B2B transactions) require thorough checks – anti-money laundering and counter-terrorist financing (AML/CFT) mechanisms – which take time.

Table 1.4 – Characteristics of Fast Payments and Non-Fast Payments

Feature	FPS (UK), SEPA Inst, Pix, UPI, RTP (US), IMPS	SEPA Core SCT, ACH (US), Bacs (UK), cheques, card settlements
Speed	Seconds (real time or near real time)	Hours to days (batch)
Availability	24×7×365	Business-hours/days only
Settlement	Real-time gross or deferred net with immediate payee availability	Deferred net batches (e.g., ACH windows, Bacs)

Source: Compiled by the author based on [5]

And the main feature is that, according to the BIS, in EMDEs, the growth of fast payments is many times faster than in economically developed countries (Fig. 1.4). Fast payments, both in terms of the number of transactions and the amount, are growing at both rates, but much faster in EMDEs. This is partly due to the convergence effect in the early stages of implementation: countries with low transaction volumes do not typically

have high limits on financial markets, as in high-income countries where payment volumes are much higher.

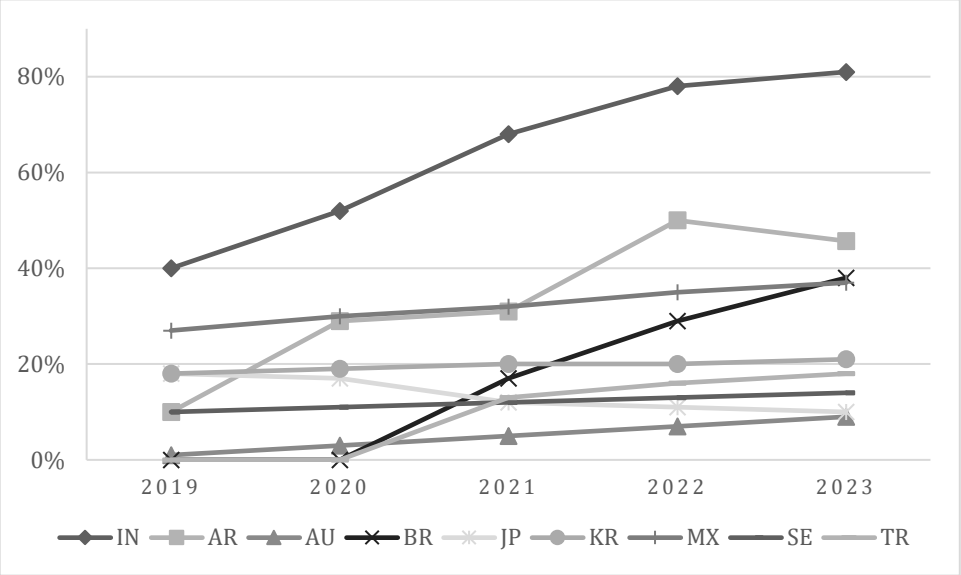


Figure 1.4 – Share of fast payments in the total cashless payment volume (applicable cashless cases only) [5]

A payment system in this section is defined as the complete set of instruments, procedures, infrastructure, legal rules and intermediaries that enables banks to interact and move funds securely. In practice, a payment follows a clear sequence: the payer selects a payment instrument (card, transfer, wallet, etc.), the gateway and processor authenticate and authorize the transaction, and then clearing and settlement – the transfer of funds via networks like Visa, SWIFT or ACH – finalizes the transfer. Nine broad payment methods are identified (e.g. debit/credit/prepaid cards, bank transfers, digital wallets, cryptocurrencies, mobile and contactless payments, online banking), each varying in reach, speed and user adoption; cash remains important for value storage and small payments despite declining overall use. Finally, payments can be classified by timing into “fast” (real-time, 24/7) and “non-fast” (batch-processed during business hours), with fast rails growing particularly rapidly in emerging economies, even though batch payments still handle the bulk of transaction value.

1.4 Trends shaping the future of cashless payments

Trends shaping the future of cashless payments vary by region and context. In some countries, such as Scandinavia and Sweden, cashless payment methods and payment systems are being actively promoted [20]. Due to the context, politics, lobbying, and socio-economic conditions, remittance users and recipients are very receptive to the idea of cashless payments. Almost three-quarters of payments in Sweden are made by cashless means. However, there are countries, such as Germany, where the transition to cashless payments is somewhat slower [22]. Despite this, some general trends in the global payment systems market can still be identified (Fig. 1.5). The most notable trend is the overall reduction in the use of cash in payments [5; 22; 73]. In particular, a significant jump in cashless payments occurred in 2020-2021 during COVID-19, when users preferred cashless payments due to health concerns [5; 13].

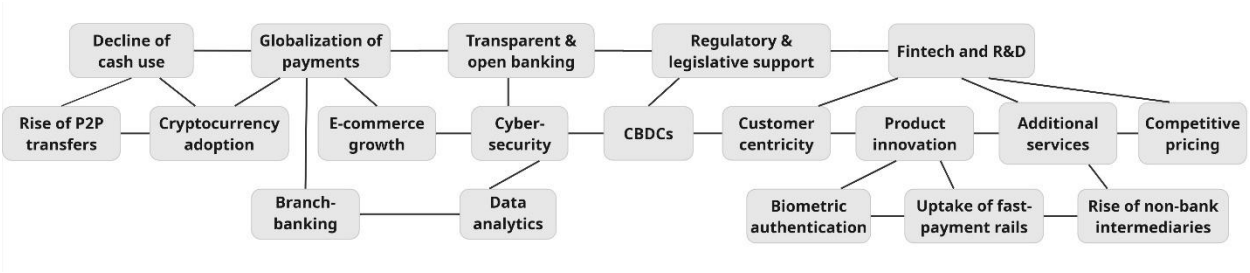


Figure 1.5 – Emerging trends in the cashless payments landscape[1]

Source: Developed by the author

As noted earlier, e-commerce has spurred the creation and rapid development of electronic payment platforms such as PayPal [27, 58]. And since e-commerce platforms by their very nature make cash payments virtually impossible, cashless payments are becoming increasingly popular as e-commerce grows. Also, the rapid growth of digital payments is highly correlated with the declining role of cash in payments, which may also be indicative of this: another confirmation of the digitalisation of payments is the fact that the decline in cash payments is highly correlated with the rapid growth of fast payments [2; 5], which are actively developing (Table 1.5).

[1] *Note: The connecting lines are used for visual grouping as well as basic interconnections only, and do not represent actual interconnections or causal relationships, which are considerably more complex.*

Table 1.5 – Volume of fast payment transactions, 2023

	Number of fast payment transactions, million	Total number of transactions, million	Fast payments as a share of total cashless transactions, %
Cashless payments, all	214,823	11,331,024	1.9
Credit transfers	197,046	20,232,722	1.0
Direct debits	182	306,730	0.1
Other payment instruments	416	1,670	24.9

Source: Author's calculations based on data [2; 5; 73].

According to the basic principles of market economics, companies need to constantly improve their products and come up with new inventions and innovations to stay afloat. And, along with technological inventions, this may be one of the reasons why financial service providers are creating more and more new products [13; 22]. First of all, this leads to customisation and an increased role of Customer Experience in financial services and financial technology. One component of this customisation is transparent banking, where users are effectively given control over their data and can consent to financial service providers sharing certain information with third parties. Through such third-party cooperation, a lot of integration is taking place – integration of the financial sector with various business models. Such cooperation allows for the adjustment and expansion of payment processes to meet the exact needs of customers. In particular, many collaborations are being born out of this, and payment services are no longer just providing payment services, but are also adding a range of additional services such as digital credit, deferred payments in instalments, which creates new opportunities for payment chains and financial institutions [27]. This also includes various collaborations with providers of various services and services, as well as the trend towards open and transparent banking.

Nowadays, a lot of emphasis is placed on customer experience. The focus on user experience is required because the payment services industry is a two-sided market, where the success of a new technology directly depends on the perception of both merchants and payers. This is because if merchants see that a certain payment innovation is popular among payers, then such technologies are likely to be adopted by merchants. In turn,

payers, seeing that this payment technology is supported by merchants as well as other payers, play an important role in choosing a payment instrument [13]. Thus, it works like a spiral: if people like something, it gains popularity, and when interest fades, the technology becomes a thing of the past [22].

Open and transparent banking helps to reduce the information gap between players providing services in the financial sector, which in turn helps to optimise costs, reduce production costs, and adjust the pricing policy of financial providers [22]. Accordingly, by optimising costs and changing pricing policies, this leads to efficiency, as all these financial payment services become more efficient and companies tend to offer lower and lower fees for their services to users [5; 27]. In addition, Visa and MasterCard note that they are investing heavily in the development of new cybersecurity and data analytics solutions based on Big Data. We are also living in an era of globalisation, where borders in financial services are being blurred, and the globalisation of payments is confirmed by the activities of Visa and MasterCard [27]. The need to constantly move, think of something new, and improve makes companies work hard on innovations, which leads to the rapid development of financial technologies with a high level of technical complexity [5; 20]. In particular, one of the latest innovations is biometric payment, where biometric data is used to authenticate the payer, speeding up the transaction process and adding layer of security. This is another level of verification, as payment security is a key aspect. An example of such a service is that in Ukraine, a lot of transactions are now carried out using face recognition. FacePay24, launched by PrivatBank in 2020, as well as Apple Pay and Google Pay, all use facial recognition [27].

Another trend is the growth of P2P transfers, and non-bank financial institutions are playing an increasingly important role in lending, investment and as payment intermediaries [27]. In fact, the trend is that the number of banks and their branches in some countries remains stable with minor fluctuations: emerging economies have seen a slight increase, while advanced economies have seen a slight decrease due to the decline in cash payments. In contrast, the number and diversity of non-banking institutions is growing rapidly, offering new formats and services.

Of course, all of these innovations cannot go unchecked by government and regulation. From time immemorial, new payment methods have been accompanied by appropriate legislative regulation [27]. Therefore, one of the trends is government support at the legislative level to protect both users and merchants, and to add an additional layer of security to funds and personal data [5].

Cryptocurrencies, in particular, were born in the 2000s as part of the effort to enhance user control over financial data, but they gained particular traction in the 2010s. In fact, cryptocurrencies are based on open banking, the main idea of which is that users control all flows, all information, and all processes. The processes taking place in one or another niche of the blockchain are clear to all users, at least to those who are familiar with the topic. That's why cryptocurrencies, especially in the 2010s, experienced a significant surge in popularity [22]. Many countries are now beginning to embrace the idea of digital, virtual currencies [27]. And in the 2020s, there is an active discussion of CBDCs – digital currencies of central banks [3; 22; 87]. So far, several countries have introduced limited use of central bank digital currencies. These countries include the Bahamas, Jamaica, and Nigeria. In addition, more than 140 countries have pilot projects of central bank digital currencies, including Ukraine. The Ukrainian pilot project 'E-Hryvnia' has been operating since 2018. In 2024, the second stage of the project's research took place. Other countries that have adopted the E-Hryvnia include the Eurozone, Sweden, Norway, Australia, Turkey, China, India, Japan, Korea, Hong Kong, and Singapore. About 60 other countries are in the process of developing or researching CBDCs [87].

Across regions, the shift away from cash is accelerating, Nordic countries lead with nearly 75 percent of payments now cashless, while others lag but, globally, we saw a pronounced jump in contactless and digital methods during the COVID-19 pandemic. E-commerce growth continues to drive electronic platforms (PayPal, digital wallets) and fast-payment rails (e.g. UPI, Pix, SEPA Inst), which now account for the vast majority of transaction counts even if batch transfers still carry most payment value. Financial services are increasingly customized around customer experience and data sharing: open banking APIs, "buy now, pay later" instalments, biometric authentication, and transparent

data-consent frameworks all aim to deepen user engagement and streamline checkout. Meanwhile, regulators and card networks are stepping up cybersecurity, privacy and AML/CFT safeguards, even as non-bank intermediaries and P2P providers expand their footprint, especially in emerging economies. Finally, blockchain-based currencies and CBDC pilots – e.g. Ukraine's E-Hryvnia – represent the cutting edge of digital-currency experimentation, with over 140 countries now exploring retail CBDCs.

CHAPTER 2. GLOBAL TRENDS IN CASHLESS TRANSACTIONS

2.1. The global shift towards a low-cash society: global statistics and key trends.

The so-called cashless society is being actively discussed in modern academic analytics. This is a society in which physical cash is not used, and all transactions are carried out through virtual and digital means. According to some definitions, physical cash loses its status as legal tender and unit of account. However, the concept of a fully cashless economy is still largely theoretical, so the term low-cash society is often used alongside it, meaning one in which the amount of physical cash is limited to a minimum comfortable level, but not eliminated completely.

Unfortunately, in modern academic practice, analytics and international organisations, there is no single approach to calculating non-cash payments – the methodologies vary significantly. There is also no single database covering information on most countries in the world. Important data can be obtained from regional, national or international organisations that collect information, but mostly only about their members. For example, the Bank for International Settlements provides detailed analysis and statistics, but it only covers information about its members – several dozen countries. The European Union also keeps statistics, and the European Central Bank publishes data on non-cash payments and transactions covering all EU countries. In addition, the ECB keeps separate statistics and publishes regular quarterly reports for Eurozone member countries. Of course, there are also data from national statistical services, central banks and government agencies, but the methodological problem lies in the significant differences in approaches and insufficient detail in the methodology. Many sources do not explain their data collection and processing methods in detail, which makes it difficult to compare and contrast different data sets. Without clear and high-quality comparability of methodologies, data from different sources become incompatible. Within the framework of this study, and in particular this paragraph, three main data sets will be used: 1. Data from members of the Bank for International Settlements, which includes

countries such as Argentina, Australia, Belgium, Brazil, Canada, Switzerland, Germany, Spain, France, Great Britain, Indonesia, India, Italy, Japan, Korea, Mexico, the Netherlands, Saudi Arabia, Sweden, Singapore, Turkey, the United States, and South Africa. russia is not included in this sample; 2. Data from the 27 member states of the European Union that are members as of May 2025; 3. Data from the Eurozone – 20 countries that are members as of May 2025, obtained from periodic reports of the ECB. During the analysis of each sample, it will be indicated which one is used to consider a specific aspect of global trends in cashless payments. At the same time, the study allows these three samples to be combined, as this provides a broader assessment of current global trends and transformations towards a cashless or low-cash society. Comparing these samples also makes sense because the Eurozone and European Union countries have similar levels of economic, political, and social development. Plus, the members of the Bank for International Settlements are mostly countries with medium to high levels of development. Of course, it's not totally fair to compare these samples, but it's the objective reality because of the limits of the available data.

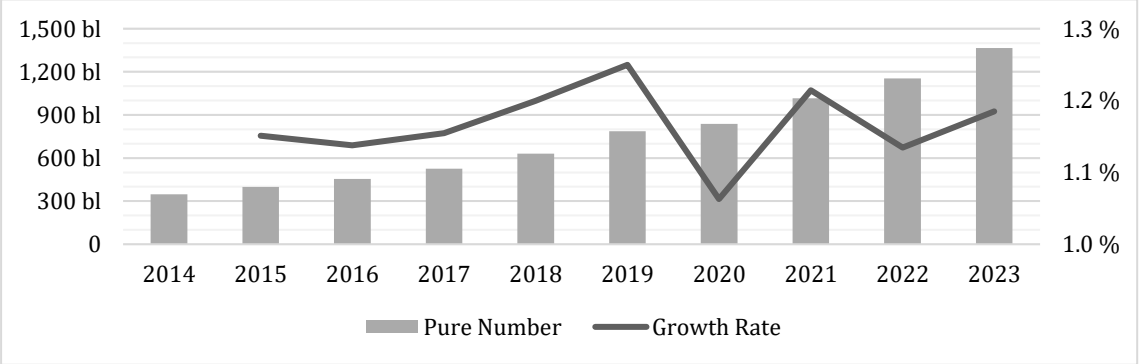


Figure 2.1. – Development of cashless payments in BIS members countries, 2014 – 2023
Source: Developed by the author based on data from [88].

This trend is observed not only in theoretical studies, academic circles, or NGOs, but is also confirmed by empirical data. Over the past ten years, the number of non-cash transactions has been growing steadily without a single period of decline (Fig. 2.1). In particular, between 2014 and 2020, the volume of such transactions grew from approximately 350 billion to 1,400 billion units, i.e. four times.

First of all, we can see that the decline in the use of cash is very rapid: one in four payments made in cash in 2016 went cashless by 2024. At the same time, payments by cards and mobile apps are growing proportionally: the share of cards almost doubled between 2016 and 2024, and the use of mobile payment apps tripled. As for the cost of transactions, the average price of cash payments at the point of sale is traditionally lower than the cost of card payments, so the total cost of non-cash transactions decreased by only 15% over the analysed ten-year period (Fig.2.2).

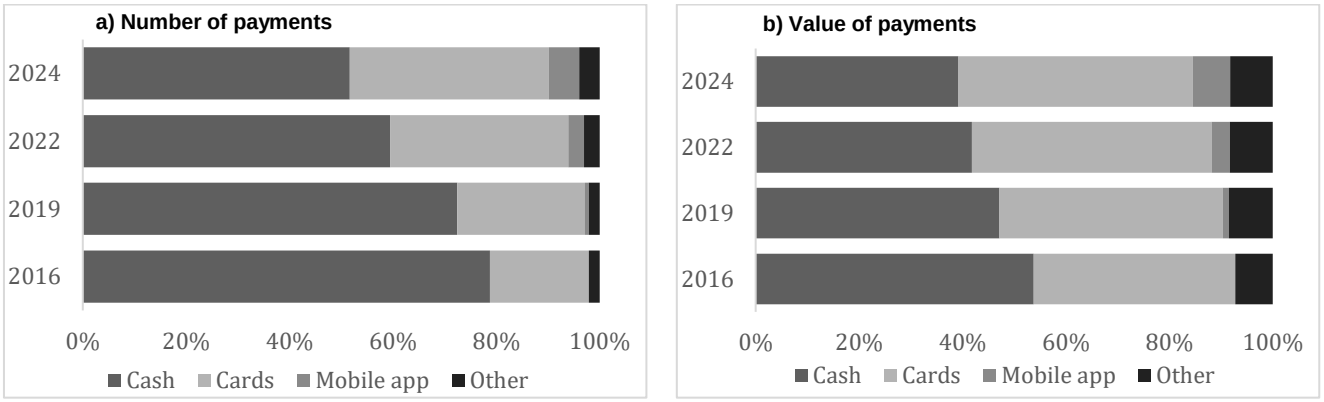


Figure 2.2 – Share of payment instruments used at the POS, Euro Area

Source: Developed by the author based on data from [89].

Demographic and socioeconomic factors also influence the choice of payment method (Fig.2.3). The proportion of people who prefer cash at the point of sale increases with age, and the willingness to use non-cash methods depends on the level of income: the higher the income, the more likely they are to choose a card or mobile app. This is in line with the cost savings of issuing and servicing cash (logistics, transportation, manufacturing, and disposal), which exceed the equivalent costs of supporting card and digital payments. However, bank fees can deter low-income people from going digital: although the law prohibits charging transaction or maintenance fees for salary and social cards, banks often impose invisible fees (e.g., SMS notification fees) that cannot be switched off. This may be one reason why people with lower incomes rely more on cash. Finally, educational attainment also plays a role: the higher the level of education, the less often people use cash at the point of sale. In the low-education group, more than half of

the payments are made in cash, while among more educated customers, the share of non-cash transactions is much higher.

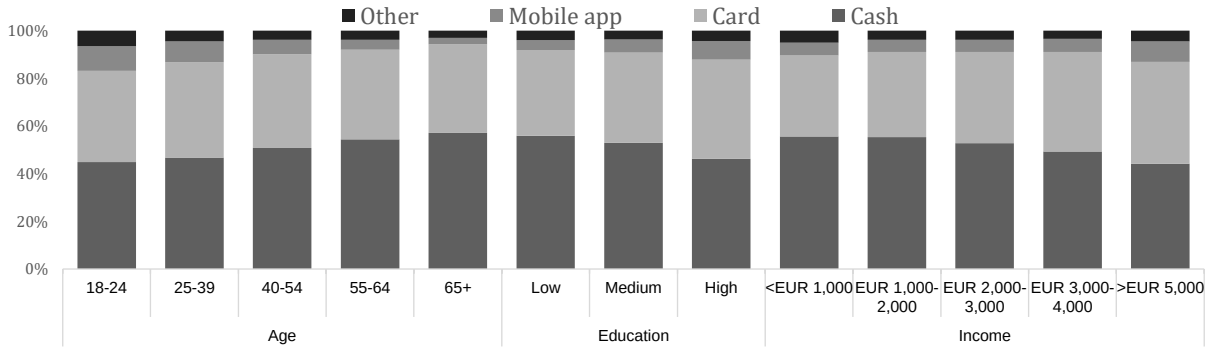


Figure 2.3 – Share of different payment instruments used at the POS, number of payments, breakdown by demographics, Euro Area, 2024

Source: Developed by the author based on data from [89].

At the same time, there has been a significant increase in the share of non-cash payments in the total number of transactions – their number and value are growing by approximately 10% (Fig.2.4). This trend can be observed across all age, education, and income groups. The difference between the shares of non-cash payments in terms of number and value is mainly offset by card payments, the number of which is decreasing by about 10% in the structure of transactions.

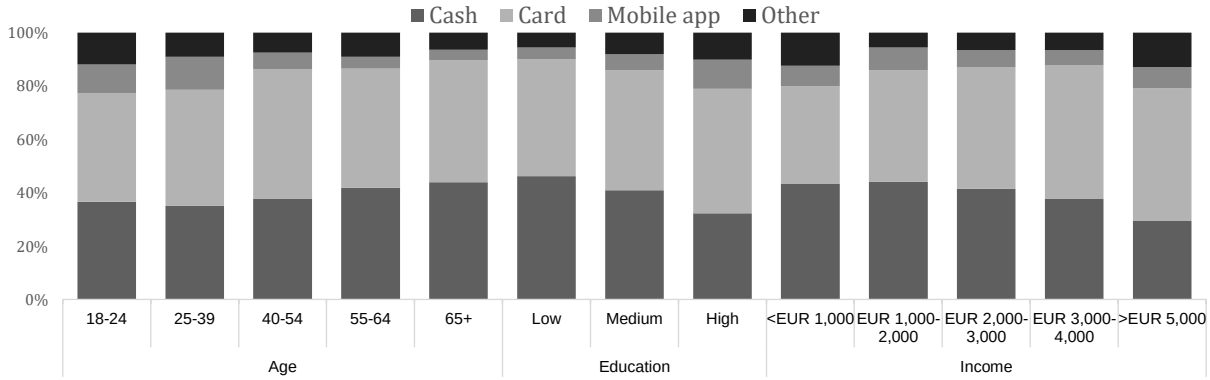


Figure 2.4 – Share of different payment instruments used at the POS, value of payments, breakdown by demographics, Euro Area, 2024

Source: Developed by the author based on data from [89].

Low-value payments are predominantly made in cash; on the other hand, about 70% of cash transactions are those worth €20 or less. On the other hand, transactions worth €100 or more are rarely made in cash, accounting for less than 5% of the total. Accordingly, on average, the higher the transaction amount, the more often a card is chosen: if the amount exceeds EUR 100, only one in three payments is made in cash,

while one in two is made by card. Figure 2.5 shows the correlation between the increase in the payment amount and the increase in the frequency of card use as a payment instrument. Moreover, the transaction amount has little or no impact on the choice of mobile payment apps.

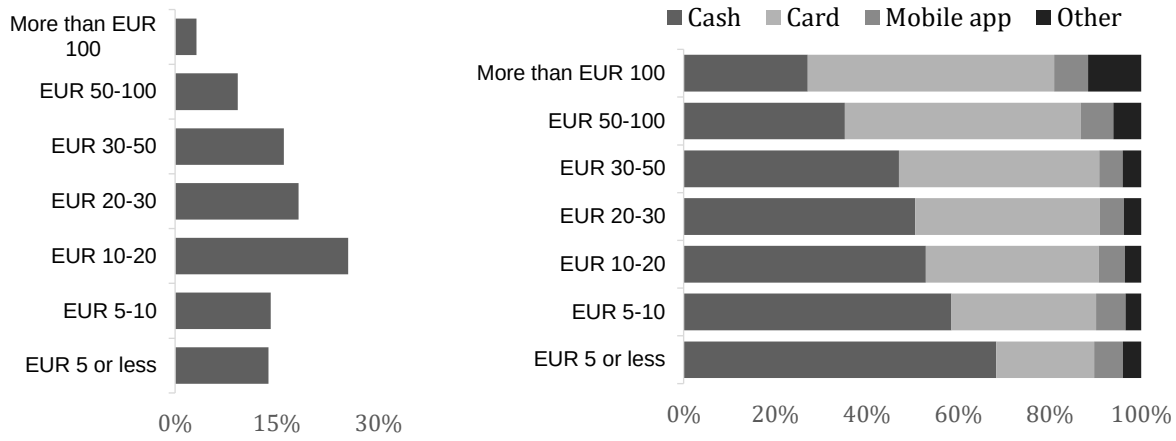


Figure 2.5 – Breakdown of POS and online payments by value and payment instrument, Euro Area, 2024

Source: Developed by the author based on data from [89].

As for online payments, they are most popular among people aged 18-40. The level of education has virtually no effect on the number of such transactions, but the share of online payments in terms of value increases significantly among people with lower levels of education. In addition, there is an inverse relationship between the share of online transactions and income: the lower the income, the higher the share of online payments, which is consistent with the assumption that online transactions typically have smaller average amounts (Fig. 2.6).

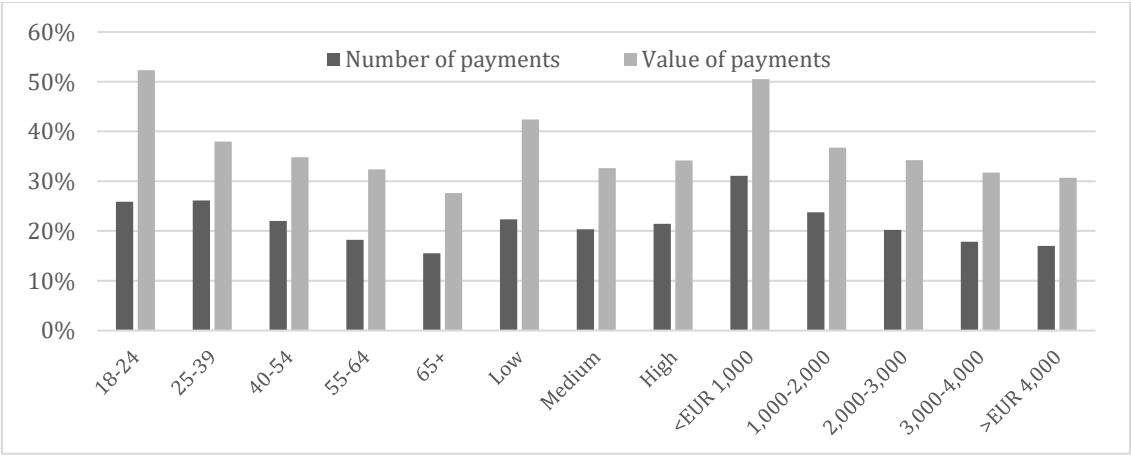


Figure 2.6 – Share of online payments in consumers' day-to-day transactions, breakdown by demographics, Euro Area, 2024

Source: Developed by the author based on data from [89].

Unexpectedly, the importance of the option to pay in cash has increased by around 2-4 percentage points over the past three years (Fig. 2.7). Somewhat unexpectedly, the importance of cash payments has increased by approximately 24% over the past three years (Appendix B1). Several factors can explain this change. The first is active lobbying by civil society organisations, trade unions and other institutions to preserve cash as a legal means of payment in order to avoid the financial exclusion of vulnerable groups (in particular the elderly and people with certain physical or cognitive impairments) for whom cash is more convenient. The second is the fear of potential cyberattacks, payment system failures, etc., especially in the context of increased cyber threats from russia as a terrorist country At the same time, this option is most important for representatives of the older generation (55 years and older). At the same time, it is most important among people with secondary specialised and incomplete higher education, while for those with only primary or basic secondary education, as well as for holders of a university PhD degree, the importance of this option is lower (Fig. 2.7).

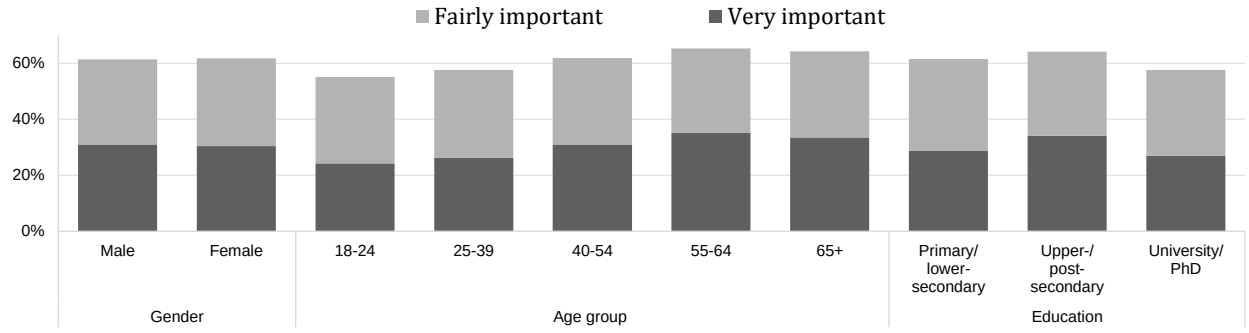


Figure 2.7 – The importance of having the option to pay with cash, breakdown by demographics, Euro Area, 2024

Source: Developed by the author based on data from [89].

Moreover, the growth was not only in terms of the number of transactions, but also in terms of their value and average transaction size. When looking at the volume of transactions by payment type in the 21st century (Fig. 2.8). Credit transfers account for approximately 90% of the total transaction volume by value. The second largest segment is direct debits, whose share has gradually increased over time. The graph showing the average value of transactions as a percentage of EU GDP shows that credit transfers,

although highly volatile, have been on an overall upward trend over the past two decades. Direct debits, on the other hand, have been the most volatile type of payment: they spiked in 2007 and then gradually declined until 2014, after which they stabilised. At its peak, the share of direct debits exceeded 60% of EU GDP. Payments by bank cards have been growing steadily over the past two decades: while at the beginning of the period their share was around 5% of EU GDP, it reached 30% by 2023. E-money and other digital payment instruments emerged only in the 2010s, so in 2023, the volumes of credit transfers, direct debits and electronic payments were equal and accounted for approximately 20% of EU GDP each.

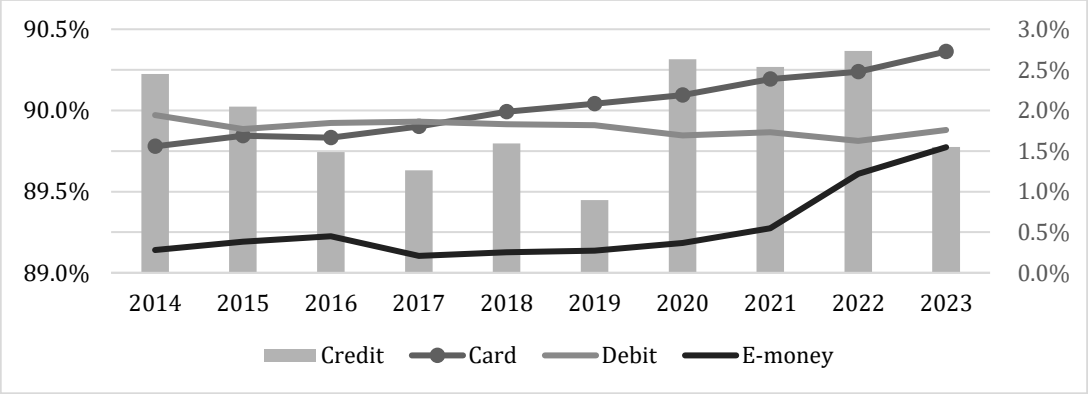


Figure 2.8 – Total volume of transactions by method, as a share of GDP, EU-27

Source: Developed by the author based on data from [90].

In the Figure 2.10, there are transactions by count summarised over the past two decades. In that case, card payments remain the most popular by number, accounting for more than half of all transactions, i.e. about 70-80 billion transactions annually. Credit transfers, direct debits and electronic payments account for the remaining share. The average annual growth rate of the number of card payments over the past twenty years has exceeded 800%, which means an eightfold increase in their number. The steady growth in credit transfers demonstrates the increasing role of bank transfers in trade, salary payments and regular payments. The slow but steady growth of direct debits signals the spread of automatic regular payments (utilities, subscriptions, etc.). There is also exponential growth in e-money, reflecting the widespread adoption of digital wallets and mobile payment apps over the past decade. Despite a slight slowdown in 2020, the next two years will see sharp growth in all non-cash channels, especially cards and e-money. This confirms the rapid digital transformation due to restrictions on direct interaction and

the desire to avoid physical contact. Also, although cards remain the leader, the combined contribution of credit transfers, direct debits and e-money is creating an ever-wider ‘pie’ of cashless alternatives. This confirms the trend towards a multi-channel approach in modern financial ecosystems.

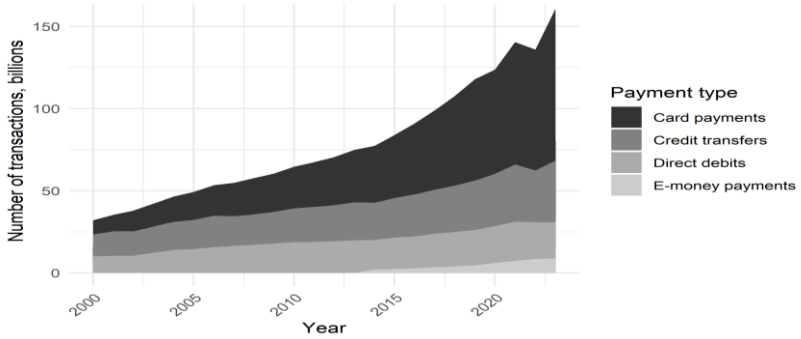


Figure 2.9 – Total number of transactions by method, EU-27 [90]

It also shows the dynamics of the number of bank cards held by residents of the 27 EU member states in 2014-2023 (Fig. 2.10). Credit cards have remained relatively stable over the past decade, with around 2 billion cards in circulation. Debit cards have shown moderate but steady growth, from around 2.5 billion in 2014 to almost 4 billion in 2023. Cash cards peaked at almost 2 billion in 2022, before halving the following year.

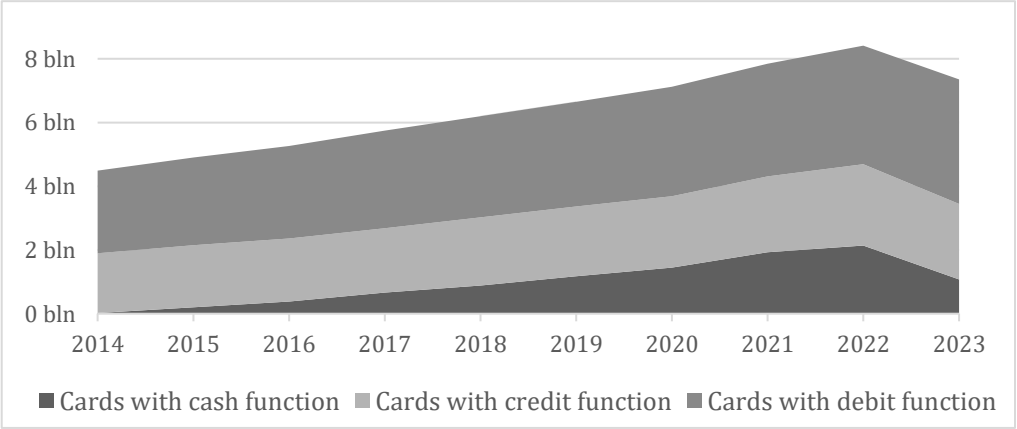


Figure 2.10 – Total number of cards by holding type, EU-27
Source: Developed by the author based on data from [90].

Magnetic stripe cards accounted for about 10% of the total number of cards, with a slight decline in 2021-2022, but their share returned to the previous level in 2023. Contactless cards showed the most dynamic growth, with their share increasing from 2% in 2014 to around 22% in 2023 (approximately 10 times). Thus, while credit cards remain the most common type of card, debit and contactless cards are playing an increasingly important role in household payments (Fig. 2.11).

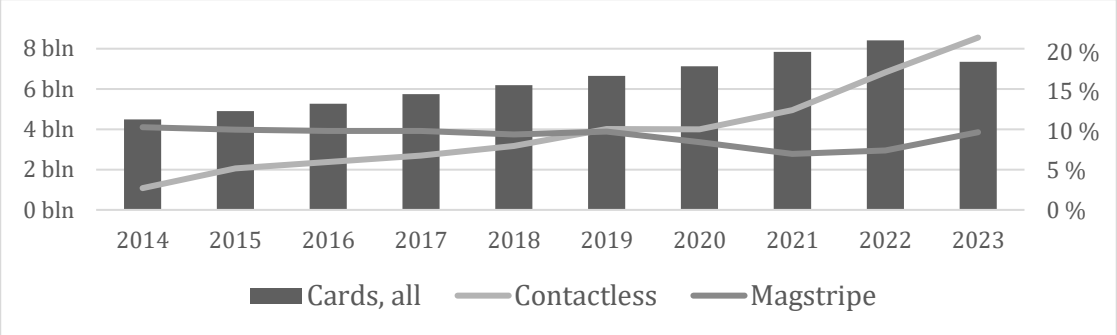


Figure 2.11 – Share of cards by technology usage, EU-27 [90]

In the case of financial institutions, the opposite trend is observed (Fig. 2.12). Their number has been gradually decreasing over the decade under study. The only year without any growth or decline was 2022. In all other years, the number of institutions decreased by several per cent annually. The number of banks declined most rapidly, while in the nonbank segment, in the number of institutions, almost doubled in 2014-2015, from about 2,500 to 6,000. Subsequently, this figure was maintained at around 6,000 institutions annually. The number of e-money institutions also remained relatively stable in 2014-2023, fluctuating between 2,200 and 2,500 institutions in the countries surveyed.

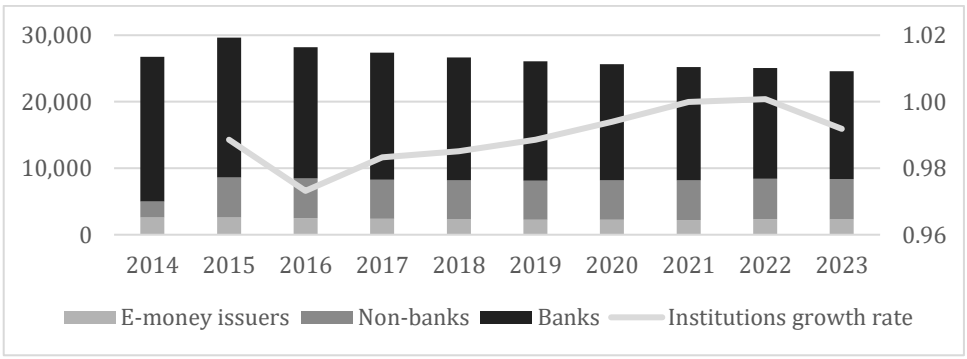


Figure 2.12 – Distribution of Financial Institutions [2]

Source: Author's calculations based on BIS statistics [2].

The number of bank branches also demonstrates a moderate negative correlation with the volume of non-cash transactions, as can be seen from the correlation matrix (Appendix B1 and B2). On the one hand, some literature suggests that a large number of branches indicates a high saturation of the financial market, active financial transactions and demand for banking services. In this case, banking services act as a proxy for the intensity of the overall payment sector, and the expected correlation with non-cash

[2] *The aggregated data cover the following countries: AR, AU, BE, BR, CA, CN, FR, DE, HK, IN, ID, IT, JP, KR, MX, NL, SA, SG, ZA, ES, SE, CH, TR, GB, US.*

transactions should be positive. However, the statistical analysis of this study shows the opposite result. This is where other assumptions come in. If there are few branches, users may fear insufficient availability of cash (geographical distance, limited opening hours, etc.) and thus keep their savings in cash. On the other hand, a small number of banks with a large network of branches creates an oligopolistic (sometimes almost monopolistic) market structure. In such a situation, banks are not interested in reducing service and transaction fees, which further hinders the development of cashless payments. Thus, the negative correlation between the number of branches and non-cash transactions may be related to both the factors of cash availability for the population and the specifics of the competitive structure of the banking sector.

For a deeper understanding of the processes and dynamics that are currently shaping the cashless payments industry, it is worth paying attention to the correlations between key metrics. An analysis of the BIS data for 2014-2023 based on a standard sample of countries shows a number of illustrative trends. In particular, there is a negative correlation of medium strength between the level of cashless payments and the number of bank branches, which may indicate a gradual shift away from physical infrastructure in favour of digital services. At the same time, there is the expected strong positive correlation between cashless transactions and the spread of contactless cards and rapid payments – in particular, in the case of retail payment systems and rapid payment systems, this relationship is close to an almost complete correlation. The number of ATMs operates in the opposite direction: it shows a negative correlation of moderate strength with the volume of non-cash transactions. Interestingly, the number of bank branches, despite its negative correlation with digital payments, shows an extremely strong positive correlation of 0.98 with the volume of cheque payments, one of the most traditional methods of transaction. The data shows that over the past decade, non-cash payments have been growing steadily around the world: credit transfers account for the largest volume, debit and contactless cards are actively increasing their share, and fast payments and e-money are developing rapidly. At the same time, the number of banks and ATMs is declining slightly, while non-bank payment institutions are maintaining a high level. The strong positive correlations between cashless transactions and the adoption of

contactless and instant payments technologies indicate a technological reorientation of the sector, while the negative correlations with the number of branches and ATMs indicate a declining role of physical infrastructure in the payment environment.

Over the last decade, countries around the world have sharply reduced cash use at points of sale, shifting instead to cards, mobile apps, and other digital methods. Between 2014 and 2023, non-cash transactions in BIS member countries roughly quadrupled, and in the Eurozone, one in four cash payments in 2016 was digital by 2024. Online shopping is most popular among 18–40-year-olds, with lower-income buyers accounting for a disproportionately large share of its total value. At the same time, issuing and servicing cash remains relatively cheap, so the average cost per non-cash transaction has only fallen modestly. Despite broad digital adoption, public concern over financial exclusion and cybersecurity has made preserving cash options more important in recent years – particularly for seniors and the less tech-savvy. Meanwhile, banking infrastructure is contracting: the total number of banks, branches, and ATMs has declined, while nonbank and e-money institutions remain stable. Strong positive correlations link digital payments to contactless and instant-payment systems, and moderate negative correlations tie them to branch and ATM counts, underscoring how payment ecosystems are moving decisively toward digital channels.

2.2. Measuring cashlessness: evidence from the Eurozone

Consumer payment behaviour in the euro area is undergoing a rapid transformation, driven by digitalisation, changes in legislation, consumer preferences and the general availability of financial infrastructure. Despite sharing a common currency, eurozone countries show significant differences in the way they make payments, including the prevalence of cash payments, the use of digital payment methods, the level of trust in non-cash transactions, and attitudes towards privacy. These differences have both economic and social underpinnings, making comparative analysis particularly relevant. This section presents a comparative analysis of payment practices in the euro area in 2024.

The analysis covers the share of different payment methods in online channels, at the POS, and in P2P transfers. Additionally, the importance of cash for consumers, attitudes towards digital payment solutions, the prevalence of bank accounts and payment cards, the rejection of certain forms of payment, and the level of concern about privacy are analysed.

Most payments are currently made by consumers at the POS (Fig. 2.13). In this segment, the situation is quite diverse: on average, the share of cash payments by number of transactions is about 40-50%, and by value, 30-45% of all payments. Usually, the number and value of transactions by different methods are significantly correlated, except in certain countries. Malta, Slovenia, Slovakia, Italy, and Lithuania are the most 'cash-based' countries. By contrast, Belgium, Luxembourg, and Finland are the least cash-intensive countries. In these countries, the statistics for cash and card payments are almost mirrored, as these two methods – cash and payment cards – together account for an average of 70-75% of all transactions, both in terms of number and value. The Netherlands, Finland, Belgium, and France have the highest share of card transactions. Estonia and Luxembourg also have a high level of card usage. Card payments are the least common in Hungary, Malta, Slovenia, and Slovakia. Mobile apps and other alternative payment methods at the POS account for the smallest share of all methods. At the same time, mobile payments are exceptionally popular in the Netherlands, where they account for almost 20% of both the number and value of transactions. In other countries, this figure varies, but is generally between 3-10% by number and 4-9% by value. Comparatively higher figures are also observed in Ireland, Latvia, Lithuania, and Finland, which can be considered as 'sub-leaders' in this segment.

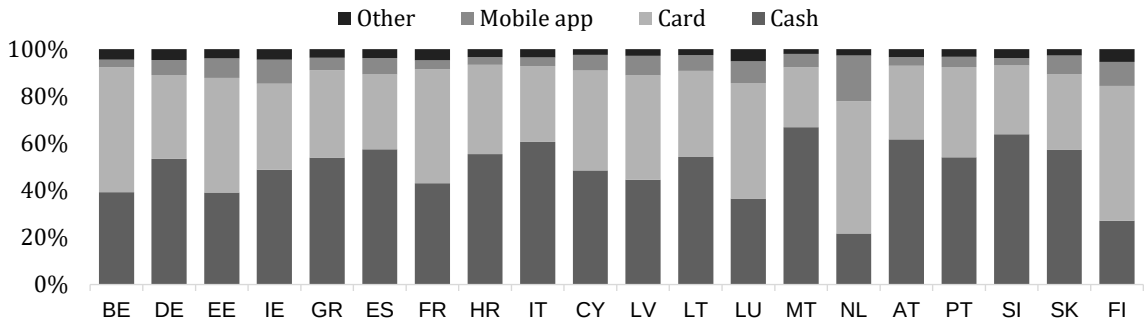


Figure 2.13 – Share of payment instruments used at the POS, 2024

Source: Developed by the author based on data from [89].

In most countries, the share of cards in terms of transaction value significantly exceeds their share in terms of number: people use cards less frequently but for larger amounts. The largest gap is observed in countries such as the Netherlands, Finland, and Sweden, where cards account for 70–80% of the value of payments but only 50–60% of the number of transactions. Conversely, cash has a greater presence in terms of the number of transactions than in terms of value: there are many small payments that are not so significant in monetary terms. This once again confirms the thesis that cash dominates mainly in low-value transactions. Mobile applications, on the other hand, occupy the 'middle segment' and are used almost equally for different payment amounts (Fig. 2.14).

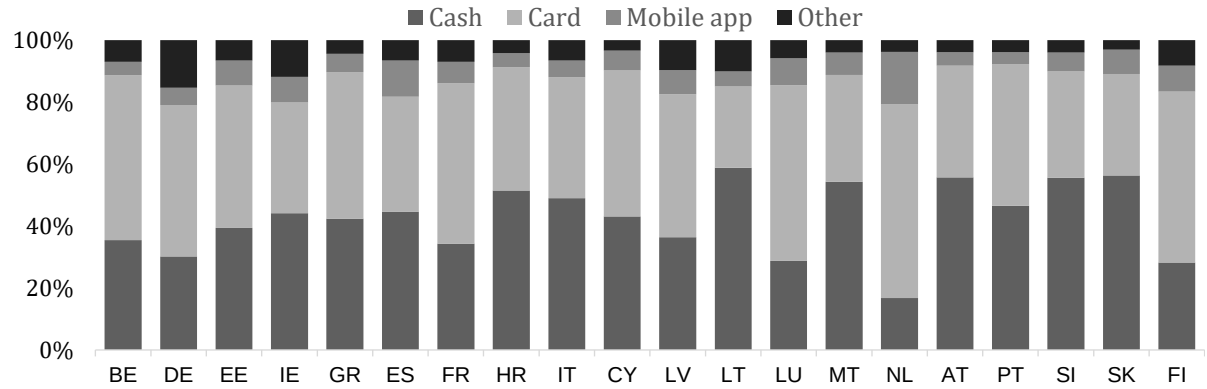


Figure 2.14 – Share of payment instruments used at the POS, by value of payments, Euro zone, 2024

Source: Developed by the author based on data from [89].

At the same time, the general trend shows a decline in the share of cash transactions at the POS over the past two years, from 2022 to 2024 (Fig. 2.15). However, the dynamics of this indicator differ significantly between countries. Germany, Cyprus, Malta, and Portugal saw the largest declines in the share of cash payments by number of transactions. In Cyprus, the decline exceeded 10%. In terms of transaction value, the largest declines were recorded in Germany, Cyprus, and Malta, with declines of more than 7%. At the same time, a number of countries recorded an increase in cash payments. For example, in the Netherlands, the share of cash in the number of transactions increased by 1%. The example of Finland is particularly illustrative, where the share of cash payments increased by 8% in terms of the number of transactions and 17% in terms of their value.

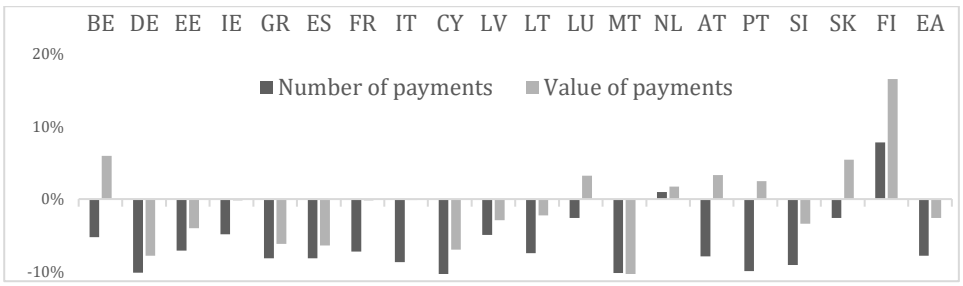


Figure 2.15 – Change in the share of cash used at the POS, 2022-24, Euro zone

Source: Developed by the author based on data from [89].

It's also interesting to look at the statistics by country on how important it is for users to be able to pay in cash. It's not about actually paying in cash, but about the priority of this option. As mentioned earlier, it is essential for users to have multiple payment options, as this increases satisfaction with the process by allowing them to choose from different methods. Among them, the cash payment option is one of the most important. The highest demand for cash payment options is observed among Germans, who are traditionally conservative (Fig. 2.16). Hungary is characterised by a rather conservative, socialist-populist population, and Greece by far-left and communist economic sentiments. In these countries, more than 40% of respondents consider it important to be able to pay in cash. Among those who think it is just important, the average ranges from 60-80%, with the lowest value (60%) in the Netherlands. The option of having cash available is important to only 46% of the Dutch population, the lowest in the Eurozone. Estonia also has low values (42%). Estonia is a very digitalised country: it has a platform similar to Ukraine's Diia, where you can put an electronic signature and order public services online. The government actively supports start-ups and fintech initiatives, which allows opening and closing bank accounts without the need to physically visit a branch.

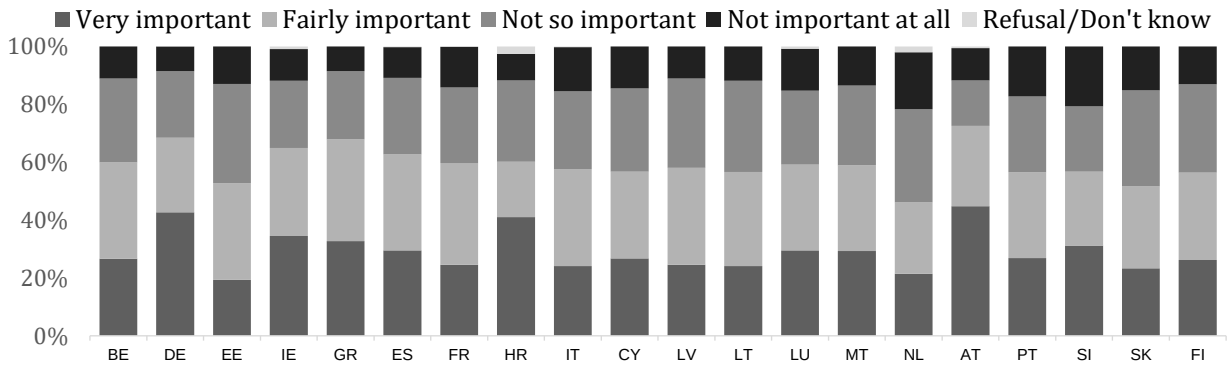


Figure 2.16 – The importance of having the option to pay with cash, 2024

Source: Developed by the author based on data from [89].

In terms of online payments, one in five payments in the eurozone is made online, accounting for around 35% of the value of all transactions (Fig. 2.17). In terms of day-to-day expenses, the leaders in terms of the share of online transactions by number are Belgium, Ireland, France, Cyprus, Latvia, Lithuania, Austria, and Slovakia, where more than 25% of all payments are made online. Estonia, France, Hungary, Latvia, Lithuania, Austria, and Slovakia account for more than 33% of all online payment turnover by value, which is higher than the eurozone average.

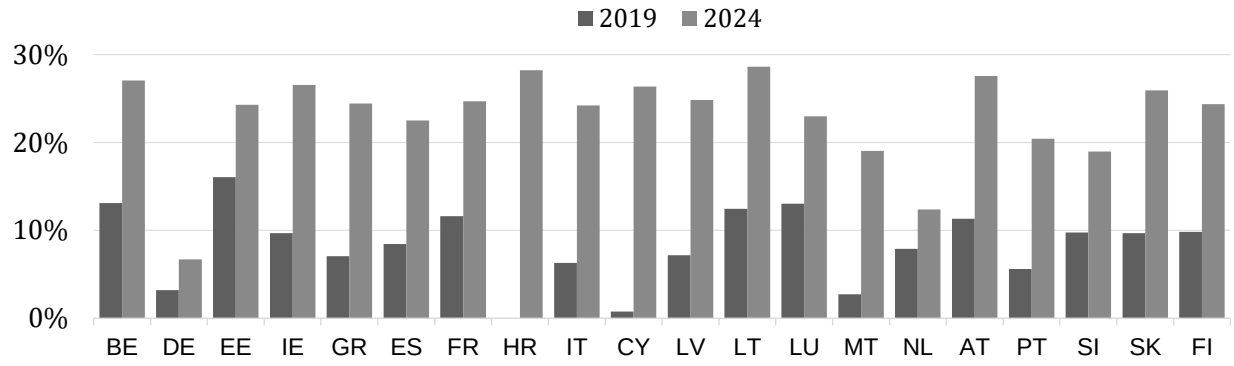


Figure 2.17 – Share of online payments in consumers' day-to-day payments, by number of payments, Euro zone, 2019-24

Source: Developed by the author based on data from [89].

There are also differences in market depth between countries (Fig. 2.18). In Scandinavia and Benelux, the gap between card share by value and volume reaches 20–25%, reflecting a high level of fintech maturity and the prevalence of cashless payments for medium and large amounts. In Austria and Central Europe, cash is still actively used for small payments, but its share in terms of value is limited.

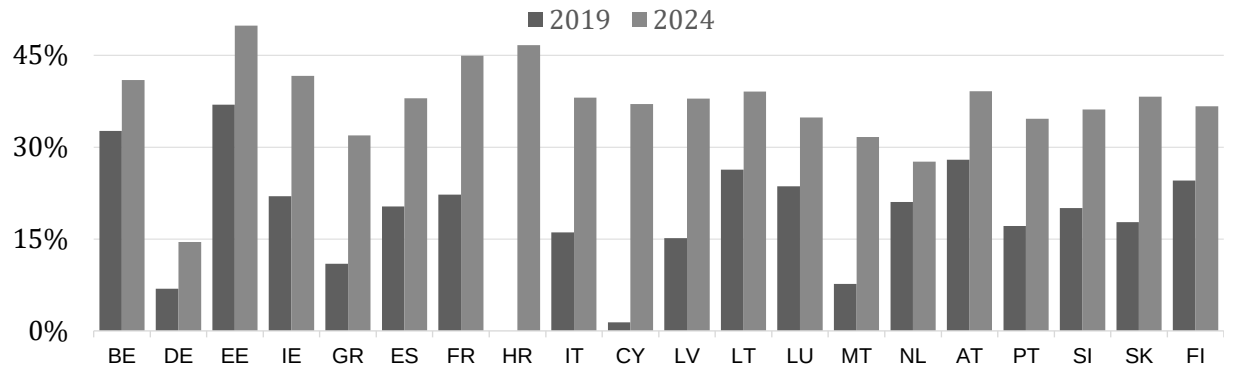


Figure 2.18 – Share of online payments in consumers' day-to-day payments, by value of payments, Euro zone, 2019-24

Source: Developed by the author based on data from [89].

The largest increase in online payments over the past five years was observed in Cyprus – more than 100% in terms of the number and 90% in terms of the value of transactions. Malta has shown rapid growth: +50% in terms of number and +30% in terms of value. Overall, the number of online payments in the eurozone increased by 25%, and their value by more than 15%. There was no negative trend: no country showed a decrease in the share of online transactions. The Netherlands recorded the smallest increase, less than 10% in both number and value, which is explained by an already high initial base. Similarly, Belgium, Estonia, and Luxembourg have low relative growth due to the high level of digital activity at the beginning of the period (Fig. 2.19).

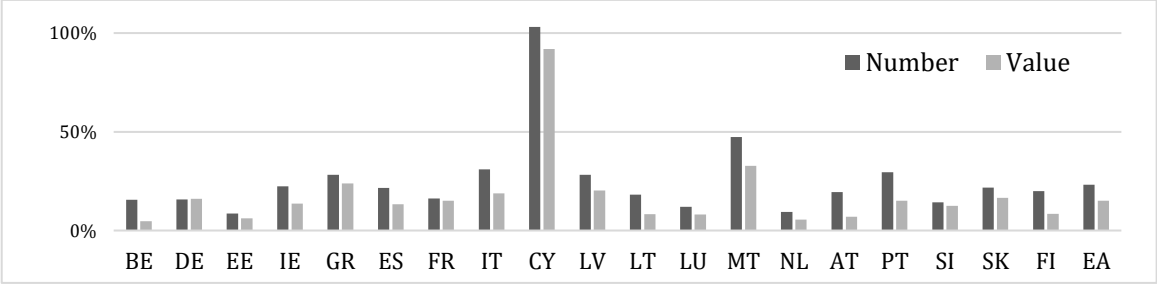


Figure 2.19 – Share of online payments, compound annual growth rate, 2019 vs 2024

Source: Developed by the author based on data from [89].

In terms of the instrument structure of online payments, cards account for approximately 50% of the euro area average in terms of the number and value of transactions. The lowest figures are in Germany (20%) and the Netherlands (9% by number, 15% by value). The highest rates are in Cyprus and Malta (over 60% by number and 50% by value). Credit transfers and direct debits account for around 5% by number; credit transfers vary considerably by value between countries, while direct debits range from 8% to 15%. Electronic wallets and e-payment solutions are the second most popular tool, accounting for 75% of online transactions in the Netherlands, almost 50% in Germany, and 33% on average in the euro area (Fig. 2.20).

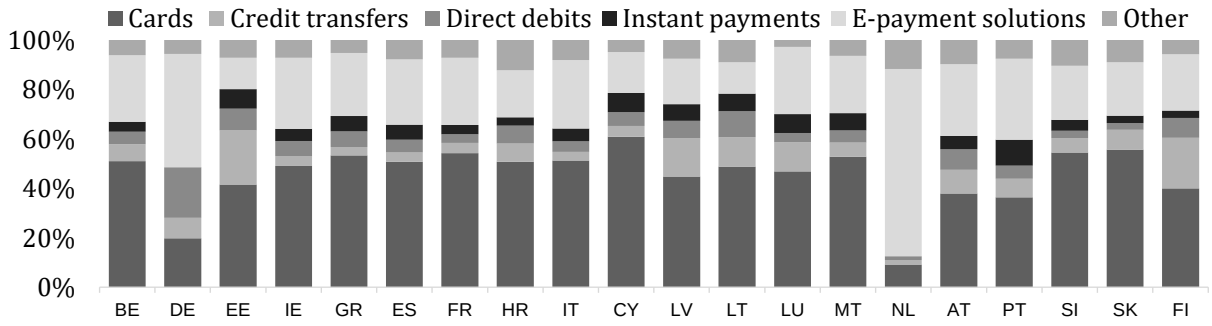


Figure 2.20. – Structure of online payments, by number of payments, 2024 [89]

The most expensive in terms of total cost are direct debits in the Netherlands and credit transfers in Luxembourg. Cards account for the largest share of the cost on average across the EU (~50%), but with significant differences (Fig. 2.21).

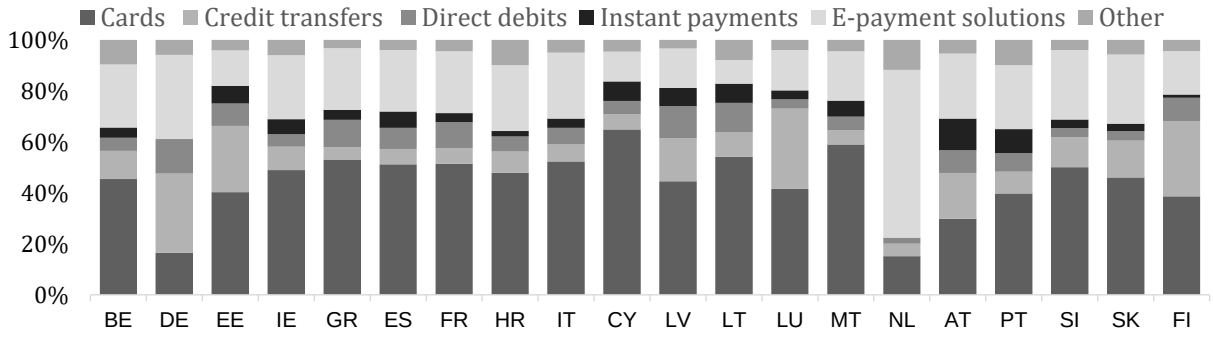


Figure 2.21 – Structure of online payments, by value of payments, 2024

Source: Developed by the author based on data from [89].

It is also important to note that a prerequisite for using card payments, credit transfers, and other methods is the availability of a bank account, and for card payments, a payment card. In general, the level of banking in the euro area is quite high: more than 9 out of 10 people have a bank account and a payment card. The lowest banking penetration is observed in Cyprus, Lithuania, Italy, and Hungary (Fig. 2.22).

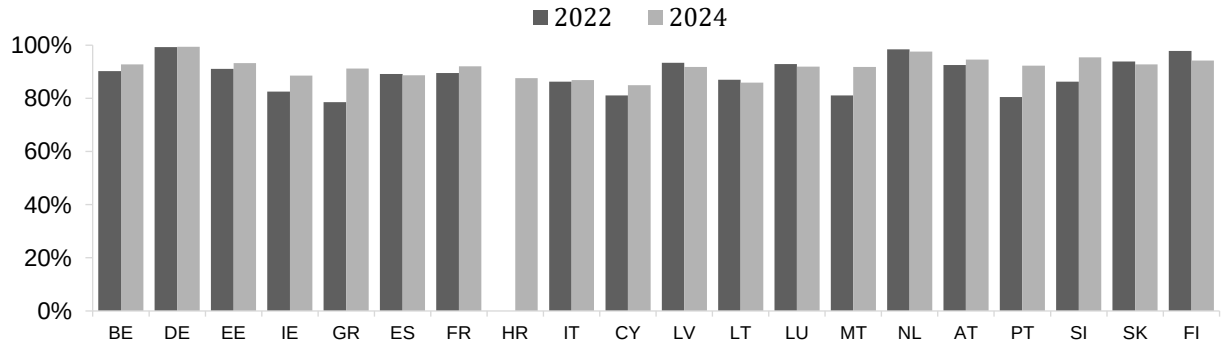


Figure 2.22 – Share of consumers who have a payment account, Euro zone

Source: Developed by the author based on data from [89].

In general, there are countries, such as Cyprus, that have a rather low level of «unbankedness»: 85% of the population has a bank account and 92% have a payment card (Fig. 2.23). This raises a reasonable question: how can the percentage of cardholders exceed the percentage of account holders? This gap is also observed in Ireland, Greece, Italy, Lithuania, Latvia, and Luxembourg. There are several explanations. Prepaid cards do not require a bank account. They can be topped up by the young people's parents or used as salary or social security cards for payments, and do not necessarily indicate the existence of an open account. Also, joint accounts and family cards allow one account to

serve multiple cards. For example, young people who are minors use cards linked to their parents' accounts. In addition, variations in survey methodology and question wording can also affect the results: a respondent may consider a card to be a ‘bank card’ even though it is prepaid, or may not consider their digital financial instrument to be a full-fledged bank account.

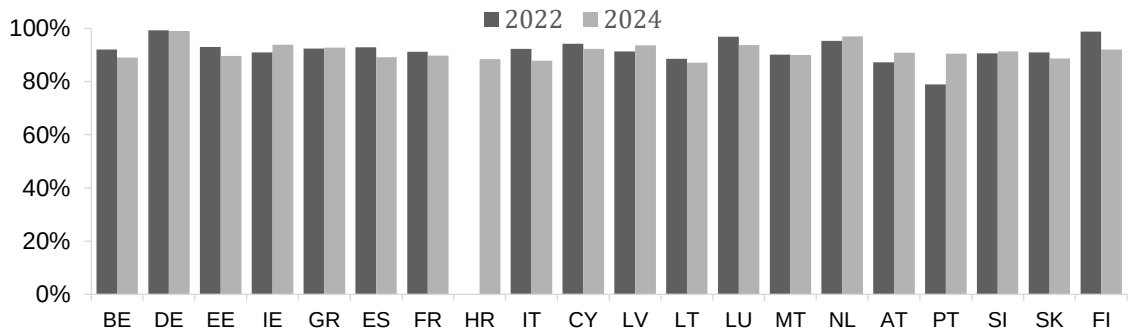


Figure 2.23 – Share of consumers who have a payment card, Euro zone

Source: Developed by the author based on data from [89].

The last interesting aspect is the frequency of refusals to accept certain payment methods – cash or non-cash (Fig. 2.24). Cash was most often refused in Lithuania, Ireland and Belgium. Non-cash methods were most often rejected in Germany, Latvia, Greece, Spain, Hungary, Cyprus, Malta, Slovenia, and Slovakia – more than 13% of cases. In countries with a high frequency of cashless payment rejections (e.g. Germany, Greece, Spain, Hungary, Cyprus, Lithuania), there is a correlation between these rejections and the actual choice of payment method at the point of sale or in P2P transfers. It is also worth noting that sometimes non-cash payments are accepted only for amounts above a certain threshold. However, this is more often the case for tourist outlets and small shops, rather than the general practice of large retailers. As the payment market is bilateral, the level of adoption of a particular method depends on both the payer and the receiver of the payment. Frequent rejections of a particular method force consumers to gradually switch to another payment method. Typically, people use two main methods that account for more than 90% of their transactions. There are several reasons for this refusal. First, credit cards (especially international and premium cards) may incur a commission of 1.5–3% of the amount, and sometimes even more. This significantly reduces thin margins and forces merchants to refuse cards from large payment systems. Direct debit for sellers in the EU is usually cheaper (lower tariff plans and fixed fees), but it requires a more complex legal

agreement and payment guarantees, which is why smaller sellers avoid it. In addition, payment terminals, cash register system settings, or internet acquiring are required to accept cards. Often, small cafes or markets simply do not have the connection or funds to purchase/rent a terminal.

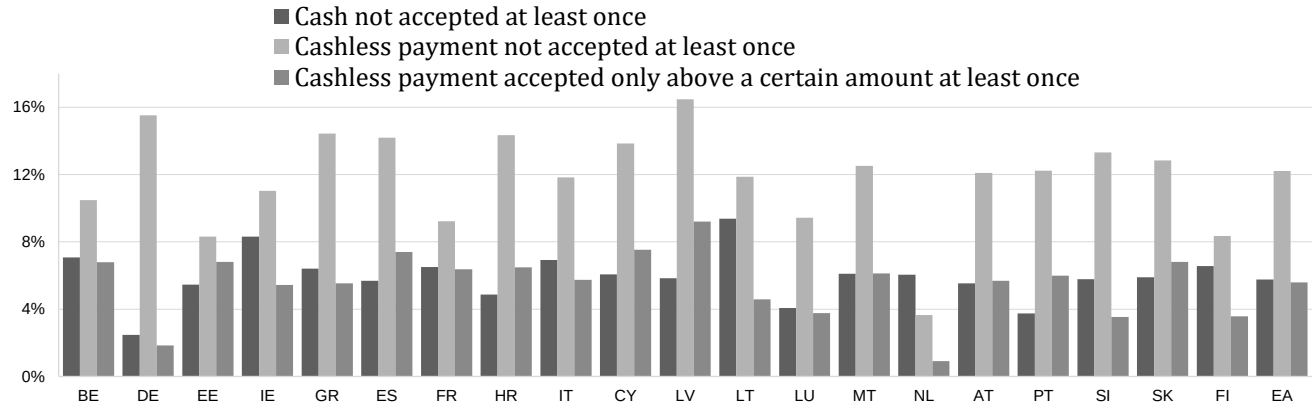


Figure 2.24 – Non-acceptance of cash and cashless payments in the past month, Euro zone, 2024

Source: Developed by the author based on data from [89].

The Netherlands is a special case: in the eurozone as a whole, consumers are abandoning cash in favour of cashless methods, mainly cards. At the same time, although cards remain the most popular payment method in terms of transaction volume and value, the Netherlands stands out for its high level of mobile app usage for payments. This is due to several factors. First, the Dutch population has a pragmatic mindset: cashless transactions are perceived as more economical and convenient. Second, retailers actively support unified technical standards for POS terminals, which simplifies the development and implementation of mobile payment apps and promotes competition among providers [91]. In addition, almost 95% of payment cards in the Netherlands are equipped with contactless technology, and the number of POS terminals supporting NFC is close to 100% [92; 93]. Moreover, the country's high level of digitalisation, mobile device penetration and high-quality internet coverage are contributing to the rapid spread of mobile payments [94; 95]. It is also worth noting that leading banks offer convenient mobile apps with QR code and NFC support, and the iDEAL platform enables direct online transfers between banks without commission in both the P2P segment and at POS terminals [96]. Finally, strong government regulation of digital payments in the Netherlands boosts consumer confidence: over 60% of users are confident that their data

is secure during online transactions, which is significantly higher than the eurozone average [89; 95].

As a result, in the Eurozone, there is a clear trend away from cash and towards cashless methods, but the share of cash payments at POS remains at 40-50% by number of transactions. The Netherlands has a high level of mobile app adoption and an advanced digital infrastructure, while in conservative countries such as Germany, Italy and Hungary, cash is recorded as the most important option for more than 40% of consumers. Online payments are growing rapidly, with an average five-year increase of 25% in number and 15% in value across the eurozone, with Cyprus and Malta leading the way. The majority of consumers have bank accounts and cards, but in a number of countries (Cyprus, Lithuania, Italy, Hungary) the share of cards exceeds the share of prepaid accounts and family accounts. Overall, all these trends indicate a gradual convergence of payment practices in the euro area, with increasing digitalisation and the preservation of regional specificities.

2.3. Understanding Sweden's low-cash economy: drivers and outcomes

The story of how Sweden became the leader and model of a cashless economy and the country with the lowest cash turnover of any country in the world. In general, since the 1950s, if we look at the share of cash in circulation to GDP in Sweden, this indicator has been declining by an average of 10% per year. This is not an accurate figure, as it was mainly due to GDP growth rather than a decrease in the amount of cash in circulation [97]. Analysing the amount of cash in circulation alone also has limitations, as inflation must be taken into account. But in any case, Sweden remains one of the countries that has seen a steady decline in the popularity of cash among European countries. In other countries, the volume of cash in circulation has largely stabilised at around the same level.

Across the board, there is a significant body of research that analyses various factors that influence the level of cashlessness in economies around the world. Such factors include opportunity costs, central bank interest rates and commercial bank deposit

rates, the number of ATMs, the number of banks and bank branches, the level of economic uncertainty and crisis, the number of EFTPOS terminals, the level of the shadow economy, the share of microbusinesses and small businesses, the share of the self-employed, the age structure of the population, etc. In general, these factors describe and explain the level of cashlessness in different societies well, but not in the case of Sweden. In such models, Sweden is an outsider, and the explanation of the cashlessness rate works about half as well as in other economies. At the same time, Sweden is one of the most cashless countries in the world, if not the most cashless country in the world [98, 99, 100, 101]. So, what makes Sweden so unique (Fig. 2.25)?

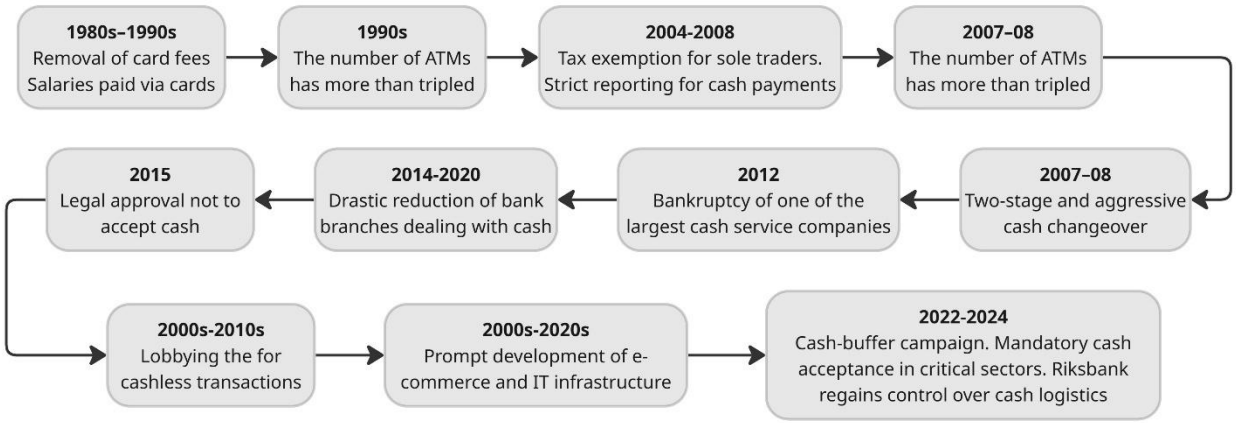


Figure 2.25 – Sweden's path to a cashless society: key milestones

Source: Developed by the author based on data from [97; 98].

The first important factor is that the entire cash service cycle in Sweden is outsourced to private companies licensed by the Riksbank (the central bank of Sweden). These companies issue cash, print banknotes and mint coins. They are also responsible for the logistics, transportation, distribution of cash and the detection and seizure of damaged or counterfeit banknotes and coins, as well as the disposal of cash at the end of its life cycle. In a market economy, such private operators are cost-oriented, so they optimise the amount of cash in circulation in line with real demand, with only as much cash in circulation as is needed in society. Since merchants have to pay these companies for cash handling, they prefer cashless payments to avoid additional costs. Commercial banks do the same, as they incur cash collection and processing costs. This led to the fact that in the 1980s and 1990s, banks and payment companies actively encouraged the

transition to non-cash methods: they cancelled fees for card payments, introduced bonuses for their use and high tariffs for bank cheques, which effectively put cheques out of circulation. At the same time, companies began paying salaries to employees by wire transfer to card accounts. For this purpose, banks offered special salary cards, which, with the consent of trade unions, were serviced without any fees for recipients [97; 98].

It is worth noting that in the 1990s, the number of card-accepting terminals increased significantly. In 1993, there were about 25,000, and three years later, there were about 70,000. Also at that time, the Central Bank acted as a facilitator of cashless payments and launched the RIX platform. This is an electronic system for processing interbank payments that allows banks to conduct electronic transactions quickly and reliably. However, unfortunately, card payments in Sweden have not grown as fast as expected and are slower than in neighbouring Scandinavian countries. Swedish banks also tested various forms of electronic payments in the 1990s, but many of these ideas were unsuccessful. Furthermore, it is worth noting that the level of uncertainty, instability and trust in government institutions (in particular the police) and the stability of the banking sector have a significant impact on the amount of cash in circulation. In general, people prefer cash when they perceive high levels of corruption, low transparency in privatisation and investment, and bank instability. At the same time, in the mid-2000s, Sweden experienced several high-profile bank robberies that became a turning point for payers and merchants in choosing a payment method. Despite the absence of significant human casualties, these robberies caused a serious shock in terms of financial losses and psychological stress. Following this, companies and trade unions, including those in public transport, banking, and trade, began to actively lobby for the abandonment of cash, arguing that it posed a danger to employees who handle cash and risk being robbed. This factor was one of the decisive factors in transition to cashless payments [97; 98].

At the same time, in the 2000s, a number of reforms were introduced to the tax system and to bring the grey economy out of the shadows. The shadow economy in Sweden was one of the largest in Europe. In 2004, the government introduced legislation that required self-employed persons to register as individual entrepreneurs and exempted them from taxation of income from these activities. At that time, the "shadow sector" was

primarily understood as household services (repair and household work, cleaning, maintenance of adjacent territories and gardens, etc.) In 2007-2008, the government introduced a tax deduction for these services: as workers' incomes were no longer taxed, they were no longer motivated to work illegally. At the same time, workers in these sectors lost social guarantees – they did not receive unemployment benefits and could not accumulate work experience for pensions due to lack of official registration. But as a result, a large part of the grey economy has become white, and the social security of workers in these industries has improved. The second important reform was the mandatory use of cash registers by all sellers, including microbusinesses. They had to report all transactions to the Swedish Tax Agency, issue receipts to customers, which allowed citizens to control the reporting of transactions and subject them to regular audits and inspections by the Tax Agency. This law effectively made it impossible for microbusinesses to manipulate cash payments and evade taxes. Since losing the opportunity to operate in the shadows meant losing the tax benefit, many entrepreneurs abandoned cash – and cashless payments remained cheaper and more convenient – and gradually switched to cards and electronic transfers [97; 98].

In 2012-2017, the Riksbank carried out a two-stage replacement of banknotes and coins [97; 98]. The need to update the cash had been discussed for more than a decade for security reasons. The transition to the new notes was quite aggressive: only 9 months were allocated for the withdrawal of old banknotes and coins from circulation and the introduction of new ones – all in two stages. After this period, the old notes became invalid and could only be exchanged at the Riksbank's head office in Stockholm. In addition, for the next 10 months, an additional fee was charged for the exchange, and to avoid tax evasion and money laundering, the exchange required careful documentation of the cash's origin. In the first phase, the 50- and 1,000-kronor notes were updated, and in 2012, the Riksbank issued 20-, 50-, 200- and 1,000-kronor notes. In the second stage (2015-2016), 100 and 500 kronor notes and 1-, 2- and 5-kronor coins were changed, with an even shorter exchange period. Due to the double update, the 1000 kronor note was changed twice, so traders refused to accept it, preferring smaller denominations. This reduced the turnover of large notes (Fig. 2.26).

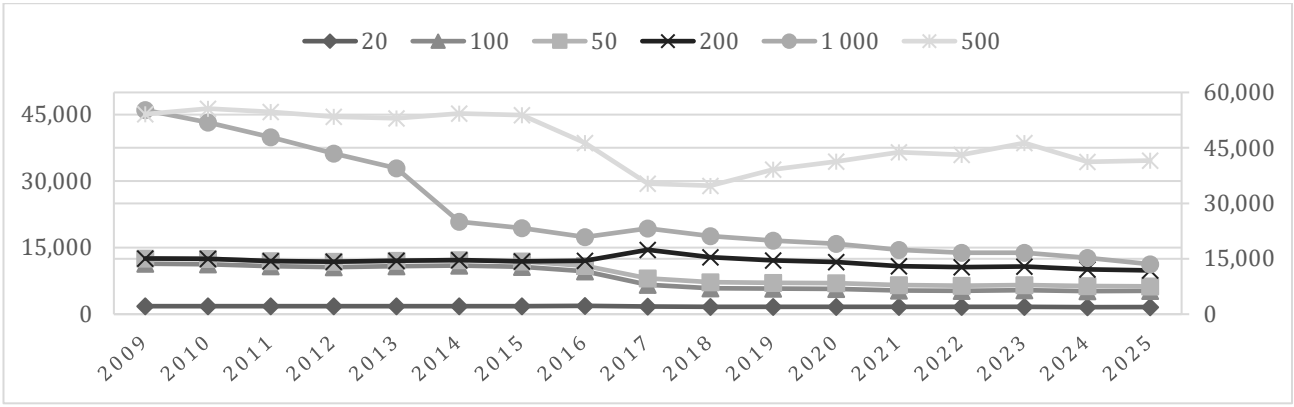


Figure 2.26 – Banknotes in circulation, SEK millions,
value per denomination [102]

In addition, between 2011 and 2016, the number of Riksbank branches that handled cash more than halved. In 2016, less than 40% of bank offices provided cash services, making the exchange of new banknotes extremely inconvenient. The transition, announced in advance (in the early 2010s), gave people time to prepare, but it was the periods of 2013-2014 and 2015-2017 that saw the peak of the decline in cash circulation in Sweden, as people exchanged old banknotes for cashless funds and actively switched to cards and electronic transfers (Fig. 2.27).

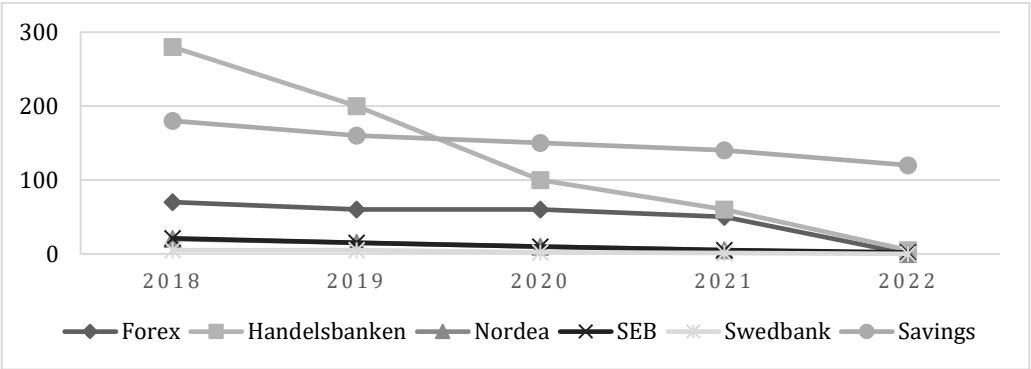


Figure 2.27 – Number of bank branches offering cash servives [103]

In addition, in 2012, Panaxia, one of the largest cash collection and transportation companies, declared bankruptcy due to a lack of liquidity and the illegal use of customer funds to cover its own expenses [97; 98]. As a result, many shops, petrol stations and other merchants lost significant amounts of money. Secondly, the exit of Panaxia significantly reduced the level of competition in the collection market. The remaining companies raised tariffs for their cash transit services in an attempt to compensate for the risks and losses. This forced many merchants to refuse to accept cash, saying: "Sorry, we only accept non-cash payments".

It should be noted that this was a time of global e-commerce boom. Physical stores and cash payments were gradually being replaced by e-commerce platforms and electronic cashless transaction services. Even when examining the specific case of Sweden, Figure 2.28 shows the share of companies registered and operating in Sweden that either fully or partially conduct some portion of their activities via e-commerce platforms, sell their products or offer services online, run their own e-commerce platforms, or use global ones. As we can see, first of all, this share is quite significant – nearly 40%. It should be emphasized that these data include all types of companies in Sweden, not just those typically considered suitable for e-commerce. That is, it covers a wide range of industries – from manufacturing (including food, beverages, electronics, pharmaceuticals, machinery, and construction) to information and communication, transport and storage, wholesale and retail trade, as well as various professional, administrative, and support services. What is also noticeable is that this share has been steadily growing, with particularly rapid development starting from 2014, and a significant spike in 2021–2022, driven by the COVID-19 pandemic.

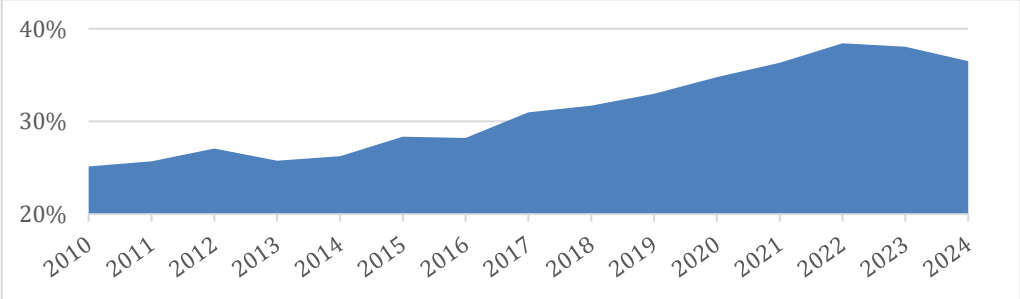


Figure 2.28 – Share of enterprises with e-commerce sales in Sweden

Source: Developed by the author based on Eurostat data [104].

This was especially attractive to young people who were open to new technologies (Fig. 2.29). More than nine out of ten young people (aged 16 to 34) used e-commerce services at least once during the past six months. At the same time, it is worth noting that e-commerce penetration is also quite high among the 45+ age group – seven out of ten people in this group have used e-commerce services at least once in the past half-year. These are remarkable figures, which can be seen as evidence of the importance of e-commerce, as well as of strong digital skills and a convenient infrastructure that makes people consider e-commerce channels easy and accessible to use.

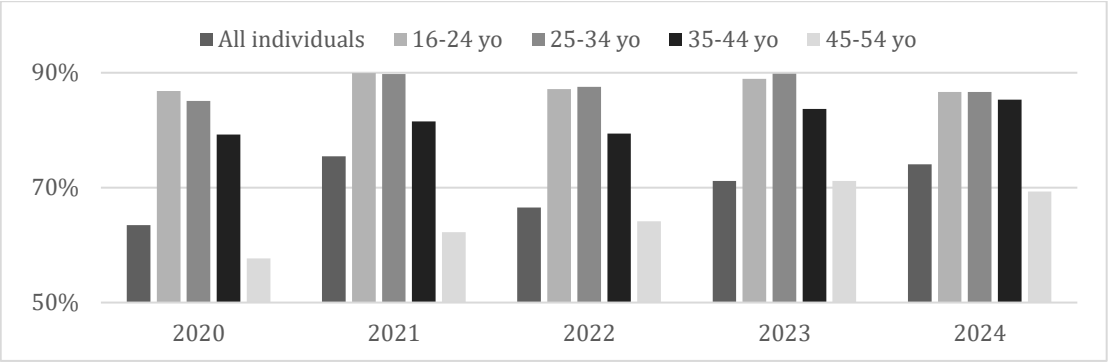


Figure 2.29 – Share of individuals using e-commerce platforms at least once in the past 6 months, Sweden, 2020–2024

Source: Developed by the author based on data from [105].

An important point is that Sweden is one of the most advanced countries in the field of information technology and telecommunications. The penetration of smartphones among the population is one of the highest in the world, Internet coverage is widespread even in rural areas, and tariffs are affordable (the Internet is inexpensive). Combined with high levels of technology adoption, this has contributed to the massive growth of e-commerce and cashless electronic payments. A selection of digital activities commonly performed by Swedes is presented (Appendix C1). These include various types of Internet and information technology usage, and the graph shows the percentage of the population engaged in such activities. What stands out is the very high level of engagement – depending on the type of everyday activity (such as using social media, reading news online, making voice or video calls via the internet, using emails or messaging apps, or accessing online banking services), a large majority of the Swedish population regularly engages in these internet-based activities. The data suggest that digital technology is deeply integrated into the daily lives of Swedes, with around four out of five people making regular use of such services.

The proportion of people searching for information about goods and services online is also exceptionally high (Fig. 2.31). This proportion has grown steadily over the last two decades, by almost 150%, from 64% to 90%. Why is this metric important? If a potential buyer searches for information online, this creates space for the development of e-commerce, and such a person is highly likely to become a user of an e-commerce platform. Interestingly, this is not only the case for young people, but also for older

people. The share of people aged 16–34 is about 90%, and those over 55 is over 85%. These figures are almost equal. The only noticeable difference is in the 45–55 age group, where the metric rose from 65% to 91%, while in the 55+ group, the growth was most dramatic: from 40% in 2003 to 86% today.

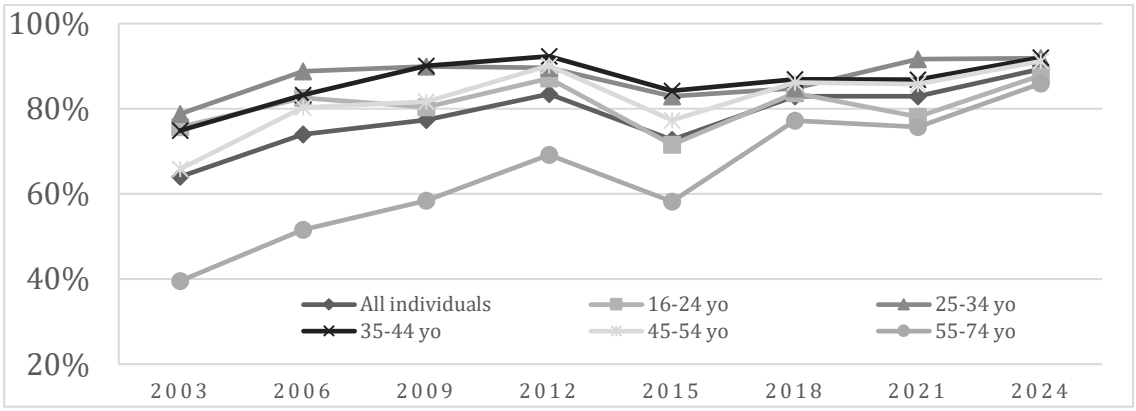


Figure 2.30 – Percentage of Swedes searching online for product or service

Source: Developed by the author based on data from [106].

Internet banking is also demonstrating high popularity and significant growth (Fig. 2.32). Over the past two decades, its prevalence has grown from approximately 40% to 85%. The most rapid increase occurred between 2003 and 2010, when Internet banking was just emerging. Initially, there were significant differences between age groups, with younger groups adapting more quickly to new services. Interestingly, since 2015, the share of internet banking users among 16–24-year-olds has fallen from 75% to 60%, which requires further research.

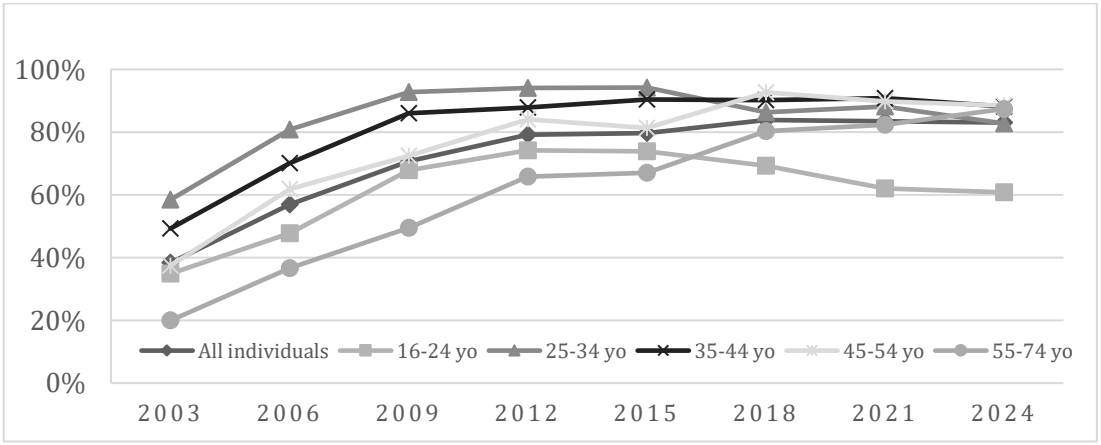
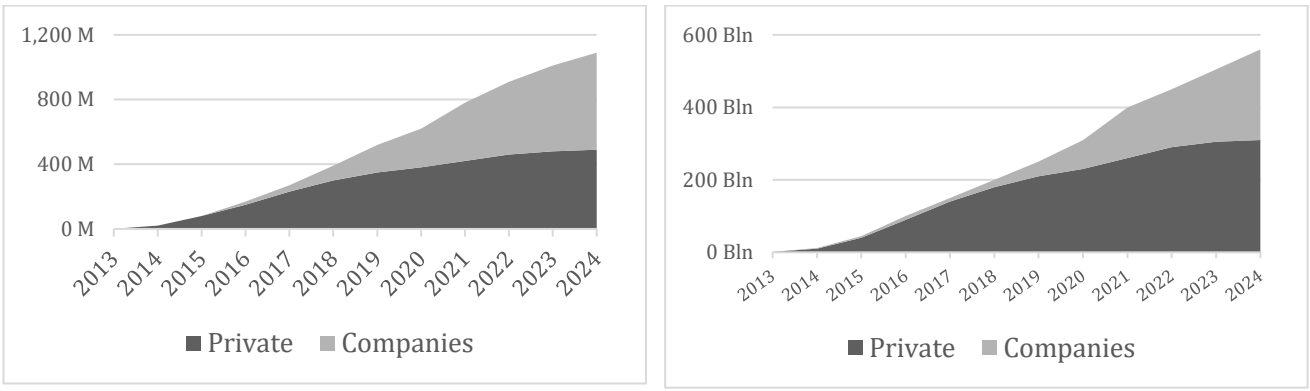


Figure 2.31 – Percentage of Swedes using Internet banking by age group

Source: Developed by the author based on data from [106].

An important factor in Sweden's rapid transition to cashless payments was the availability of effective alternatives to cash. One of the key solutions in this area was the

launch of the Swish mobile application in 2012, an innovative instant money transfer platform [107; 108; 109]. Swish makes it easy to make P2P, C2B and even B2B transactions without any fees. The money arrives instantly, regardless of the sender's or recipient's banking institution. Swish's success is attributed to its integration with all major banks in Sweden and the support of the central bank, which has given it credibility and a wide reach. A few years after its launch, 5 out of 6 Swedish adults were actively using the app [97; 98]. The number of Swish app users is constantly growing. Its popularity among private users has been growing since its launch, and in more than 10 years, the number of private user transactions in 2024 reached almost 500 million (Fig. 2.32). Companies joined somewhat later, around 2016–2017, but their growth has been much faster: companies now account for approximately 60% of all transactions, which amounts to 600 million transactions per year as of 2024. The average transaction size in the app in 2024 was around SEK 5,000 (≈ €60).



a) by count **b) by value**

Figure 2.32 – Annual transactions via Swish [109]

The total value of transactions via the app is also growing steadily, especially among private individuals, with an annual increase of approximately 110–115% from 2018 to 2024 (Fig. 2.32). As for B2B transactions, businesses only began to actively use Swish in 2021, which also correlates with the peak of the COVID-19 pandemic. The volume of B2B transactions in 2024 reached SEK 140 billion (≈ €13 billion) and has doubled since 2021 to ≈ €23 billion per year. year. In the period 2017–2020, the increase was around 200%, with a sharp jump in 2021, followed by a slowdown to an average annual growth rate of 120%, which is still very high.

Swish is not the only example of interbank cooperation in Sweden. Other examples include Bankomat AB, a joint ATM network created by leading Swedish banks. Users of all participating banks can withdraw funds without fees, which reduces costs for both banks and customers, and BankID, a national digital identification system used to log in to online banking, sign documents, authorise Swish and many other services (analogous to the Ukrainian system "Diia" or "ID Bank", and it is another example of the high level of trust and integration between government and financial institutions in Sweden). Thus, the successful transition to a cashless society in Sweden was made possible not only by the Riksbank's strict cash policy, but also by the availability of effective, convenient, free and secure alternatives that were widely supported by both citizens and banks [97; 98].

One of the important factors behind the low level of cash use in Sweden is the high level of public trust in the banking system and the government. People generally tend to keep their savings in cash and prefer cash payments when they do not trust banks, especially in times of crisis and uncertainty with high risks. For example, in many countries during financial crises, people withdraw funds from accounts and deposits and cash them in. This is not the case in Sweden. Even during the financial crisis of 2008-2009, there was no noticeable surge in demand for cash [97; 98].

Another unique feature of Sweden is that the law provides for the right of sellers to refuse to accept cash (Fig. 2.33). A seller can say: "We only work with non-cash payments", and this is a legally enshrined and common practice for both parties [97; 98]. The Riksbank has played an important role in the transition to low cash use, actively lobbying for cashless payments [110]. In cooperation with NGOs, think tanks, government agencies and other stakeholders, the Riksbank published numerous reports and analyses and conducted an information campaign to show that cashless payments are cheaper, more convenient, more efficient and more environmentally friendly than traditional cash. This approach worked in favour of the cashless transition.

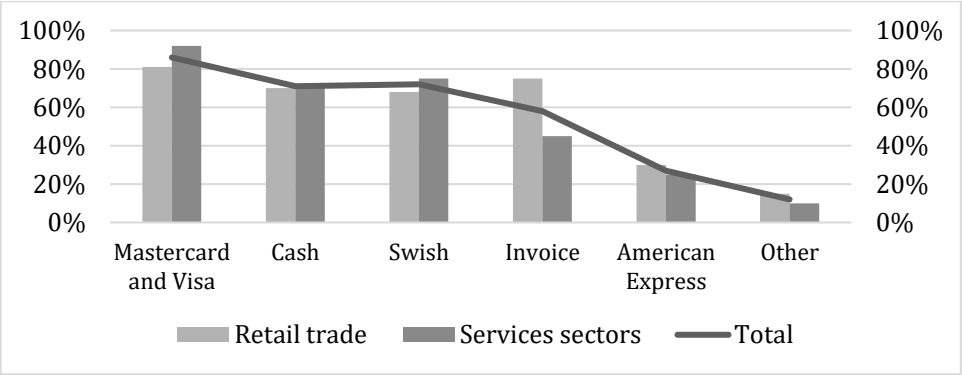


Figure 2.33 – Percentage of respondents who accept each payment method [102]

The situation changed dramatically in 2022, when the full-scale russian invasion of Ukraine forced the Swedish government to take measures to strengthen the role of cash. According to a study by Riksbank and the annual Payments report 2025 [111], most merchants can accept cards (offline and other cashless methods), while only two-thirds of small merchants accept cash (Fig. 2.34). In early 2022, the government sent out information leaflets advising citizens to keep a certain amount of cash at home, enough to survive for several days in the event of payment system failures or security threats [102]. In this way, the authorities emphasised the role of cash as the most reliable and stable means of payment in a crisis. At the same time, the right of sellers to refuse to accept cash was enshrined in law, but critical institutions (grocery stores, pharmacies, consumer services, etc.) were obliged to accept cash as a mandatory payment method. In 2022, the Riksbank expanded its competence in maintaining the cash infrastructure themselves, once again assumed responsibility for the collection, storage and delivery of banknotes and coins to guarantee uninterrupted access to cash [112; 113; 114].

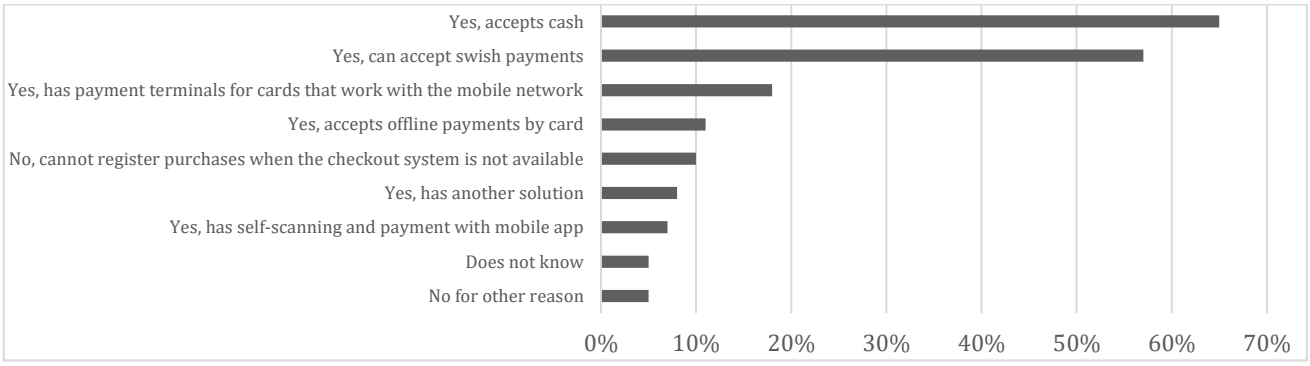


Figure 2.34 – Ability to accept payments when ICT is not working, 2023 [111]

As for households, there was no significant increase in the use of cash in 2022. However, in 2023, cash became a much more popular payment method, especially in

critical service sectors (Fig. 2.35). This also correlates with the actions of lobby groups and NGOs that advocate for the preservation of cash, arguing that a cashless society could exclude certain segments of the population, such as rural residents, people with physical or cognitive disabilities, immigrants without bank accounts, and older people for whom cash remains a more convenient and familiar means of payment [13].

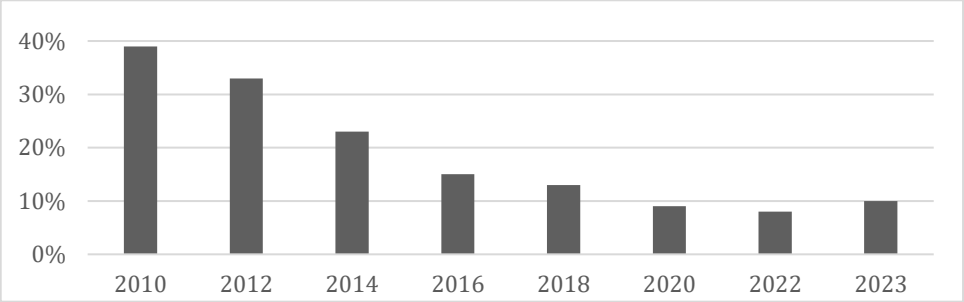


Figure 2.35 – Percentage of people who paid cash for their last in-store purchase [111]

However, despite the government's calls, Swedes did not panic, which again underlines their trust in the government and banks. The share of cash payments among all transactions has increased, but the 2023 survey showed that cards and the Swish app are still the most popular payment methods (Fig. 2.36). They are followed by online transfers via internet and mobile banking, direct debits, e-bills, and then cash. Also, more people decreased their use of cash than increased it in 2023. At the same time, the share of users of digital tools continues to grow rapidly.

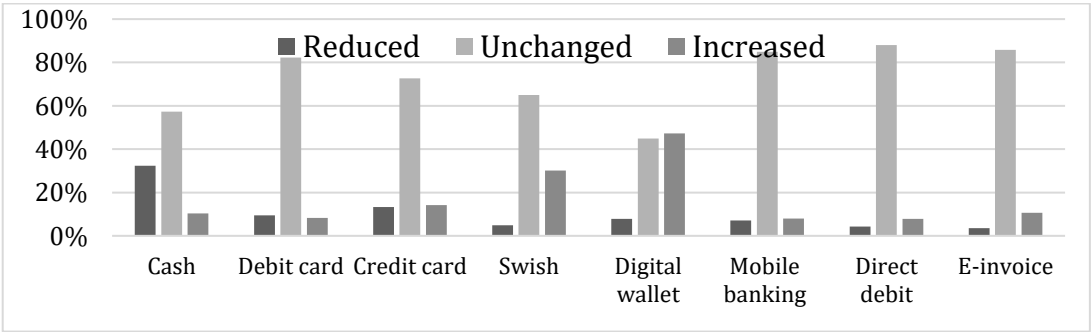


Figure 2.36 – Dynamics in payment methods in Sweden, 2023

Source: Developed by the author based on data from [101].

In 2023, security was the main reason for switching to cash payments: respondents cited it in two out of three cases of increased cash use. Half of those surveyed believe that cash allows them to better control their spending, and one in four believe that it provides greater anonymity. At the same time, only 8% of those who use cash more often said they did not have access to digital payment methods. Among those who reduced their use of

cash (about a third), the main motivation was inconvenience. Half of respondents said that cash is simply not accepted in many places. In addition, cash is perceived as a more complicated and less convenient payment method (Fig. 2.37).

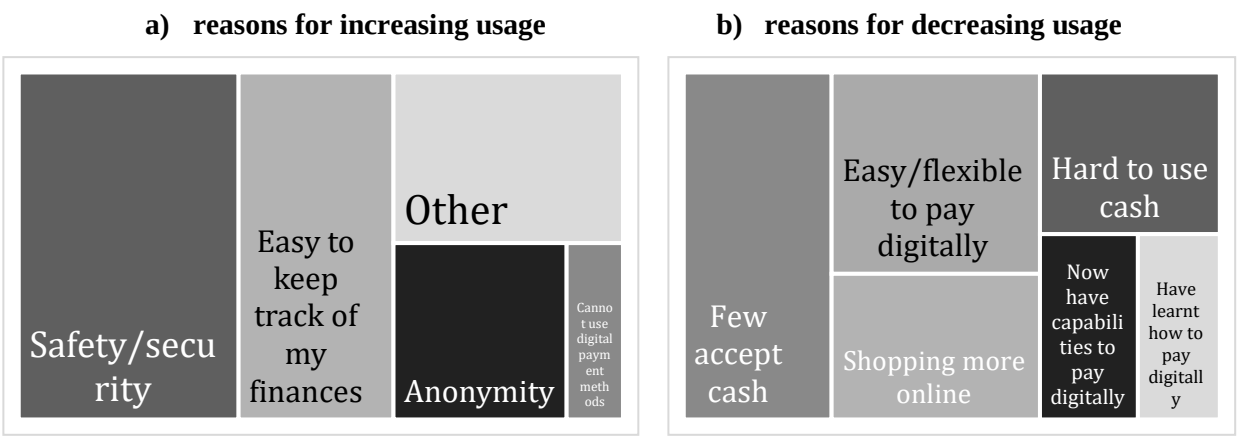


Figure 2.37 – Factors influencing changes in cash usage intensity

Source: Developed by the author based on data from [101].

The use of debit and credit cards has remained almost unchanged: the share of those who reduced their use is roughly equal to the share of those who increased it. At the same time, the main reasons for the increase in the use of payment cards are simplicity and flexibility, security, and the growth of online shopping, where cash payments are not accepted. On the other hand, those who have reduced their card use say that there are more convenient and efficient alternatives (Fig. 2.38). Interestingly, most people significantly increased their use of digital wallets (Apple Pay, Samsung Pay, Google Pay, etc.) – approximately 50% of respondentsThus, it is likely that these 32% of those who have reduced their use of cash have switched to digital wallets and Swish.

Figure 2.38 – Factors influencing changes in card payment usage intensity

Source: Developed by the author based on data from [101].

Swish has grown in popularity by about 30%, and it is likely that those who have reduced their use of cash have switched to digital wallets and Swish. Also, 4 out of 5 respondents cited simplicity and flexibility as the main reason for its increased use. About 50% started using Swish more often because of its wide acceptance among merchants and e-commerce, as well as its security (Fig. 2.39).

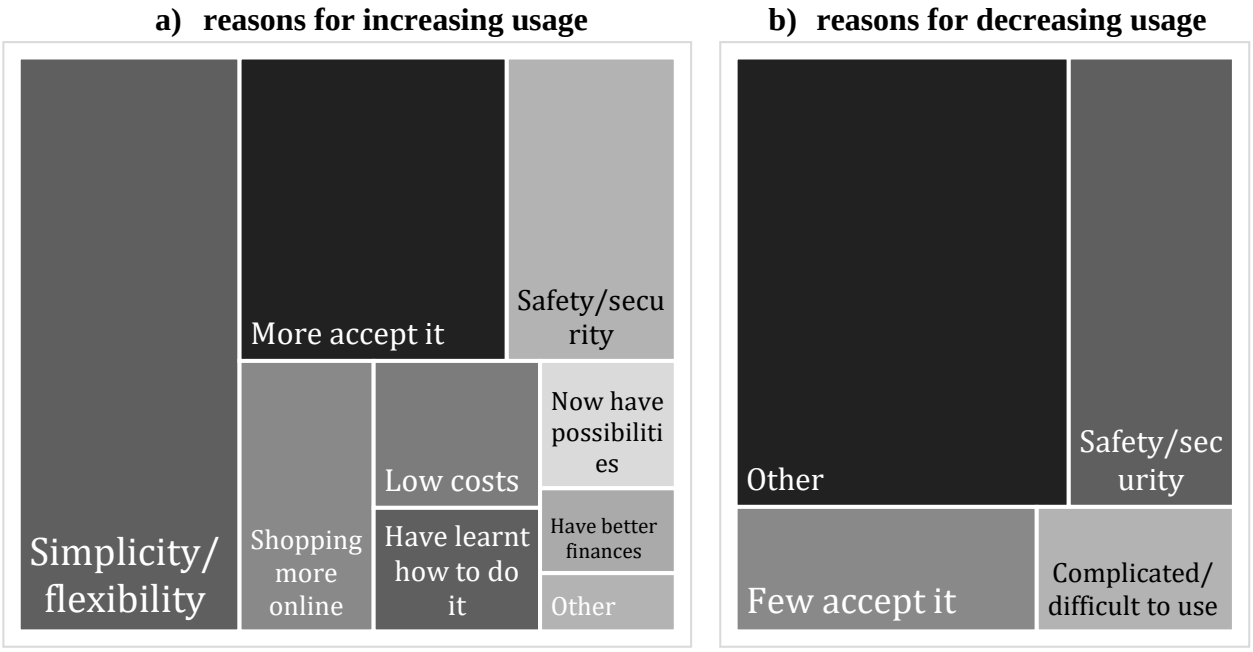


Figure 2.39 – Factors influencing changes in Swish app usage intensity
Source: Developed by the author based on data from [101].

Sweden has become one of the world's most prominent examples of the transition to a cashless economy. Thanks to its high level of digitalisation, trust in financial institutions, and the introduction of innovative payment solutions such as the Swish mobile app, the country has achieved the goal of having only about 10% of in-store purchases made in cash. However, recent geopolitical developments, including russia's full-scale invasion of Ukraine in 2022, have forced the Swedish authorities to rethink their strategy. The government and Riksbank have begun to encourage citizens to keep some cash in case of crisis, and have initiated legislative changes to ensure the availability of cash payments in critical sectors. This case demonstrates how, even in a high-tech society, risks need to be taken into account and financial inclusion needs to be ensured for all segments of the population.

2.4. Central bank digital currencies in the modern economy

This part is devoted to central bank digital currencies. In general, a CBDC can be defined as a digital equivalent, a digital form of a country's national currency that is legal tender and payment. And this digital currency is issued and traded by the central bank and has a direct obligation to the central bank. CBDCs can be a digital equivalent or a digital complement to paper currency (cash) (Table 2.1). Digital currencies of central banks are currently a very popular topic that is gaining momentum and being studied [21]: the option of introducing the issuance of digital currencies is being considered by governments of more than a hundred countries in one form or another and is actively discussed by international organisations such as the International Monetary Fund, the World Bank, the Organisation for Economic Cooperation and Development, and is widely represented in the discourse of the modern academy (Appendix D1). Among the key motivations for exploring CBDCs are the pursuit of more efficient and secure payment systems, increasing financial inclusion, and responding to the decline in cash usage in many advanced economies [2; 7; 21; 24; 116].

Table 2.1 – Central bank digital currencies concepta from selected sources

Author(s) / Institution	**Definition**
Ozili, P. K.	"a CBDC is a currency in digital form that is issued by a central bank and is a liability of the issuing central bank. A lay person could see a CBDC as the digital equivalent of central bank-issued paper currency or cash." [23]
Ward, O., Rochemont, S.	"a digital form of central bank money that is different from the balances in traditional reserve or settlement accounts." [117]
Bitter, L.	"a potentially interest bearing, centrally issued, account based, digital type of central bank liability that is accessible to the general public." [118]
European Central Bank	"electronic central bank money that (i) can be accessed more broadly than reserves, (ii) has much greater functionality for retail transactions than cash, (iii) has a separate operational structure compared to other forms of central bank money, allowing it to potentially serve a different core purpose." [119]
International Monetary Fund	"a digital representation of a sovereign currency issued by, and as a liability of, a jurisdiction's central bank or other monetary authority." [120]

National Bureau of Economic Research	“a monetary value stored electronically that represents a liability of the central bank and can be used to make payments.” [116]
Bank of Canada	“a monetary value stored electronically that represents a liability of the central bank and can be used to make payments.” [121]
Central Bank of Nigeria	“fiat digital money issued by a central bank.” [9]

In general, central bank digital currencies can be divided into two main categories based on the principle of operation: token-based CBDCs and account-based CBDCs (Table 2.2). Token-based CBDCs (sometimes called cash-like digital currencies) function very similarly to physical cash. It is designed to complement or even replace a certain portion of cash transactions, being an interchangeable tool for physical cash. In terms of user experience, using such a digital currency is almost indistinguishable from transferring or paying with regular cash: almost complete anonymity is maintained [2; 21; 24]. Among the advantages is the possibility of offline payments, as information about available funds is stored in a token-based digital key and can be transferred without access to the Internet. Also, such settlements are instantaneous and direct, as they do not require the participation of banks or other financial institutions other than the central bank [7].

Table 2.2 – CBDC design comparison: token-based vs. account-based approaches

Feature	**Token-based CBDC**	**Account-based CBDC**
Principle of operation	Mimics physical cash; “cash-like” digital token	Works like a bank deposit account at the central bank or via a commercial intermediary; “deposit-like” digital account
Anonymity	Nearly full anonymity (no persistent user identity attached)	None: full authentication and KYC required for each user and transaction
Privacy level	High privacy for small transactions, but limited audit trail for regulators	Low privacy: full transaction records enable oversight and compliance
Offline payments	Possible: value stored in the token and can be transferred without internet access	Not possible: network connection required to verify balances
Programmability	Limited: only token metadata and simple flagging of conditions	Rich: supports smart contracts, conditional logic, scheduled and recurring payments
Transaction speed	Instant and direct (no intermediaries except the central bank)	Instant (so long as any regulator- or bank-imposed limits are not exceeded)

KYC / Authentication	Not required for basic transfers; optional tiers may exist	Mandatory KYC/registration when opening an account
Functionality	Limited: peer-to-peer transfers and payments	Extended: supports scheduled/recurring payments, deferred payments, instalments, lending, etc.
Operational complexity	Moderate: requires secure token wallets and offline validation infrastructure	High: requires robust account management, real-time settlement, and regulatory compliance systems
Intermediaries	Only the central bank	Central bank directly or commercial banks acting as intermediaries, depending on the chosen model
Disintermediation risk	Low: token CBDC runs alongside cash and does not encourage mass shift from deposits to CBDC	Low: token CBDC runs alongside cash and does not encourage mass shift from deposits to CBDC
Impact on the banking sector	Minimal: complements existing cash without disrupting deposit base; banks remain primary credit providers	– If banking sector is uncompetitive: may spur banks to raise deposit rates, optimise costs and strengthen through competition – If sector is already competitive: risk of "bank run" as users shift funds to CBDC, threatening bank stability
Risk regulation	Central bank may set issuance limits at distribution points	Central bank can impose holding limits and transaction caps to prevent sudden outflows, though overly strict limits may undermine CBDC appeal
Cross-border capability	Technically possible if token standards interoperable, but requires bilateral agreements	More complex: requires integration of multiple interbank and regulatory frameworks

Source: Developed by the author based on information from [2; 7; 23; 24; 25; 116; 121]

Account-based CBDCs (sometimes called deposit-like CBDCs) function similarly to bank accounts: the user must open an account with the central bank or, according to the relevant model, with a commercial intermediary bank, undergo a full KYC procedure and register his or her account. The feature is the lack of anonymity: all transactions are authenticated, just like in traditional banking [116; 121]. The disadvantage is that such payments cannot be made offline – a network connection is required – but the speed of transactions can also be instantaneous, provided that a certain limit is not exceeded, set by the regulator or the bank. The advantage of the account-based model is the possibility of extended functionality: the platform is essentially online banking, where you can implement instalment payments, regular payments, deferred payments, lending, etc [24; 121]. However, there is a significant risk of disintermediation of the banking sector.

Banks currently act as intermediaries between the central bank – the issuer of the national currency and guarantor of its liquidity – and end users, or retail payers, accepting deposits and issuing loans. If the central bank directly manages users' accounts, a significant part of the intermediary functions of private banks could be transferred to the central bank. Users in this case would be able to transfer funds from commercial bank accounts to accounts at the central bank, which could significantly shake up the traditional banking system [2; 21; 25].

However, even if we are talking about the account-based CBDCs, two different scenarios are possible. The first scenario is that if the banking sector in the country is not competitive, then such a strategy of the central bank can, let's say, play to the advantage, in particular, due to the fear of deposit outflows from commercial banks [21; 23]. This fear may encourage banks to raise interest rates on deposits. Of course, it will not be possible to raise rates indefinitely, and banks will be forced to optimise costs, review their business model and cut operating expenses. This could lead to growth and strengthening of the banking sector through increased competition, as a new player, the central bank, will appear. On the other hand, if the banking sector is already competitive and in a state of equilibrium (deposit rates are as high as possible, lending rates are as low as possible, and transaction fees are minimal or non-existent), then commercial banks have no room to grow. If the central bank, then decides to launch a digital currency with more favourable rates for keeping funds in their accounts, users may become indifferent to where they keep their funds. In both scenarios, this could lead to a ‘bank run’ where users actively transfer their funds to the central bank's digital currency [21; 23]. In addition to reshaping the banking market, this also threatens the stability of the banking sector. However, even in this case, central banks can take regulatory measures to mitigate the side effects of CBDCs [25; 121]. For instance, they might introduce tiered wallet structures that offer larger holdings only to verified institutions while capping individual retail balances. This is a controversial point, however, as too strict restrictions may negate the benefits of digital currencies for end users: if transaction limits are too low, users may not feel it makes sense to switch to central bank digital currencies when banks and cash provide immediate settlement at all times. Moreover, central banks could design CBDCs

to operate alongside existing payment systems rather than replace them, thereby preserving correspondent banking relationships and cross-border settlement channels. So, a balancing act needs to be struck so that limits prevent a bank run without undermining the appeal of CBDCs [21; 25].

When it comes to other models of issuing digital currencies by central banks, the main approaches are direct models and two-tier models. Direct models assume that users hold their accounts directly with the central bank (Fig. 2.40). This type of the CBDC model maximises security, but increases disintermediation risks and requires significant investment from the central bank in order to mitigate possible threats to banking sector. In this case, the central bank, in addition to its traditional functions, takes on an extremely large part of the roles currently performed by commercial banks. After all, working directly with users, central bank – issuer and manager of the CBDC will have to build a know-your-costomer system, a compliance system, a customer support service, customer experience management, dispute resolution mechanisms, a data management system, etc in order to run na full-cycle management circle od the CBDC. This significantly changes the role and tasks of the central bank [21; 25].

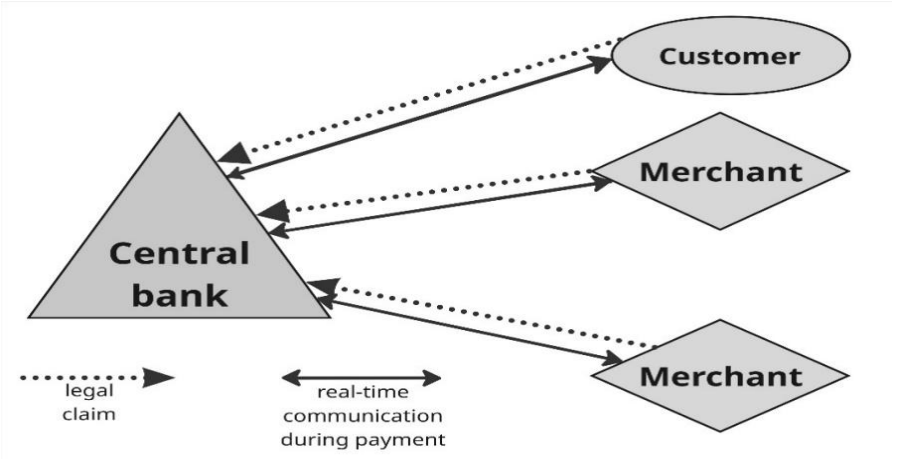


Figure 2.40 – Operational principle of the single-tier (direct) retail CBDC model

Source: Developed by the author based on inforantion from [2; 21; 24].

Instead, there is a two-tier model, also called an indirect or synthetic model. In this scheme, the central bank issues digital currency only for intermediaries (commercial banks and other non-bank financial institutions), and they already serve end users (Fig.

2.41). This preserves the role of intermediaries, optimises some of the costs, and preserves the market component of the banking sector, but has a number of disadvantages [25; 121]. In addition, such a model can reduce the risk of a systematic outflow of funds from commercial banks to CBDCs. At the same time, it makes it easier to manage the expansion of the central bank's balance sheet, as end-user deposits will also appear on the central bank's balance sheet [120]. Thus, we can distinguish between two types of central bank digital currency models: hybrid and indirect. The key difference is that in both cases, CBDC PSPs, which are actually intermediaries, are entitled to make payments among themselves in real time. As for the hybrid model, these PSPs cannot conduct transactions directly – all transactions are conducted through the central bank [21]. The central bank acts as an intermediary for direct transactions between different PSPs. It works like this: The central bank periodically (e.g. hourly) compiles and displays Retail Balances that cover all transactions between PSPs [2; 25].

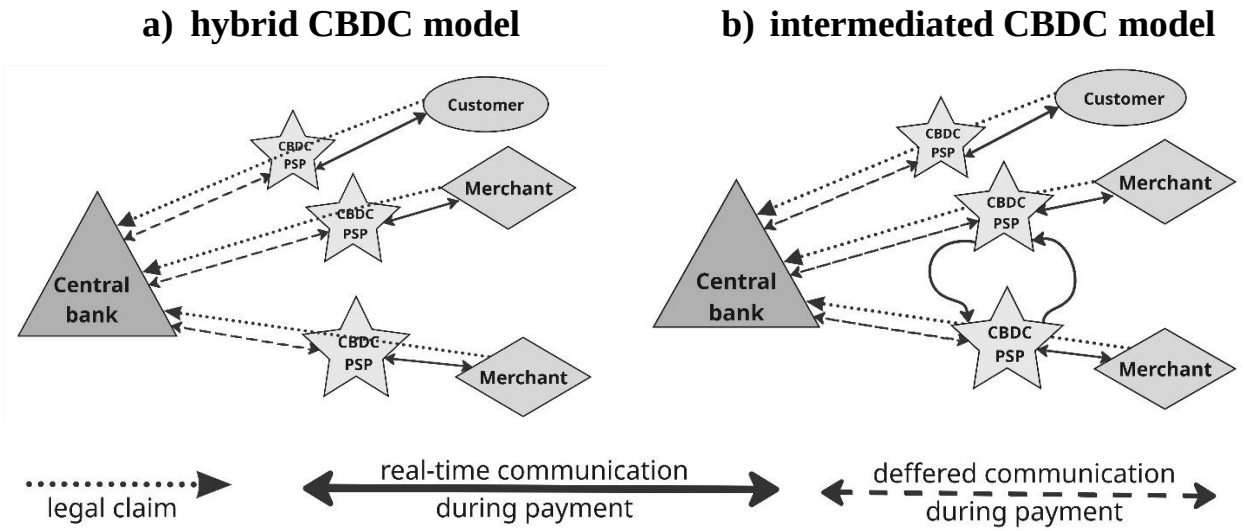


Figure 2.41 – Operational principle of the two-tier retail CBDC model
Source: Developed by the author based on information from [2; 21; 24].

Of course, each such innovation or development requires careful research and planning, and this planning and implementation cannot be a one-off. Instead, they should become a continuous digital currency lifecycle, in which the central bank ensures the stable functionality of the digital currency, identifies risks, plans mitigation measures (risk mitigation), assesses and controls existing problems, and then monitors the

effectiveness of the measures taken and, based on the results of the analysis, launches a new cycle of improvement [7; 21; 24; 25].

Central bank digital currencies are legal-tender digital forms of a country's fiat currency, directly issued and backed by the central bank. They come in two operational variants – token-based "cash-like" CBDCs, which offer near-anonymous, offline transfers much like physical cash, and account-based "deposit-like" CBDCs, which require KYC, operate online, and can support advanced banking services such as lending and instalments. Issuance can follow a direct model, where end users hold CBDC accounts at the central bank, or a two-tier (or hybrid) model, in which commercial banks and other intermediaries distribute and manage retail CBDC on behalf of the central bank. Effective CBDC rollout thus demands a continuous lifecycle of design, risk mitigation (e.g., holding and transaction limits), monitoring, and iterative improvement.

2.5. Cashless transition in Ukraine: current status, challenges and prospects

Ukraine is currently one of the world leaders in digital transformation and is actively implementing innovations in the payment sector. It has a developed infrastructure for cashless and electronic payments: from widespread POS terminals and instant payment systems to the state ID platform BankID. Support for cashless payments is being strengthened by initiatives such as the national system "Prostir" and the development of the digital currency E-Hryvnia. During the wartime, these solutions have become critical, ensuring the stability of financial services even in frontline and de-occupied regions. At the same time, the electronic platforms Diia and "ProZorro" are strengthening the transparency of the economy and promoting de-shadowing, while accelerating the digital transformation of the entire state.

Despite the start of russia's terroristic full-scale invasion of Ukraine on 24th February 2022 and seemingly logical assumptions, cashless payments in Ukraine are showing an upward trend, indicating resilience during wartime and early post-war recovery. According to data from the National Bank of Ukraine, compared to the first

quarter of 2024, in the first quarter of 2025, the number of transactions with Ukrainian bank cards in absolute terms increased by 13.5% [122; 123; 124]. Of these, more than 95% in terms of number and 65% in terms of amount were non-cash transactions. The remaining share of cashless paymenrs included cash-related card transactions, such as cash withdrawals or receipts. It is noticeable that there is an unquestionable trend towards the growing popularity of non-cash payments in Ukraine and abroad using issued by Ukrainian bakcs payment cards, both in terms of volume and number. When it comes to card transactions, the largest share in terms of amount and number is accounted for by payments via payment terminals. In second place is the payment for goods and services on the Internet, as well as transfers from cards to bank accounts, for example, to repay loans or replenish deposits (Fig. 2.42).

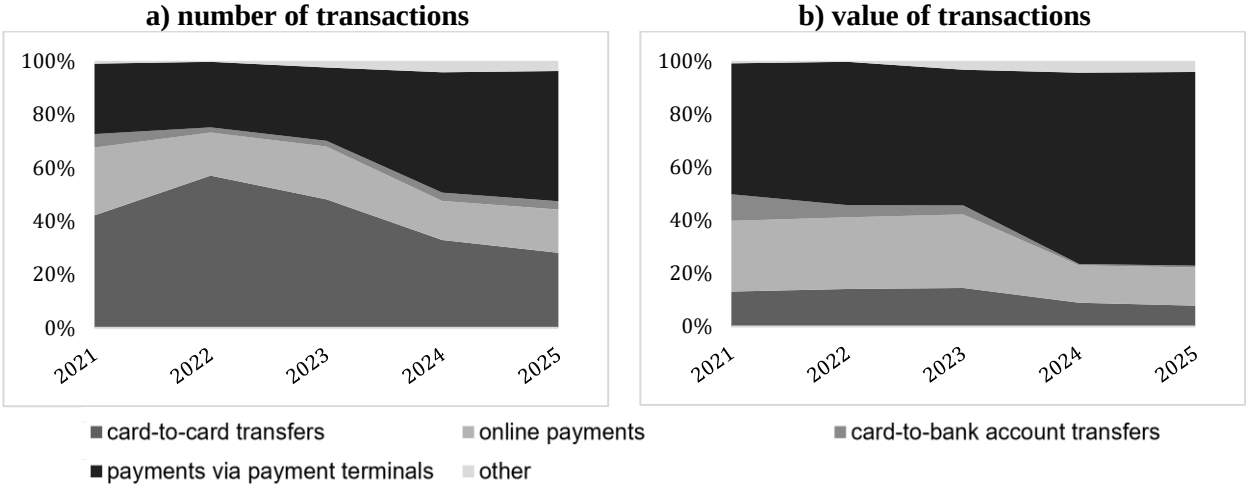


Figure 2.42 – Distribution of cashless payments by transaction type
Source: Developed by the author based on data from [125; 126; 127; 128; 129].

Despite the destruction of the payment infrastructure, the number of contactless cards continues to grow, and the number of active POS terminals in the retail and service network in the first quarter of 2025 increased by approximately 4% compared to the first quarter of 2024, while the number of merchants accepting card payments increased by 5% (Fig. 2.43). The number of cards issued increased by 4%, and among them, the number of active cards (used for transactions) increased. In terms of card types, contactless and tokenised cards are growing rapidly, and, accordingly, fewer transactions are being made with cards that require physical data reading.

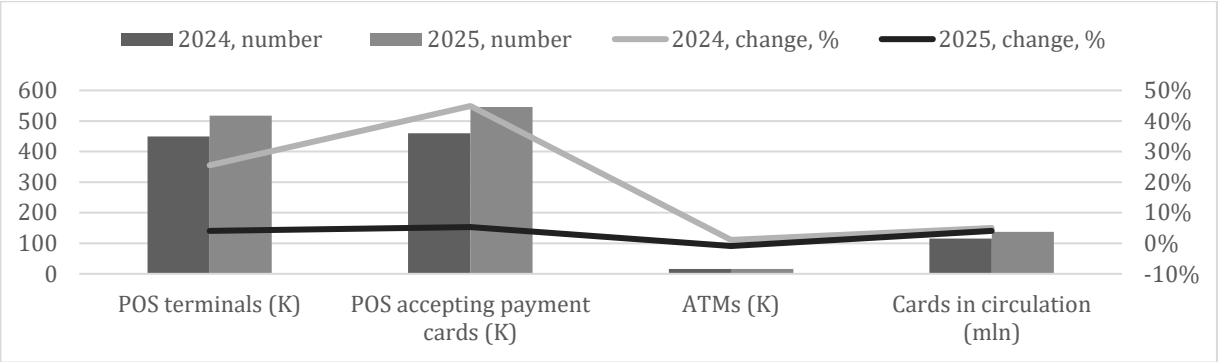


Figure 2.43 – Payment infranstructure facilities, annual counts and annual growth

Source: Developed by the author based on data from [130; 131].

The number of transactions using contactless cards or gadgets that support NFC technology is also growing. The number of ATMs has also decreased slightly, by approximately 1%. According to the NBU methodology, it is unclear whether this decline is due to reduced demand for ATM services or physical damage and loss of control over them due to russian full-scale war and temporary occupation of territories (Fig. 2.44).

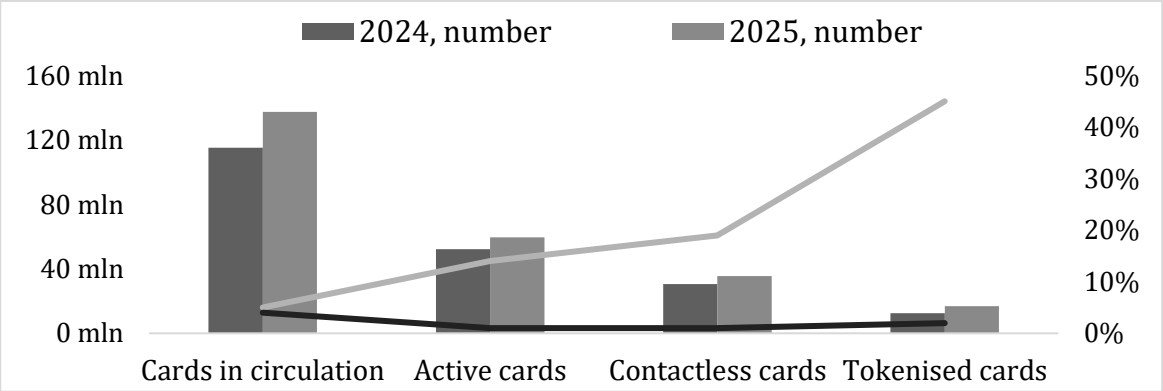


Figure 2.44 – Breakdown of cards in circulation: active, contactless & tokenized, count and annual growth)

Source: Developed by the author based on data from [130; 131].

Mastercard also notes an increase in the use of bank cards (according to its own data). According to Mastercard's research, 75% of respondents made cashless payments for utilities: that is, 3 out of 4 payers always or mostly pay for utilities by card. Two out of three payers purchase medicines with a card. Half of card users pay for tickets for all types of public (urban and interurban) transport, as well as for clothing and footwear. Two out of three Ukrainians choose cashless payment when given the choice. In 2023, one in ten Ukrainians said they prefer shops that offer cashless payment methods, i.e. they avoid shops where card payments are not available [132; 133].

Charity also contributes to cashless payments. Most donations are now collected cashlessly, and Monobank has introduced “Monobanky Charity”, an innovation that allows funds to be collected transparently and efficiently for various needs [134; 135]. This enables volunteers to raise funds to support the military and civilians. For the convenience of donors, a charitable cashback has been introduced: every month, Monobank pays cashback for selected categories of goods and offers to automatically transfer it to charity, providing a choice of funds and donation directions [136]. Rounding up the purchase amount is also popular, with the difference going to charity. Payment systems such as NovaPay [137], Ukrzaliznytsia [138], and others offer to automatically add a certain amount to the payment amount for volunteering or charity, chosen by the payer, when paying through their platforms.

In addition, there are government initiatives such as the so-called “Zelensky's Thousand” [139; 140] and a programme to support domestic producers through a cashback programme [141; 142], which is only available for non-cash card payments. This encourages users to make non-cash payments, as they receive cashback when paying by card, unlike when paying in cash. Social payments, in particular assistance to internally displaced persons, are mainly made cashless to bank cards. If people cannot receive payments to their card, the funds are transferred to a mobile account, which is also a cashless method.

Also, despite russia's full-scale invasion and the destruction it has caused, Ukraine's payment sector continues to stand out for its innovations. For example, on 1 December 2024, a new version of instant electronic payments from the NBU successfully launched in Ukraine, which, among other things, increases the level of innovation, transparency and accessibility. Currently, systemically important banks such as Oschadbank, Universalbank, Ukreximbank and others have already connected to this instant payment system, and the rest of the banks will gradually join according to their own plans [143].

Subsequently, the National Payment System “Prostir” was launched in Ukraine on the initiative of the National Bank of Ukraine. This is a system for card transfers in Ukraine in the national currency, the hryvnia. The purpose of the Prostir system is to simplify the payment for goods and services throughout Ukraine, reduce transaction costs,

facilitate online payments, including payments for utilities, delivery of goods and services, and taxis, as well as provide commission-free P2P transfers from card to card, even between cards of different banks. The Prostir system also allows users to withdraw cash at ATMs, bank branches, retail stores, pharmacies, and petrol stations equipped with POS terminals. A special feature is here that the NBU has made every possible effort to ensure that 100% of terminals in Ukraine meet the standards and requirements, i.e. support Prostir cards, which really increases their convenience throughout Ukraine [144; 145; 146; 147; 148].

Another rather innovative e-banking solution in Ukraine is BankID, a state-run remote identification system developed and operated by the National Bank of Ukraine [149; 150; 151]. BankID ensures the transfer of users' personal data from the bank where the account is opened to the service provider. It works as follows: any user who has an account with a financial institution participating in the BankID system can undergo identification, i.e. provide personal data and confirm their identity and documents. All it takes is a few clicks in mobile banking: the user selects the BankID login option and consents to the transfer of data. Data is transferred only with the user's consent and through secure channels using an electronic signature or bank seal. The system has a high level of security, as the identifier (bank) and service provider are verified by the NBU, and the BankID infrastructure is protected by enhanced cybersecurity measures. All data is encrypted and does not fall into the hands of third parties, preventing its unauthorised use. The BankID system has become extremely popular: since its launch in 2020, the number of identifications has grown exponentially in five years. By 2024, the number of successful identifications through BankID had doubled, reaching almost 90 million per year. The system became particularly important during the war: approximately one in six identifications was carried out to work with the Reserve+ platform of the Ministry of Defence of Ukraine [152], an electronic office for conscripts and reservists. In this way, BankID has significantly simplified and optimised identification processes in critical conditions (Fig. 2.45).

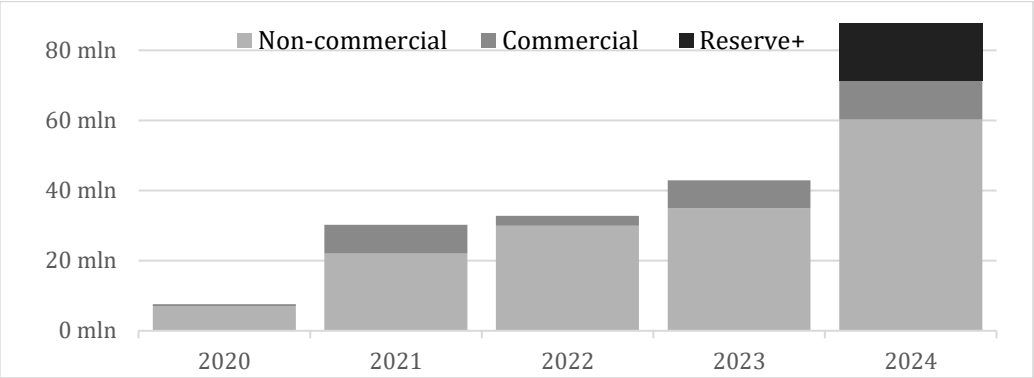


Figure 2.45 – BankID NBU system performance, successful identification count [150]

In Ukraine, known for its modern trends in the payment sector, the National Bank is actively working on developing its own digital currency – the E-Hryvnia [153; 154; 155]. In 2019, the NBU launched the first pilot project for a blockchain-based digital currency to test the technology in real-world conditions. This stage involved the release of a limited number of e hryvnias for a select group of test participants. The project gathered the necessary feedback and helped develop more realistic models for the functioning of the e hryvnia. The prerequisite for the creation of a digital currency is a high level of non-cash electronic payments in Ukraine, especially as a result of russian aggression. The country already has a developed payment infrastructure and continues to implement new innovative solutions in electronic and internet banking. The E-Hryvnia project is a logical continuation of the development of the digital financial sector.

According to the National Bank of Ukraine, the E-Hryvnia should increase financial inclusion, as banking services will become accessible to people with limited access due to geographical, physical or cognitive constraints (Fig. 2.46). The E-Hryvnia is also expected to strengthen confidence in the national currency, increase its stability and improve monetary transmission. In theory, digital currencies issued by central banks, and the E-Hryvnia is not the exemption, can strengthen the central bank's ability to conduct monetary policy by ensuring accurate and transparent control of money supply and flows. In addition, it is important that the E-Hryvnia counteracts the spread of private digital currencies, such as cryptocurrencies. Despite the current popularity of cryptocurrencies and the position of liberal economists who actively lobby for the adoption and wide spread legalisation of cryptocurrencies as a tool for expanding user

control over their own assets, market economy and anonymity, cryptocurrencies remain highly volatile and potentially dangerous, as there are no uniform standards for security checks against hacker attacks, fraud or data leaks. In addition, there is uncertainty in the regulation of cryptocurrencies – the global status of cryptocurrencies varies from country to country, and there is no single detailed and well-thought-out approach to their regulation due to the novelty of the technology. As a result, cryptocurrencies, in my opinion, carry more risks than benefits [153; 154; 155]. In Ukraine, legislation is currently attempting to regulate the crypto market in various ways, but due to the anonymous nature of cryptocurrencies, they are widely used for the shadow economy and tax evasion. These cryptocurrency effects lead to significant losses in state revenues and can serve as a cover for money laundering, terrorist financing and other illegal operations. The current discussion regarding central bank digital currencies is a response to the proliferation of private cryptocurrencies [156; 157]. The NBU emphasises that the E-Hryvnia is intended to reduce dependence on private digital currencies and increase the transparency of settlements, which will enable more effective monitoring of financial flows and de-shadowing of the economy [158; 159; 160].

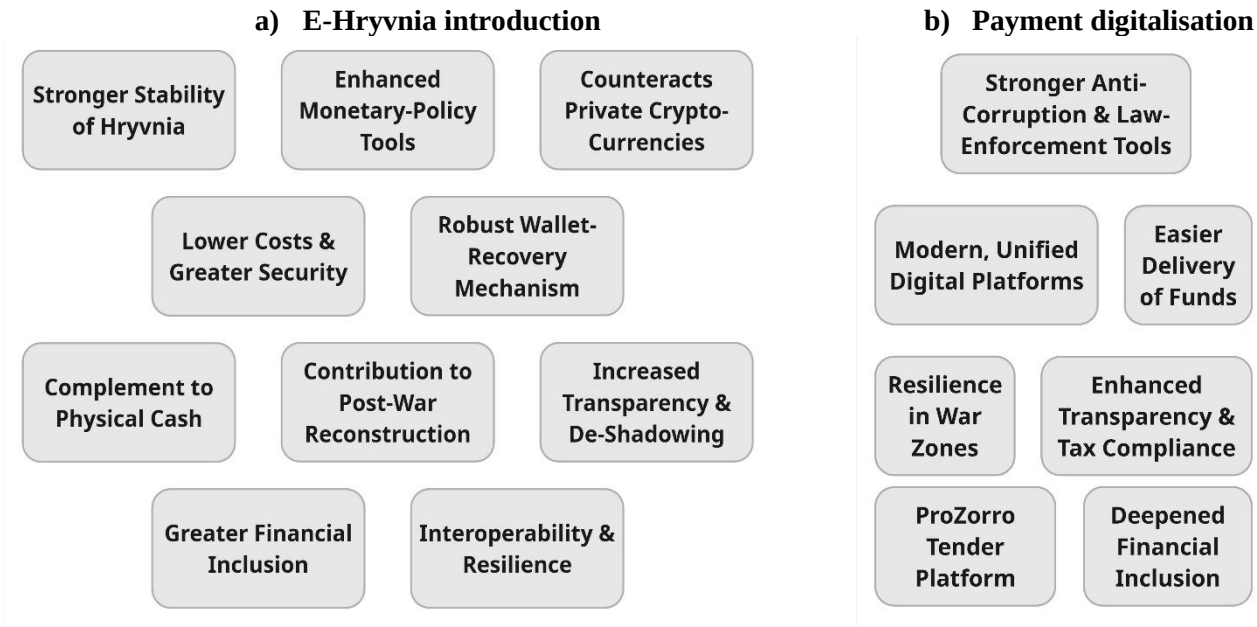


Figure 2.46 – Key benefits of digitalising economy

At the same time, the E-Hryvnia model is designed so that the NBU does not have direct access to data about transaction participants (Appendixes E1 and E2). The

confidentiality of users' personal information is guaranteed by banking secrecy, and it is stored by financial service providers. However, even under such conditions, digital payments leave a digital trail, which greatly simplifies the detection and prevention of illegal transactions. Additional advantages of the E-Hryvnia include reduced transaction costs and enhanced security for users, banks and merchants, as there is no need for collection, physical logistics and contact with cash. This remote identification, integrated with BankID, reduces the cost of the branch network and is extremely important in wartime to ensure the security of collection logistics in frontline and recently de-occupied regions. At the same time, central bank digital currencies have their own challenges. For example, the possibility of losing access to a digital wallet due to forgotten data or loss of a qualified electronic signature. The National Bank of Ukraine guarantees a simple mechanism for restoring access through BankID. In addition, the E-Hryvnia will allow users to quickly switch between different banks or non-bank institutions if their main bank is temporarily unable to provide services due to technical or security restrictions. The National Bank of Ukraine notes that there is currently no point in completely abandoning physical cash. The E-Hryvnia should complement existing payment instruments, allowing Ukraine to keep pace with global trends and providing another option with its own advantages for users, payers and merchants. The model developed by the National Bank of Ukraine is called the two-tier retail CBDC model, under which there are no direct transactions between users and the NBU. The E-Hryvnia is a platform operated by the National Bank of Ukraine, but financial interactions take place through commercial financial institution. The movement of funds and information between the NBU and commercial institutions is centralised, while PSPs organise P2P and P2B transfers, payments, etc. This model is designed to prevent disintermediation of the banking sector, prevent excessive load on the National Bank of Ukraine, and ensure the smooth functioning of the payment sector while maintaining the confidentiality of user data. The main goal is not only to preserve the role of banks, but also to stimulate the development of new financial services and, accordingly, economic growth [154; 155; 156].

The transition to a cashless economy in Ukraine also has broader implications and a number of advantages (Fig.2.46). First and foremost is the advantage of inclusion: as shown in paragraph 2.2, in any country, particularly in Europe and the EU, certain population groups in remote rural areas have limited access to banking services. Some age groups and people with physical or mental disabilities also often do not have access to banking services. In addition, banks charge fees for their services, which means that some people cannot afford to open an account or use cards. Therefore, the transition to a cashless economy is primarily aimed at increasing the inclusion of citizens. Expanding infrastructure, installing terminals, providing internet coverage, opening branches and introducing digital identification, creates the basis for greater inclusion in the financial sector [184]. This issue is particularly relevant in Ukraine: due to russian aggression, the population of frontline, occupied and recently de-occupied territories, where fighting and shelling continue, is suffering. Digital payments provide access to financial services when cash handling is difficult or dangerous due to collection and security risks. Thanks to digital identification, citizens can receive services and open accounts without presenting paper documents, which can be lost during evacuation or destruction. This gives them access to payments through electronic identification. Internally displaced persons, who also lose their documents, avoid additional bureaucracy and stress when applying for services. The digitisation of payments enables IDPs to receive state support, subsidies and social transfers in the form of electronic transfers to cards or accounts.

The second very important strategic aspect of a cashless economy is increasing the transparency of the entire economic sphere. According to research conducted by the NBU and the Ministry of Economy, during 2010–2013, the average level of the shadow economy was about 30% of Ukraine's GDP [159]. The shadow economy is measured using official methodologies that do not cover all illegal transactions, so the actual figures may be higher (Fig. 2.47). According to the NBU, about 90% of shadow payments are made in cash, and about 60% of such transactions are initiated by sellers who deliberately offer cash payments to avoid transparent taxation [160]. 99.9% of bribes are paid in cash, while non-cash payments leave an electronic trail and can be tracked [161].

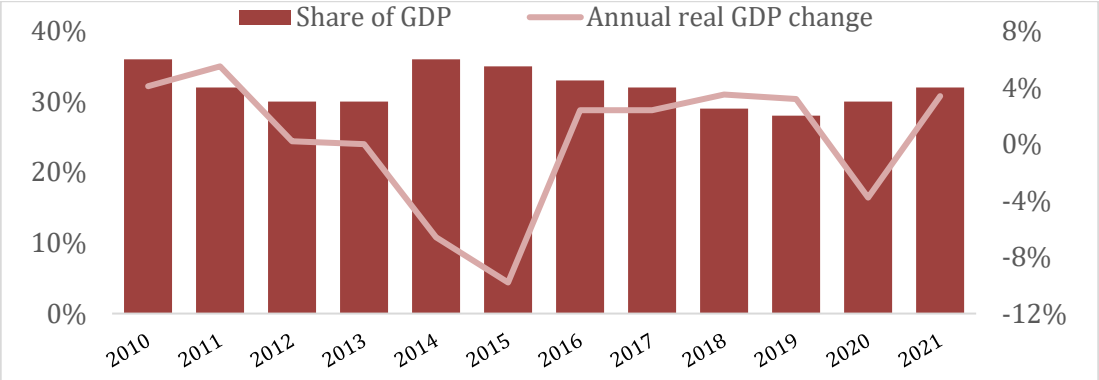


Figure 2.47 – Integral indicator of the shadow economy in Ukraine [159]

That is why Ukraine has passed a law requiring small businesses to install POS terminals and issue paper and electronic receipts with a mandatory QR code for each non-cash transaction to customers [162; 163; 164]. Although there is no definitive data on the impact of these regulations on reducing the shadow economy (partly due to limited access to information under martial law), it can be assumed that the widespread installation of terminals and issuance of receipts contribute to a reduction in tax evasion and 'envelope wages.' Another tool for combating the shadow economy, corruption and illegal financing is the transition to cashless payments [165; 166], through which entities lose their anonymity: banks can record large or suspicious payments and, at the request of law enforcement agencies, provide the necessary data in accordance with open banking regulations. Bank secrecy does not apply to cases of suspected illegal transactions, so law enforcement agencies can track transactions, sources of income and money laundering schemes. Examples of government payments (pensions, subsidies etc) are initiated as cashless transfers to cards or mobile accounts. This enables the government to quickly and securely distribute emergency grants from external donors, minimise logistical costs and ensure the transparency of every hryvnia paid in real time. The set of digital tools includes the Diia platform, where you can file an electronic declaration, fill out tax forms and pay taxes online [167]. A significant achievement was the ProZorro system, introduced in 2016 for electronic procurement and auctions. It opened up access to tender information to the public, allowing civil society organisations and think tanks to monitor government spending and expose corruption schemes. The World Bank noted that ProZorro helped uncover large money laundering schemes in public procurement [167;

168; 169]. Thus, cashless payments and digital platforms not only simplify financial transactions but also serve as effective tools for de-shadowing the economy and fighting corruption.

Therefore, it can be concluded that current trends in cashless payments in Ukraine indicate a rapid growth in the role of card and electronic payments thanks to a developed network of POS terminals, internet banking and mobile applications (Monobank, Privat24, etc.), as well as the introduction by the NBU of the instant electronic payment system (SEP) and the national system ‘Prostir’. The BankID platform simplifies remote identification, while the state services ‘Дія’ and ProZorro enhance the transparency of financial transactions and public procurement. During wartime, cashless payments ensured the stability of payments in frontline and de-occupied regions, as well as the rapid transfer of social payments and charitable donations. At the same time, the NBU is preparing a pilot E-Hryvnia, which will open up new opportunities for financial inclusion, reduce transaction costs, and help combat the shadow economy and corruption, cementing Ukraine's status as one of the leaders in digital transformation in the payment sector.

CONCLUSIONS

The evolution of cashless payments has gone through several key stages. In the 17th–19th centuries, cheques and centralised clearing houses appeared, in the mid-20th century, the MICR system has automated cheque processing, but fraud remained widespread. To reduce it, chip payment cards began to be introduced in the 1970s-1980s. Alongside cards, ATMs appeared, providing access to funds outside business hours. The first decade of the 21st century saw the dawn of e-commerce, while NFC technology launched contactless payments (MasterCard PayPass, Visa payWave). At the same time, the first digital wallets appeared (Apple Pay, Samsung Pay, Google Pay) ushering in a new era of mobile and cashless payments.

As a result of the conducted research, the concepts of transaction and payment were clearly defined and distinguished. As the technological basis of cashless payments constantly changed and new innovations appeared, the concept of cashless payments itself also changed. Often, "cashless", “digital”, and "electronic" payments are used as complete synonyms, since almost all cashless payments are digital, and most digital payments are electronic.

It has also been found that payment cards and e-payments are the key payment methods in the modern economy. Mobile applications such as digital wallets, P2P transfers, account-to-account transfers, and, in particular, mobile banks are becoming even more popular due to their convenience and extended capabilities. The latest innovation has been the implementation of blockchain technologies in the payment sector, including private cryptocurrencies, CBDCs, and mobile applications. There is a general decline in the use of cash, which has accelerated due to the COVID-19 pandemic. Globalisation of payment systems is increasingly integrating them into e-commerce. New FinTechs and active R&D are contributing to enhanced cybersecurity, fast payment solutions, and customer-centric approach. However, cash is still important for people who want to keep their savings "under the mattress". Cash also dominates low-value transactions. Credit transfers account for around 90% of the value of all non-cash transactions, while card payments account for more than half of their volume.

A comparative case study revealed that the Netherlands and Scandinavian countries are generally leaders in implementing the latest technologies for cashless payment methods. The Netherlands leads the eurozone countries in all indicators, followed by Finland and Estonia, France, and Italy. On the other hand, countries such as Germany, which is traditionally cash-oriented, countries with lower levels of economic development for the eurozone, such as Slovakia and Hungary, populist Austria, and offshore Cyprus lag significantly behind in the implementation of cashless payment methods.

Sweden is the undisputed global leader in creating a low-cash society. Sweden has been reducing the number of ATMs, has introduced a series of laws on enhanced tax reporting and mandatory cash registers. In 2015, Sweden passed a law allowing retailers to legally refuse cash as a means of payment. Commercial banks reduced the number of branches handling cash. Riksbank outsourced all cash services, and in the 2000s, the Riksbank carried out an aggressive two-stage cash changeover. Sweden became a leader in the development of e-commerce and well-developed ICT infrastructure. However, in 2022, due to russia's full-scale invasion of Ukraine, the Riksbank obliged critical retailers to accept cash. Despite this, Swedes have only slightly increased their use of cash, continuing to actively use digital and electronic methods.

An actively developing sector is the research and launch of CBDC pilot versions. In general, the advantages of CBDC include increased financial inclusion, reduced transaction costs, increased competition, greater transparency, and assistance in combating money laundering and terrorist financing. When properly programmed, CBDCs can also help with privacy and security, as well as increase inclusion among the unbanked population. CBDCs are becoming an additional monetary policy tool for central banks. The disadvantages of CBDC include the risk of disintermediation. There are two main models of CBDC. Token-based CBDC, which is essentially a digital analogue of cash, and account-based CBDC, which functions as a deposit account at a central bank or through commercial intermediaries.

As for Ukraine, the country is highly digitised with a wide range of adapted digital solutions in various areas. Even despite the full-scale russian invasion, the number and

value of cashless payments are steadily increasing. The payment infrastructure is expanding: the number of POS terminals and cards in circulation is growing, as is the activity of issued cards and the number of contactless and tokenised cards. Numerous innovations are being introduced: monobanks that facilitate donations to charity; cashback for charitable contributions; integrated donation options from Monobank, Nova Poshta, Ukrzaliznytsia, Oschadbank, and others. Social payments (pensions, subsidies, IDP assistance, national cashback and other types of assistance) are mostly or exclusively cashless, which allows real-time tracking of cash flows and contributes to greater transparency of budget expenditures. In 2024, the NBU launched a new system of instant payments between payment service providers, including commercial banks. During russia's full-scale invasion, the Prostir platform was launched, which brings together all commercial banks and payment service providers, standardises cards, eliminates commissions and unifies ATMs and POS terminals. BankID has been in operation since 2020, providing digital authentication and authorisation for users to access public and commercial services, and its use has more than doubled in the last year. The development of the hryvnia is actively underway: the first pilot project was launched in 2019, and the second in spring 2022. The hryvnia aims to reduce costs, increase security and financial inclusion, especially in temporarily occupied or frontline regions where cash services are difficult and can lead to loss of savings. In addition, it will contribute to post-war reconstruction, serve as an additional monetary policy tool during the war-induced economic crisis, and increase the interoperability and resilience of payment services. To increase transparency in public procurement, the Prozorro platform was launched, which has made tenders and the use of budget funds about three times more efficient. Overall, digitalisation and the transition to cashless payments allow banks to track cash flows and break the chains of the shadow economy.

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APPENDIXES

Appendix A

Table A.1 – Definition of most popular payment methods

Payment Method	Definition
Payment cards	This payment method is a payment instrument based on card-scheme rules that enables withdrawing or placing cash and transferring value via an end-user account linked to the card [34; 62; 86].
Debit cards	This payment method is a payment card linked directly to a bank account, allowing the payer to spend only available funds and to authorize one-off or merchant-initiated recurring transfers [62; 170].
Credit cards	This payment method is a payment card issued by banks or financial institutions that enables purchases on credit up to a set limit, with balances paid later and interest charged on borrowed funds [34; 42].
Prepaid cards	This payment method is a preloaded debit card that can be spent up to its stored balance and reloaded online, at ATMs, or participating locations, functioning similarly to a gift card [196].
Bank transfers	This payment method is a direct transfer of funds between bank accounts, supporting one-off domestic or SEPA/SWIFT credit transfers [62; 86; 170; 171]
Digital wallets	This payment method is an electronic service or mobile application that securely stores payment information and enables electronic or NFC-enabled transactions [86; 172; 173].
Cryptocurrency	This payment method is a decentralized digital currency not issued by central banks, such as Bitcoin or Ethereum, used for online transactions on blockchain networks [174; 175; 176].
Mobile payments	This payment method is payments conducted through mobile devices using dedicated apps or QR codes to initiate and complete transactions [86; 170; 177].
Contactless payments	This payment method is transactions performed by tapping a contactless-enabled card or device near an NFC-enabled point-of-sale terminal [62; 178].
Online banking	This payment method is payments initiated directly from a bank account via online banking platforms or internet-banking interfaces [62; 86; 179; 180].

Appendix B

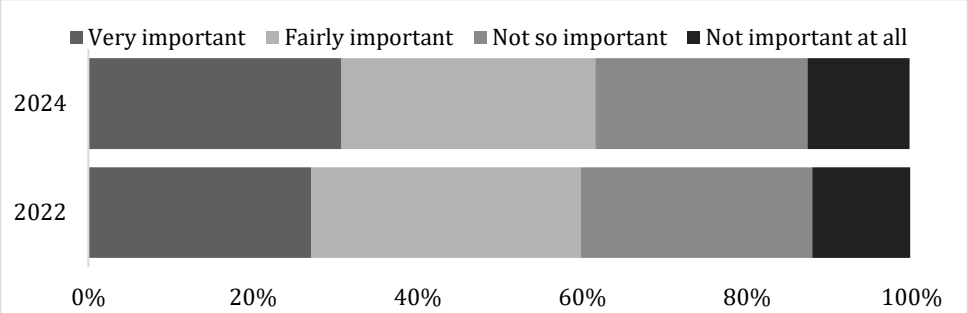

Figure B1 – The importance of having the option to pay with cash, Euro Area data
Source: Developed by the author based on data from [89].

Table B.1 – Correlation matrix of cashless payment instruments and financial channels

Source: Developed by the author based on data from [88].

	Cashless payments	All cards	Cards with debit function	Cards with credit function	Contactless cards	Magstripe cards	Credit transfers	Direct debits	Cheque payments	Card and e-money payments	E-money payments	Fast payments	Retail & fast payment systems	Fast payment systems	Retail payment systems	EFTPOS	ATMs	Cash withdrawals	Cash deposits	All institutions	Banks	E-money issuers	Non-banks	Accounts
Cashless payments	1.0	0.9	0.9	0.9	0.4	0.9	0.6	0.6	-0.6	0.7	0.1	0.9	0.6	0.8	0.7	0.5	0.1	-0.9	0.4	-0.1	-0.8	0.1	0.5	0.2
All cards	0.9	1.0	1.0	1.0	1.0	0.8	0.2	0.7	-0.9	0.9	0.9	0.6	0.8	0.8	1.0	1.0	0.5	1.0	0.9	0.9	0.9	0.6	0.5	0.0
Cards with debit function	0.9	1.0	1.0	0.9	1.0	0.8	0.9	0.6	-0.7	0.9	0.9	0.6	0.8	0.8	1.0	0.6	0.6	1.0	0.9	0.9	0.8	0.8	0.8	-0.1
Cards with credit function	0.9	1.0	0.9	1.0	1.0	0.7	0.2	0.5	0.3	-0.9	1.0	0.9	0.5	0.8	0.8	1.0	0.9	0.2	0.1	0.9	1.0	0.8	0.8	-0.1
Cards with cash function	0.4	1.0	1.0	1.0	0.8	0.1	0.6	0.0	-0.8	0.9	0.9	0.9	0.6	0.7	0.8	1.0	0.9	1.0	0.9	1.0	0.9	0.8	0.8	-0.2
Contactless cards	0.9	0.8	0.8	0.7	1.0	-0.8	0.2	-0.2	-0.5	0.8	0.9	0.9	0.9	0.7	0.9	0.7	0.9	-0.7	0.7	0.7	0.6	0.6	0.6	-0.2
Magstripe cards	0.6	0.2	0.9	0.2	0.1	-0.8	1.0	0.6	0.1	0.9	0.9	0.6	0.6	0.9	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	-0.1
Credit transfers	0.9	0.7	0.6	0.5	0.6	0.2	0.6	1.0	0.3	0.6	0.7	0.3	0.6	0.8	0.8	0.5	0.7	0.5	0.0	0.1	0.5	0.4	0.4	-0.1
Direct debits	0.6	-0.2	-0.1	0.3	0.0	-0.2	-0.6	0.1	1.0	0.3	0.0	0.0	0.0	0.4	-0.2	0.1	-0.1	0.5	-0.2	0.0	0.3	0.4	-0.1	0.7
Cheque payments	-0.6	-0.9	-0.7	-0.9	-0.8	-0.5	0.1	0.3	1.0	-0.9	-0.6	0.1	0.6	0.5	0.8	0.5	0.7	1.0	0.9	0.9	1.0	0.8	0.8	0.2
Card and e-money payments	0.7	0.9	0.9	1.0	0.9	0.8	0.9	0.6	0.3	-0.9	0.8	1.0	0.6	0.8	0.8	1.0	0.9	-0.9	-0.9	-0.1	0.9	0.8	0.8	-0.2
E-money payments	0.1	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.0	-0.6	0.8	1.0	0.7	0.9	0.9	1.0	0.9	0.9	-0.8	-0.8	0.7	0.7	0.7	-0.1
Fast payments	0.9	0.6	0.6	0.5	0.6	0.9	0.6	0.3	0.0	0.1	0.6	0.7	1.0	0.6	0.8	0.5	0.7	0.5	0.5	0.4	0.4	0.4	0.4	-0.2
Retail & fast payment systems	0.6	0.8	0.8	0.8	0.7	0.7	0.9	0.6	0.0	0.4	0.7	0.8	0.6	1.0	0.8	1.0	1.0	0.2	0.6	0.9	0.7	0.9	0.9	-0.1
Fast payment systems	0.7	0.8	0.8	0.8	0.9	0.7	0.9	0.8	-0.2	0.5	0.8	0.9	0.8	0.8	1.0	1.0	0.9	0.1	0.5	0.7	0.6	0.7	0.7	-0.6
Retail payment systems	0.5	1.0	1.0	1.0	0.7	0.9	0.9	0.5	-0.2	0.5	1.0	0.9	0.5	1.0	1.0	1.0	0.9	0.1	0.1	0.8	0.9	1.0	0.8	-0.2
EFTPOS	0.1	1.0	0.9	0.9	0.9	0.9	0.7	0.1	0.7	0.9	0.9	0.7	1.0	0.9	0.9	0.9	1.0	0.9	0.9	0.8	0.9	0.8	0.7	0.2
ATMs	-0.5	0.5	0.6	0.1	1.0	-0.7	0.9	0.5	-0.1	1.0	-0.9	-0.8	0.5	0.2	0.1	0.1	0.1	0.9	1.0	1.0	1.0	0.9	0.0	0.1
Cash withdrawals	-0.9	1.0	1.0	0.2	1.0	-0.7	0.9	0.0	-0.1	1.0	-0.9	-0.8	0.5	0.0	0.1	0.1	0.9	1.0	1.0	1.0	1.0	0.8	0.9	0.1
Cash deposits	0.4	0.9	0.9	0.1	0.9	0.7	0.9	0.1	-0.2	0.9	0.9	0.9	0.6	0.7	0.9	0.5	0.8	1.0	1.0	1.0	0.9	0.9	0.9	0.3
All institutions	-0.1	0.9	0.9	1.0	0.7	0.9	0.5	0.0	0.9	0.9	0.8	0.5	0.9	0.7	0.9	0.7	0.9	0.8	1.0	1.0	1.0	0.8	0.9	0.6
Banks	-0.8	0.9	0.8	1.0	0.9	0.6	0.9	0.4	0.3	1.0	0.9	0.7	0.4	0.7	0.6	1.0	0.8	1.0	1.0	1.0	1.0	0.8	0.8	1.0
E-money issuers	0.1	0.6	0.8	0.8	0.6	0.9	0.4	0.4	0.4	0.8	0.8	0.4	0.9	0.7	0.8	0.8	0.7	0.7	0.9	0.8	0.8	1.0	0.6	-0.1
Non-banks	0.5	0.5	0.8	1.0	0.7	0.9	0.4	-0.1	0.8	0.8	0.9	0.4	0.9	0.4	0.8	0.9	0.9	-0.1	0.9	0.9	0.8	0.6	1.0	-0.2
Accounts	0.2	0.0	-0.1	-0.1	-0.2	-0.2	-0.1	0.7	0.2	-0.2	-0.1	-0.2	-0.1	-0.2	-0.2	-0.2	0.1	0.1	0.3	0.6	1.0	-0.1	-0.2	1.0

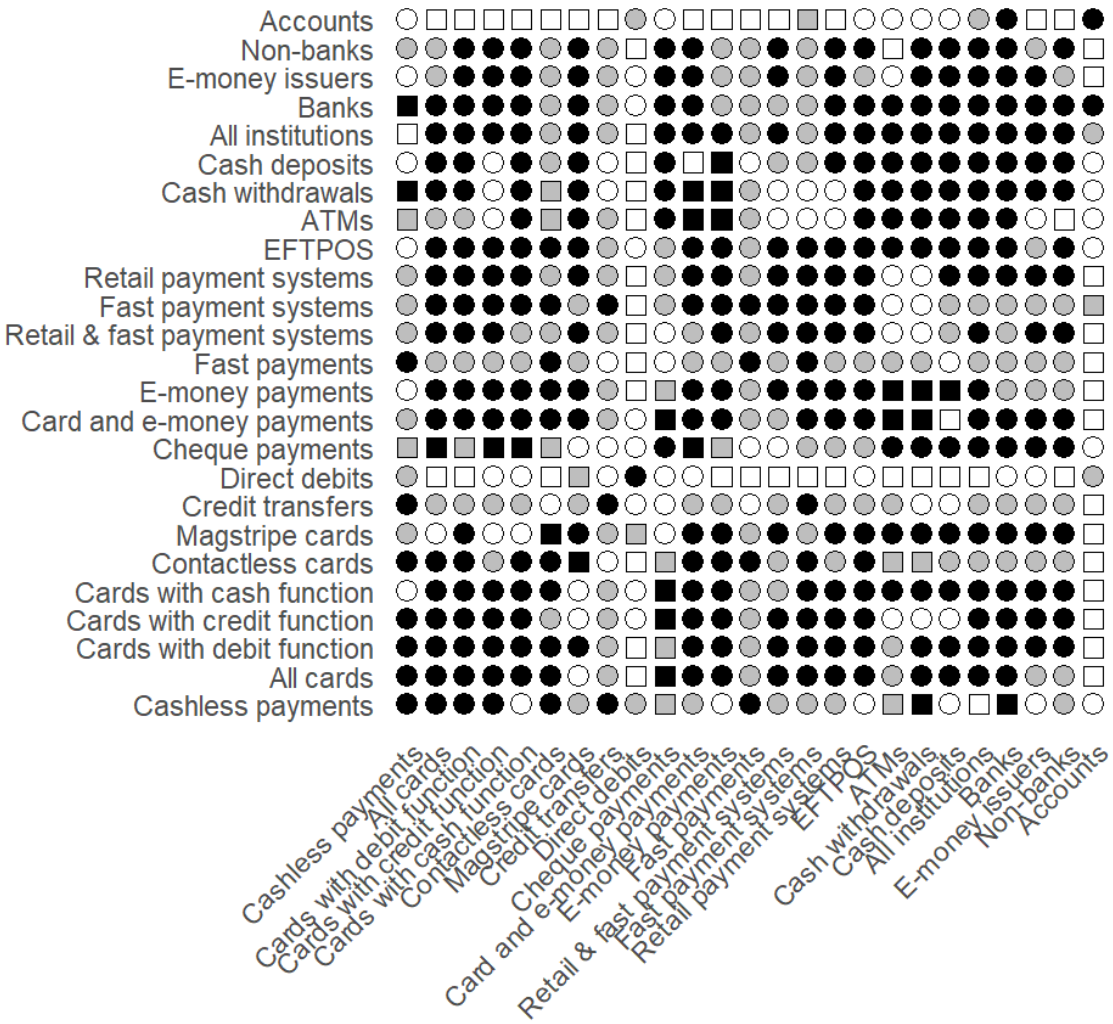

Figure B.2 – Correlation matrix of cashless payment instruments and financial channels

Source: Developed by the author based on data from [88].

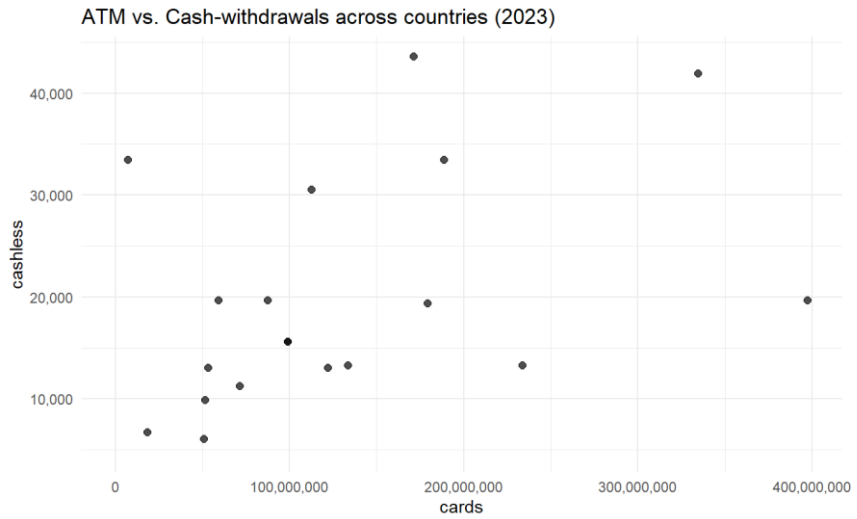

Figure B.3 – Comparative scatter plots, EU-27, 2023
Source: Developed by the author based on data from [90].

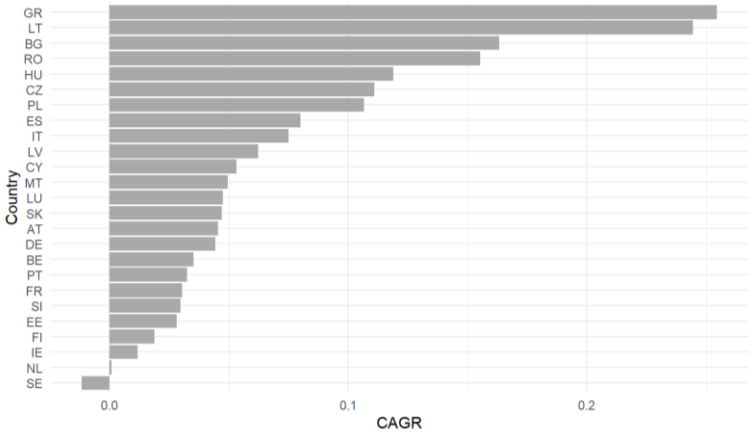

Figure B.4 – CAGR of card payments, value to GDP ratio, by country, 2014-2023
Source: Developed by the author based on data from [90]

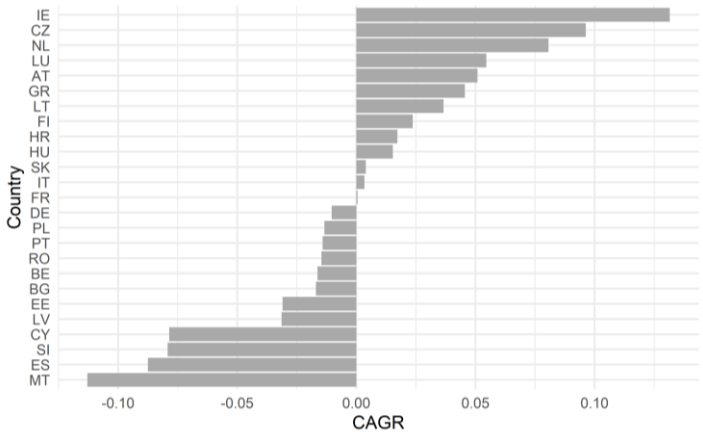

Figure B.5 – CAGR of credit transfers, value to GDP ratio, by country, 2014-2023
Source: Developed by the author based on data from [90]

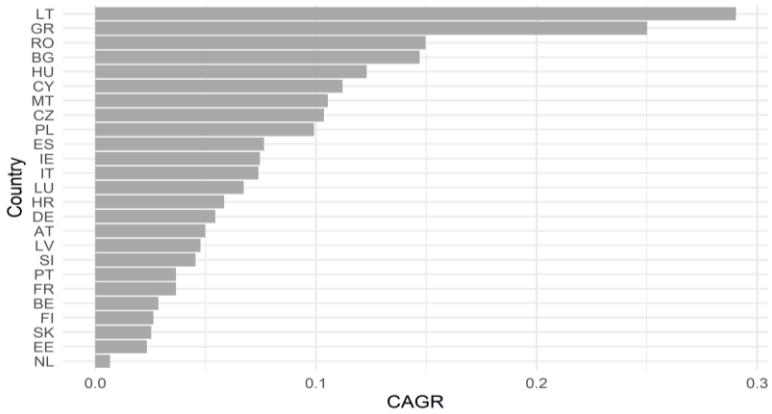

Figure B.6 – CAGR of direct debits, value to GDP ratio, by country, 2014-2023
Source: Developed by the author based on data from [90]

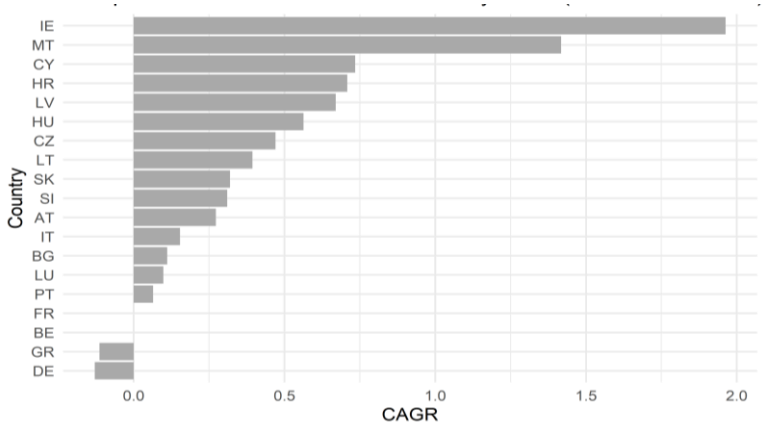

Figure B.7 – CAGR of e-payments, value to GDP ratio, by country, 2014-2023
Source: Developed by the author based on data from [90]

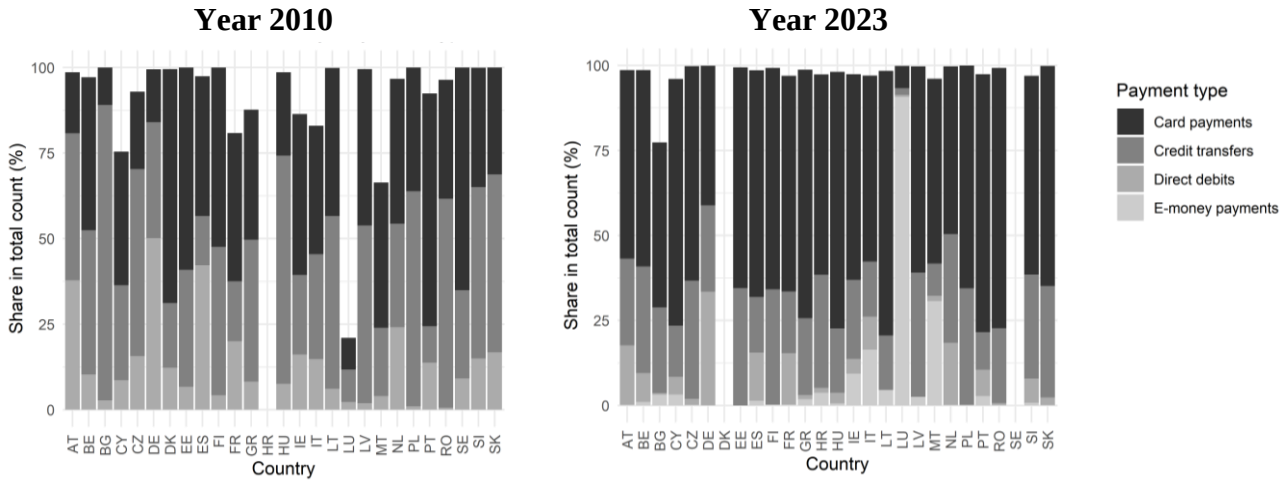

Figure B.8 – Share of transaction count by payment type
Source: Developed by the author based on data from [90]

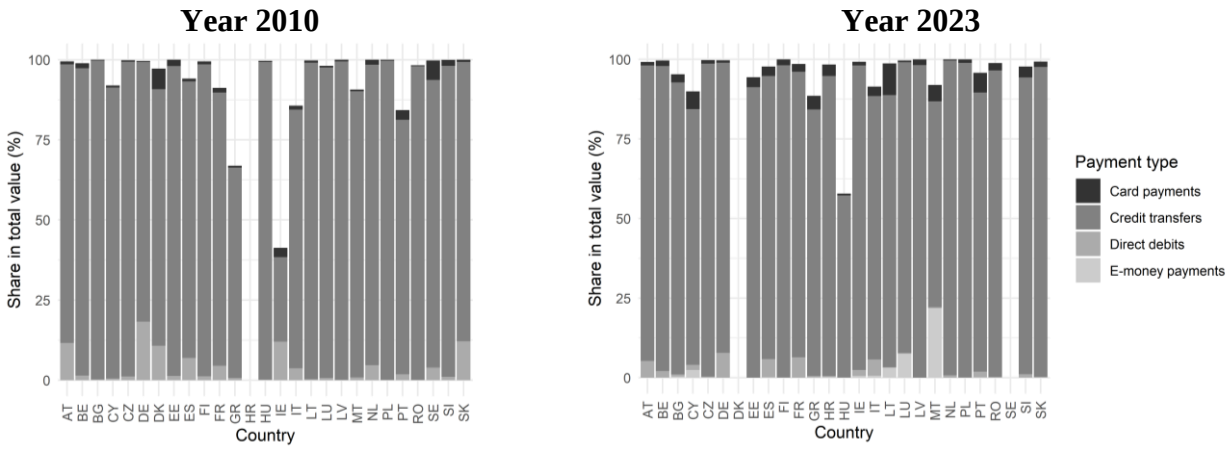

Figure B.9 – Share of transaction count by payment

Source: Developed by the author based on data from [90]

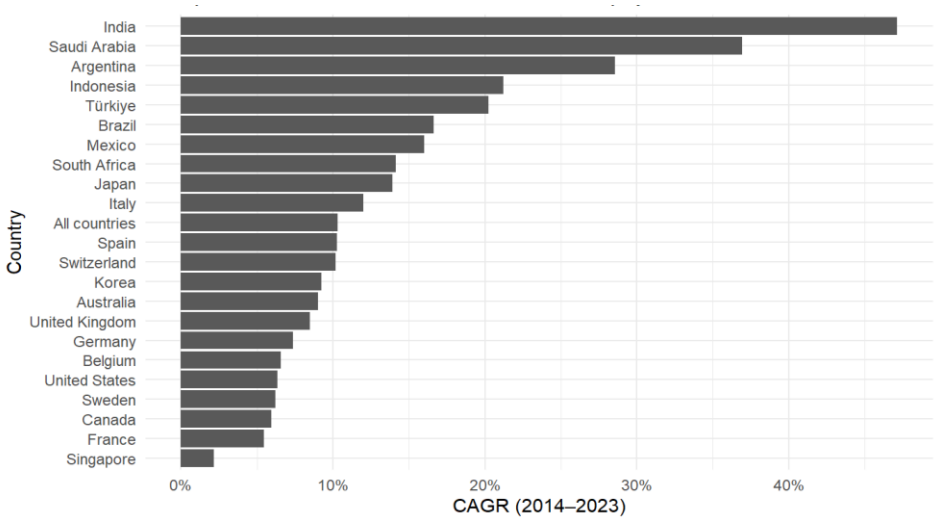

Figure B.10 – CAGR of cashless payments, value to GDP ratio, by country, 2014-2023

Source: Developed by the author based on data from [88]

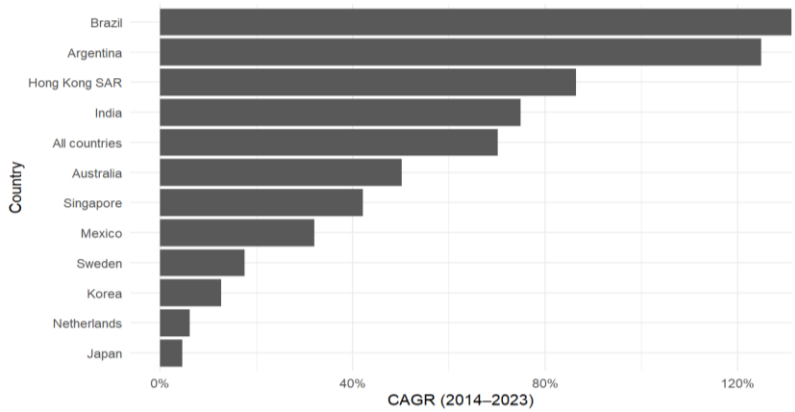

Figure B.11 – Compound annual growth rate of fast payments, value to GDP ratio, by country, 2014-2023

Source: Developed by the author based on data from [88]

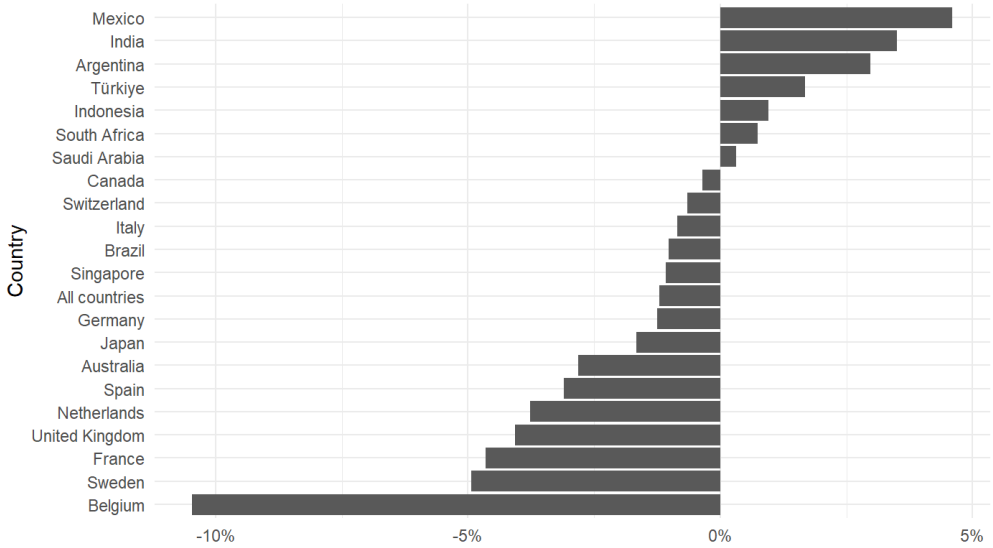

Figure B.12 – Compound annual growth rate of ATMs, value to GDP ratio, by country, 2014-2023

Source: Developed by the author based on data from [88]

Appendix C

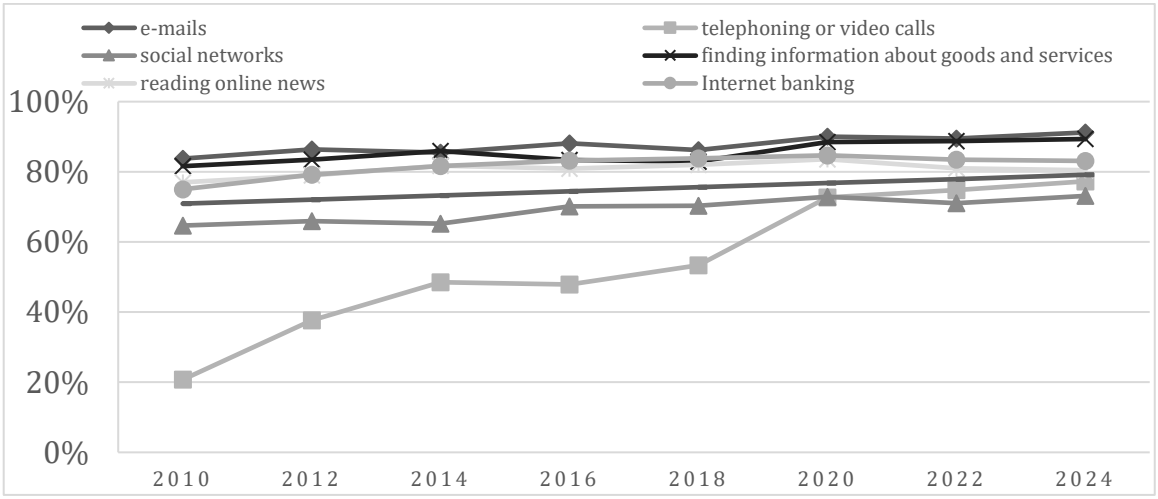

Figure C.1 – Share of Swedes engaged in key internet-based activities
Source: Developed by the author based on data from [106].

Appendix D

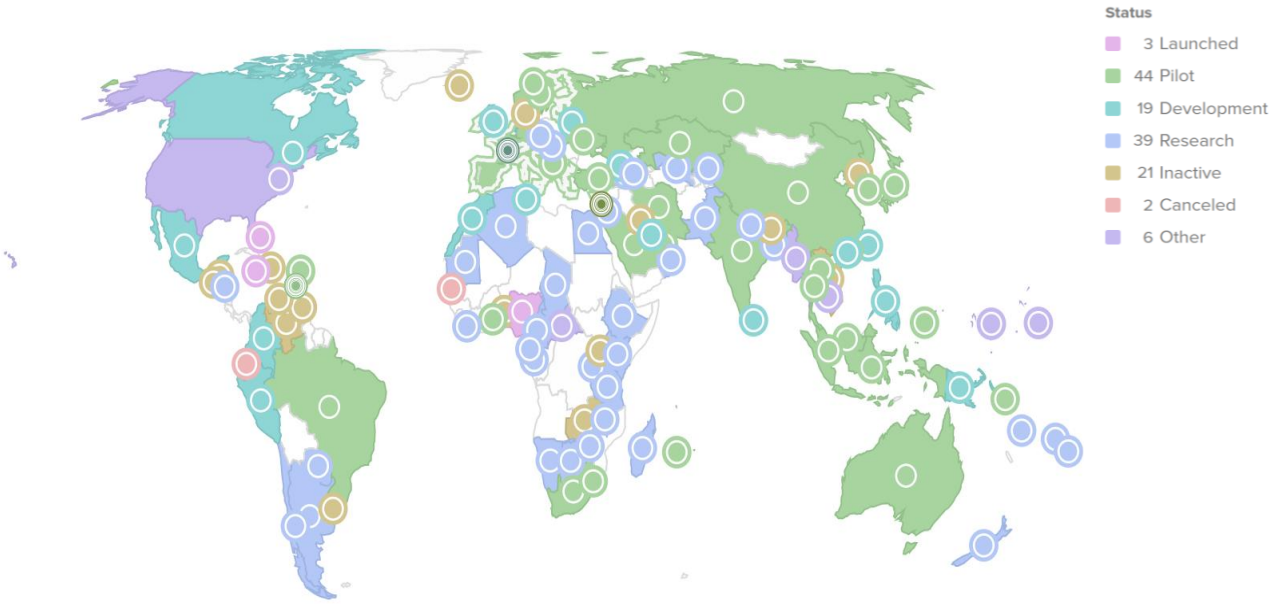

Figure D.1 – The status and stage of development of CBDCs in different countries around the world [87]

Appendix E

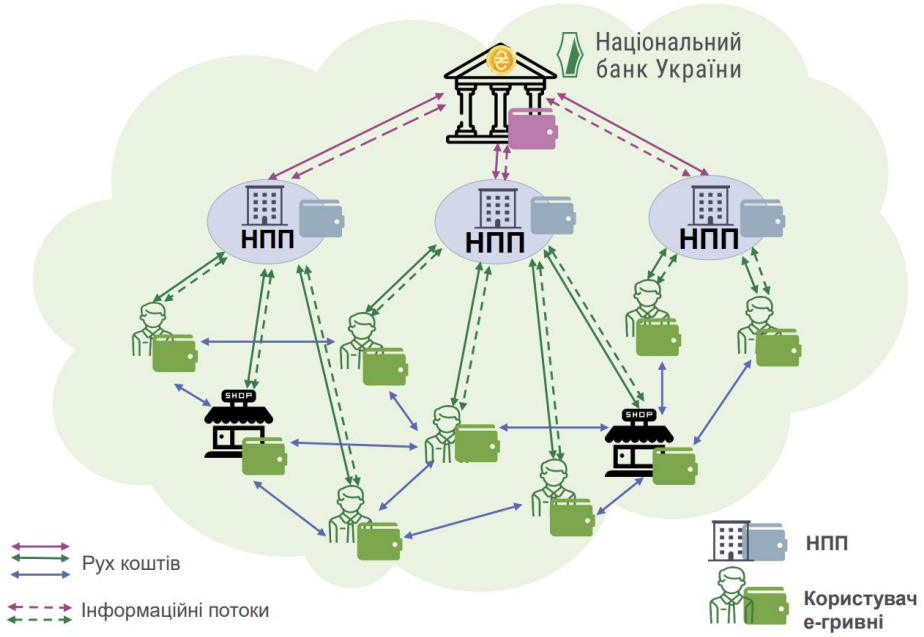

Figure E.1 – E-hryvnia platform: interaction between wallets [154]

Figure E.2 – Creation and release of E-Hryvnia into circulation [154]