

The development of Central Bank Digital Currencies

Why central banks are developing their own central bank digital currencies?

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Abstract

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Abstract <p>Development of digitalization is inevitable, and the popularity of cash is declining. Digitalization, however, brings many challenges in terms of payment methods. One future currency we may use on a large scale is the Central Bank Digital Currency.</p> <p>This thesis aims to determine why Central Bank Digital Currencies are needed and what issues must be considered when planning and launching them. The thesis also examines questions related to the topic, such as benefits, risks, and superficially associated safety. We started the thesis in May 2022.</p> <p>The thesis has a theoretical background that examines the subject's current state. The theory part reviews definitions and limitations related to money and its history, central bank operations, and digital currencies. The section also examines the research questions, interviewees, and thesis methods. The thesis interviewed developers and administrators of different public administration online services from other job titles. The purpose is to find out from the interviewees how exactly they see development of central bank digital currencies and what issues have been taken into account when it is being developed.</p> <p>The research results examine and analyse the interview results and compare the results between different financial institutions. We use the theoretical background section to help analyse the studies, which is a reasonable basis for examining the results.</p> <p>Finally, we make the final reflections and summary of the thesis.</p>		
Keywords CBDC, Central Bank Digital Currencies, Money, Payment Method		

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1 Introduction

1.1 The background of the thesis

Different means of payment and methods are present in our everyday life. Most of the money we spend today is invisible to us and we do not notice its presence. Many of the items we buy cannot even be done with physical money. What future has of this matter? We live in the digitalization era when many everyday procedures and transactions are carried out virtually. For most people, especially in the euro area, digital payment transactions are already a matter of course and commonplace. The popularity of cash is falling, especially among young people, future makers, and decision-makers.

Few people think about where the money used comes from and which entities control its movements. In addition to financial crises and alternative currency systems, cryptocurrencies have also entered the market. Fast and anonymous digital wallets and money transfers attract consumers to consider switching to them. The big question is, what if money traffic were to be competitive and a new central bank-based payment system was offered?

In this thesis, we investigate the development of Central Bank Digital and their motivators, analyse benefits, risks, and security-related questions on this topic. We primarily examine the issue from the viewpoint of the Eurozone.

1.2 Existing studies and projects

Research and development work on Central Bank Digital Currency (CBDC) is carried out by central bank worldwide. According to the [cbdctracker.org](https://www.cbdctracker.org/) service, there are nine pilot powers, with China as the most significant economy. On the other hand, the US central bank is still investigating potential benefits and risks. (Fed 2022) In general, the central banks of the states - together with the region's leading bank - do continuous research work, and new information is updated periodically.

The European Investment Bank (EIB) has also prepared for the digitalization of financial markets by issuing the first digital bond based on a free blockchain. The project is project selected by the Banque de France as part of the Central Bank Digital Currency (CBDC) sphere (EIB 2021).

Numerous higher education theses related to the topic have also been done at universities, both at bachelor's and master's level. Related theses are, can cryptocurrency fulfil the money functions? An assessment of cryptocurrencies as a reserve currency. (Kuikka. O. 2019), master's theses about Central Bank Digital Currency: Sweden and the United Kingdom Cases (Virtanen 2021) and Implications of Central Bank Digital Currency on European Union Technology Efficiency (Korhonen 2022). These are among many theses related to our topic.

1.3 Thesis goal

With digitization and the fast development that comes, many may wonder how necessary all this development, innovations, and ideas really are. Many are surely also thinking: "Don't credit and debit cards already make money digital?" Our thesis aims to facilitate the internalization of this development and to present a possible digital currency to be used in the future. We explain the benefits, the advantages and dangers of Central Bank Digital Currency (CBDC) and examine how to make CBDC a secure digital asset to own, enabling users to make risk-free payments to each other. The research can provide helpful information, especially for such persons and organizations who want to ride the wave of development and know why and how large organizations plan such revolutionary sounding, but also so mundane, innovation.

Many questions are related to the development, launch, and especially large-scale implementation of Central Bank Digital Currencies. Valid points are for example:

- Future of current banking system.
- Regulation of the money supply.
- Other legal, economic, and environmental effects.

The main focus of this thesis is the development process and status of the CBDC, which our research question also addresses.

1.4 Research question

- Why do central banks plan or launch their own virtual currencies? (Central bank digital currencies)

Explanation for the research question is sought in this thesis. The topic has to be divided into different parts in the theory section to get a comprehensive and in-depth answer to the research question. The theory section serves as the foundation for inquiry-based research, and topics are gathered based on already existing knowledge. The interview seeks to confirm the Bank of Finland's and Nordic Investment Bank's position corresponds to the claims of the theory section and to bring new perspectives from developers and administrators.

The thesis also includes sub-questions that support and help in solving the research question.

The sub-questions of the thesis are:

- What is the relationship between private cryptocurrencies and central banks?
- What are the potential benefits and risks of CBDC?

The thesis contains information from academic articles directly from financial institutions and scientific sources. The thesis clarifies the topic for readers interested in payment methods, the financial sector, and digital currencies implemented with the help of digitalization. Financial institutions and developers of central bank digital currencies gave their perspectives on the topic.

1.5 Thesis method

“To better comprehend ideas, opinions, or experiences, qualitative research entails gathering and analysing non-numerical data (such as text, video, or audio). It can be used to get comprehensive understanding of a situation or come up with fresh research concepts.” (Bhandari 2022) The method can be used to reveal intricate details of a situation or to spark new study concepts. A few advantages of qualitative research are its adaptability, use of natural settings, production of fresh ideas, and valuable findings. Other advantages include changes in views within a target group, explanation of information that numbers alone cannot reveal, and a more flexible approach. (Vaughan 2021). On the other hand, its disadvantages can be, for example, unreliability, subjectivity, limited generalizability and labor-insentivity. In practice, this non-numerical data means, for example, other studies and academic articles (Bhandari 2022). Other drawbacks could be considered, such as the fact that

depending on the researcher's background and expertise, it is not a statistically representative method of data collection and can lead to inaccurate results (Gaille 2018).

In order to minimize these, the data was selected according to exact criteria. The data had to be created by a reliable and professional entity, Due to the topicality of our topic, all data had to be updated, based on scientific research. Primary sources have primarily been used in the thesis, but in some parts secondary sources have been considered equally reliable, especially in matters that are "common knowledge", such as the possible developer of Bitcoin.

The thesis's research approach is qualitative, and it is done without a hypothesis. The importance of qualitative research is emphasized in a topic that dates to the future and is therefore still speculative. The outcome of the study cannot be predetermined. But this research method suits the best when you want to get in-depth information about in research results. (Bhandari 2022.)

The data collection method was interviewing, which included six questions. The first question is the essential main question of this thesis. The remaining five questions are closely related to the topic and complement each other. We conducted the interview via the Microsoft Teams service with a representative of the Bank of Finland. The interviewee could answer the research questions in their own words, and we used the open interview method elements to get deep into the topic. The interviews were done through email with the European Investment Bank and the Nordic Investment Bank. The interviewees answered the questions below in their own words and they sent the answers back by email. Questions have been prepared in advance so that the open interview method can be used in the interview elements, i.e., to discuss the topic more deeply in your own words and ask additional questions on the subject.

2 Money and monetary policy

In this chapter, We examine the definition and background of money, from gold standard and paper money to cryptocurrencies. In addition to this, we examine the central bank's Operations and monetary policy. We also explain why central banks need to stay involved in the development brought about by digitalization and what opportunities, risks, and other questions are related to the development.

2.1 The history of money and payment methods

The history of money is extensive and goes back thousands of years. Currency has evolved into many distinct forms throughout history. From the early days of business, through the creation of the first metal coins and, finally, the first paper money, money has always been essential to how our society operates. Money is a valuable item that facilitates the exchange of goods and services. One form of currency that has value because of the materials it is constructed of is metal coins. (Ritcher 2022.)

Bartering has a long history that goes back to 6000 B.C. Since there was no money, goods were traded with each other. A farmer might exchange labor for livestock. In the past, people would trade goods and services for the necessities. These exchanges laid the groundwork for our modern economy and aided in the creation of modern money. (Ritcher 2022.)

Despite the fact that the utilization of metal as a medium of exchange can be traced back to the Babylonian civilization over two millennia ago, the standardization and certification of currency through the minting of coins only occurred in the seventh century BC, maybe with the exception of a few rare instances. The earliest coins were crude, bean-shaped ingots of electrum, a naturally occurring amalgam of gold and silver, engraved with a crude punch mark attesting to either weight or quality. (Friedman, M., Meltzer, Allan H. 2022.)

The Zhou Dynasty in China is credited with creating the first standard metal coinage, along with other weapons like knives and spades and miniature copies of cowry shells. However, Lydia, a kingdom in modern-day Turkey, produced the first coins that we would recognize as such in the 7th century B.C. (Cottier 2021.)

The worth of the metal was initially determined by weight. Still, throughout time, governments or authorities decided against weighing it and stamping the metal to make the value visible. Since then, coins were becoming one of the earliest forms of currency that allowed for count-based payment rather than weight-based payment, making them a significant turning point in the history of money. (Friedman et al. 2022.)

Carrying significant amounts of gold, silver, or other metals proved difficult, exposing them to loss or theft. More than a thousand years ago, paper money was used for the first time in China. Merchants used the first paper in the form of what is now known as promissory notes. Merchants have to leave coins with someone they trust and receive a printed receipt from that person detailing the amount that had been put. Although it took several centuries for paper money to replace the need for coinage in some situations, thus the transition from paper receipts to paper money was relatively straightforward. Paper money and banknotes were widely used in other regions by the 18th and early 19th century. Governments began to act as a supervisory force gradually. They defined legal tender as the kind of payment that qualified as a tax payment. Compared to other forms of payment, paper money has higher price stability. It is simple to transport enormous sums of money and trade fast (Redmond 2021). Governments can regulate their supply, so if there is a need, more may be printed, which means that a government can constantly adjust its printing habits to suit the demands of its economy.

Paper money's extensive use resulted in further issues. Forgery was widespread because the cost of creating paper money was far lower than its trade value. Then it was necessary to modify the paper and use metallic strips and other technologies to make forging more challenging. A plastic money card is a thin card with identification data, allowing the cardholder to charge goods and services to their account. Automated teller machines (ATMs), banks, and the internet read the card data. Credit cards were created in the 1950s. These cards allowed their owners to use them in various locations and businesses. When using a bank credit card, the bank sends the cardholder a bill at the end of the billing cycle. The cardholder then pays the bank the outstanding balance in whole or interest-bearing monthly installments, and credit cards operate under this system. Three cards are prepaid, debit cards, and credit cards. Convenience-wise, credit cards and debit cards are standard options. The bank account's predetermined amount is placed onto a debit card, and money is deducted from the account after each purchase. (Ritchie 2022.)

The way that credit cards vary from other payment methods is in the absence of a required balance. The way that credit cards vary from other payment methods is in the absence of a required balance. Instead, lenders may decide to place a credit limit on your card, allowing you to spend up to that amount before you must begin repaying it to use the card again. Consumer credit cards were initially offered in the 1920s, and their use has increased since then. Online payments have become more convenient due to the Internet explosion and the expansion of eCommerce. Online is one of the most often used payment methods for goods and services nowadays. Purchasing things with online payments is as simple as entering credit card or debit card information on a webpage. (Ritchie 2022.)

The 21st century has seen the introduction of new developments including mobile payments and virtual currencies. A mobile phone, tablet, or other portable electronic device is used to transmit money in exchange for an item or service. With mobile payment technology, it is now feasible to send money to friends and relatives. Apple Pay and Google Pay are increasingly competing for retailers' approval of their platforms for point-of-sale transactions. (Beattie 2022.)

2.2 Cryptocurrency

Cryptocurrency refers to a digital currency that is created using encryption algorithms. Cryptographic technologies allow cryptocurrencies to act as a currency and accounting system, meaning that every transaction made with cryptocurrency can be tracked and traced. Cryptocurrencies are stored using cloud-based services in a crypto wallet. They are stored on a computer and nowadays on a mobile device. (The State University of New York.)

Digital currency as a concept is significantly older than cryptocurrency. The unknown cryptographer created the first cryptographic currency in 1983, "E-cash" (Chohan U, 2017). The first cryptocurrency defined by current standards is Bitcoin, which appeared on the market in 2008. The identity of Bitcoin's creator, who solely goes by the alias Satoshi Nakamoto, is still unknown. The project's purpose is to create a peer-to-peer network-based digital currency system, which is decentralized outside of regulation and authorities. (Nakamoto, 2008 pp.1-8, according to Kuikka 2019.)

The popularity and number of cryptocurrencies have grown throughout the 2010s (ConsensusSys 2019). In December 2022, their total number is estimated to be 22,099, and the total market cap of all is \$811,685,030,471, which means more than 811 billion US dollars (Coinmarketcap). However, most cryptocurrencies are not valuable or have no active movement. When the "dead" cryptocurrencies are discounted, there are about 9000 active cryptocurrencies left. (Howarth 2022.)

A block is a single record, while the chain is the whole collection of records that make up the entire ledger in the blockchain system. The network is composed of computers that validate those blocks and the ensuing chain as transactions occur. Instead of depending on a single, massive database run by a single central authority, a blockchain tries to ensure data integrity in a decentralized manner. Blockchain has two features: built-in privacy protections and data integrity protections. (Agreda 2020.)

Cryptocurrencies work on blockchain-based encryption technology. The blockchain uses distributed ledger technology and several technological procedures to validate the legitimacy of transactions. The blockchain is a decentralized digital ledger maintained on a node that contains all transactional data previously exchanged. The data is continuously updated as new transactions are done inside the blockchain. The method works by chronologically keeping track of the transactions, creating an "incremental chain" of transactions. With equal access to the ledger's history for all participants who are blockchain users and public distribution of the data, each user receives an automatic synchronization of new data. as soon as it is added to the ledger. (OECD blockchain primer 2018.)

2.3 The fundamental purposes of money

Money is a concept that can be either tangible or intangible, utilized to hold, measure, and transfer value. Commodities, coins, paper, claims as account money, and, more recently, digital forms have all been used to represent money in the past. New digital forms of payment are prompting a reevaluation of what can be used as money. The fundamental purpose is to allow a trade to occur without the so-called "double coincidence of barter" by separating buying from selling. There are two subcategories within primary functions. (Friedman 2022.)

2.3.1 Medium of Exchange

Money served as a means of exchange in all transactions involving purchasing or selling commodities and services, making this one of its primary purposes. The capacity of money to function as a medium of exchange is supported by features that simplify it. That is to be exchanged for products or services in transactions, such as social acceptance, convenience, low use costs in relation to exchange values, and ease of transferability. (Vaz, Milne, Brown & Azmat 2022.)

2.3.2 Store of value

You can use money to decide how valuable a good or service is. Simply put, money may be used to indicate the value of any good or service. Though currencies vary from country to country, money also adheres to a standard and is recognized everywhere. The ability of the money to be liquid or easily convertible, to have easily traceable ownership, to be used as payment, and to have an enduring value all support the store of the value function. Money

must be able to maintain a stable value to support transactions and prevent value changes resulting from various usage scenarios or domains to serve as a store of value. (Vaz et al. 2022.)

2.3.3 Unit of Account

Given a standard method to measure or value commodities or services, units of account enable more trade at which payments can happen later. This function determines the appropriate quantities to transact in the intertemporal allocation of resources, such as deferred payments, borrowing, credit, and the expansion of payment systems. (Vaz, J. et al. 2022.)

2.4 Monetary policy

The term "monetary policy" refers to the actions and statements made by a central bank to maintain the financial system stability as well as to regulate and control the amount and pace of growth of the money supply in a nation. Central banks utilize monetary policy to control macroeconomic factors like combat inflation, reduce unemployment, and promote fair long-term interest rates. The amount of money in circulation changes when interest rates rise or fall, which impacts inflation and economic growth. Most central banks are required to maintain inflation at a specific level. (Brokke & Engen 2019.)

These regulations are carried out via a variety of tools, including altering interest rates, buying or selling government assets, and altering the amount of money in the economy. The central bank or a similar regulatory authority develops these rules. (Brokk et al 2019.)

2.4.1 Monetary policy and CBDC

Private company-made cryptocurrencies would start to impact monetary policy and financial stability once they start to be widely accepted, causing in central banks losing control of the monetary transmission systems. As a result of these changes, states' growing interest in cryptocurrencies has prompted research on the CBDC that they can regulate. The link between both the central bank's digital currency and monetary policy may differ depending on how the CBDC is set up. While some studies concentrate on the account-based structure of CBDC, others are centered on the division of wholesale and retail, and still, others are based on its transfer to the private sector. (Akdag & Bozma 2022, 77-78.)

The development of CBDC, which is seen as a move by central banks against cryptocurrencies, may have diverse effects on monetary policy and approaches to financial stability. The impacts of CBDC on monetary policy are:

- “CBDCs might affect how credit is provided”
- “By lowering monetary policy autonomy, CBDC increases asymmetric spillover in the global financial system.”

Regarding financial stability, CBDCs could lead to unexpected bank deposit withdrawals during crises. The ease of access to central bank reserves in a digital economy causes the elasticity of deposit demand to rise along with the quick flow of funds (Akdag 2022).

To preserve monetary and financial stability, central banks must function. It is crucial to keep in mind that different central banks' mandates differ across the country. However, monetary policy is something that practically everyone has. When considering how monetary policy is implemented, we frequently consider how central banks' newly created reserves are distributed to the economy. (Virtanen 2021.)

2.5 Central Bank

The European Central bank determines that the central bank is a public institution whose purpose is to manage a country's currency or and its money supply, which means the amount of money in circulation. Central bank's objective is price stability, and monetary policy should support employment and government finances. A central bank is not a commercial bank, which is how it differs from a regular financial organization. A person cannot apply for a loan from the central bank or open an account there. It is not for profit because it is a public institution. (Eurosystem 2015.)

A central bank is a private, non-governmental entity that controls banks, establishes monetary policy, and provides financial services like economic analysis. Its goals are to maintain low unemployment, low inflation, and a stable currency for the nation. Central banks have an impact on intermediaries and other financial institutions like banks. Even though they are the driving force behind their operations, central banks do not make a profit. (Amandeo 2022.)

2.5.1 Function of Central Bank

Central bank is a crucial element in economic stability of market economies. Central banks serve as the national government's banks (although they generally operate outside governmental politics). By printing money, such as banknotes and cash, and changing interest rates, they control the amount of money in circulation. By establishing the capital and reserve criteria for member banks like savings and loan institutions, they regulate those institutions. Additionally, they can serve as a last resort ledger for governments and other financial institutions. (Segal 2019.)

The flow of money to customers and how it is spent are governed by a central bank. It can both produce new currency for the economy and manage how commercial banks distribute it. The central bank has complete control over all aspects of monetary policy, including inflation, currency rates, and the money supply. To maintain control, it makes use of a number of tools. It can set interest rates, perform open market operations by acquiring assets from financial institutions, and control the value of a home currency by buying foreign currencies. (Ajayi 1999.)

- A central bank manages monetary policy. For monetary policy reasons, Central Bank's role is to issue currency in sufficient quantities to keep the economy running smoothly.
- It is operating as a government's bank or as the government's fiscal agent.
- It functions as a commercial bank's bank, including serving as a lender of last resort.
- Keeping track of the country's international reserves and exchange rates.

2.5.2 Central bank objectives

The objectives of central banks have drastically changed over time. Full employment was the main objective of central banks in the 1970s. On the other side, the emphasis on employment distracted central banks from inflation. There was a massive oil crisis in 1973. It caused the unemployment rates in developed nations to rise significantly. In response, central banks pumped money into the economy, hoping to spur investment and job creation, boosting employment temporarily, but this had long-term consequences resulting in double-digit inflation. As listed below, central banks have realized a more balanced approach is required and need to concentrate on multiple goals rather than just one. (Boyce 2022.)

- **Economic growth:** It is crucial to take into account the idea of political prosperity, as well as the concept of macroeconomic outcomes. Stable growth, employment, a

consistent price level, and consistency in the current balance of payments account are examples of macroeconomic stability.

- **Full employment:** One central bank's main goal was to achieve full employment. Central banks act if employment begins to maintain pace.
- **Financial stability:** The central bank usually serves as a lender of last resort to maintain financial sustainability.
- **Price stability:** While aiding the government in accomplishing its economic goals, such as growth and employment, central banks help to maintain price stability. In order to create macroeconomic stability and to provide the ideal conditions for long-term growth in output and employment, the aim highlights the significance of price stability.
- **Exchange rate stability:** A currency shock occurs when demand for a country's currency falls rapidly and could result from a domestic political or financial catastrophe. In case this market instability emerges, central banks seek to prevent it.

The base rate is determined by the central bank, along with reserve requirements for private banks, regulation of the money supply through open market operations, and management of the nation's foreign exchange reserves. (Boyce 2022).

2.5.3 How do central banks use blockchains

The core and foundational technology of today's digital cryptocurrencies is blockchain. Global central banks are actively investigating potential CBDC blockchain uses. Numerous central banks have started initiatives to integrate blockchain in CBDC since 2016. Proof-of-concept prototypes for some projects have been complete and developed to demonstrate the necessity for a digital euro. (Zhang & Huang 2022.)

The Bank of England, the Bank of Canada, and the Federal Reserve System are a few of the central banks that have begun to investigate digital currencies. The Federal Reserve Bank of Philadelphia said that the emergence of (CBDC) will place the Fed in competing directly with commercial banks in a document published in June 2020. A CBDC enables significant intermediation by enabling the central bank to compete with financial companies for deposits and maybe engage in some lending of those deposits. (Economist 2018.)

A CBDC could be issued using a centralized database system (such as in Sweden) or distributed ledger technology a CBDC (as in China). The Corda Distributed Ledger Technology (DLT) is used to create the retail CBDC prototype for the ECB, which ensure some degree of partial anonymity in payments. The issuance of a CBDC via DLT like blockchain has various benefits: Blockchain technology was created to achieve high data privacy. The CBDC

has the potential to develop into an anonymous payment system comparable to cash. It is also claimed that DLT systems are frequently very secure and difficult to attack because of the underlying encryption. As per the data reported by the World Bank, the transaction costs often constitute around 7% of the aggregate transaction worth and entail a prolonged settlement duration. Through the utilization of a CBDC that operates on a DLT platform fortified with robust encryption mechanisms and energy-efficient consensus protocols, these limitations can be solved. (Gross, Klein, Sander 2020.)

The Euro would become programmable using a blockchain-based CBDC. IoT devices like machinery, automobiles, and sensors might employ euro-denominated smart contracts to directly deliver services like leasing and factoring on a pay-per-use basis. The ramifications of such a digital fiat money are astonishingly optimistic when viewed within the framework of a machine economy. Blockchain technology is best suited for providing a wallet and computer chip to billions of devices. As a result, a device can accept payments, send money, and generate invoices and accounting records in the Euro currency. Blockchain technology makes it simple for these millions of devices to join a payment network and be incorporated into automated business procedures. (Gross et al. 2020.)

3 Central Bank Digital Currency (CBDC)

People cannot use cash for online payment, which reduces the usefulness of physical currency as a payment method in the digital age. The popularity of digital payments and online purchasing has caused a gradual decrease in the use of cash. The digitalization of the economy significantly impacts how people pay for things. The dominance of banks in payment systems is being challenged by the growth of digital platforms. Payments are combined with digital services like messaging apps, e-commerce services, and other financial services like loans and collateral by both huge technology businesses and financial start-ups. Banks continue to offer the payment methods behind these solutions but need access to the customer interface. There is potentially more disruption due to rapidly evolving and complex payment innovations. (Ahnert, Assenmacher, Leonello, Monnet & Porcellacchia 2022.)

Generally, CBDC is defined as a central bank-driven digital currency that is available to consumers and organizations. Similar to current forms of money, CBDC would allow the consumer to make digital payments. The Federal Reserve considers CBDC the safest digital asset because it does not involve credit or liquidity risks. (Fed 2022.)

The European Central Bank (ECB) is constantly working with the national central banks of the euro area on introducing the digital euro. The idea would be to be a central bank's digital currency, sort of like an electronic counterpart to cash. The purpose would be to give consumers more choices in determining the payment method. (ECB 2022.)

We use debit and credit cards daily, where the money is electronic. And we can carry out transactions to the other side of the world with relative ease. However, there are considerable differences between electronic money and digital currency. The Central Bank of India (RBI), which is among the pilots of CBDC projects globally, explains the differences as follows:

A CBDC would be different from publicly accessible digital currency since it would be a Reserve Bank obligation rather than a commercial bank's (RBI 2022). In practice, this would mean the transfer of liability to central banks instead of commercial banks, which raises various questions.

In recent years, a lot of new crypto-assets have appeared all over the world. Sometimes referred to as "cryptocurrencies (RBI 2022). The name cryptocurrency is misleading, though, as they don't perform the three functions of money: a reliable medium of exchange,

a store of value, and a unit of account." (European Central Bank, 2022) The European Central Bank does not consider cryptocurrencies to be real currencies because no central unit requires, supports or controls these currencies, and there is always no certainty as to whether they can be converted into money. Even the so-called stable coins could be more stable, as their value is determined only by the promise of a private party. On top of everything, they can't pay everyday expenses and our bills. (ECB, 2022.)

A digital economy needs digital money to function correctly. Cash is becoming less and less popular as an effective form of payment as more transactions occur online. (Figure 1. Figure 2.) The problems with today's digital money exist despite its increasing dominance over physical money. The interbank payment rails system now in place has yet to keep up with technological advancement entirely. (Ahnert et al. 2022.)

Figure 1. Development of online purchases in Eurozone

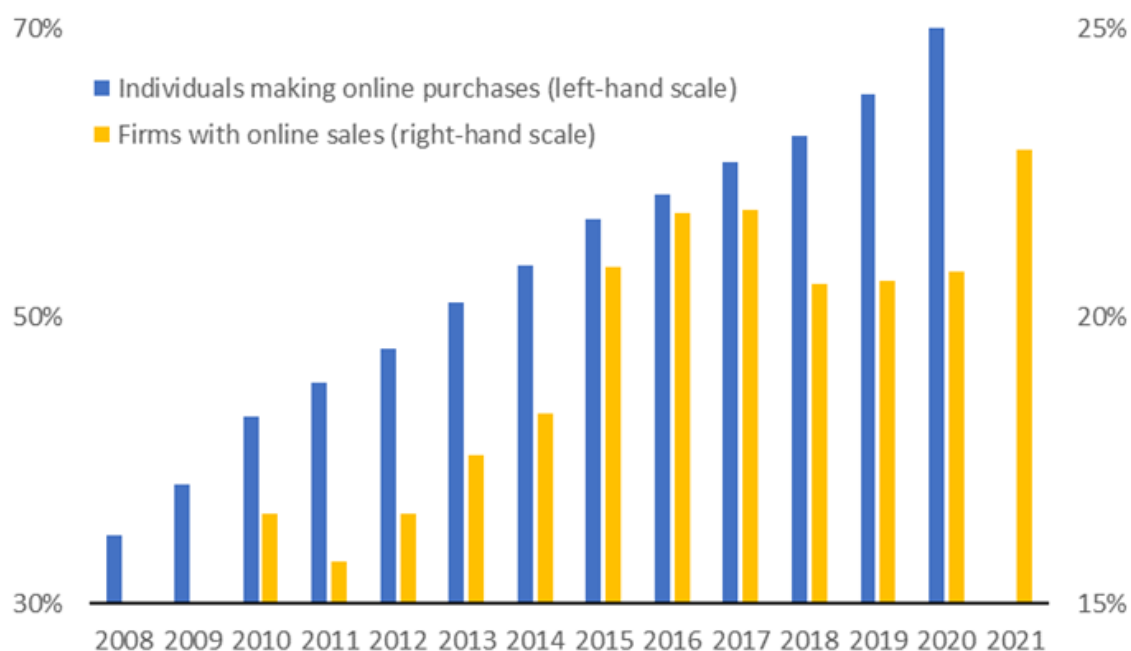
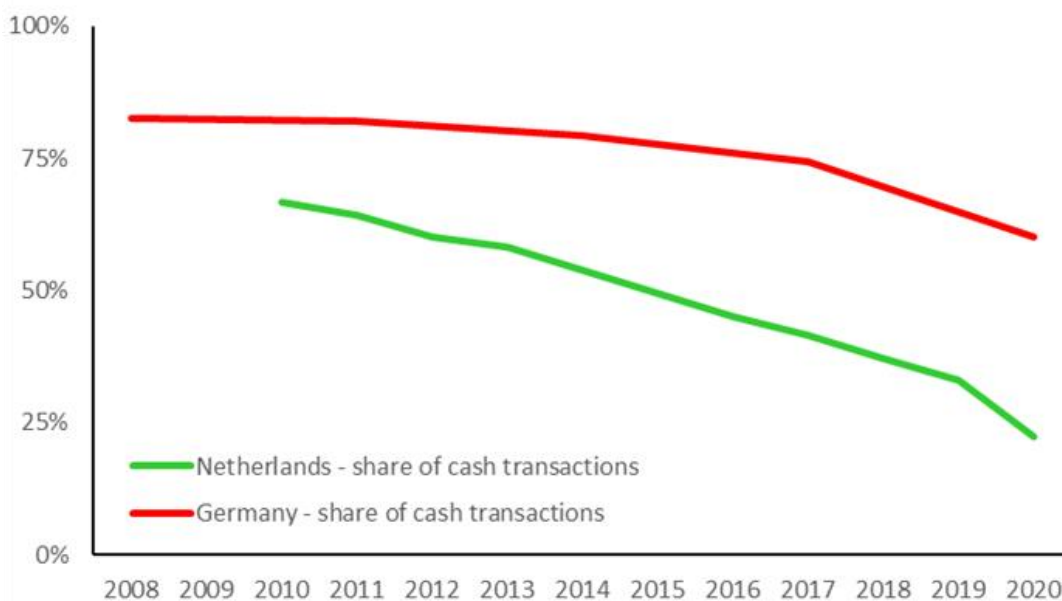


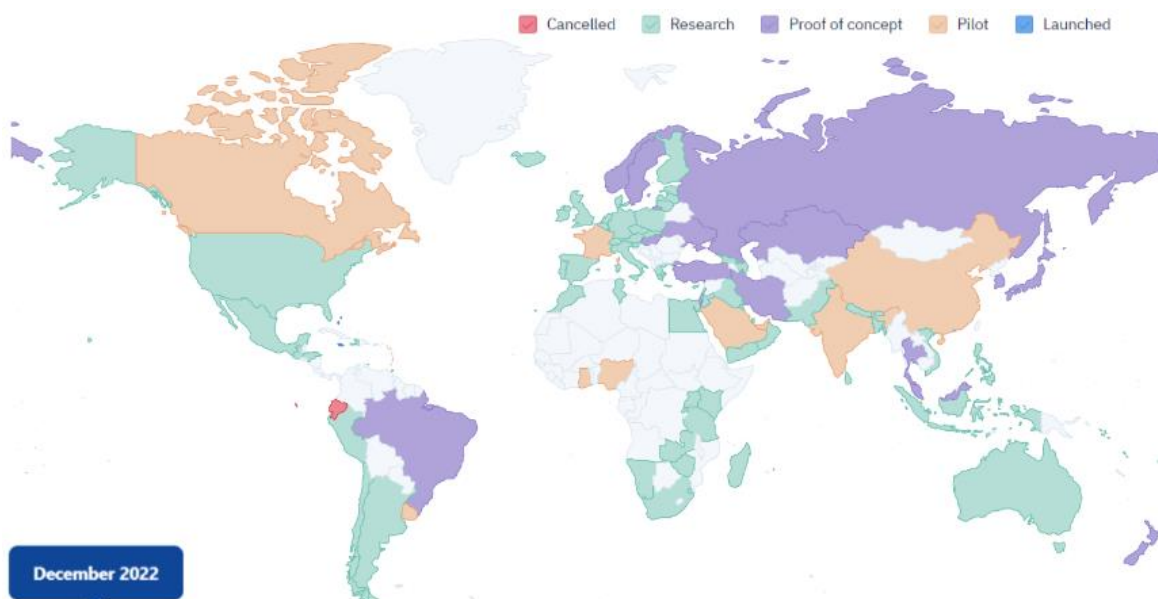
Figure 2. The evolution of cash usage



3.1 CBDC around the world

Central Bank Digital Currencies (CBDC) are something central banks issue and control. As a result, they are safer and less volatile than cryptocurrencies. While some people might believe that CBDCs (Central Bank Digital Currencies) is a new idea, they have been around for thirty years. The Bank of Finland introduced the Avant smart card, a type of electronic money, in 1993. Although it was abandoned in the early 2000s, the system can still be regarded as the first CBDC ever. However, CBDC research has only just started to be conducted globally. Central banks worldwide are now investigating their potential advantages, such as how they enhance the effectiveness and security of payment systems. As of 2022, close to a hundred CBDCs were either under examination or in the developmental phase, with a mere two CBDCs being in fully operational status: the Nigerian eNaira, launched in October 2021, and the Bahamian sand dollar, introduced in October 2020. Different countries have different reasons for investigating and releasing CBDCs. (Stanley 2022.)

Figure 3. CBDC Around the World



Cropped and edited screenshot. A country may have several CBDCs; the map displays the state of each country's most developed stage. Available at <https://cbdctracker.org/>

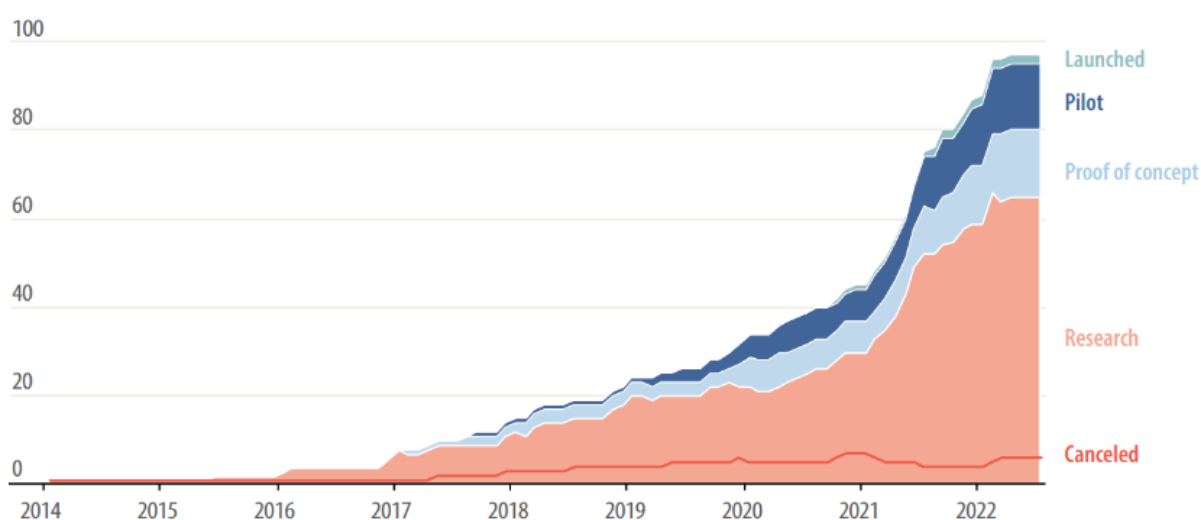
Figure 4. CBDC status watchlist table for European countries

Digital currency	Country / Region	Central Bank(s)	Announcement	Status
France wholesale CBDC	France	Banque de France	2022	Pilot
Wholesale Digital Euro	Euro Area	European Central Bank	2022	Research
Retail Digital Euro	Euro Area	European Central Bank	2022	Research
France CBDC	France	Banque de France	2022	Pilot
Hungary CBDC	Hungary	Central Bank of Hungary (MNB)	2022	Proof of concept
e-krona	Sweden	Sveriges Riksbank	2017	Proof of concept
Denmark CBDC	Denmark	Nationalbanken	2022	Research
Jura	Switzerland & France	Swiss National Bank Swiss National Bank, Bank of France and Bank for International Settlements	2021	Research Research
DELPHI	Austria	Oesterreichische Nationalbank	2021	Research
Austria CBDC	Austria	Oesterreichische Nationalbank		Research
Digital zloty	Poland	Narodowy Bank Polski (NBP)	2017	Research
Georgia CBDC	Georgia	National Bank of Georgia	2021	Research
Czech Republic CBDC	Czech Republic	Czech National Bank	2021	Research
Project Helvetia	Switzerland	Swiss National Bank	2020	Research
France CBDC	France	Banque de France	2019	Pilot
Digital Euro	Euro Area	European Central Bank	2020	Research
e-franc	Switzerland	Swiss National Bank	2019	Research
United Kingdom CBDC	United Kingdom	Bank of England	2018	Research
e-hryvnia	Ukraine	National Bank of Ukraine	2017	Proof of concept
Rafkrona	Iceland	Central Bank of Iceland	2018	Research
Stella	Euro Area	European Central Bank	2016	Research
RSCoin	United Kingdom	Bank of England	2015	Research
Avant	Finland	Bank of Finland	1993	Cancelled

CBDC tracker (2021-2022). Today's Central Bank Digital Currencies Status. The data available at: <https://cbdctracker.org/> Figure edited.

The dashboard's primary element is the data table. Each CBDC's data row has columns that can be customized. Some fixed columns such as Country/Region, Central Bank(s), Announcement Year, Status, Update Rate, Digital Currency are constant. The CBDC activity over the previous 12 months is graphically represented in the Update rate column. It takes the shape of a bar graph, with each bar representing a CBDC's monthly activity (the number of news items + the number of updates).

Figure 5. CBDC research and development



The chart shows the status of CBDC's worldwide. Available at <https://cbdctracker.org/> Figure cropped

- Cancelled:** Nations that deactivated or cancelled a CBDC.
- Research:** Nations that began testing CBDC and issued several research studies on the substance.
- Development:** Nations preparing their CBDC for a full-scale launch but who have already launched a small-scale pilot.
- Pilot:** Countries testing CBDC in a real environment with a small number of parties, such as for domestic interbank or international use cases.
- Launched:** Nations that have formally introduced a CBDC.

3.2 CBDC's potential benefits

A CBDC may serve as the foundation of a new payment system and as a bridge between existing and emerging payment services. A fast digital economy may also maintain the primacy of safe and trusted central bank money. Since they serve as an intermediary, widely transferable, and identity-verified, they best meet the requirements. Customers would choose CBDC over a bank account primarily because it is unaffected by financial crises. Eliminating such risk would be advantageous for both economies and societies. Furthermore, transferring money between banks and across countries is much simpler. There would be no need for interfaces between various bank systems. An update to the central bank's records is all that is required. Due to its simplicity, the process is quicker and less expensive. (Darko 2020.)

According to Siripurapu (2021, 9), many central banks, notably the Federal Reserve of the United States, are considering developing their digital money, known as central bank digital currency (CBDC), to assert sovereignty. CBDC provides the speed and other benefits of cryptocurrencies without risks. Citizens having direct accounts with the central bank is one option to implement CBDC. The central bank's endorsement would make CBDC a secure digital asset to own, giving governments additional tools to manage the economy.

The realization of a Central Bank Digital Currency (CBDC) would necessitate real-time fulfillment and completion, facilitating secure and risk-free peer-to-peer payments. Such a digital currency could serve as a means for individuals, corporations, and governments to engage in actual financial transactions and remit payments for debts. CBDCs could be leveraged by governments to assemble tax revenues and furnish direct welfare disbursements to citizens. Additionally, a CBDC has the potential to be configured to distribute payments at predetermined intervals.

CBDC should:

- “Deliver advantages to consumers, businesses, and the economy as a whole that outweigh the costs as well as risks.”
- “Provide these benefits more effectively than other alternatives.”
- “Enhance, rather than replace, current money types and ways to give financial services.”
- “Safeguard the privacy of customers.”
- “Keep a lookout for illegal acts.”
- “Be supported by a large number of critical stakeholders.”

(Board of Governors of the Federal Reserve System).

3.3 CBDC's potential risks

Andrew Stanley (2022) states that leading experts believe that CBDCs can improve access to money, boost payment efficiency, and reduce transaction costs, increasing financial inclusion and making domestic payment systems more resilient and competitive. CBDCs can increase financial flow transparency and lessen currency conversion. Even though CBDCs offer many potential advantages, central banks must first decide whether there is a strong rationale for their adoption, mainly whether there is enough demand. There is not, at least not yet. Moreover, central banks must consider the risks associated with issuing CBDCs. For purchasing CBDCs, users can take too much cash from banks simultaneously, which could lead to a crisis.

The central banks should be able to manage the threats caused by cyberattacks while preserving data security and financial integrity (Stanley, A. 2022). Already, the whole financial sector and central bank institutions are highly concerned about cyber security. Malware and fraud are cyber threats that threaten every payment system. It is difficult to trace the identities of the parties involved in a transaction under the current structure; therefore, central banks must consider anti-money laundering and counter-terror financing concerns and standards for issuing a CBDC (Brokke et al. 2019 according to Wadsworth, A. 2018 & CPMI 2018.)

Before a CBDC may be approved for widespread usage, several legal, technological, and operational challenges need to be addressed based on the preliminary research and testing conducted by several central banks. In light of the potential establishment of a CBDC, central banks must consider the adequate level of privacy, as determined by the sociological and technological context. This process would take time and might involve many complex public policy designs. Although central banks typically have the exclusive power to create a legal tender, creating a digital currency might call for legislative adjustments. Only a few countries have passed legislation that directly covers cryptocurrencies and blockchain technology, as well as its designation as an asset class. It may be a barrier to the adoption of this technology. (Brokke et al. 2019, according to CPMI 2018.)

3.4 CBDC as a valid currency

We spend daily money on our daily expenses, needs, and pleasures. Still, on average, estimated 340 million Europeans use euro banknotes and coins, cash, and pay in euros when making purchases. We use both types of money, and understanding this difference is vital for CBDC or public money. CBDC is also called public money, the name of its public sector creator, the central bank. We use central bank money, i.e., cash already, every day. All notes and coins in our wallets are already public and the only central bank money available. However, using cash is different than digital payments. (European Central Bank.)

3.4.1 Practical consequences of launching a CBDC

CBDCs are a rapidly evolving invention anticipated to significantly impact most large national economies, resulting in a fundamental change in the structure of the domestic and global economies, and the vital implication for commercial banks' profitability and operations. Each country likely makes sovereign judgments regarding the issuance and design of CBDCs based on its assessment of the CBDC's objectives, market maturities, and other local circumstances. (Foster, Blakstad, Gazi, & Bos 2021.)

CBDCs disrupt the financial ecosystem, increasing payment efficiency and providing an extra operational and technological alternative to the current money paradigm. CBDCs has impact money supply considerations and monetary policy, necessitating new regulatory concerns and alternative ways to implement monetary policy. (Bank for International Settlements 2021.)

Because central banks are moving quickly toward adoption, adding significant complexity for commercial banks, commercial banks should take advantage of this time to study the digital currency landscape and reinvent it for developing services, opportunities, and value creation. Financial institutions and other providers of financial services should make adequate preparations for the emergence of this novel asset category, its influence on their balance sheets, consumer value propositions, and benefits. They may need to modify their infrastructure to execute CBDC transactions; enhance digital apps to add CBDC capabilities while utilizing current procedures; modernize user interfaces; and make open, interoperable infrastructure, like digital wallets. Organizations may also need to establish the necessary training to manage CBDC-related procedures, technologies, and regulations. CBDCs are expected to influence the profitability of card services, and these firms have taken preventive measures. For instance, Mastercard recently made a virtual testing environment available to Central Banks so they could examine CBDC use cases and let users virtually customize the platform. (Deloitte 2022.)

Central bank use CBDC as a complimentary to cash, so keeping cash in a commercial bank makes sense for medium and long-term investments. Given the need to maintain adequate liquidity for their loan positions, financial institutions may opt to increase deposit interest rates. Still, there are also benefits to using CBDCs for payments in terms of speed and cost. (Peter 2021.)

3.4.2 Legal aspects of CBDC

Law and regulation are the most critical issues. In an ideal world, authorities would deal with the crucial unresolved problems of establishing clear legal and regulatory frameworks for CBDCs on the global level. There has yet to be a significant international accord in place (Reynolds B. Paris D. Reuters 2021). Central banks have underlined that the introduction of CBDC creates numerous important legal difficulties, similar to other legal and economic authorities. Some of these queries deal with the fundamental connection between money, the government, and the law.

- “Are central banks authorized to issue CBDC?”
- “Is CBDC the real currency?”
- “Should digital currency be legal tender?”

These questions are fundamentally reasonable, especially since many private stable cryptocurrencies are also on the market as alternatives.

A Prerequisite for launching a CBDC is that it can be adapted for meaningful use under existing laws and regulations. Critical legal issues that the launch of the CBDC requires to be clarified are the Central Bank Law and the Monetary Law. (Wouter B., Masaru I., Catalina M., Arthur R., Hans W. and Akihiro Y. 2020.)

The Central Bank Acts regulate all activities of central banks. These laws define the mandate of central banks, as well as determine their decision-making structures and confirm their autonomous status as institutions. All actions outside the central bank's powers are subject to legal and political scrutiny. (Wouter et al. 2020.)

There is no formal distinction between the central bank and monetary laws in legislation. Monetary law concerns the state's rights and powers to issue currency, often set out in the constitution covering the official currency, such as the dollar, euro, or yen, and the general payment method. The legislation sometimes makes a formal distinction between the Central

Bank Act and the Monetary Act. Conceptual monetary law concerns the government's authority to issue currency and is often set out in the constitution. It covers the official monetary unit, such as the dollar or yen, and the accepted payment method. (Wouter et al. 2020.)

The monetary law related to means of payment is more difficult to change than the central bank law. It has to consider many different issues, such as the state's right to put it into circulation, the status of a legal means of payment, private law privileges, and criminal law protection against counterfeiting. Amending the constitution is also a time-consuming and extensive process. The IMF study questions about the functioning of the CBDC as a general payment method, as part of the population, would not technically be able to use it. Instead, it proposes that CBDC's position as a means of payment would be limited to so-called "advanced entities" such as the state itself, the public sector, large corporations, and financial services. (Wouter et al. 2020.)

3.4.3 CBDC and economics

The economy's general structure is rapidly changing due to continuous digitalization. The two main driving forces are the dominance regarding the business model of digital platforms and the growing importance of intangible inputs like data and software. Even though both promise considerable efficiency improvements, worries are growing that they may also encourage market dominance and anti-competitive behaviour. (Ahnert et al. 2022, 7.)

Additionally, from the consumer's perspective, settlement still needs to be improved: bank transfers continue to take 1-2 business days, even between jurisdictions. The development and implementation of instant payment systems continue to move slowly, and retail payment systems are often highly fragmented. Despite being ideally adapted for the needs of international e-commerce, credit cards are nevertheless expensive for retailers due to the dominance of a few key card networks. Additionally, they eventually depend on the same old-fashioned settlement methods. (Ahnert et al. 2022, 10.)

Established institutions' need for more innovation in payment methods has brought new opportunities. Many new payment service providers have appeared on the market, and they have been able to increase their market shares with online retail payments—the possibility of connecting digital trading to many different platforms and application formats. For example, Klarna, Affirm grant credit, and WeChat combined social networking and payment. Go-Jek offers various services from one application, and money transfer and telecommunications can be done with ApplePay, M-Pesa, and GooglePay. (Ahnert et al. 2022, 10.)

CBDC would channel the effects on monetary stability via the financial system. Banks could experience an increase in funding costs, leading to a decrease in their profit margins. This could entice financial institutions to take bigger risks when it comes to the asset side of their balance sheets, such as by making riskier loans or purchasing speculative securities. (Ah-nert et al. 2022.)

The success of measures taken to stabilizing the monetary system, for instance, can be increased by CBDC design elements, which can also significantly impact financial system stability. It is common knowledge that the effectiveness of policy interventions like bailouts and liquidity support depends on their timing and design. Better information enables decision-makers to make more informed choices. Movements in central bank CBDC accounts may offer real-time data on the condition of the financial sector, enhancing the central bank's efficacy measures and promoting overall financial stability. (Keister & Monnet 2022.)

The potential for a CBDC to increase the frequency or intensity of bank and other financial institution runs has come up frequently during policy talks. The concept is straightforward: if depositors and short-term creditors had the choice to hold a safe, practical CBDC, they might be more willing to withdraw money from financial institutions quickly during difficult economic times. (Keister et al. 2022.)

Banks minimize their maturity spreads when depositors have access to CBDC, lowering their risk of depositor runs. Banks provide depositors with liquidity services or the capacity to withdraw the money as needed and make payments. Given their propensity for extending loans and retaining long-term assets, their investments demonstrate longer maturities than their liabilities. Since of this imbalance, banks are more susceptible to bank runs because they might not have enough liquid assets to cover too many simultaneous withdrawal demands from depositors. Additionally, the CBDC would offer liquidity services to both individuals and companies. The utilization of CBDC may lessen the need for liquidity services from banks. In response to this downturn, banks make necessary adjustments by mitigating their exposure to bank runs by reducing the maturity differentials reflected on their balance sheets. (Keister et al. 2022.)

4 Research

In this section, research is reviewed, the purpose of which is to clarify which questions this thesis is supposed to answer. For this thesis, interview requests have been made to the Bank of Finland, the European Investment Bank, and the Nordic Investment Bank. Bank of Finland and Nordic Investment bank obtained these results. The European Investment Bank did not answer the interview questions, but they sent material related to the topic. First, we go through the method used to conduct the interview, after which we clarify the research questions and introduce the interviewee.

The interview questions can be found in Appendix 1 and Appendix 2.

4.1 The interviewee

The Bank of Finland acts as Finland's national monetary authority and central bank. It is part of the euro system, which is responsible for monetary policy and other central bank actions in the euro area (Bank of Finland). The person we are interviewing works at the Central Bank of Finland in a unit whose area of responsibility includes matters related to CBDC. As Finland is part of the Eurozone, these matters are done together with the European Central Bank. We chose the Central Bank of Finland to be interviewed because they have the best expertise on our thesis topic.

The Nordic Investment Bank (NIB) is an international financial institution covering the Baltic and Nordic countries. They say their mission is to finance projects that improve the productivity of the operating area and benefit its environment. The original owner countries of the bank are Finland, Sweden, Norway, Denmark, and all the Baltic countries, Estonia, Latvia, and Lithuania, joined it in 2005 and have been equal members ever since. Visions that NIB wants to improve in its member countries include, for example, sustainable growth, technological innovations, combating climate change, developing a circular economy, and protecting marine areas. (Nordic Investing Bank) We chose our second interviewee from the Nordic Investment Bank, as we wanted to get their perspective on our topic, especially the possible effects of CBDC on the economy and societies. The European Investment Bank's representative also recommended Nordic Investment Bank's expertise.

4.2 Conducting the research

Our goal was to get as comprehensive an overview as possible of the opinions of the financial world regarding our thesis topics. However, we soon realized that it is difficult to find suitable institutions, as only a few have anything to do with CBDC, as it is still in the research and inventory stage. We requested interview requests from three financial institutions, two of which agreed to our request. The rest did send valuable links that we could use as our sources. We initially approached the Central Bank of Finland via email, through which, after calls and dialogue, we got in touch with an employee working on CBDC. We interviewed a representative of the Central bank of Finland via Microsoft Teams. The interview lasted about one hour.

We did an email interview with Nordic Investment bank, as it was an easier way to get in touch with them. The representative of Nordic Investment Bank spoke about the subject in his own words, answering the questions sent to them in advance.

We were also in dialogue with the European Investment Bank. In the end, they couldn't find a suitable person to answer our questions due to time constraints, so despite the effort, we couldn't get expert views from there. However, we received helpful links, which have also been used as a source in the creation of this thesis.

5 Results

This section reviews the research results. The results are following the interview questions in the subsections were obtained from the Bank of Finland's interview. The analysis is done by comparing the collected data with the theory base.

5.1 Motivations to use CBDC

The main question: Why do central banks plan or launch their own virtual currencies? (Central bank digital currencies)

According to the Central Bank of Finland representative, there are many different motivators for planning or launching Central Bank Digital Currencies (CBDCs) depending on the geographical or socio-economic area. For example, in China, Europe, and the countries of Central America and the Caribbean, the need for CBDC is different, leading to the fact that the regions with a greater need for CBDC are significantly ahead of the Eurosystem. As an example, "Sand Dollar" is already in use in Uruguay and the Caribbean; in addition, in China, there are estimated to be up to 200 million users of CBDC, E-yuan.

The areas are different from economic and digital environments. China, where various payment applications such as Alipay and Wechat payment are prevalent, wants to be a leading country in digitization in many sectors, such as payment systems, in which case the launch of digital money is in the state's interests. The main reason for the launch of CBDC in China has been to increase competition. At the same time, the Caribbean, whose countries are, on average poorer, wants a simple and standard payment system that would be inexpensive to maintain.

European Union's longer-term vision is to anchor monetary, central bank-oriented money as their currency instead of money from commercial banks. As the use of cash decreases, the currency used in the future could be a digital currency originating from the European Central Bank. Strategic autonomy is a significant motivator for the development of CBDC in the Eurozone. Private banks' most used credit card companies are VISA, Master Card, and American Express. Because of this, the data of European consumers moved to multinational companies in the United States. The goal is to create a regulated payment system in the EU. Another motivator is financial inclusion, as a significant number of people living in the EU do not have personal bank IDs. However, this does not apply to Northern Europe or Finland to a large extent.

5.2 The relation between cryptocurrencies to central banks

What is the relationship between central banks and private cryptocurrencies?

It is possible that a cryptocurrency, especially a so-called stable coin, will become more widely used among people. However, this scenario contains excellent risks if the money market were wholly private and not under the control of the states, as it would affect the economy of the states and regions comprehensively. The launch and general introduction of a stable coin could happen very quickly, in which case the states' central banks would lag behind the development. The Libra currency launched by Facebook is considered a significant turning point for central banks. The Libra coin was a booster for many to start the research process to develop CBDC. There is no connection between private cryptocurrencies and the national CBDC.

According to Nordic Investment Bank, the relationship between cryptocurrencies and central banks is minimal. They emphasized that all measures taken with cryptocurrencies are too unstable for central bank operations. They added to the question that central banks, like governments, may be interested in regulating taxation, even if they do not manage it directly.

Some countries, such as El Salvador and the Central African Republic, have adopted Bitcoin as their official currency. However, for the time being, according to the human development index, these are developing countries whose economies are not of significant size. Paying with Bitcoin is also impractical due to its fluctuating value.

5.3 Benefits and risks

The question about benefits and risks of CBDC is

What are the potential benefits and risks of CBDC?

Referring to question 1, the Bank of Finland emphasized that the benefits of CBDC depend strongly on geographic location. The benefits were strongly related to potential motivators, why central banks in different parts of the world are developing or have already launched CBDC. The benefits that a CBDC could bring are as follows:

- Competition in the payment instrument market; Challenging the duopoly of VISA and Master Card could lead to more efficient and cheaper payment instrument services for the consumer.

- Financial inclusion; persons without bank credentials or unbanked could access digital payment methods.
- Strategic autonomy; we would not be dependent on a few private companies, as it is difficult to predict the geopolitical future.
- Money transfer; Transferring money and paying with it would be faster and cheaper for both consumers and merchants.

The representative of the Nordic Investment Bank saw that the development of CBDC could bring positive side effects to central banks. These effects could be effective monitoring of payments made in the system and easier preparation of taxation. However, the results could only occur if the use of cash was radically reduced, which they considered unlikely.

The same benefits apply to every geographic location. However, the Caribbean and China's need to benefit from CBDC differs. In the Caribbean, financial inclusion is a key benefit, as a significant part of the population does not have bank accounts. At the same time, China is benefiting more from internal competition regarding payment systems. The Chinese government also wants to be a technological development pioneer and have payment systems under its control.

Just like the benefits, the risks can also vary depending on the geographical location. The Bank of Finland particularly emphasized the following issues as risks.

- A solid and well-functioning financial and banking system; it is not easy to assess what would happen if consumers did not have deposits in commercial banks but used CBDC instead. This could be a risk for monetary security.
- With relation to the previous risk, the transfer of deposits to a central bank account, the financial structure of banks would change radically.
- Uncertainty: What would happen to trust in central banks if something went wrong. The Central Bank of Finland underlined that people's trust is crucial.

Many unpredictable things can still happen when it comes to new innovation and technology that is still mainly in the hybrid stage. Central banks are constantly working to minimize risk and make CBDC as functional as possible.

5.4 Timeliness and future of the topic

The following questions relates to the timeliness and future of this topic:

The arrival of new payment methods takes time for people to get to know and trust new systems. On what schedule is CBDC planned for widespread use?

How is CBDC security and privacy guaranteed?

The Bank of Finland considered the topic future oriented. Central Bank Digital Currencies are in the investigation phase and are not yet widely used. In Europe, the design phase could start by the end of this year (2023), which would mean seeing what the digital euro could look like and how it could work. A rough estimate of when the digital euro could be launched is about four years away. Sweden, considered one of the pioneers of CBDC, is roughly at the same pace as the rest of Europe. Despite this, it is not guaranteed that people will start using it immediately or trust it. There is no official timeline for large-scale deployment, which isn't easy to estimate.

A representative of the Nordic Investment Bank also expressed the view that the practical consequence of launching CBDC could enable more users of cryptocurrencies if they become stable and safe coins. He presented a theory where central banks could offer these currencies to their members, who would be banks, stressing that this would not be a decentralized system. Banks could then deliver the currencies to consumers.

The Bank of Finland stated that the security of the CBDC is a crucial issue. According to it, the safety of monetary traffic could increase if it were more strictly central bank oriented. The central bank could regulate the money supply and interest rates not to vary much, improving financial stability. On the other hand, the same risks with, for example, deflation and inflation would remain the same. Again, digital wallets' data security solutions are complex and constantly being developed.

5.5 CBDC as valid currency

The following questions relates to the CBDC as a valid currency:

The arrival of new payment methods takes time for people to get to know and trust new systems. On what schedule is CBDC planned for widespread use?

What are the economic impacts of CBDC on financial markets?

The Bank of Finland considered this part of the study to be the most important. It was also difficult to answer the question, because we cannot know what has to be happened, but the Bank of Finland is constantly considering issues related to this question. With people's trust in central banks, CBDC could be a viable currency. The Central Bank of Finland raised the question about whether CBDC would be a legal tender. Would accepting its use be mandatory? In some European countries, for example, cash is legal tender, meaning that the use of coins and banknotes in debt payment is accepted. Acceptance of CBDC as a debt payment method could also speed up its adoption.

Nordic Investment Bank's representative's position on the subject was concise, and they emphasized that the area could be more familiar to the organization and to themselves. CBDC currently does not have a substantial impact on the economy or financial markets, and in general, its impact is weak, as the potential effects would only be relevant if the development favorable to CBDC continued and the use of cash was radically reduced.

5.6 Differences in results between the institutions of the interview

Overall, the answers between the two interviewees differed as expected. The services offered by financial institutions are also different, and they focus on different areas. We should consider that the Bank of Finland is a state actor that develops public financial services and cooperates with other state actors. At the same time, Nordic Investment Bank is a private company.

When we started talking about central bank digital currency, and related side topics, each interviewee thought that the development of the subject is still ongoing. The Bank of Finland had a clear vision of when the digital euro could be launched in Europe, but even they could not say precisely how it would be widely distributed. On the other hand, Nordic Investment Bank said that the development phase takes time, and they needed more detailed information on the question.

Neither saw the relationship between central banks and private cryptocurrencies as significant. Bank of Finland also emphasized that CBDC and cryptocurrencies are entirely different things. On the other hand, Nordic Investment Bank stated that cryptocurrencies are too volatile for all central bank functions.

As for the practical consequence of the CBDC, both institutions stated that bank and consumer confidence is key. Without trust, the project could not be carried through.

When we asked about the impact of the CBDC on monetary policy, both saw that it could make it easier for central banks to affect money supply and interest rates. However, Nordic Investment Bank added that this could only happen if all central bank-originated money were digital currency rather than just a tiny portion. Both institutions acknowledged that this development would be difficult and slow, as it could mean a radical reduction of cash. It would be hard drive through society.

5.7 Analysing the results with the theoretical background

This thesis is divided into the theoretical background and the actual research section. The academic background has also been divided into sub-sections to make it easier to follow the thesis and make the topic easy to understand.

Although not all interview questions were directly related to the topics of the theoretical background, many issues discussed in the academic background were strengthened, and new perspectives were obtained. In addition, we did not seek verification for the explanations of the concepts because we assume that they are relatively clear to experts and interested readers.

First of all, we are grateful to both interviewed parties and others who have shared sources to contribute to the completion of our thesis. It was also great to notice how much expertise the Central Bank of Finland has in this matter, and how Nordic Investment Bank is also aware of the underway developments.

In the first section of the theoretical background, (2.1 History of money, 2.2 Cryptocurrency) we went through the history of money superficially because it arouses the reader's interest and is closely related to the topic. From the history of money and its mechanisms, we quickly jumped to the cryptocurrency section, because cryptocurrencies were already related to one of the sub-questions of our research. A representative of the Bank of Finland estimates that cryptocurrencies have also impacted the development of CBDC. In particular, the Bank of Finland considered so-called stable coins a threat, as they had already gained popularity

as a payment method. Thus, the central banks gradually woke up and started creating their own digital currency.

When the interviewees were asked about the impact of CBDC on monetary policy, the responses were consistent with the research referred to in chapter 2.4.1 (Central bank digital currency and monetary policy) (Akdag 2022). However, Nordic Investment Bank representative emphasized that reducing paper money is so complex that the actual effects are negligible.

In chapter 3.1, there is a map created by Cbdctracker.org (figure. 3) that shows at what stage every geographic area is in the development of CBDC. The map confirms the differences highlighted by the Central Bank of Finland, what is the motivation of different societies to implement CBDC.

In section 3. Central Bank Digital Currency, we present two panels (Figure 1, Figure 2). The first of the panels offers the development of e-commerce and online payment for individuals and the product of companies selling online. The picture shows how popularity has grown in Europe in the last ten years. The Bank of Finland mentioned that digitization is one of the central motivators of CBDC planning.

The second panel, on the other hand, presents the development of the popularity of cash in the Netherlands and Germany. The curve describing cash transactions is going downwards, meaning an increase in the popularity of online payment transactions. According to the Central Bank of Finland, central banks worldwide have woken up to this development. The design and launch of CBDC mean that central banks also offer a digital currency alternative alongside cash. The study's starting point was the assumption, also stated by the Central Bank of Finland, that cash cannot be used to pay for online transactions.

In chapter 3.2 (CBDC's potential benefits), we refer to the blog published on digital asset (What is a Central Bank Digital Currency and why should people prefer CBDC over bank accounts) (Drako 2020), which mentions that CBDC will bring a safe, fast and one-time digital currency that would be used on modern payment platforms. The article notes that CBDC is also simple and cheaper than the current banking system. The Central Bank of Finland said this would bring strategic autonomy to the European Economic Area and reduce dependence on other factors. The view of the representative of Nordic Investment Bank could have been more objective but saw the benefits of CBDC as mostly positive side-effects, such as the ease of tax regulation and monitoring.

In section 3.3 (CBDC's potential risks), we refer to Central bank digital currency (CBDC): an exploratory study on its impact and implications for monetary policy and the banking sector, a dissertation (Brokke & Engen 2019.). According to them, before CBDC can be accepted for widespread use, several legal, technological and operational challenges must be resolved based on preliminary research and testing by several central banks.

Nordic Investment Bank's representative saw many risks and problems in the possible launch of CBDC that should be solved. In particular, the whole process would take a long time before the digital currency could be used safely in a way that would have the trust of institutions, businesses, and consumers. When asked about the matter, the Bank of Finland supported the claims presented in the theoretical background but assured that every issue had been considered in the development phase. As a new perspective, an already existing, the well-functioning banking system was introduced, which the communities are already widely used to.

Neither party took a direct stand on cyber security issues, and it was also not the area of expertise of the interviewees. However, an interview with the Bank of Finland revealed their IT security team, whose task area also includes the matter in question.

Section 3.4 discusses CBDC's functionality as a valid, real currency. The chapter is divided into three sections, discussing the possible consequences of CBDC, its impact on the economy, and its legal aspects. The questions we ask the institution to differ slightly; for example, we aim to get more information about possible economic effects from the Nordic Investment Bank.

In section 3.4.2 (Legal aspects of CBDC), the book *Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations* (Wouter B., Itanani M., Marguilis C., Rossi A, published by the International Monetary Fund (IMF) Weenink H., Yoshinaga A. 2020) we also investigate legal issues and problems related to the topic. For example, we go through how the CBDC should be integrated into the Central Bank and Monetary Act and how their regulation is problematic.

The Bank of Finland raised the question of CBDC's legal tender. It was one thing that would have to be decided and involve various legal technicalities. Nordic Investment Bank did not add anything. The answers differed the most in relation to the theoretical background in this section. Legal matters are where there is still plenty to investigate.

(In section 3.4.3.) (CBDC and economics) we refer to the academic article, *Cold hard (digital) cash: The Economics of central bank digital currency* (Ahnert et al. 2022), which is a

summary of their working paper *The Economics of central bank digital currency*. The article highlights the use of cash and the growth of e-commerce, affecting the necessity of CBDC. As a question, they saw that CBDC could raise banks' funding costs, which would drive them to take more significant risks when investing in the most speculative objects. A blog post published in the Office of Financial Research (OFR), *How would a Central Bank Digital Currency Affect Financial Stability?* (Keister 2022) tells how a well-planned and functioning CBDC could improve financial stability and reduce the need for liquidity services provided by banks.

According to the Bank of Finland, some stable cryptocurrencies can increase the popularity of consumers and financial operators, and CBDC would offer a more durable alternative to this. On the other hand, a representative of the Nordic Investment Bank considered that the popularity of cryptocurrencies could increase with the CBDC, which could be more financially unstable for banks. However, the impact of CBDC on the economy was speculative for both, and they did not set out to predict it.

6 Conclusion

In this thesis, an answer was sought to one research question, why central banks develop and launch Central Bank Digital Currencies.

We gained a lot of new information and perspective on the research question. We use various academic articles, blog posts, and already prepared research prepared by experts in the field.

The first thing was to find out the terminology and open up the history of money and the means of payment so that the reader could understand the broad context of the topic. We also had to find out, among other things, the prevalence and functionality of CBDC, as well as the impact of cryptocurrencies, so that we could get indications of where we wanted confirmation and additional information through, for example, interview questions.

The development of the CBDC and the handling of the problems associated with its debut have become much clearer. The interviewees were very good at bringing out different points of view, for example, why consumer credit is of the utmost importance to successfully launch a CBDC and adopt it in everyday payment transactions. There was no direct answer to the problems and challenges, but the experts constantly considered these questions. It is difficult to deal with future-oriented topics because no one can accurately predict how the world's economy and politics will turn out.

Financial institutions were interviewed directly via the Microsoft Teams service and e-mail. We prepared more in-depth questions for Nordic Investment Bank to utilize their expertise the best. We also noticed that many people are working on the CBDC with varying job titles, from IT-professionals to financial experts.

All in all, we are delighted with the results. In particular, the interviewee from the Central Bank of Finland took a lot of effort to comprehensively answer the questions, for which we are very grateful. However, it took a lot of work to approach the interview subjects, as it often took a long time to find the right person to ask about the possibility of an interview, and there were only a limited number of people with relevant information. We have yet to get a consultation from one of the financial institutions we wanted, which affected the scope of the results and made the thesis more difficult. However, those who participated in the interviews were excited about the topic and hoped to be able to help to do this thesis.

Approaching the subject of an interview took time and effort, as we mentioned before. Emails and phone calls were often forwarded multiple times to find the right person to answer the interview questions. We couldn't compare the interview results before we received them, so continuing the thesis from time to time slowed down.

Although many topics have been written about CBDC in recent years, our further research proposals for the topic are, for example, the effects of CBDC on the economy or the environment. We believe that similar topics for other contexts would be relevant.

As for our learning and its evaluation, we have developed well in the areas of the thesis, especially in background research, searching for the proper scientific articles, and acting as the interviewer's party. The most challenging thing in doing the thesis has been the joint scheduling. We have both studied and had paid jobs during the thesis, making this the most difficult part of our studies. However, we are satisfied, and we hope that our thesis can benefit others interested in future technologies, cryptocurrencies, and the financial world related to the various matters in research and development.

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Appendix 1. Interview questions the Bank of Finland

- Why do central banks plan or launch their own virtual currencies? (Central bank digital currencies)
- What is the relationship between central banks and private cryptocurrencies? (like Bitcoin or Ethereum)
- What are the potential benefits and risks of CBDC?
- The arrival of new payment methods takes time for people to get to know and trust new systems. On what schedule is CBDC planned for widespread use?
- How is CBDC security and privacy guaranteed?
- Is Finland's own virtual currency project going independently or together with the European Central Bank?

Appendix 2. Interview questions Nordic Investment Bank

- Why do central banks plan or launch their own virtual currencies? (Central bank digital currencies)
- What is the relationship between central banks and private cryptocurrencies?
- What are the potential benefits and risks of CBDC?
- How the CBDC system should be created and what are the long-term effect of CBDC
- How CBDC effect on monetary policy?
- What are the economic impacts of CBDC on financial markets?
- What could be the practical consequence of launching a CBDC?
- Is this topic current?

