



universität  
wien

# MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Impact of Central Bank Digital Currencies to the Credit  
Creation Process“

verfasst von / submitted by

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angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of  
Master of Science (MSc)

Wien, 2020/ Vienna, 2020

Studienkennzahl lt. Studienblatt /  
degree programme code as it appears on  
the student record sheet:

UA 066 915

Studienrichtung lt. Studienblatt /  
degree programme as it appears on  
the student record sheet:

Masterstudium Betriebswirtschaft

Betreut von / Supervisor:

Assoz. Prof. Mag. Dr. Paul Pichler

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# 1 ABSTRACT

In recent years, the blockchain technology has not only brought about the success of privately issued cryptocurrencies but, even more importantly, spurred the discussion of transferring its accompanying benefits to other potential uses such as the issuing of a Central Bank Digital Currency (CBDC). In a recent announcement, Christine Lagarde, president of the European Central Bank (ECB), underlined this topic's relevance by declaring to further promote research in this subject area (ECB, 2020; Crowdfundinsider, 2020). Despite the increasing interest of issuing a CBDC, no country yet has done so and there is still a huge debate about the possible ways of implementation. Importantly, the specific choice of CBDC would be of utmost relevance, as different options would have hugely deviating effects to the economy. In this paper it is shown how the issuing of a CBDC would affect the way of credit creation, the functioning of both commercial and central banks and thus the economy, depending on the certain characteristics of issued CBDC. Built on the Money Flower framework this work distinguishes between three versions of CBDC, which differ in two main characteristics: their accessibility and their feature of being token-based or account-based (Bech & Garratt, 2017). Based upon this scheme, this paper identifies a conservative form of CBDC, only accessible to banks but not the public, a moderate form to which the public also has access but is anonymous and a radical one, which is based on accounts held at the central bank directly and is thus not anonymous. Remarkably, the latter is predicted to provoke the most profound changes to the banking system and is expected to change it to a narrow banking system. Even though some papers provide evidence that such a radical version is likely to completely alter the functioning of banks and to lead to a narrow banking system, no paper has investigated on the concrete effects of issuing a CBDC to the credit creation process and their accompanied effects, based on the different possible versions of such a currency (Gouveia et al, 2017; Engert & Fung, 2017). Hence, this work focuses on the effects to the process of credit creation and the functioning of banks under the three different versions of CBDC outlined prior. Thereby, it tackles the existing research gap by hypothesizing on the possible implications to the banking system.

## **2 INTRODUCTION**

### **2.1 Background and Relevance**

Given the success story of Bitcoin and other privately issued cryptocurrencies, this has drawn the attention to the benefits of the underlying blockchain technology. These mainly comprise its peer-to-peer exchangeability and thus the absence of a third party, thereby ensuring little to no political interruption. In addition, transactions costs, which normally occur due to these intermediaries, are tremendously reduced for cryptocurrencies (Stevens, 2017; Dierksmeier & Seele, 2018; Brito, Shadab, & Castillo O'Sullivan, 2014). By also increasing transaction speed, all of these changes drastically improve overall efficiency (Kiayias & Panagiotakos, 2015). This makes these currencies highly attractive and has prompted the discussion whether these are also transferrable to other uses, such as the issuing of digital currencies for central banks. It is aimed to make use of these efficiency improvements and lower transactions costs and apply these to wholesale or retail payments in everyday transactions. Even though no government has decided to issue its own CBDC, some countries have investigated extensively on this topic, such as Sweden, Australia, England and Canada, whereby former one is one of the predominating leaders in this discussion (Griffoli et al, 2018). Due to Sweden's declining demand for physical money, i.e. cash, the country has considered to issue its own digital currency called E-krona. Other countries have published papers assessing advantages and disadvantages thereunder Malaysia, England and New Zealand (Kumhof & Noone, 2018; Wadsworth, 2018; Ahmat & Bashir, 2017). The European Central Bank (ECB) has remained rather reserved in the beginning of the ongoing debate about the implementation of a CBDC. Yet, Christine Lagarde, president of the ECB, reported that the ECB's invest in this field of research so as to keep up with rising demand for faster and cheaper payments transactions. In order to satisfy this demand and secure its role as an important worldwide market player, a shift towards a more digital payment system is inevitable (ECB, 2020). Also, it was announced to set up a task force to further promote research for digital currencies as well as analyze both its advantages and disadvantages (Ledger Insights, 2019; Crowdfundinsider, 2020). Yet, the ECB remains unclear about whether they will certainly issue a CBDC any

time soon. Other challenging decisions include, but are not limited to, the point in time of its introduction as well as its specific form. Importantly, these choices entail side effects such as disruptions to banking structures, money creation and the economy, amongst others. Hence, one can say that the debate about the issuing of a CBDC is not only an extremely relevant one, but expected to become even more relevant in the next few years.

## **2.2 Research Gap and Objective**

Looking at what has been done in literature so far, it is obvious that there has been a fair amount of studies investigating on the possible advantages and disadvantages as well as economic implications of the issuing of a CBDC. On one hand, some studies highlight the potential benefits in efficiency and dynamics as well as the increased possibilities of the conduct of monetary policy for central banks. Firstly, it is argued that the underlying technology of the DLT will decrease transaction costs, thus leading to efficiency gains in payments (Gouveia et al, 2017). Proponents of the issuing of a CBDC also point out that it will provide additional options for central banks to conduct monetary policy, such as the charging of negative interest rates. Also, it will raise the opportunity for a new monetary policy tool called 'Helicopter Money', raising possibilities to increase money supply (Dyson & Hodgson, 2016). What is more, it is suggested that the issuing of a CBDC would minimize financial risk as well as the risk for bank runs. This is predicted to be stimulated by a conversion from the current fractional reserve banking system to a narrow banking system, as demonstrated in literature (Flaschel et al, 2010).

On the other hand, there are also major risks and disadvantages concerning the implementation of a CBDC regime, as it will lead to unpredictable outcomes for banking and thus the development of the real economy. In addition, the predicted change in the banking system and the conversion of the central bank to a narrow bank is also seen as a threat, as shown by some authors (Engert & Fung, 2017; Stevens, 2017). A more detailed analysis of this will be provided later in this paper, within the context of the impact of the implementation of a radical version of CBDC.

Even though there is a wide range of analysis of the effects of the issuing of CBDC to the overall economy, there is no study that focuses on the effects to the credit market and the altering of the functioning of banks. In addition, there are no unified versions of CBDC across studies, but they differ in their distinct characteristics. Hence, there are hugely deviating views on possible consequences of the implementation of such a currency regime, as there is no consensus on a specific CBDC option. Yet, a concrete distinction is of particular relevance. Decisively, only some versions are likely to change the current banking system and to lead to a shift to a narrow banking system (Gouveia et al, 2017). Also, further consequences provoked by a shift towards a narrow banking system remain undiscussed in current literature. Given that, this paper tackles the existing research gap by examining on the effects of a CBDC to the credit creation process and the functioning of banks. It comes up with a model and distinguishes between three options of CBDC, comprising a wholesale CBDC, a moderate public CBDC and a radical version of retail CBDC. It analysis the effects to the credit creation for every CBDC option separately. By this, the thesis outlines the altering of functions of commercial and central banks and the likely shift to a so-called narrow banking system, which is likely to occur due to the issuing of a radical version of CBDC. In addition, it hypothesizes on the possible economic consequences resulting from such a narrow banking system, based on existing economic concepts. Thereby, this thesis significantly contributes to existing literature by studying effects to the credit creation process and the banking system triggered by the issuing of CBDC based on a model with three different versions of such. For this, it combines the current knowledge in CBDC with prevailing macroeconomic approaches found in literature and unites these in such a way that new knowledge can be gained.

## **2.3 Methodology**

This work builds an analysis of CBDC versions, derived from literature. Yet, it is not only reviewing existing literature, but building three distinctive scenarios of credit creation under different CBDC regimes. Explicitly, it combines published papers in such way, that the main characteristics of CBDC are identified. Upon this, this thesis builds its own model of CBDC versions and creates an analysis of the consequences to the process of credit creation and the functioning of banks. Thereby, existing

theories in literature are combined in such way that new hypothesis can be postulated. This work considers findings from both research subjects – i.e. the current functioning of credit creation and banking as well as CBDC - so that the effects of the implementation of CBDC to the credit creation channel and the economy can be projected. For this, the most recent literature and political publications within the ongoing CBDC discussion are taken in consideration. As this is a highly new topic, the amount of literature is limited and so are its published papers in high-quality journals. Hence, this paper does account for nearly all publications about CBDC, but still carefully evaluates their validity. The papers used for the analytic review are all published from 2016 onwards, so timeliness is definitely given. Amongst the most important papers which are taken into consideration are 'Central Bank Digital Currencies: assessing implementation possibilities and impacts', 'Digital currencies: Threats and opportunities for monetary policy', 'Central bank Digital Currencies', and many more. Also, publications from central banks (CB) such as the CB of Sweden, Malaysia and England are taken into account.

## **2.4 Structure**

This paper is divided into three parts, the introduction, the main part and the conclusion and is structured as follows: The introduction comprises the background and relevance of the research topic. Afterwards, an overview of current literature and the existing research gap is identified. Thereby, this paper also lines out the objective of this paper and its contribution to existing literature. The main part of this work consists of the analysis that addresses the research question and comprises the model of the impact of different versions of CBDC to the credit creation channel. In order to do so both research subjects, CBDC and the current process of credit creation, are elaborated in detail. Firstly, the main features of the credit creation channel and features of the current fractional reserve banking system are investigated. Specifically, its practical application and implications are shown as these are strongly shaping the functioning of banks and the supply of credit and thus are major determinants of the economy. In addition, the narrow banking system, which stands in contrast to the fractional reserve banking system, is briefly described. In a next step, the work contextualizes different versions of CBDC depending on the existence of certain features, which is based on the 'Money Flower' framework (Bech

& Garrat, 2017). Thereby, the paper identifies three different versions of CBDC, which all share two characteristics but differ in the remaining two. In particular, all versions are issued by the central bank and electronic; yet distinct each other in being universal or restricted and token-based or account-based. Accordingly, all of these versions are examined in detail. Based on this, the study analyzes the possible effects of the implementation of different versions of CBDC for the creation of credit and the functioning of banks. It shows that whilst a conservative form of CBDC does not alter the credit creation channel by its nature, a radical one is likely to lead to a narrow banking system (Gouveia et al, 2017; Stevens, 2017). Yet, it can be forecasted that also a conservative version will have impacts in the efficiency and dynamics of money creation. This work then elucidates on specific economic implications and consequences of such a system, which are provoked by a radical version of CBDC. By this, the paper closes the existing research gap and contributes to literature. The conclusion then summarizes on the main findings of this work and finalizes with limitations and recommendations for possible future research.



### **3 CREDIT CREATION**

In the following paragraphs the credit creation process with its main characteristics and implications is outlined. Firstly, a terminology of money and credit is given. Afterwards, the functioning of banks is described, as this is essential for the creation of money and the functioning of the economy. Then, particular features of the procedure in the current economy will be elaborated. All of these are of utmost relevance, as the issuing of a CBDC, depending on its version, affects money creation and the functioning of banks and thus has impact to the economy.

#### **3.1 Characteristics of Money**

Money is any legal tender that can be used in order to purchase good and services. Earlier, money was constituted of commodity money and got its value from the underlying commodity such as gold. In today's economy money mostly takes on the form of fiat money, i.e. money that does not have any intrinsic value, such as the traditional paper bank notes. Rather, it gets value from people's trust in it being accepted for payments and its more or less stable value in the long term. All forms of money have to fulfill three main functions – i.e. to be a medium of exchange, a store of value and a unit of account – in order to be classified as such. In order to further classify money, there are several features in which different forms of money differ. For example, money may exist in electronic form or physical form, whereby about 92% of total money is digital and only 8% is physically represented, i.e. cash. Yet, cash is used for the majority of payments under EUR 20, as according to the ECB. In addition, one may distinguish between money that is issued by the central bank and private money. Most of the money is issued by the central bank; cryptocurrencies are an example of private money (ECB, 2015).

#### **3.2 Actors in the Financial System**

Both central banks and commercial banks are the major operators within the financial system. Notably, the Federal Reserve Bank (Fed) is the central bank of the United States, and the European Central Bank (ECB) in the European Union and world leaders for the economic well-being. In general, the central bank's conduct of monetary policy is one of the main influencing factors for the economy, with their

major goals of keeping inflation low and steady at around 2% as well encourage maximum employment. They do so indirectly, i.e. by setting the short-term interest rate, called federal fund rate in the US, on bank reserves. By this, they influence the cost of money and can thus stimulate or suppress the growth of the economy. Yet, specifically commercial banks are the driving force within the credit creation process, as shown in the next paragraph.

So as to classify money, there is a distinction between outside and inside money within an economy. The central bank is the controller of so-called outside money, which is not accessible for the public and consists of banknotes and bank reserves. Inside money comprises the money created by commercial banks, i.e. bank deposits. In the current monetary system, commercial banks are the main actors in the traditional banking functions, i.e. taking deposits and issuing loans. This is of particular relevance, as the creation of inside money is the main influencing factor for credit creation within an economy, as shown later in the paper.

### **3.1 Characteristics of Credit Creation**

Commercial banks create new money simply by issuing new loans to individuals, thereby simultaneously creating a matching deposit. Despite conventional wisdom, the amount of granted loans does then not depend on the current amount of savings investors place in the bank. Rather, commercial banks structure their portfolio and hence adjust the supply of credit so as to maximize their rate of return. This, amongst other variables, depends on the interest rates set by the central bank on bank reserves, which will be elaborated in the next paragraph. Of course, there are other factors that influence a bank's profitability and thus portfolio allocation decisions, such as loan and cash demands as well as discount rates. Still, commercial banks cannot issue their loans endlessly, but have to meet certain regulatory standards in order to ensure a bank's liquidity. The most important one and also main characteristic of the current banking system is the fractional reserve banking system and the implied maturity transformation, outlined as follows (Goodhart, 2010; McLeay, Radia & Thomas, 2014).

The practiced fractional reserve banking system encapsulates that banks have to hold a certain percentage of their issued loans as liquid assets that are similar to cash, such as reserves, at the central bank. Yet, this system works in a reverse way in contrast to what the public believes, as according to the ECB and the Bank of England. Pedagogical theories often state that the reserves held at the central bank strictly determine the amount of credit that can be supplied by commercial banks, calculated by a certain factor also known as the money multiplier. However, in practice commercial banks are mostly not directly limited by the reserves they hold in their supply of credit. Instead, the granted loan supply sets the quantity of reserves, which a bank requires to have in order to meet regulatory standards. This is given by the percentage that is defined according to the fractional reserve banking system. Primarily, commercial banks decide on their preferred loan supply, which is mainly determined by the respective short-term interest rates charged by the central bank. Thereby, it is clear that as interest rates drop, it gets more profitable for banks to issue loans, because prices for reserves at the central bank decline. The central bank then aims to supply the needed reserves in order to match the commercial bank's requirements. Accordingly, the bank's loan supply predominantly influences the supply of reserves by the central bank; rather than *vica-versa*.

In addition, the fractional reserve banking system implies that only a small percentage of issued loans is secured by liquid money and is actually available. This characteristic is known as maturity transformation and entails that banks can lend out loans for a longer time frame than savers place their deposits. Consequently, this implies that those deposits are not fully backed up by liquid assets. Still, this fractional reserve banking system restricts the supply of loans to some extent, as they have to keep a certain percentage as reserves, as previously outlined (European Central Bank, Monthly Bulletin, 2011; European Central Bank, 2016). Due to the fact that mostly savers do not request their total money at the same time and immediately, this system works. Yet, in case everyone wants to withdraw money simultaneously, this would lead to a bank run. Clearly, this has profound implications for the whole economy and the financial risk, which will be outlined later in the paper.

## **4 CBDC**

### **4.1 Overview of CBDC**

Across all studies, CBDC can be classified as electronic money that is issued by the central bank. Also, it encapsulates the three main characteristics of money, i.e. to serve as a medium of exchange, a unit of account and a store of value. However, there is a huge divergence in other specific characteristics and its implementation form in existing literature. Significantly, its distinct features are from high relevance as they greatly shape the impact to the banking system. This of course results in deviating implications and effects of such currencies. Thus, a clear and specific classification is required in order to assess possible consequences to the money creation process. This paragraph introduces and accurately describes the main frameworks and upon this builds a model with three versions of CBDC. Firstly, dominating models existing in literature are elaborated, as these build the base for these three versions. Then, all of these three versions are outlined in detail. Within this, explicit effects of the issuing of a CBDC to the credit creation process and its impact to the economy are investigated, thereby addressing the existing research gap. All three versions of CBDC Options are analyzed separately and consequences to the credit creation process as well as the economy are elaborated. Thereby it is shown that a radical version of CBDC, is predicted to have the most profound impact to the credit creation mechanism and to the economy. Yet, also a wholesale CBDC as well as a moderate public CBDC are likely to have economic implications. Still, these will not change the nature of banking and the credit creation process, but rather lead to possible changes in the efficiency and dynamic of the banking system.

### **4.2 Categorization of CBDC**

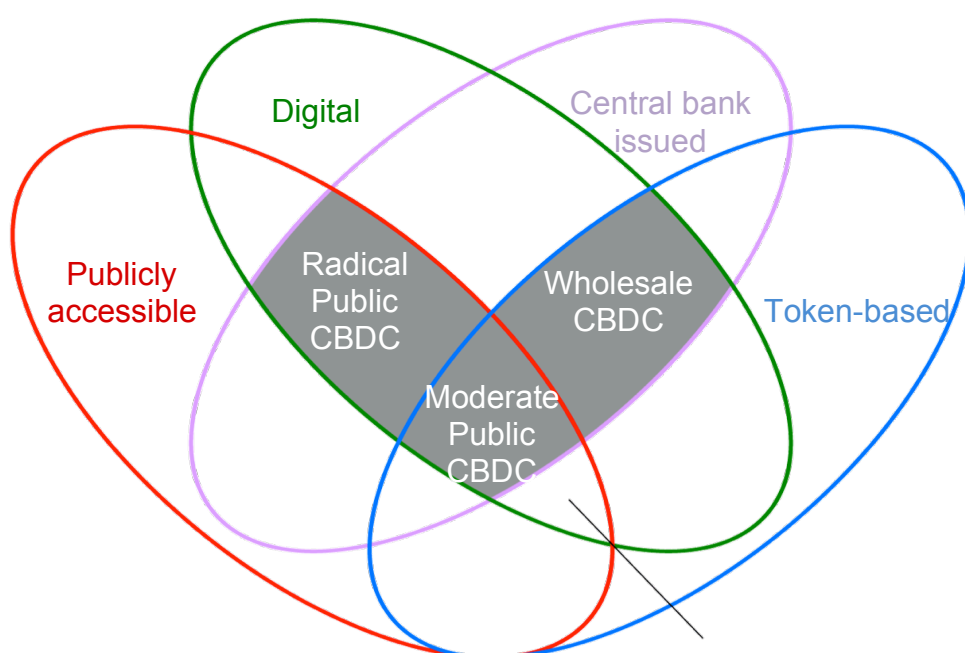
One dominating classification scheme for CBDCs is the Money Flower introduced by Bjerg in his paper 'Designing New Money: The Policy Trilemma of Central Bank Digital Currency'. In this, money is classified by three main features: the issuer; its currency form and its accessibility. The type of issuer depicts whether it is issued by the central bank. The currency form indicates its electronic representativeness - i.e. if a digital version of it exists - such as it is the case for cryptocurrencies or deposited

currency accounts. The accessibility determines whether universality is given, which identifies if it is accessible only to certain actors or to everybody, including the general public. In case it is only accessible for banks, this would mean it is restricted, whereas currency in a universal currency regime would also be accessible to individuals. The paper by Bjerg demonstrates that existing forms of money lack at least one feature and none satisfies all three characteristics: Cash is both central bank issued and universally accessible but not electronic; reserves are electronic and central bank issued but not universally accessible whereas bank account money is electronic and universally accessible but not issued by the central bank. However, CBDC is said to be the first currency that encapsulates all three features (Bjerg, 2017). Other authors have adapted and extended this 'Money Flower' framework by Bjerg so as to particularize different versions of CBDC. In the paper 'Central Bank Cryptocurrencies' the authors Bech & Garratt add a fourth feature – the peer-to-peer exchangeability – and thereby establish a new taxonomy of money. In particular, its peer-to-peer exchangeability depicts whether it is transferable without the intervention of a third party such as it is the case for cash. This framework enables a distinction between two types of Central Bank Cryptocurrencies (CBCC), i.e. wholesale and retail. The difference between those two is whether they are universally accessible, whereas former one is not universal (Bech & Garratt, 2017). The paper 'Central Bank Digital Currencies', published by the Bank for International Settlements further modifies this model provided by Bech & Garratt and replaces the characteristic 'peer-to-peer exchangeability' by categorizing whether the currency is token-based or account-based. Mainly, the distinction between these two is the verification process. For a token-based currency regime, transactions can be made peer-to-peer and there is no intermediary needed for verifying the validity such as it is the case for cash. In contrast, account-based currency forms do need verification from a third party, which makes them centralized. In case of CBDC's, this party would be the central bank. Hence, this determination is hugely similar to deciding whether they can be transferred peer-to-peer, as account-based transactions typically do not satisfy peer-to-peer exchangeability (Coeuré & Loh, 2019). The paper 'Central Bank Digital Currencies: assessing implementation possibilities and impacts' identifies four different versions of CBDC, which differ in their characteristics similar to the aforementioned options. The authors base their categorization on the three

properties accessibility; anonymity and whether they are yield bearing. As outlined in the previous framework by Bech & Garratt, the currency's universality defines who has access to it. A currency's anonymity concerning a central bank can be equalized by its per-to-peer exchangeability. Clearly, as currency can be transferred between individuals such as it is the case for cash, the central bank cannot trace it, thus making it anonymous. In addition, this model includes the possibility of charging interest rates. The authors demonstrate that cash takes on the mentioned features – i.e. anonymity, universality, and no yield bearing. Also, cash is exchangeable peer-to-peer. There has not been a digital version that does so, yet; a CBDC could be implemented in such way to carry all these characteristics (Gouveia et al, 2017).

### 4.3 CBDC Characteristics

The distinct versions of CBDC used in this thesis are mainly based on the aforementioned Money Flower framework originally provided by Bech & Garratt. These three forms are illustrated in the Money Flower, depicted below. The next paragraphs will deeply investigate on the features of such CBDC options as well as its implications to credit creation. Remarkably, all of these versions encapsulate the characteristic of being electronic and issued by the central bank. Yet, they differ in the fact whether they are publicly accessible or not and account-based or token-based.



*Table 1: Money Flower, including all three Options of CBDC*

## **4.4 Option 1: wholesale CBDC**

### **4.4.1 Characteristics**

The first form of CBDC is a wholesale CBDC and only used for transactions in the wholesale market. It is issued by the central bank and is both electronic and token-based. Yet, it is not universally accessible, which implies that it is restricted to interbank settlements and cannot be accessed by the public. Implied by its characteristic of being a wholesale CBDC, it cannot be used for payments between individuals, but only between banks. Its application is said to result in more efficient interbank payments, by making them cheaper and faster due to the reduction of liquidity risk. These efficiency gains are enabled by the avoidance of the use of existing banking networks, which are exposed to higher risk. In addition, the DLT within a wholesale CBDC would lead to greater transparency and better risk management (Mills et al, 2016).

CadCoin is an example of a wholesale token-based CBDC, fulfilling the three properties illustrated in Table 1. It is electronic, issued by the central bank and token-based. However, it is only accessible to a group of selected users and thus lacks universality. It was invented and issued within the so-called 'Project Jasper', a cooperation between the Bank of Canada, R3, a blockchain software company and seven other financial institutions. Its aim is to make large value transactions between financial institutions via the DLT, thus benefiting from the advantages of this technology. Although it has not yet been put into everyday practice so far, the Central Bank of Canada and Singapore have successfully conducted a simulation of a cross-border transaction with the use of CadCoin tokens. This marks the first transfer of digital currencies between central banks (Monetary Authority of Singapore, 2019; Financial, Times, 2019).

### **4.4.2 Credit Creation under a wholesale CBDC**

Given its characteristics of being a wholesale CBDC and token-based, it can be predicted that the credit creation process and the functioning of banks would be vastly similar to the current process. Also, the mechanism of issuing loans would continue to work as in the current fractional reserve banking system. Of course, the special needs for commercial banks to fulfill specific requirements according to the

banking regulations will still prevail. As this version of CBDC would only be transferred between commercial and central banks, loans to individuals would receive their loans in the current version of money. Yet, money transfer between the central bank and commercial banks would be conducted in the form of CBDC. Consequently, if an individual requests a credit, this transaction would be made between the commercial bank and the individual, equally as nowadays. The underlying currency of this would not be in CBDC, but in the current version of money. By assessing the impact to the balance sheet of both consumers and banks in the process of credit creation, one can also see that there is no drastic change in such. Graphic 1, shown in the Appendix, indicates the mechanism of issuing a loan to an individual within a currency regime adapting a wholesale CBDC. It is shown that both central banks and commercial banks incorporate a CBDC in addition to their other monetary holdings. Yet, the individual does not get in touch with CBDC resulting in an unchanged balance sheet compared to the current process. From this it is clear, that the overall process of credit creation is largely remaining the same but there are some changes in the dynamics. Altering both the efficiency and competitiveness in the banking sector brings about these changes in dynamics. A wholesale CBDC is said to lead to efficiency gains by making use of the underlying DLT technology (Engert & Fung, 2017). Thus, this allows for faster and cheaper transactions between commercial and central banks. This results in a more efficient credit creation process, as reserve requirements could be met immediately. As wholesale payments make up for a large share of monetary transfers in an economy, this is expected to positively affect the entire economic system (Chapman et al., 2017). In addition, this kind of CBDC would allow tracing capital flows, which are exchanged between banks. This would guarantee a higher degree of transparency of transactions and the monitoring of payments. Hence, one can detect illegal transactions more easily as well as manage financial risk early. Also, these gains in transparency result in facilitated market activity for central banks in an economy (Coeuré, B., & Loh, J., 2019). Still, as this is a wholesale CBDC, this would only be applicable to transactions made between banks and not the public.

By assessing economic implications of the issuing of a wholesale CBDC it is likely that it results in higher competition within the banking sector. Yet, long-term



consequences of this increased competitiveness, which is brought about by the issuing of a CBDC, remains undiscussed in current literature. Thus, this thesis investigates on different theories, i.e. the market hypothesis and the information hypothesis, and contrasts their opposing arguments. Thereby, it is pointed out that these diverging views lead to unpredictable long-term consequences.

Notably, a CBDC is said to facilitate access to the payment system due to cost reduction. Thus, this will lead to greater competition and greater contestability in payments in the banking sector (Gouveia et al, 2017; Chapman et al., 2017; Engert & Fung, 2017). The effects of competitiveness in the banking sector are a highly discussed topic in literature. Yet, these have not been linked to the issuing of a CBDC. Notably, there are some diverging views on possible impacts to the economy caused higher competition within one industry, which are the market power hypothesis and the information hypothesis. These theories predict to have contradictory effects to credit availability and hence to economic development. In general, industrial competitiveness can be measured by the market concentration level, such as the Herfindahl–Hirschman Index; or by market power parameters. The more concentrated a market is, the less competitive, as few firms or banks share a high degree of power. Low concentration levels then characterize highly competitive markets. The market power hypothesis bases its argumentation line on the reduction of the interest rate triggered by an increase in competition. As outlined by Chong et al, lower interest rates then result in fewer credit constraints for firms. Credit constraints are referred to as the lack of loan supply versus demand, which leads to a so-called financial gap. A decrease in credit constraints then facilitates financing for firms and hence boosts the issuing of loans. Consequently, this theory proclaims that there is a negative relationship between market concentration levels and supply of credit. On the contrary, the information hypothesis, which is represented in the Petersen-Rajan model, depicts that firms are more likely to get credit in more concentrated markets, i.e. less competitive ones. This theorem points out that highly competitive markets are likely to lower incentives for relationship management activities of a bank, in particular gathering information about possible customers. It is argued that more concentrated markets then motivate banks to receive so-called soft information of clients, thus increasing credit availability. Hence, a positive relationship

between market concentration levels and the supply of credit is estimated, according to the information hypothesis (Carbo-Valverde, Rodriguez-Fernandez & Udell, 2009). Clearly, those two theorems proclaim opposing effects on the availability of credit. Hence, this also results in diverging long-term consequences to the economy. On one hand, the market power hypothesis states that higher competition in the banking sector will lead to reduced credit constraints for firms, thus increasing the supply of credit. Supposedly, one can predict that this will lead to higher investments and hence boost the economy. On the other hand, the work published by Petersen and Rajan states the opposite, i.e. that an increase in competitiveness will damp credit supply and thus negatively impact financing for firms. From this theory, it can be projected that increased competition in the banking sector will depress the economy. Accordingly, it can be argued in both ways in which direction an increased competition will affect the economic development. Apart from that, the implementation of an wholesale version of CBDC is predicted to increase efficiency for interbank settlements and decrease transaction costs. Both of these aspects indisputably are positive for economic well-being.

## **4.5 Option 2: moderate public CBDC**

### **4.5.1 Characteristics**

The second version of CBDC in the framework provided by Bech & Garret comprises all the four aforementioned properties – i.e. universal accessibility, electronic representativeness, being issued by the central bank and its token-based manifestation. Thus, it is not only open for wholesale transactions but is also accessible and usable by the public. In this paper, it will be referred to as moderate public CBDC. It is moderate, because its token-based feature assures that transactions will be anonymous and not be recorded by the central bank or any other institution. This implies that it is exchangeable peer-to-peer without any intermediary. It is similar to Option B and C in the working paper ‘Central Bank Digital Currencies: assessing implementation possibilities and impacts’, which are both universal and anonymous and carry the additional possibility of charging yields. Option B, which does not include the yield-bearing feature, is called ‘CBDC similar to cash’ and adequately describes the major use of this option: One can imagine using this kind of

CBDC as a means of payment for individuals in everyday life as well as for money transfers between banks. Option C in the aforementioned paper carries the additional alternative to charge yields. Hence, this could serve as a new monetary policy tool. Yet, this thesis does not take into consideration such option due to too high complexity.

As outlined in the paper 'Central Bank Digital Currencies' by Bech & Garratt, Fedcoin is an example for this conservative version of a public CBDC (Bech & Garratt, 2017). The concept of Fedcoin has been developed by the Federal Reserve Bank of the United States and illustrates a cryptocurrency issued by the central bank itself, which makes it a sovereign currency. Its main goal would be to serve as a substitute for cash by operating at a fixed exchange rate to the US dollar, which is set by the Federal Reserve.

#### **4.5.1 Credit Creation under a moderate public CBDC**

It is expected that the functioning of banks as well as the mechanism of credit creation is remaining rather unchanged under a moderate public CBDC, similar to a wholesale CBDC regime. As this version of CBDC is token-based, commercial banks would keep their function as credit lenders to customers. Because this CBDC version is also accessible to the public, not only banks but also citizens would hold this currency. It is assumed, that CBDC is hold in addition to other forms of money. Hence, consumers would have to substitute their holdings in CBDC for deposits, so as to balance their asset-to-liability ratio, thus decreasing the amount of overall deposits. It is argued that this then suppresses the credit business of commercial banks, i.e. lowering the supply of credit (Gouveia et al, 2017). The concept of credit creation would remain the same: consumers would request loans via the commercial banks, which act as the main lenders but have to hold a certain percentage of reserves directly at the central bank. Thus, the current fractional reserve banking system with its implied features would still prevail. The difference of the credit creation process under this regime would be, that credits could also be issued in CBDC, in addition to traditional money. On a different note, it can be speculated that the efficiency changes occurring under a wholesale CBDC are even stronger under a

moderate public CBDC, due to a wider range of application. This would lead to faster and cheaper transactions, thereby positively affecting lending.

## **4.6 Option 3: radical public CBDC**

### **4.6.1 Characteristics**

This version is the most radical form of CBDC and encapsulates the following features: it is electronic, universally accessible, central bank issued and, decisively, account-based. Due to its universality, it can be used for transactions both between citizens as well as interbank settlements, similar to a moderate public CBDC. Yet, as it is account-based and not token-based, this makes it a radical version of CBDC. This feature could be incarnated by direct accounts held by individuals at the central bank. Consequently, the intermediary, i.e. the central bank, would be in charge of every transaction made. This would prevent anonymity and drastically increase surveillance power of central banks, as they had direct insights in an individual's financial situation. As shown in the paper 'Central Bank Digital Currencies' this would certainly exclude anonymity and peer-to-peer exchangeability (Coeuré & Loh, 2019). Yet, such radical version of CBDC is not likely to be issued any time soon and would probably be the last step of implementing such a currency. Notably, explicit implications of this will be discussed in the next paragraph.

One of few examples of such radical version of CBDC is called 'Dinero electrínco' (Bech & Garratt, 2017). This is a digital online payment system provided by the Ecuadorian government, which can be accessed and used via an App. The money is deposited via currency accounts and denominated in US dollars, as this is the official currency of Ecuador.

### **4.6.2 Credit Creation under a radical public CBDC**

Given the currency's features of being account-based, this option is expected to have the most profound impacts to the banking sector and the economy and to completely change the current functioning of both commercial and central banks. The currency's feature of being account-based would encapsulate that individuals hold accounts directly at the central bank. One can imagine this similar to having bank deposits at commercial banks, yet just without the characteristic of these being private

institutions. In order to receive a loan, individuals would have to place requests directly at the central bank. The central bank would then be endowed with the additional functions of banking, i.e. taking deposits as well as issuing loans. Accordingly, monetary transactions and requests would be made between central banks and individuals, which ultimately reduces activities of commercial banks. It would make the central bank the main actor in money creation and deposit management, thereby taking away the major functions of commercial banks. In the current system commercial banks are endowed with the traditional banking activities, i.e. taking deposits and issuing loans. However, the transition to this system would completely silence commercial banks and make the central bank the main actor in banking. What is more, this CBDC version would transform the central bank to a so-called narrow bank; in which the quantity of issued loans would depend on the deposits placed within the central bank (Engert & Fung, 2017). Hence, there would be no maturity transformation, as new loans have to be backed up by existing money. Consequently, this would end the current fractional reserve banking system and transform it into a partially narrow banking system (Stevens, 2017). This will be accompanied with wide effects to the economy, outlined as following. As commercial banks would be disentangled from their traditional banking activities – i.e. taking deposits and issuing loans - these would fall into the hand of the central bank. This would transform them into a so-called uber bank, which then serves as the main financial intermediary (Raskin & Yermack, 2016). For the process of credit creation, the disappearing of the maturity transformation will drastically affect credit supply. Due to the fact that in this narrow banking system each credit has to be backed up by existing money, this will drastically reduce credit supply (Cukieman, 2019; Raskin & Yermack, 2016). As evidence suggests, constraints in credit supply are likely to suppress economic activity (Stevens, 2017). It is highly probable that this decline in loan supply will not satisfy demand of both firms and households. Consequently, this constrained credit markets will reduce companies' investments and particularly hinder them to enter new investment opportunities. Also, constrained firms typically trim their technological innovation, employment and capital spending (Gerlach-Kristen, O'Connell, & O'Toole, 2015). These decreasing investments of firms will have particularly negative effects for overall economic growth in the long-term (Campello & Graham, 2010). Furthermore, one can argue that this dampening of

credit will also curb consumptions of households, thereby aggravating negative effects to the economy. Ketterer and Andrade also point out in their paper that taking away lending activities from commercial banks will increase costs and make the process more inefficient; thereby negatively affecting economic activity (Ketterer & Andrade, 2016).

In addition to this reduction in credit supply, the currency's account-based feature grants the central bank direct insight into monetary holdings of individuals, as deposits from individuals are placed directly in the central bank. This will not only bring about a drastic increase in surveillance power of central banks, but also affect credit allocation decisions. As any bank wants to minimize default risks for credits, it can be projected that loans will be issued primarily to individuals who are the most likely in paying back. Possibly, citizens with fewer outlooks in paying back loans, such as those having a worse education, are less likely to receive loans. For some citizens, this will even more so hamper the supply of credit and make it nearly impossible for some to receive a loan. Of course, this is also highly critical from a data security point of view; yet these legal issues will not be discussed further in this thesis. The transformation to a narrow banking system also has huge impacts to financial risk and stability. On one hand, proponents of the narrow banking system promote the idea that it will improve financial stability and reduce the risk for bank runs. Mainly, it is argued that the disappearing of the maturity transformation makes the central bank more liquid, given their match of loans and deposits, thereby decreasing liquidity and solvency risks. It would then disentangle the central bank from their function of being the lender of last resort (Stevens, 2017). Yet, on the other hand, the shift to a narrow banking system will also result in an enormous centralization of power and risk. Thereby, it would make the financial system and thus the entire economy highly dependent on the central bank's well being (Cukierman, 2019). From this, it is clear that the implementation of this radical version of CBDC has profound effects to financial stability and risk; however, it is difficult to predict in which direction and to what extent this will occur. What is more, this transformation of the credit creation process has implications to changes in the balance sheet, as depicted in Figure 3. Precisely, the issuing of a loan would increase the balance sheet of the central bank, and not such of the commercial bank.

By making the central bank the main issuer of credit, it will increase their liabilities, as depicted in Figure 3. Accordingly, this would require the same amount of increase in assets in order to remain their balance sheet equilibrium. This results in an overall increase in the central bank's assets and liabilities, which is referred to as an inflated balance sheet. Importantly, composition and size of a central bank's balance sheet is from significant importance for conducting monetary policy as well as financial markets and hence economic development (Shiratsuka, 2010; Curdia & Woodford, 2011; Caruana, 2012; Reis, 2017).

## **5 CONCLUSION**

### **5.1 Summary**

Given the recent announcements of central banks considering to issue a CBDC in the near future, it is shown that this topic is of utmost relevance. Yet, although there is a fair amount of studies investigating on potential advantages as well as drawbacks of the issuing of such a currency, no papers so far has solely examined effects to the credit creation channel by differentiating between different forms of CBDC. Hence, this paper tackles this existing research gap and aims to answer consequences of issuing a CBDC to the money creation mechanism and the functioning of banks. The main argument made in this paper is that the effects of the issuing of a CBDC foremost depend on the way of implement and certain characteristics of such a currency. This work builds its analysis on three different versions of CBDC, represented within the Money Flower: a wholesale CBDC, a moderate public CBDC and a radical public CBDC. Whilst both a wholesale CBDC and a moderate public CBDC based on tokens are likely to leave the mechanisms of credit creation unchanged, a radical CBDC version, which is based on accounts directly held at the central bank, will drastically alter the current banking system and transform it into a narrow banking system. Even though a wholesale CBDC and a moderate version of public CBDC are not expected to change the overall mechanisms of credit creation, they both will affect the efficiency and dynamics of payments in the current banking system. For a moderate public CBDC, these effects will be greater due to their wider range of application. The transformation to a narrow banking system under a radical version CBDC will silence commercial banks from their traditional banking functions, i.e. taking deposits and issuing loans, as those activities will be transferred to the central bank (Engert & Fung, 2017). Also, it will end the current feature of maturity transformation for commercial banks. Thus, these credits will have to be fully backed up by deposits, which is expected to enormously reduce credit supply to the overall economy. It can be speculated that this is likely to further influence economic development, as restrained credit markets are said to suppress economic growth. In addition, this change in the banking system converts the current central bank to a so-called uber bank thereby not only remodeling the



current structure of banks but also allocating financial risk and power (Cukierman 2019; Stevens 2017).

## **5.2 Limitations and Future Recommendations**

It has to be stressed that this analysis is limited to some extent: Firstly, this analysis is based on predictive theoretical concepts only and without the use of real data, as no country has issued a CBDC so far. This makes it highly abstract and reduces the validity of such. Furthermore, this paper is built on the *ceteris paribus* assumption, i.e. leaving all other economic determinants unchanged. Yet, it is obvious that the issuing of a CBDC will mostly affect not only the credit creation channel, but rather change the economic system as a whole. This would then potentially have side effects as well as spillover effects to other economic determinants, which are not taken into consideration in this thesis. Apart from that, this paper assumes that regulatory standards and financial policies stay the same under a CBDC regime. However, these are likely to be affected as well, which will then have impact to the credit creation channel. Also, as it is unclear how consumers demand for CBDC will evolve, this analysis assumes rationale behavior of consumers regarding the demand for CBDC. This implies that CBDC' demand will be the same as for other forms of money, thereby neglecting potential individual preferences of agents. By having a CBDC that is also accessible to the public, specific demand for the currency will be of utmost relevance when determining consequences stimulated by the issuing of such. Given the fact there is no practical evidence yet, this places significant limitations on the study. Hence, there are some recommendations for future research on this topic, which will be discussed next.

Even though a fair amount of research has been done in this research area, there is still great room for future research. Also, given this topic's increasing interest it is undeniable that it is of utmost relevance and further studies on CBDC are highly needed so as to guarantee an implementation of such currency in the best way possible. Firstly, there are open questions concerning some features of the different CBDC versions. With respect to a moderate public CBDC, it can be distinguished between a version eliminating cash and not doing so, whereby the former version gives the central bank the possibility to charge negative interest rates. For examining

effects of issuing a public CBDC, the amount of currency that is allowed to be issued should be quantified. In addition to this, future research should tackle further consequences to the economy, provoked by a narrow banking system under a radical version of CBDC. Also, other economic consequences, stimulated by the issuing of different versions of CBDC, should be investigated more extensively. These include but are not limited to effects to financial and liquidity risks, possible future roles of commercial banks if there are any, but also socio-ecological developments. From all this, it is obvious that this topic is not only a highly interesting one, but also has great potential for future research, given the current gaps in existing literature.

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## 7 APPENDIX

### 7.1 Balance Sheet Graphics

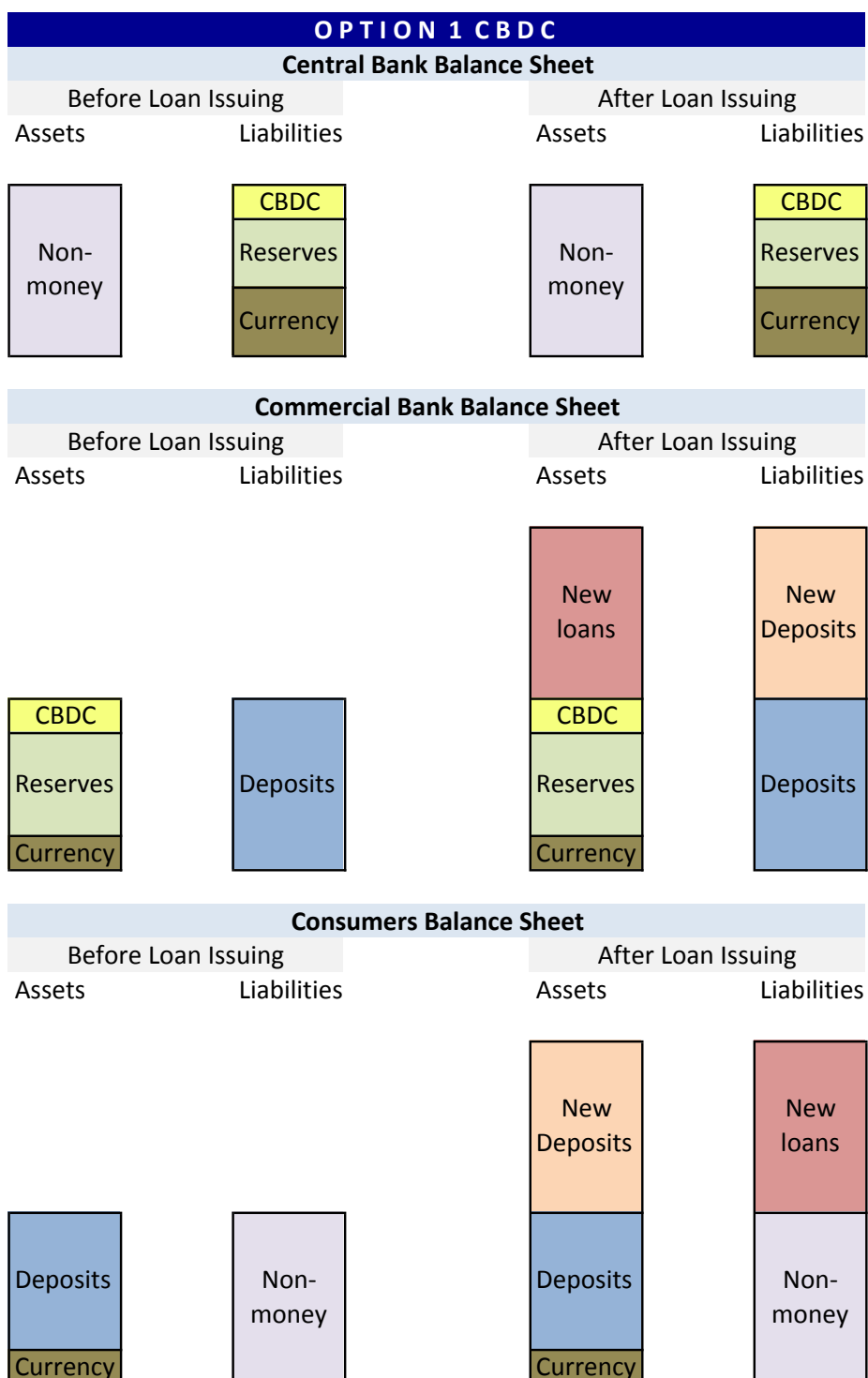


Figure 1: Option 1 CBDC

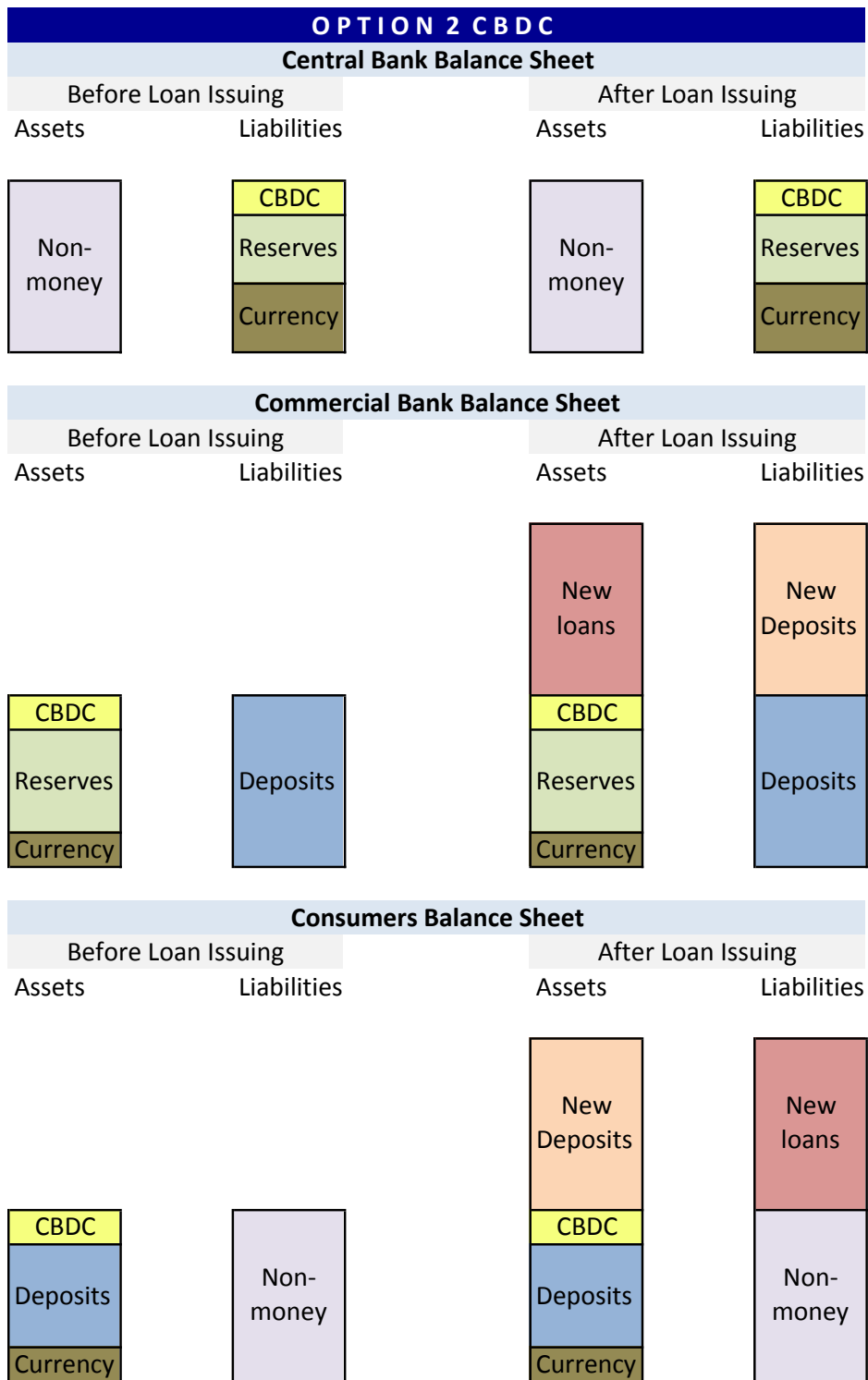


Figure 2: Option 2 CBDC

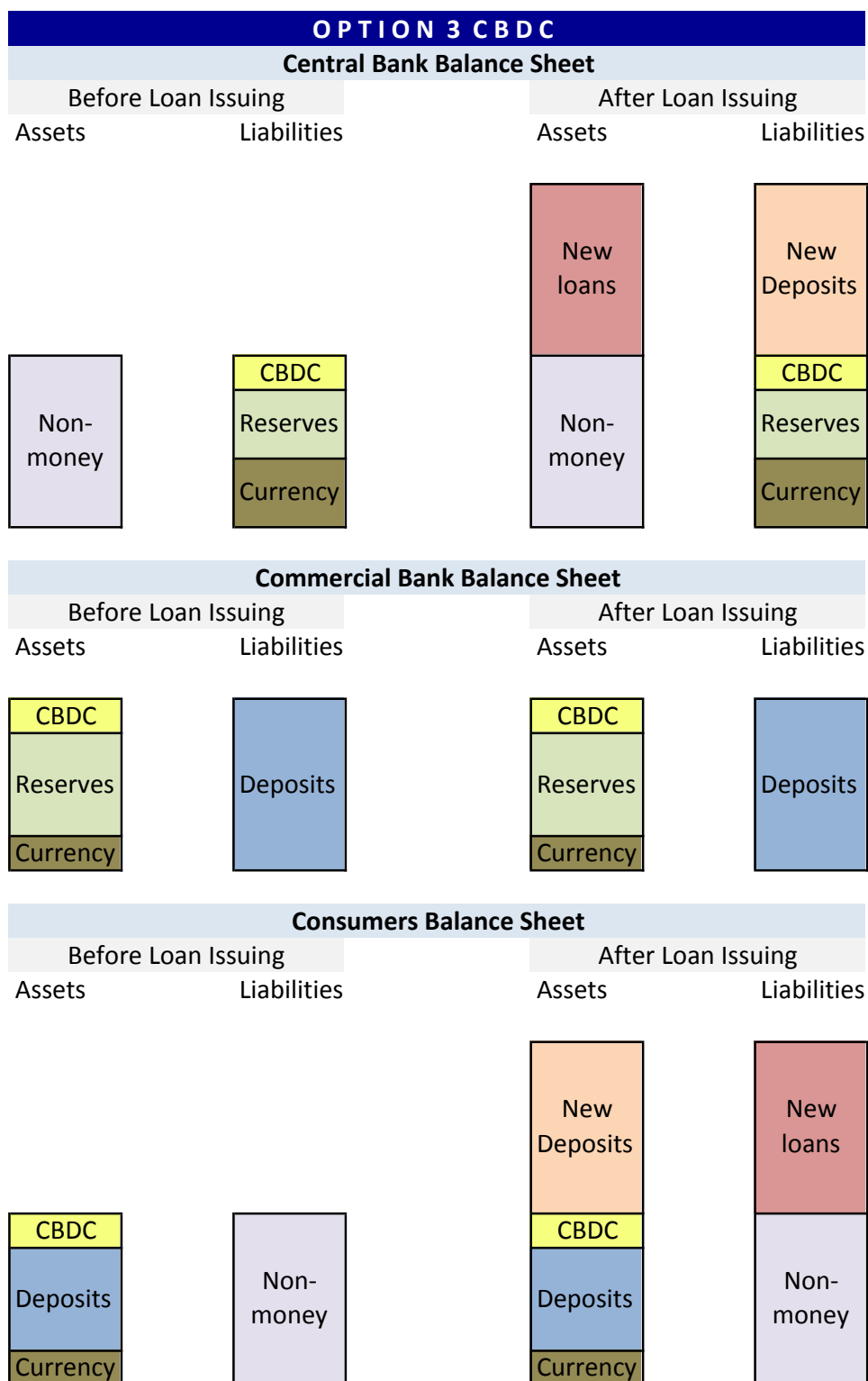


Figure 3: Option 3 CBDC

## 7.2 Abstract German Version

Die Erfindung der Blockchain Technologie hat in den letzten Jahren nicht nur die privaten Kryptowährungen erfolgreich gemacht, sondern auch Diskussion über eine mögliche Ausgabe von digitalen Zentralbankgeld angeregt und dabei die begleitenden Vorteile der Technologie zu nutzen. In einer kürzlichen Verlautbarung hat Christine Lagarde, Präsidentin der europäischen Zentralbank, die Relevanz dieses Themas unterstrichen und betonte, dass zukünftig die Forschung in diesem Bereich verstärkt werden soll. Trotz des zunehmenden Interesses hat bis jetzt noch kein Land digitales Zentralbankgeld ausgegeben und es gibt noch immer eine umfangreiche Debatte über verschiedene Möglichkeiten der Implementierung. Zu betonen ist, dass die Form des digitalen Zentralbankgeldes von hoher Relevanz ist da die damit verbundenen Auswirkungen auf die Wirtschaft unterschiedlich einzustufen wären. Diese Arbeit zeigt, welche Auswirkungen die Ausgabe von digitalem Zentralbankgeld auf die Kreditvergabe und die Geschäftstätigkeit von Kommerzbanken und Zentralbanken in Abhängigkeit von den jeweiligen Eigenschaften der digitalen Zentralbankwährung hat. Basierend auf dem "Money Flower" Schema, unterscheidet die Arbeit zwischen drei verschiedenen Versionen von digitalem Zentralbankgeld, welche sich in zwei wichtigen Charakteristiken unterscheiden: Die Verfügbarkeit für den öffentlichen Sektor und die Unterscheidung in token-basierte oder account-basierte Währung (Bech & Garratt, 2017). Aufbauend auf diesem Schema legt diese Arbeit drei verschiedenen Formen des digitalen Zentralbankgeldes dar: Eine konservative Form, zu welcher lediglich Banken unter Ausschluss der Öffentlichkeit Zugang haben; eine moderate Form, zu welcher auch die Öffentlichkeit Zugang hat bei gleichzeitiger Anonymität; und eine radikale Form, welche auf Accounts basiert, die direkt an der Zentralbank gehalten werden und daher nicht anonym ist. Besonders die radikale Form hätte große Auswirkungen auf das Bankensystem mit der Voraussage dass es ein „Narrow Banking System“ zur Folge hätte. Wenngleich auch einige wissenschaftlicher Arbeiten argumentieren, dass diese radikale Form des digitalen Zentralbankgeldes das Funktionieren des Bankensystems komplett ändern würde und zu einem „Narrow Banking System“ führen würde, gibt es noch keine Arbeit, welche die Konsequenzen der Ausgabe unterschiedlicher Formen digitalen Zentralbankgeldes auf die Kreditvergabe und die begleitenden Effekte analysiert (Gouveia et al, 2017; Engert & Fung, 2017). Daher

fokussiert sich diese Arbeit auf die Auswirkungen der Ausgabe der drei Versionen eines digitalen Zentralbankgeldes auf die Mechanismen der Kreditvergabe und der Funktion der Banken. Dabei schließt diese Arbeit die bestehende Lücke in der Literatur und stellt Hypothesen über mögliche Implikationen für das Bankensystem auf.