LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER

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MASTER'S FINAL WORK

DISSERTATION

ARE NEGATIVE INTEREST RATES ON BANK CREDIT POSSIBLE?

FRANCISCO FERREIRA CAVACO

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Francisco Ferreira Cavaco

Abstract

Under the current monetary framework, central banks are limited in their pursue of price stability and full employment due to the zero lower bound on nominal interest rates. This happens because negative nominal rates on bank deposits – deemed a necessary condition for negative nominal rates on bank credit – will cause a massive flight from deposits to cash, as cash pays zero nominal interest rates.

To counter this constraint, we propose a new monetary architecture that by making the central bank the single source of funding for bank loans at negative nominal interest rates, enables banks to profitably extend credit at negative nominal rates - while still paying zero interest rates on their clients' deposits.

We find only two objections with our proposal. First, people could start living off credit obtained at negative interest rates. Second, households and firms which would otherwise use their deposits to fund expenditures would instead fund them through loans obtained at negative interest rates. While the first objection can be easily prevented by requiring banks to provide negative rate loans *conditional* on their use to purchase goods and services, the second cannot be completely solved. But it can be minimized through loan-to-value requirements.

Overall, we conclude that nominal negative interest rates on bank credit can, in fact, be achieved through minimal changes in the current process of money creation.

Keywords: Monetary Policy; Negative Interest Rates; Zero Lower Bound; Bank Credit; Money Creation.

JEL Codes: E40; E43; E50; E51; E52; E58.

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1. INTRODUCTION

Before the global financial crisis, the world was supposedly "prepared" for an economic slowdown. Governments had space for fiscal stimulus, and perhaps more importantly, central banks (CBs) had room for conventional monetary policy. However, aggregate demand (AD) fell so much in the crisis that even cuts to zero of CB nominal interest rates were unable to bring economies back to full employment (FE). As a result, CBs had to opt for other monetary tools, mainly *quantitative easing* (purchase of sovereign and private bonds in exchange for newly created reserves) and *forward guidance* (providing information about future monetary policy decisions, in order to change the expectation of future short-term interest rates, and consequently influence today's long-term interest rates).

The European Central Bank (ECB) began using unconventional monetary policies in 2008, starting with the fixed-rate full allotment to provide an unlimited amount of liquidity to banks (Constâncio, 2018). Afterwards, in 2012, the ECB announced the undertaking of Outright Monetary Transactions (OMTs) in the secondary market for sovereign bonds in the Euro Area (Banco de Portugal, 2017). This was crucial to ensure the stability of some Euro Area members, as their government bond yields were too high for those countries to issue new debt in the primary market. Thirdly, between March 2015 and December 2018 the ECB delivered another package of non-standard monetary policy through the Asset Purchase Programme (APP), which included the purchase of not only government debt but also corporate debt (although in a much lesser extent). The APP was reintroduced in September 2019, when the ECB announced the purchase of 20 billion euros per month (ECB, n.d). Other CBs followed or were already implementing similar strategies.

Although these policies have helped to stabilize output and unemployment, the existence of a zero lower bound limit on the CB interest rates constraints the ability of monetary authorities to counter cyclical downturns, unemployment, and deflation (Assenmacher & Krogstrup, 2018). Additionally, one could argue that unconventional policies have not been enough for CBs to achieve their goal of price stability. For example, the Bank of Japan's (BoJ) reference rate has been near zero for two decades, and despite its massive effort to boost inflation through asset purchases - as of July 2020, the BoJ's balance sheet reached 120 percent of GDP – the inflation rate has remained well below the target of 2 percent (the average inflation for the period 2010:08 to 2020:06

was 0.5 percent). The same can be said for the Euro Zone, where the ECB's balance sheet reached 53.9 percent of GDP (as of July 2020) and yet inflation has rarely reached the target. So, increasing the monetary authorities' toolkit is certainly something we should look for.[1]

When economies were hit by the Covid pandemic, the major CBs did not have much room - under conventional methods - to first secure flow of credit in the various money markets (to avoid a liquidity crunch) and then to help the economic recovery. The Federal Reserve (Fed) and the Bank of England (BoE) cut the rates towards zero. The ECB already had the refinancing rate at zero. And all increased the purchase of private and public bonds.[2]

On the past nine crises, the Fed had cut the interest rate by an average of 5.5 percent (Yellen, 2016), which is substantially higher than the Fed's 1.75 percent cut – to zero - in the current recession. Why did the Fed stop at the zero level? The reason is simple. The Fed was afraid that it might create a flight from deposits with negative rates into cash.

The fact that CBs have not been able to cut interest rates into deep negative levels and, thereby, deliver negative interest rates on bank credit is attributed to the impossibility of having banks financing negative interest rate loans with their clients' deposits at even more negative interest rates. Under the current system, banks finance the extended loans mainly through the reserves created by deposits.[3] Commercial banks' business is centred on the activity of extending loans at a certain interest rate that must be higher than the one paid on their sources of funding. Therefore, extending bank loans at negative rates could never be possible without even more negative interest rates on bank deposits – but this would most certainly result in massive withdrawals. Because of this, the current macroeconomics literature that discusses ways to break the zero lower bound on interest rates attempts to eliminate the incentive to withdraw deposits even when the nominal

[1] Contrarily, Reifschneider (2016) argues that asset purchase and forward guidance can compensate for the inability of the Federal Reserve to cut short-term reference rates below zero. In fact, according to model simulations, in the US a combination of interest rate cuts, forward guidance, and asset purchase could replicate the same economic effect of a hypothetical reduction of the short-term interest rate to deep negative levels.

[2] The ECB increased the size of the APP envelope by an additional 120 billion euros (to be used throughout the year) and introduced the Pandemic Emergency Purchase Program (PEPP), which consisted of an envelope of 750 billion euros (ECB, 2020a) that later was increased by an additional 600 billion euros (ECB, 2020b). The Fed announced an unlimited purchase of bonds, including private bonds in the primary market (Fed, 2020). Similarly, the BoE put forward a bond buying programme of 200 billion British pounds to be used to acquire non-financial investment-grade corporate bonds and UK government bonds, which later was increased by an additional 100 billion British pounds (BoE, 2020).

[3] For example, in 2018, deposits accounted for 55 percent of Euro Area banks' total liabilities (ECB, 2020c).

interest rates are deeply negative – for example, by phasing out large denomination notes in order to make large-scale hoarding of cash much more costly (Rogoff, 2017).

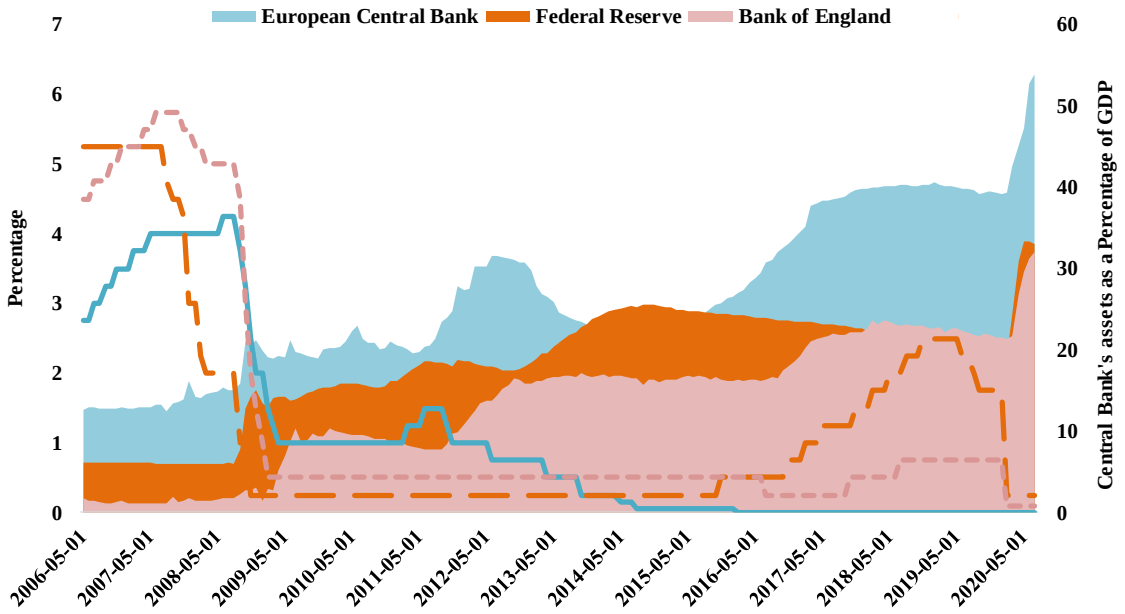
The goal of this paper is to propose a different way of breaking the lower bound. Instead of developing a solution that allows banks to charge negative interest rates on their clients' deposits without creating a flight into cash as Rogoff does, we propose a new monetary architecture that allows banks to borrow all the funds they need to provide loans to the economy from the CB at deep negative interest rates, so that they can profitably lend at negative interest rates while paying zero interest rates on their clients' deposits.

The paper is organized as follows. Chapter 2 presents the different approaches proposed in the literature to deal with the zero lower bound problem. Chapter 3 provides a comprehensive explanation of how money is created in modern economies. Bearing this in mind, chapter 4 presents a new monetary architecture capable of generating negative interest rates on bank credit even with non-negative interest rates on bank deposits. Chapter 5 concludes.

2. REVIEW OF ALREADY PROPOSED WAYS TO BREAK THE ZERO LOWER BOUND

After the Global Financial Crisis, all major CBs decreased their short-term policy rates to near zero in order to reduce unemployment (see figure 1). The American and British economy eventually recovered to FE, allowing their CBs to tighten monetary policy. However, for the Euro Zone economy, those interest rate cuts were not enough to bring it back to FE, and, as a consequence, the ECB policy interest rate has been stuck at the lower bound level since then.

Figure 1 - Central banks' reference interest rate and size of their balance sheet



The reference rates are the following: ECB euro short-term refinancing rate, US federal funds target rate - upper bound and UK Bank of England official bank rate.

Source: European Central Bank, Federal Reserve Board, Bank of England and Bloomberg, August 2020.

So, a question arose: what if the ECB could lower its policy rate to a deeper negative level? Maybe the economy would return to FE. But, is it possible?

2.1 CONSTRAINTS ON BREAKING THE ZERO LOWER BOUND

For a long time, it was assumed that CBs could not set policy interest rates at negative values. CBs feared that lowering their short-term reference rates too deep into the negative territory would cause a massive flight into cash – since cash pays a zero nominal interest rate.

However, recent events like the ECB negative interest rate policy in its deposit facility rate in June 2014, where the rate was cut to minus 0.1 percent, questioned the existence of a zero lower bound. Therefore, the debate now is how much lower can policy rates go, where is the effective lower bound? As of October 2020, the ECB's deposit facility rate is at minus 0.5 percent. One could argue that the interest rate on deposits can be as negative as the cost implicit in holding cash: the inconvenience of living without automated payments, web access to account balances, storage and transportation costs, and protection over theft.

The recent experience with some CBs has shown that commercial banks have been hesitant in reducing the deposits rate further to negative values, even with policy rates in the negative spectrum.[4] Banks do not want to initiate mass withdrawals, therefore, they have been very cautious with their deposits' rates (Bech & Malkhozov, 2016). The problem is that no one knows where is the effective lower bound, that is, how far can we go until banks have no other option than to pass the cost to their clients, and if they do, how deeply negative the rate can be before it creates a flight into cash. This is the million-dollar question of practically all the literature involving breaking the lower bound.

2.2 PROPOSED SOLUTIONS TO BREAK THE ZERO LOWER BOUND

As Rogoff (2017) highlights, there are four different methods to break the lower bound: removing cash from circulation, enforce negative interest rate on cash (through some technological approach), decoupling cash from electronic bank reserves, and finally, making holding cash as costly as having a deposit pay a negative interest rate. While recognizing the contribution of each theory, we will discard the second option, as paying negative interest rates on currency is far from being a viable solution.[5]

We review each of these methods next.

[4] The Denmarks NationalBank, The European Central Bank, The Swiss National Bank, and The Bank of Japan.

[5] This idea, introduced by Gesell (1916), consisted of worsening the store of value property of money by imposing a tax on holding money to improve it as a medium of exchange during times of financial distress when people saved money rather than lend or spend it. By requiring the purchase of stamps to be attached to the back of each banknote, it would be possible to impose a negative interest rate (the cost of the stamp) on paper currency. Keynes (1936) objected to the idea, as it would not be possible to impose such a system without affecting the liquidity of money.

Removing cash from society

Given the nature of cash, that is, the fact that it pays a zero nominal interest rate, it would make sense to remove it completely from the economy to enable banks to charge negative rates on deposits and thus enable them to set negative rates on credit. And although there are other benefits that come with removing cash – i.e., less tax evasion and criminal activities – cash still plays an important role in our society. Cash still plays an important role for small to medium transactions in several economies, and removing it prematurely, before electronic means of payment are well entrenched within the various groups of society - for example, the older population tend to be less exposed to electronic means of payment - could disrupt the economy (Assenmacher & Krogstrup, 2018). Besides, cash is fundamental in preserving privacy and securing against a systemic electronic failure. Having said this, if there are other ways (that cause less frictions) to break the lower bound, then those should be considered.

Decoupling cash from electronic money

An idea proposed by Buiter (2007, 2009) and Agarwal & Kimball (2015), and later reinforced by Assenmacher & Krogstrup (2018), is that the CB could set up two different currencies with an exchange rate between them, allowing cash to lose value in relation to electronic money in periods of negative CB interest rates.

This would work in the following way: the CB divides the monetary base into two separate domestic currencies, cash and reserves issued only electronically. Reserves would pay a nominal interest rate, which could be negative if needed. The CB would set a spot cash reserve conversion rate between reserves and cash. Commercial banks would have to deposit or withdraw cash from the CB not at par value but at the conversion rate, which would be adjusted daily. At the end of every business day, the CB would announce the next day rate of conversion. So, if the CB reduced the interest rate to, say, minus 5 percent, after one year, every unit of account in electronic money would represent 1.05 unit of account in paper currency. This would avoid an early run into cash.

For this dual currency system to work and to be able to remove the lower bound from the economy, it is necessary that the electronic money becomes the unit of account: every nominal contract would have to be expressed in electronic money, quoted prices for goods, services and financial assets, wage contracts, taxes and so on. Cash would remain a means of payment, but the price in cash would deviate from the electronic money's

prices, and so there would be two different inflation rates in the economy. However, this solution raises two problems.

First, it would require legal and regulatory reforms. The CB would have to announce the electronic money as the legal tender. Buiter (2007) recommends that all contracts where the state is a counterpart should be written in electronic money, that taxes should be payable only by electronic money and that only contracts specified in electronic money could be legally enforced. Without such reforms, the system would seize to prevent the lower bound on paper currency, as people could simply withdraw their deposits and transact only with cash.

Second, it would be necessary that when the interest rate on electronic currency is negative, prices denominated in cash must be constantly changing in the same proportion as the conversion rate. If not, people would still prefer to withdraw their deposits and continue their lives purchasing goods and services using cash. So, this would not be practical because it would force businesses to constantly change their price tags.

Another objection pointed by Rogoff (2017) is that after a period of negative interest rates, both currencies would no longer be exchanged at par, and if the monetary authority were to restore the par, it would have to pay a positive interest rate on electronic money, which could conflict with other monetary objectives.

Making holding cash as costly as paying negative interest rates on deposits

Mankiw (2009) proposed that the CB could make holding cash less attractive by announcing that a year from now it will pick at random a digit from zero to nine, and all the currency with a serial number ending in that digit would no longer be considered legal tender. This would make the expected return on holding currency equal to minus 10 percent. In this situation, economic agents would prefer to hold a deposit at any nominal interest rate as long as it paid more than minus 10 percent. But this does not solve the problem. As soon as the CB announced the new policy, agents would withdraw their cash (to avoid the negative interest rate on deposits) and later deposit it back just before the date of the policy.

To solve the problem, it would require a small change to Mankiw's solution. Every week, the CB would choose at random a number from 0 to 1,000 and all the banknotes with a serial number ending in that number would no longer be considered legal tender. Since the probability of having one banknote with the serial number ending in that last number is 0.1 percent, the annual expected return to hold cash would be 0.1 percent times

52 (total number of weeks), or minus 5.2 percent. Thus, because they are risk averse, economic agents would prefer to hold a deposit at any nominal interest rate higher than minus 5.2 percent.[6] And if the CB wanted to further decrease the nominal interest rate, it could simply increase the frequency of the policy or increase the quantity of numbers that would drop off circulation each week.

An alternative solution would be to make hoarding money more costly by phasing out large denomination notes. This approach, proposed by Rogoff (2017), takes into consideration the fact that the zero lower bound level of interest rate is not actually zero, but a small negative number. Therefore, by eliminating the largest denomination banknotes, it becomes harder and more expensive (higher shipping and storage costs) to hold money in the form of currency and in this way make households and firms want to hold it in the form of deposits even if they imply negative interest rates.

This approach not only reduces the effective lower bound to a deeper negative level, but it also supports the argument that although currency is becoming less important in transactions (as opposed to credit and debit cards), it is still the main medium of exchange in criminal transactions and tax evasion (Rogoff, 2015). Activities that would become substantially less present in our society if, for example, all cash took the form of 1-euro coins.

[6] Note that there are no risk lover agents (i.e., agents that simultaneously prefer to face a higher risk and a lower expected return), because even if there are, these agents will eventually become insolvent.

3. THE NEW VIEW ON MONEY CREATION

Contrarily to other proposed ways to break the zero lower bound, we develop a solution that enables banks to extend loans at negative interest rates while paying non-negative interest rates on deposits. But, before introducing our solution, it is necessary to understand the process of money creation in the economy.

Thus, in this chapter we explain how money is created in the economy. This explanation first emerged with Moore (1988) and has recently spread into the mainstream after the Bank of England published a paper on money creation by McLeay et. al. (2014).

3.1 MONETARY BASE VS. MONEY

To understand the creation of money, it is necessary to distinguish between monetary base (MB) and money. MB consists of currency in circulation and reserves held by banks, where the majority of these reserves take the form of banks' deposits at the CB. On the other hand, money represents all means of payment, that is, all titles that allow households, businesses, and the State to buy goods and services, pay incomes and debts. There are two types of money: currency and bank deposits, which represent most of the money in modern economies.

3.2 RELATIONSHIP BETWEEN CREDIT AND DEPOSITS

The *old* view

The *old* view of money creation takes banks as intermediaries from savers to debtors, where the deposits received by savers are used to extend loans to those who need money. However, the act of saving would not in fact create deposits or "funds available" for banks to lend. The reason is as follows: when households decide to save money in a bank account instead of spending, that deposit is created at the expense of deposits that would otherwise go to companies. Therefore, an act of saving does not make additional deposits available.

The *old* view of money creation takes money as *exogenous* to the economy by assuming that money is created as a result of the initiative of the CB to create reserves. It is assumed that, through the money multiplier, the CB can decide the quantity of money in circulation by creating a certain quantity of reserves. The CB injects a certain amount of MB, say 100 euros, into the banking system, and by determining the reserves requirement, say 10%, the banking system will successively extend credit until the

maximum amount of money is reached, which in this case and assuming no currency circulation will be 1,000 euros (Mishkin, 2013, ch. 14).

The new view

However, the money multiplier theory is not a valid representation of reality.

In fact, (see Moore, 1988; Howells, 1995; Palley, 2002 and McLeay et. al., 2014) the CB implements monetary policy *not* by setting a certain amount of reserves but by choosing the price at which banks can borrow reserves, that is, by choosing the interest rate. Specifically, the process of money creation can be described as follows. At any time, banks can borrow any amount of reserves they desire from the CB at the interest rate set by the CB as long as they have collateral. The CB is the lender of last resort, and so it cannot refuse reserves demanded by banks, as this could endanger the stability of the financial system. Banks then apply a spread to the CB interest rate and thereby set the interest rate at which they are willing to lend money to economic agents. At this level of interest, agents will demand a certain amount of loans and, no matter whether banks own reserves or not, they will grant the amount of credit they consider to be creditworthy.[7]

When a bank extends a loan, it does not hand the agent the amount of the credit worth of notes and coins (as suggested by the old view of money creation). Instead, the bank credits the agent's bank account with a bank deposit the size of the credit. This is the moment that new money is created.

Note that the net wealth of the bank and of the household are not affected. The reason is the following. When the bank extends the loan, it creates a liability (the household deposit), but at the same time, it obtains an asset (the bank loan). In turn, the household acquires an asset (the deposit) and, at the same time, a liability (the loan). More generally, the money created by banks and held by households, businesses, and the State is not net wealth; it is an asset (the checkable deposit) offset by a liability (the bank loan) of the same value.

But if banks create money, it is only logical to assume that they also destroy money, which in fact happens. When economic agents who got a bank loan in the past eventually pay the loan back, the bank simply crosses out the agent's deposit from its liabilities and, at the same time, crosses out the bank loan from its assets. Hence, the payment of a bank

[7] Constâncio (2011) states that first banks take their credit decisions and only then look for the necessary reserves at the CB.

loan leads to the destruction of a checkable deposit (money) of the same amount. Here we are ignoring interest payments for simplicity.

In sum, the creation of money is an endogenous process that results from the *initiative* of economic agents to demand credit and is carried out by commercial banks until all demand for worthy credit is satisfied. Thus, the bank credit is the source of money creation, and, as explained above, it is the bank credit that creates deposits and not the other way around.

3.3 THE PROCESS OF MONEY CREATION

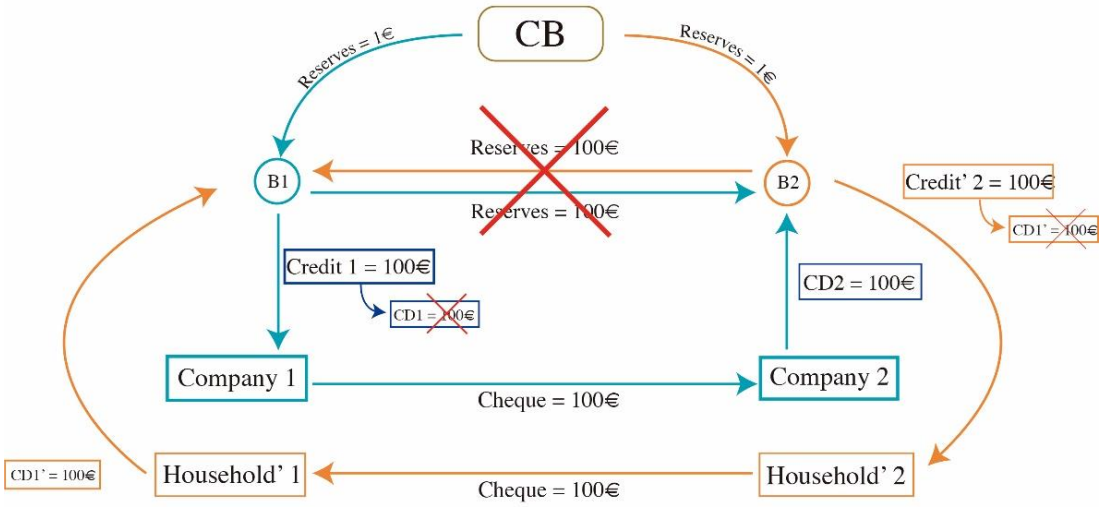
This section details the process of money creation carried out by commercial banks. We will first illustrate assuming the existence of two Eurozone banks. Afterwards, we will assume a single bank. Finally, we will describe a more realistic approach.

Two banks

To understand why banks do not need to hold deposits in order to grant credit, let us take the case of a commercial bank (B1) that lends 100 euros to a company (see figure 2). The moment the credit is extended, a checkable deposit (CD1) of 100 euros is opened in the company's account. To do this, the bank starts by needing to get 1 percent of that amount in reserves from the CB, 1 euro. The reason is that, since January 2012, Eurozone banks are required to hold 1 percent of deposits as reserves. However, the company will surely use the CD1 to make a payment to another economic agent, who is likely to be a customer of another bank, say, B2. Given this, B1 ends up forced to get 100 euros in reserves from the CB in order to hand them over to B2.

However, at the same time, B2 is very likely to extend a loan to an agent that will make a payment in favor of B1. If this credit is also equal to 100 euros, then no reserves will be sent by each bank as the two payments cancel out. Therefore, at the end of the day, each bank only needs to borrow from the CB reserves equal to 1 percent of the deposits it creates: 1 euro (=1% x 100 euros).

Figure 2 - Money creation by two banks



Source: Own elaboration

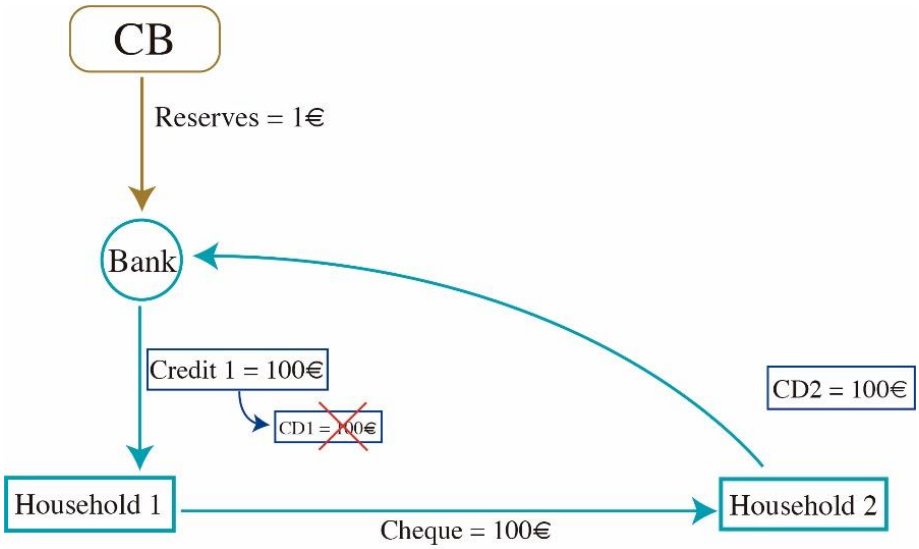
A single bank

Imagine now an economy where there is only one commercial bank. This is a good way of understanding how small is the amount of reserves banks need to get from the CB in order to extend credit to the economy.

Consider the case of a household (H1) who wants a mortgage loan of 100 euros (see figure 3). The single bank grants the loan by crediting the value of the loan to the deposit account of the household and, at the same time, adding the mortgage loan to its assets' column. This creation of 100 euros of money will require the single bank to obtain only 1 euro in reserves. The moment H1 buys the house, it writes a cheque in favour of the seller of the house (H2). But since there is only one bank in the economy, H2 will deposit the cheque of 100 euros in the very same bank. This simply deletes the deposit of H1 and creates a deposit of the same amount for H2. No change in the bank's total deposits occurs, and therefore it will still be required to hold only 1 euro.

But the bank does not stop here. If there is more creditworthy demand for credit, the bank will keep on granting loans. Suppose that a third agent asks for a loan, for example, a company (C1) that needs 100 euros to pay a supplier (C2). Through the same mechanism mentioned before, the bank will end up creating 100 euros in the form of a new checkable deposit, again by borrowing only 1 euro in reserves. The conclusion is that the single bank seems to be a "money machine": it can create any amount of deposits with almost no CB funding. However, as we will explain in the next section, there are limitations to the amount of credit the single bank can extend.

Figure 3 - Money creation by a single bank



Source: Own elaboration

An approach to reality

The previous examples were meant to illustrate that banks can extend credit with only a small amount of reserves that can be easily acquired at the CB. Although this is true, in reality, there are other factors that must be taken into consideration.

First, the previous examples assumed that the money created through the extension of bank credit would be passed on to other economic agents, keeping the form of a checkable deposit. In reality, part of that checkable deposit might turn into other forms of money. It can happen that some will be withdrawn, and some will be converted into a savings deposit, say, 10 and 60 percent, respectively. In this case, only 30 percent of the money created will remain as a checkable deposit. The difference in this scenario is that the bank will have to back 100 euros of credit with a loan of 10.3 euros from the CB: 100 percent of the 10 euros withdrawn and 1 percent from the 30 euros checkable deposit.[8]

In this case, the profits of the bank will be lower because while the bank earns interest on the 100 euros lent, it pays interest on the deposit of 60 euros savings plus on the 10.3 euros of reserves. If we assume the interest charged on the loan equal to 3 percent, the CB interest rate equal to 1 percent, and the interest rate paid to savings deposits also 1 percent, then the bank's profits will be equal to:[9]

[8] For the sake of simplicity, we assume that savings deposits do not need to be backed by reserves.
[9] Due to logistic costs, the interest rate on savings deposits tends to be lower than the central bank interest rate. Here we assume it to be the same.

$$3\%\ x\ 100€ - 1\%\ x\ 10.3€ - 1\%\ x\ 60€ = 2.3€$$

Note that in the case in which 100 percent of the money created would remain in the form of a checkable deposit, the bank's profits from extending the loan was almost the same as the revenue generated from it, because the bank did not pay interest on the checkable deposits, and only needed to back it up with reserves equal to 1 percent of the deposit created. The profits would thus be higher, equal to:

$$3\%\ x\ 100€ - 1\%\ x\ 1€ = 2.99€$$

Second, assume now that B1 extends a credit of 103 euros – instead of 100 euros - to a customer that makes a payment in favour of a customer of the second bank (B2). And that B2 extends a credit of only 100 euros to a customer that makes a payment in favour of a B1's customer. In this case, B1 will be obliged to send 3 euros in reserves to B2, and B2 will need to back the resulting deposit of 103 euros with 1.03 euros in reserves.

In this scenario, the funding costs increase for B1 since it now must borrow 3 additional euros at 1 percent (the CB interest rate). However, the B1 also sees its revenue rise by 3 euros times the interest rate charged to the customer, say 3 percent. Therefore, the bank will end up increasing its profits, even though it was forced to send 3 euros in reserves to B2. As for B2 is concerned, it now needs reserves equal to 1.03 euros and receives 3 euros from B1. Thus, it will end up with 1.97 euros in excess reserves, which it can then deposit at the CB to benefit from the deposit facility interest rate.

3.4 LIMITATIONS ON BANKS' CAPACITY TO CREATE MONEY

Although banks are responsible for the creation of money, they are limited in the amount of money they create. This happens because there are three main factors that limit the quantity of loans banks are able to extend (McLeay et. al., 2014).

1st) Banks are limited by the amount of credit demanded by economic agents

Once banks set the interest rate on their loans, the quantity of credit and money they will create will not be decided by banks but rather by the amount of (creditworthy) demand for credit by economic agents.

On the other hand, note that as economic agents use the loans to spend on goods and services, they will pass that money on to others. How these economic agents then respond will influence the quantity of money in the economy. There are two possibilities. First,

they continue to spend, and so that money continues to be passed on to other agents. The second possibility is that the economic agents that receive the money from the ones that contracted the loans immediately use that money to repay existing bank debts. In this case, the money is quickly destroyed.

2nd) The monetary policy carried out by the CB

If the interest rate of loans influences the number of loans demanded, then the monetary policy carried out by the CB can limit the amount of credit extended and thus of the quantity of money created, as it directly impacts banks' interest rates. In particular, if households and companies start to demand too much credit, this excessive increase in credit will lead to an excessive increase in demand for goods and services, which in turn will lead to inflationary pressure in the economy. As soon as the CB predicts a future increase in inflation above its target, it will increase its interest rate in order to mitigate the excessive demand for credit. This will reduce the amount of credit in the economy and, therefore, the creation of money by banks.

3rd) Regulatory policies

Prudential regulation is a third restriction on money creation, as it acts as a brake on banks' lending activity.

Regulation limits the amount of bank lending via capital requirements.[10] For example, Basel III - an internationally agreed set of measures developed by the Basel Committee on Banking Supervision after the Great Financial Crisis (BIS, n.d) - enforces banks to hold a minimum level of capital. Internationally active banks are obliged to the following capital requirements (BIS, 2017, 2019):

- Common Equity Tier 1 (CET1) must be at least 4.5 percent of risk-weighted assets at all times plus a buffer of 2.5 percent. CET1 (common shares and stock surplus, retained earnings, other comprehensive income, qualifying minority interest, and regulatory adjustments) is the highest quality form of capital. It is meant to absorb losses at the moment they occur.
- Tier 1 capital (CET1 plus additional Tier 1 capital, AT1) must be at least 6 percent of risk-weighted assets at all times plus a buffer of 2.5 percent. Like CET1, AT1

[10] The goal of capital requirements is to ensure that banks do not take excessive risks when making new loans, thereby ensuring the stability of the financial system and of the economy as a whole.

also absorbs losses on a going-concern basis; however, AT1 instruments do not meet all the criteria to qualify as CET1.

- Total capital (Tier 1 capital and Tier 2 capital) must be at least 8 percent of risk-weighted assets at all times plus a buffer of 2.5 percent. Tier 2 capital is gone-concern capital, meaning that these instruments are meant to absorb losses – when banks fail - before depositors and general creditors do.

In sum, banks need to have an equity of at least 10.5 percent of their risk-weighted loans. This can impact on money creation, as banks may not be able to satisfy extra demand for credit if they cannot increase their capital. For example, if a bank has an amount of total loans equal to 100 million euros, then its equity must be equal to 10.5 million euros. If the demand for credit directed to the bank increases by 10 million euros, the bank must be able to raise 1.05 million euros in capital; if it is not, it will not be able to increase credit and create more money.

4. THE SOLUTION TO NEGATIVE INTEREST RATES ON CREDIT

The monetary architecture we propose in this chapter that enables negative interest rates on bank credit takes into account the explanation of the previous chapter of how money is created in modern economies. Banks create money as a result of the *initiative* of economic agents to demand credit. In turn, this depends on the interest rate charged by banks, which is influenced by the CB's reference rates at which banks can borrow reserves. Banks can borrow any amount of reserves they need at the interest rate set by the CB.

4.1 A MONETARY ARCHITECTURE THAT ENABLES NEGATIVE INTEREST RATES ON BANK CREDIT

To achieve negative interest rates on bank credit it is necessary to ensure the following three conditions:

- First, all the necessary funding to extend negative interest rate bank loans must come from the CB, to ensure that banks keep the interest paid on deposits at a non-negative level.
- Second, banks must have the right to obtain from the CB at negative interest rates reserves equal to the full amount of credit they extend, so that it can be profitable to extend credit at negative rates.[11]
- Third, for banks to have access to negative rates funding from the CB, they must prove that those reserves are being used to extend loans at negative interest rates to households and firms, to ensure that negative rates reach the real economy.[12]

In this setting, banks would have an incentive to lend to economic agents at negative rates while still paying non-negative interest rates on deposits. For example, a bank would lend 100 euros to a business at minus 5 percent interest rate to then borrow 100 euros from the CB at minus 6 percent, making a profit of 1 euro (=1% x 100 euros). Banks' credit to the economy would no longer be funded by deposits; it would be fully funded by credit from the CB.

[11] It should be noted that when CB's reserves pay a negative interest rate, the existence of a reserves requirement rule is useless because banks will want to obtain the maximum amount of reserves they are allowed to in order to benefit from the negative rate.

[12] As explained in the previous chapter, banks do not need preexisting funds to extend credit: they can first lend the money and then obtain the necessary reserves to back the deposit created by the credit.

Hence, under the proposed monetary architecture, banks would operate as an intermediary between the CB and its credit clients. That is, if economic agents demanded more worthy credit at negative interest rates, then the CB would satisfy that demand via the banking system.

To illustrate the dynamics of money creation under this framework, next we detail the process of money creation, assuming there are only two commercial banks operating in the economy.

Consider a household (H1) which borrows 100 euros to buy a house at minus 5 percent interest rate from a commercial bank (B1). The bank creates a checkable deposit (CD1) of 100 euros in the account of the household and, at the same time, adds an asset to its balance sheet, the loan. Under the proposed monetary architecture, the bank will afterwards use the document, proving that it extended a mortgage loan of 100 euros, to borrow 100 euros at minus 6 percent from the CB.

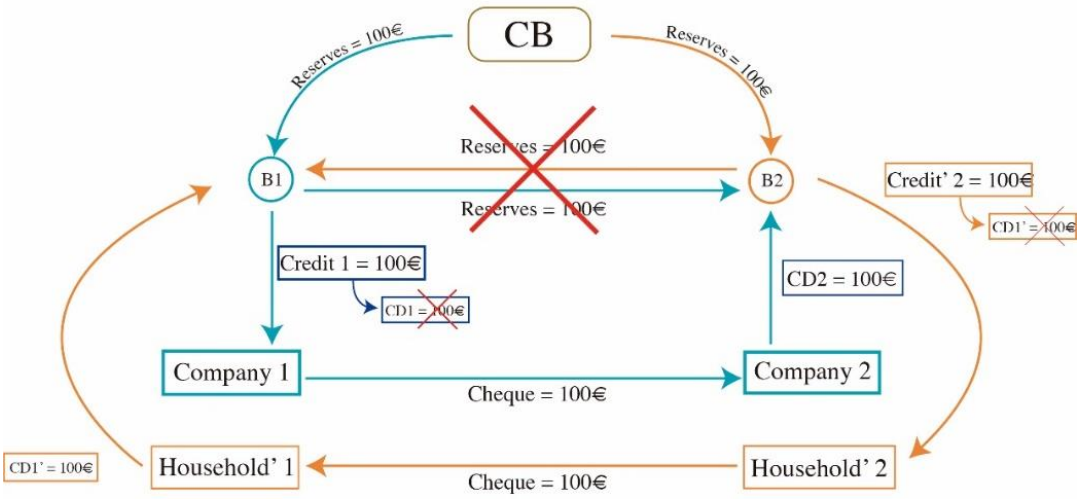
Now, when H1 buys the house, it transfers the 100 euros to the seller of the house (H2) which is likely to be a client of another bank (B2). As a result, B1 is obliged to transfer 100 euros in reserves to B2.

However, in its lending activity, B2 is likely to extend a loan of, for the sake of the argument, 100 euros to an agent (A2). Like B1, B2 will use the document proving the extended loan, to borrow 100 euros at minus 6 percent from the CB. Again, for the sake of the argument, A2 is likely to make a payment to a customer of B1. As a result, B2 is obliged to transfer 100 euros in reserves to B1. However, because the payments the two banks must make to one another cancel out, they do not have to send reserves to each other. So, at the end of the day, both banks will have borrowed from the CB the reserves equal to 100 percent of the deposits they created, that is, 100 euros (=100% x 100 euros).

The two loans extended by the two banks thus ended up creating 200 euros of money, backed by 200 euros of monetary base. Not only is it possible to lend at negative rates, but it also ends up being profitable for banks to do so. Each bank pays 5 euros (5 percent of the 100 euros loan) to the borrowers, but at the same time, it receives 6 euros from the CB (6 percent of the 100 euros loan). This results in a profit of 1 euro for every 100 euros of credit extended.

All this is illustrated in Figure 4.

Figure 4 - Money creation by two banks under the new monetary architecture



Source: Own elaboration

4.2 ADVANTAGES OF THIS SOLUTION

CBs would not have to rely on *quantitative easing* and, therefore, avoid a situation where it becomes very difficult to revert it. And since the ECB is limited on the amount of sovereign bonds it can hold of each member-state, a future crisis might force it to change the limits, or at least continue to introduce new programmes such as PEPP, in which the purchases under this programme do not count to the imposed limits.[13] Now, this does not seem like the best long-term solution. One of the many good things about conventional monetary policy is that it can be easier to revert.

It should also be noted that in the Euro Area, negative interest rates have done a good job in depreciating the value of the Euro - a good way to help stimulate the economy through the exports channel, which is an important part of the European economy. Moreover, negative rates also play a crucial role in assuring low funding costs for the governments because they push down the whole yield curve of sovereign government bonds.

Finally, it should be noted that in the presence of deeply negative rates, it is not certain whether economic agents would respond by increasing consumption or instead by increasing savings in order to counter the depreciation in their savings. This problem is

[13] This would probably be criticized by certain institutions, such as the German Constitutional Court, that forced the ECB to justify that the Assets Purchase Programme did not constitute direct financing of member-states.

fixed in our solution because negative interest rates on credit do not require negative interest rates on deposit accounts.

4.3 SIMILAR MECHANISMS

Our proposed monetary architecture would, in some ways, be similar to the current Targeted Longer-term Refinancing Operations (TLTROs) programme of the ECB, through which banks can obtain long-term funding at attractive conditions from the ECB, depending on the amount they lend to non-financial corporations and households. The more loans banks extend to non-financial corporations and households (except mortgage loans), the more attractive the interest rate on their TLTRO borrowing becomes.[14]

While TLTROs have provided incentives for bank lending to the real economy and led to lower interest rates in the Euro Area to households and firms (ECB, 2017), it was not enough to generate negative interest rates on bank credit. For a simple reason: unlike our solution, it does not create the necessary incentive for banks to lend at negative rates.

On the other hand, in our proposed monetary architecture, banks would be able to obtain 100 percent (instead of 50 percent, which is the maximum they are currently allowed to obtain through TLTROs) of the extended loans in CB credit *conditional* on the confirmation that they extended those loans at negative interest rates.[15] This creates an incentive for banks to lend at negative interest rates to be able to benefit from the CB's more negative interest rate. Under our monetary framework, banks could borrow at negative interest rates without limit as long as they continued to extend negative interest rate loans to the real economy.

4.4 EVENTUAL PROBLEMS

A first objection that can be raised against the proposed monetary architecture is that people could start living off credit. For example, if the interest rate on credit is minus 6 percent, people could borrow 100 billion euros, keep 94 billion euros to pay the debt after

[14] Currently, as a response to the Covid-19 crisis, the ECB eased the conditions on the most recent series of TLTROs (TLTRO III), reducing the interest rate on all targeted longer-term refinancing operations by 25 basis points to minus 0.5 percent and, for banks that meet certain lending criteria, to as low as minus 1 percent. For a bank to satisfy the lending criteria, the amount of its eligible net lending between 1 March 2020 until 31 March 2021 must at least match the amount they extended during the same period in the previous year (ECB, 2020d).

[15] Previously, under TLTRO III, banks could only borrow up to 30 percent of the reference outstanding amount of eligible loans. As of March 2020, the borrowing allowance was increased to 50 percent of the stock of eligible loans (ECB, 2020e).

one year, and live off with the other 6 billion euros. Thus, the mechanism that should be used to stimulate the economy is being used as a way of earning money without any impact on the economy. However, this problem can be eliminated by requiring banks to provide loans at negative rates *conditional* on the use of those loans to purchase goods and services.

A second problem that can be raised against the proposed monetary architecture is that households and firms which would otherwise use their deposits to fund expenditures will instead fund them with bank loans (to profit from negative rates). For example, instead of making a purchase with 100 euros from their own money, they could ask for 100 euros of credit at minus 6 percent interest rate to make the purchase. At the end of the year, they would repay with only 94 euros.

Now, this problem cannot be completely solved, but it can be mitigated. For instance, only certain types of credit would be provided at negative rates, like those for the purchase of a house or the investment in productive projects, and economic agents would be required to put down a minimum share of the whole expenditure out of their own money. Other types of credit, for example, for companies to pay wages or suppliers and for households' consumption, would not be provided at negative rates, so as to avoid economic agents using credit instead of their own money.

Note furthermore that this is not a fundamental problem. Indeed, even if some agents benefit from the explained arbitrage, the central objective of the proposed monetary architecture – to stimulate AD to FE – is achieved as effectively as intended. Besides, we believe that negative interest rates on credit would result in such a strong stimulus to AD that the CB would follow deep negative rates' policies for a short period of time and, therefore, the identified arbitrage would soon be resolved.

4.5 PSEUDO-PROBLEMS WITH THE SOLUTION

This section is entitled pseudo-problems with the solution because there are some issues that at first sight might seem to be problematic, but that on closer inspection do not present any fundamental problem with respect to the effectiveness and/or the possibility of the proposed monetary architecture.

Distortion of the relative prices and consequent inefficiency in resources allocation

A problem that initially occurred to us is that the proposed monetary architecture would reduce the relative price *paid by consumers* for the goods that could be bought with negative interest rate credit. Therefore, this would change the composition of demand and production of the economy in favour of those goods at the expense of others. However, this idea is wrong. In fact, negative rates would be used only when the economy is below FE. Therefore, the rise in demand and production of goods that can be bought with credit would be based on the use of resources that otherwise would be unemployed, not on resources from other productive sectors.

Increase in the Central Bank's liabilities

The CB incurs losses to finance the negative interest rate loans, which will increase its liabilities to the point where it could surpass its assets, leading to a negative equity position. However, the argument that the CBs should have positive equity to be able to function is wrong. In a fiat money system, the money issued by the CB – which constitutes its debt – cannot be claimed over the CB's assets, and the CB can always redeem its debt by issuing new banknotes. Therefore, the CB does not need equity (contrarily to private companies); it can function with negative equity. Thus, a negative equity position for the CB will never result in the need for capital injection by its "owners", the Eurozone member States in the ECB case (see De Grauwe, 2015).

Increase in inflation

The funding of negative rate credit by the CB will create a substantial amount of money, but this will not lead to an increase in inflation when the AD is below FE.

Inflation will only rise if AD rises above FE (see Friedman, 1968). In this case, the unemployment rate will fall below the natural rate of unemployment. At this level, firms will vie for workers and be willing to grant increases in real wages for the next period (it takes time for firms to start increasing wages) above productivity growth. This will lead to a growth rate of the nominal wage in excess of productivity growth above the current level of inflation, and consequently, to an acceleration in the increase in unit costs and prices, i.e., to higher inflation rate. Only in this case will a rise in the quantity of money result in an increase in inflation.

Arbitrage in house purchases

Another pseudo-problem that we identified is that it may, at first sight, seem that negative interest rates will lead to the following arbitrage. Imagine household 1 asks for 100 euros to buy a house (at a minus 5 percent interest rate) and then sells the house to another household 2 for 100 euros (if the house keeps the same value) and repays the loan of 95 euros to the bank, making 5 euros of profit. Household 2 does the same thing, selling the house to household 3, also making 5 euros of profit. And imagine that household 3 repeats the same process, and so on. Thus, each household has the incentive to ask for credit to buy a house and sell it (making a profit of 5 percent).

However, a closer inspection reveals that this is not a problem. First, the purchase and sale of a house cannot be immediate since households must wait one year to benefit from the 5 percent interest rate. Thus, we will have the *same* house transacted, say, 10 times between each of the 10 different households, profiting 5 euros each year. Therefore, this hypothetical scenario would be the same as if one single person bought the house for a 10-year period and never sold it. That person would receive 5 euros of interest for each year of the 10-year mortgage. The effect on the quantity of money and on AD would also be the same in both scenarios.

Note furthermore that, under the proposed architecture, credit at negative rates could be restricted to *new* houses, since the purpose is to stimulate construction and consequently, output and employment.

Low banks' profitability

Constâncio (2019) has argued that negative rates should come to an end because they have proved to be harmful to banks' profitability and thus are endangering the stability of the financial sector.

However, this does not have to be the case. The only plausible reason for low rates to generate low profits is the following. Imagine a household that bought a 100 euros house in June 2007 when the ECB's refinancing rate was 4 percent. The bank applied a spread of 0.25 percent over the ECB's rate and funded the 100 euros in (say) the following way:

- 20 euros from the Interbank Money Market (IMM), for which it paid an interest equal to the ECB's (4 percent).
- 50 euros from time deposits, for which it paid 3 percent interest.
- 30 euros from checkable deposits, for which it paid 0 percent interest.

The financial margin was 4.25 percent charged on the loan minus the weighted average of 4, 3, and 0 percent (2.3 percent). Therefore, the financial margin (1.95 percent) was way larger than the spread (0.25 percent) of the credit interest rate on the ECB's rate.

However, when the ECB reduced the interest rate from 4 percent to 0 percent, the interest charged decreased from 4.25 percent to 0.25 percent. What about the funding cost? The interest rate paid on the IMM also fell by the same 4 percentage points, but the interest paid on time deposits decreased by only 3 percentage points, and the interest charged on checkable deposits did not fall at all. The overall result was a collapse in the financial margin, from 1.95 percent to 0.25 percent.

In sum, the low rate generated small profits because the bank had committed the mistake of setting the spread on the ECB interest rate, instead of setting the spread on the *average cost of funding*. The bank did this because it had never occurred to it that the interest rate would one day fall to zero.

More generally, why should the margins (between the interest banks receive and the interest they pay for funding) depend on the interest being positive, zero, or negative? In the long run, that margin should depend only on the intensity of the competition between banks (the larger the intensity, the lower the margin) and on the logistic non-financial costs (the larger the costs, the larger the margin will have to be to afford it).

Therefore, in the long run, the level of the CB interest rate should not affect the profits of banks. Bankers should start fixing their price as any other business does: setting a margin over the variable cost (the spread of the interest rate charged over the average funding cost, and not merely on the ECB's rate), in order to generate enough money to cover their fixed costs and to generate a return on capital at least equal to the normal level.[16]

By the way, note that this means that, if the legal capital requirements increase, banks should increase the spread over the average cost of funding so as to keep the profit rate at the normal level. This would also have implied that, when the ECB reduced the interest rate towards 0 percent or negative rates, the spread included in the credit interest rate should have increased in order to keep the financial margin unchanged.

Conclusion: there should be no reason for zero or negative rates – or, for that matter, capital requirements - to have any permanent effect on banks' profits.

[16] For an explanation on how businesses set their prices (profit margin over their average total cost) see Leão (2011, pp. 121-122).

Creation of Zombie firms

Another critique of negative rates made by Constâncio (2019) is that today some firms only survive due to the low-interest-rate environment and that under positive rates, those firms would not be efficient enough to compete and stay "alive". Therefore, the negative rates' experience should come to an end.

However, this is not necessarily a problem. Indeed, following this logic, the CB should not set its policy rate equal to zero either; it should raise it to, say, 2 percent to avoid the creation of inefficient firms that would only survive at 0 percent interest rate. But then one could then argue that at an interest rate of 2 percent, some indebted companies would not be efficient enough to operate under a higher interest rate, and so the policy rate should be raised to, say, 4 percent.

In sum, the economy will always adjust to the current cost of funding. At any interest rate level, there will always exist indebted companies that would not survive under higher rates. Thus, at any moment in time, the interest rate should be at the level that guarantees AD equal to FE.

5. CONCLUSION

The global financial crisis of 2008/09 forced CBs to reduce their policy rates towards their effective lower bounds. On the other hand, because of the low economic growth of the subsequent years, monetary authorities did not have the opportunity to raise their policy rates to a comfortable level - that is, to a level where they would have room to lower them by enough to counter a future economic downturn. So, in the Covid-19 crisis, they had to resort to alternative monetary instruments – mainly, expansionary fiscal policy implicitly financed by quantitative easing of CBs.

However, this must not be the case. If the monetary framework set out in this paper were in force, CBs would have been in a position to cut interest rates to minus 3, 5, or even 10 percent. Besides, implementing that monetary structure would not have required drastic changes to the current process of money creation.

The monetary framework proposed in this paper is based on three pillars: (i) the funds needed by banks to extend loans at negative rates should all come from the CB, which will charge a negative interest rate for those funds, (ii) banks must be free to borrow reserves equal to 100 percent of the loans they extend at negative rates and (iii) to have access to CB reserves at negative rates, banks must prove those reserves are supporting loans to the real economy at negative interest rates.

The first pillar ensures that banks do not fund their loans with deposits and, therefore, negative rates on bank credit does not require negative rates on deposits. The second pillar ensures that banks can profit from the operation (for example, banks will only lend at, say, minus 3 percent, if they are guaranteed the access to reserves equal to 100 percent of the money lent at an interest rate equal to, say, minus 4 percent). And, the third pillar is fundamental to encourage banks to extend credit at negative rates. Otherwise, if competition was not intense, banks could borrow from the CB at deep negative interest rates and then extend credit at positive rates, obtaining an enormous spread on the loans.

A monetary framework based on these three pillars is thus able to generate negative nominal interest rates on bank credit while allowing banks to pay zero nominal interest rates to their depositors.

We find only two objections to our proposal. First, people could start living off credit obtained at negative interest rates. Second, households and firms which would otherwise use their deposits to fund expenditures would instead fund them through loans obtained at negative interest rates. While the first objection can be easily prevented by requiring

banks to provide negative rate loans *conditional* on their use to purchase goods and services, the second cannot be solved entirely. However, it can be minimized through loan-to-value requirements and by requiring that only certain types of credit can be obtained at negative interest rates. Besides, the presence of such arbitrage would not undermine the purpose of the policy, which is to bring AD back to FE. Overall, we conclude that nominal negative interest rates on bank credit can, in fact, be achieved through minimal changes in the current process of money creation.

Although there might be other viable options to break the lower bound - the removal of cash from circulation or the increase in the cost of switching from deposits to cash - such policies would not be accepted by the public because they would imply deep negative rates on deposit accounts. This does not happen when the negative rates are entirely introduced via the credit channel.

However, one possible criticism to our proposed monetary architecture is that implementing such policies has never been done historically, so we cannot fully anticipate the effects in the economy. While this is true, not being able to stimulate the economy under the current monetary framework, implying very prolonged periods with output below potential, is a far greater cost that most developed countries face nowadays.

Finally, it should be noted that the discussion of solutions to break the lower bound is not only of academic interest but of a contribution to help increase the CBs capacity to respond to sharp economic downfalls. Hence, our paper might prove useful to monetary authorities or at least to help further extend the study on this subject that has yet received little attention from the literature.

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