The Practice of Central Banking (full text)

This text is based on parts of the online freely accessible book *Introduction to Central Banking* published in 2021 by Ulrich Bindseil (Director General – Market Infrastructure and Payments at the European Central Bank) & Alessio Fotia (former student of Ulrich Bindseil at the Freie Universität Berlin). If students and/or teachers want to go more in depth into the practice of central banking, this is a great place to start.

1. Introduction

This text addresses economists, students and central bankers who would like to be introduced in a concise manner to actual central bank operations, i.e., real-world central banking as determining the central bank balance sheet, the flow of funds in the financial accounts of the economy, and central banks' related interest rate and lender of last resort policies. While the text has been kept simple and accessible, the readership who may benefit from the text goes beyond undergraduate students, as knowledge on central bank operations, financial accounts, and their relation to better known policy fields, is sometimes limited also amongst research-oriented central bankers and post-graduate economists interested in monetary policy.

Whilst price stability is generally thought of as the first concern of central banking and is since 2021 at the centre again, financial stability issues were more often centre-stage in the previous fifteen years. Understanding the interaction between central banks and the wider economy, and with financial systems in particular, is critical. Central bank balance sheets and the financial flows driving their evolution across time (and simultaneously the evolution of the accounts of the other financial sectors, as every financial asset is also a financial liability of someone else, and vice versa) cover an important part of this interaction. They also help us to understand "active" central bank operations, being those initiated by a central bank, such as open market operations, and "passive" central bank operations, being those initiated by other sectors, such as the recourse of banks to standing facilities offered by a central bank, the withdrawal of banknotes by households via banks, or the in- and outflow of foreign reserves in a fixed exchange rate system.

However, financial accounts do not capture the entire reality of central bank operations. First, interest rates are crucial for monetary policy transmission, and this text will therefore also explain why and how operations and financial accounts, together with the interest rates set on central bank operations, determine market interest rates. Second, the distance to default of private sector debtors, and what it implies for financial stability and central bank operations, depends not only on balance sheet figures, but also on a number of parameters outside balance sheets, such as asset price volatility, information asymmetries, and liquidity buffers of firms as determined by asset liquidity and the central bank collateral framework.

Central bank policies are often divided into three broad types: conventional and unconventional monetary policy and the function of lender of last resort.

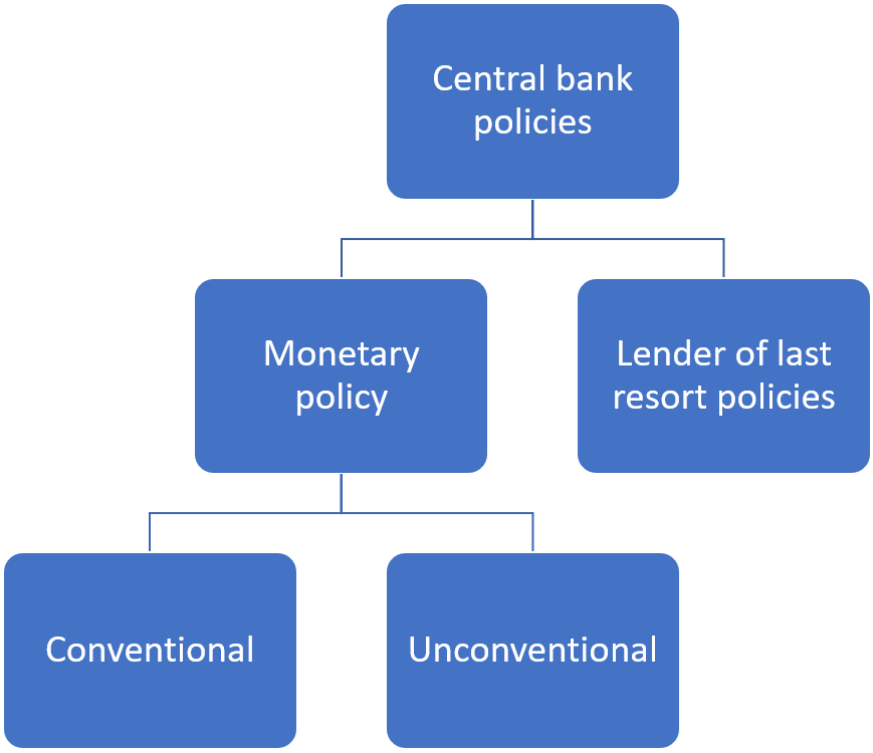

Figure 1: Types of central bank policies

The lender of last resort (LOLR) function is about providing liquidity to solvent financial institutions against good collateral when they otherwise are unable to meet their obligations and can cause financial instability. The lender of last resort function was central to the birth of central banking as initially larger commercial private banks tried to support smaller banks in need to prevent bank runs. Central banks emerged to effectively take on this role of lender of last resort and focused on maintaining and stabilizing the monetary and financial system.

While the goal of financial stability is central to the lender of last resort function, the goals of price stability and maximum GDP growth and employment are at the core of monetary policy. At the end of the 20th century it became normal to distinguish between conventional and unconventional monetary policy, although some argue the distinction is less useful since 2008 as both are continuously used. Conventional monetary policy refers to setting a target for the overnight interest rate to pursue price stability and maximum GDP growth and employment. Unconventional monetary policy comes in when conventional monetary policy is not sufficient due to the zero lower bound and is characterised by instruments such as quantitative easing asset purchase programmes.

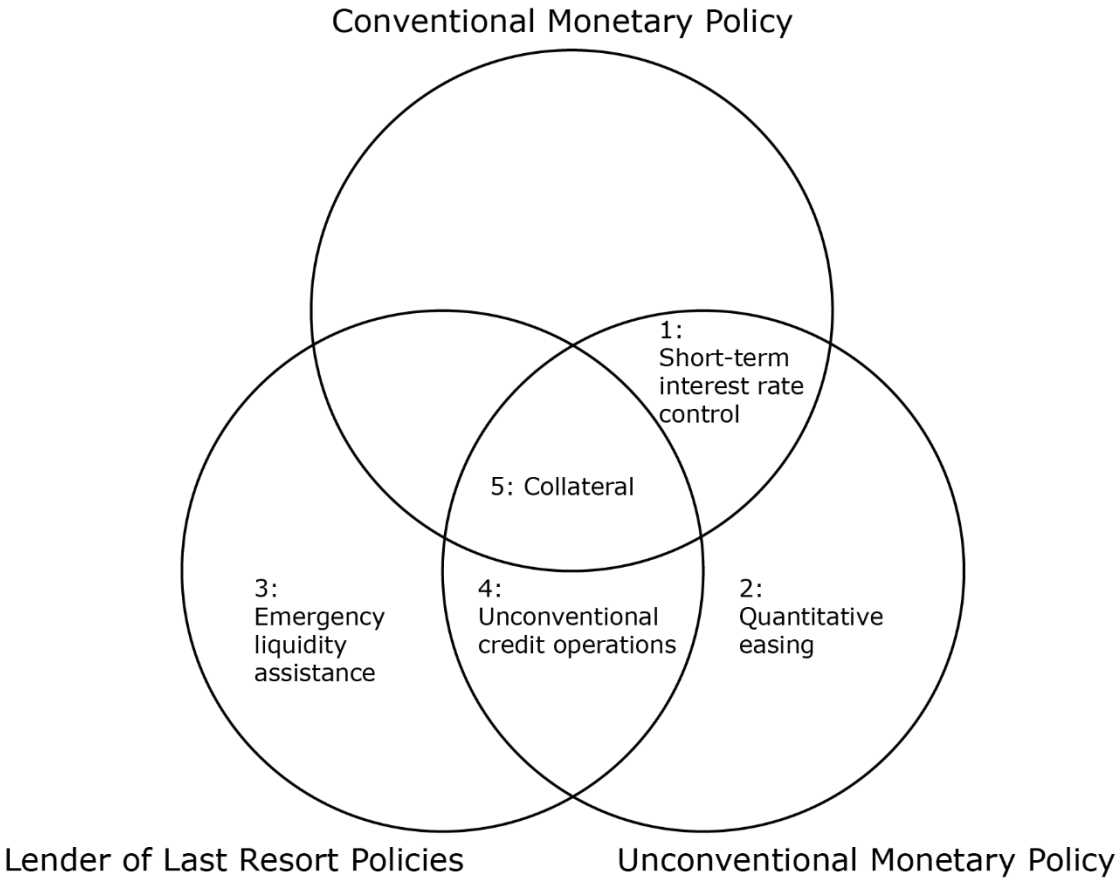

Figure 2: Instruments and types of central bank policies

A brief description of the various central bank policy instruments depicted in figure 2:[1]

1. **Short-term interest rate control** is conventional monetary policy. Short-term interest rate increases are generally thought to lower growth, employment and inflation, while lower interest rates are associated with higher growth, employment and inflation. Negative interest rate policy (NIRP) can be classified as "conventional" monetary policy, as it is a continuation of central bank short-term interest rate policies. Still, it has something unconventional, as it had never been done before 2013. There is debate over whether nominal negative interest rates policies substantially below zero are possible and can be a desirable policy option in some cases.
2. **Quantitative easing** (QE) types of asset purchase programs are unconventional monetary policy operations. These outright purchases are transactions in which the central bank buys bonds from the private sector in secondary markets without any contractual obligations to resell them at a later date.
3. **Emergency liquidity assistance** (ELA) is about supporting banks by lending freely against good collateral to solvent institutions at a penalty rate to prevent financial instability. This is the lender-of-last-resort function and therefore outside monetary policy. At the same time, ELA may prevent contagion of a run on a bank

[1] Central banks also have other important policy instruments, such as micro- and macro-prudential regulation of private banks, banking for the government, monetary financing, and foreign exchange policies, but for brevity and focus they are left out here.

or financial market causing more runs. In this sense, ELA decisions may often be non-neutral for monetary policy.

4. **Unconventional credit operations** such as credit easing asset purchase programs are unconventional monetary policy measures but can also have lender-of-last-resort content, if the program aims (also) at improving the funding liquidity of the firms issuing the debt purchased. By strengthening the lender-of-last-resort the funding stress of commercial banks is reduced, which contributes to maintaining the readiness of banks to provide credit to the economy at a moderate mark up to short-term risk-free rates.
5. **Collateral** is the one and only element in the intersection of the three circles. It is necessary to conventional monetary policy credit operations, and when there are liquidity crises and/or the zero-lower bound problem, broadening the collateral set supports funding liquidity of banks, which attenuates the crisis and supports bank lending.

2. Conventional Monetary Policy

2.1 Short-Term Interest Rates as the Operational Target of Monetary Policy

This section introduces conventional monetary policy, i.e. when short-term interest rates are not constrained by the zero lower bound. We introduce the concept of an operational target of monetary policy and explain why central banks normally give this role to the short-term interbank rate. The idea of a 'natural' rate of interest, which assumes that there is a long run equilibrium interest rate that is neutral in relation to inflation, is introduced. A brief overview of the monetary transmission mechanism, the ways in which monetary policy decisions can influence inflation and economic growth, is given. We then zoom further into monetary policy operations and central bank balance sheets by developing the concepts of autonomous factor, monetary policy instruments, and liquidity-absorbing and liquidity providing balance sheet items. Subsequently we explain how these quantities relate to short-term interest rates in the floor approach, and how the central bank can rely on this relation to steer its operational target. Finally, we explain the importance of the collateral framework and related risk control measures (e.g. haircuts) for the liquidity of banks and for the conduct of central bank credit operations.

The Targets of Monetary Policy

The operational target of monetary policy is an economic variable, which the central bank wants, and indeed can control on a day-by-day basis using its monetary policy instruments. It is the variable for which (i) the policy decision making committee sets the target level in each of its meetings; which (ii) gives guidance to the staff of the central bank what really to do on a day-by-day basis, and (iii) serves to communicate the stance of monetary policy to the public.

There are essentially three main types of operational targets: (i) a **short-term interest rate**, which is today and was until 1914 the dominant approach; (ii) a **foreign exchange rate**, for central banks which peg their own currency strictly to a foreign one, usually a small or developing economy; and (iii) **a quantitative, reserve related concept**, which was in different variants the official operational target of the Federal Reserve of the United States in the period 1920–1983. However, how it was meant to be applied is not completely clear (for a deeper discussion of this topic, see Bindseil [2004]).

The **ultimate target** of monetary policy is the objective that the central bank wants to achieve in the medium or in the long run. It is the precise quantitative specification of the objectives established by the mandate of the bank. Currently there are two predominant ultimate targets:

- **Inflation rate**: usually defined as an annual increase of the consumer price index. It is the most common target for advanced economies and is used also in some emerging economies. In some cases, it is the ultimate target together with other objectives. For example, in the case of the Fed, the objectives spelled out in Section 2A of the Federal Reserve Act are "maximum employment, stable prices, and moderate long-term interest rates";
- **Foreign exchange rate**: in case of a currency peg, the ultimate target is the exchange rate, and all other variables, and the operational and ultimate target collapse into one.

Other ultimate targets, which have been applied in the past, or which are currently being discussed, include:

- **Monetary aggregates**: Friedman (1982) proposed to make a narrow monetary quantity the ultimate target of the central bank. A somewhat less radical variant was defined by the Deutsche Bundesbank with monetary growth as an intermediate target to pursue price stability (Deutsche Bundesbank 1995).
- **Nominal GDP targeting**. At least since Clark (1994), nominal GDP targets have been considered as an alternative monetary policy strategy to inflation targeting. Recently, Williams (2016) has advocated nominal GDP targets as they would have a number of advantages in a world with lower growth and lower natural interest rates.
- **Price-level targeting** has similarities to inflation targeting, but would compensate past deviations of actual inflation from the target with subsequent opposite deviations. Such an approach would reduce long-run uncertainty regarding the price level. For a survey, see Ambler (2009). Arguably the Fed adopted elements of price-level targeting in its recent decision of pursuing an *average* inflation rate of 2% by allowing an inflation rate moderately above 2% after periods in which inflation has been below 2% (Fed 2020d).

A central bank may have a **single or dual mandate**: for example, the ECB has the primary objective of price stability and other economic objectives are subordinate to that imperative (EU 2007), while the US Fed has, according to the Federal Reserve Act as amended in 1977, the statutory objectives for monetary policy of ensuring that actual economic growth keeps up with potential economic growth, with maximum employment and stable prices merely the visible consequences of this policy, rather than the targets themselves. However, in practice the Fed has acted as though it has a 'dual mandate' for targeting full employment and low inflation.

The ultimate target must be precisely defined: for example, the ECB decided that "Price stability is defined as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%." and operationalised the target by aiming at an increase of the HICP of "close to but below 2%" with a medium-term orientation. Some, like Ball (2014), have suggested that it would be better to set the inflation target to 4%, at least in the possible new world of secular stagnation in which the zero-lower bound can easily constrain monetary policy (as further explained in the next section).

2.2 *Box 1: The Idea of a Natural Rate of Interest*

Adapted Version of a Natural Rate of Interest by John C. Williams of the Federal Reserve Bank of San Francisco (2003)

A key question for monetary policymakers, as well as participants in financial markets, is: "Where are interest rates headed?" In the long run, some economists assume that nominal interest rates will tend toward some equilibrium, or "natural," real rate of interest plus an adjustment for expected long-run inflation. This is also sometimes referred to as a neutral or non-accelerating rate of interest.

Unfortunately, the "natural" real rate of interest is not observable, so it must be estimated. Monetary policymakers are interested in estimating it because real rates above or below it would tend to depress or stimulate economic growth; financial market participants are interested because it would be helpful in forecasting short-term interest rates many years into the future in order to calculate the value and, therefore, the yields of long-term government and private bonds.

In thinking about the natural rate of interest, economists generally focus on real interest rates. They believe that movements in those rates, more so than in nominal rates, influence businesses' decisions about investment spending and consumers' decisions about purchases of durable goods, like refrigerators and cars, and new housing, and, therefore, economic growth.

Over 100 years ago, Wicksell defined the natural rate this way:
"There is a certain rate of interest on loans which is neutral in respect to commodity prices, and tends neither to raise nor to lower them." (1936 translation from 1898 text, p.102.)

Since then, various definitions of the natural rate of interest have appeared in the economics literature. Here, the natural rate is defined to be the real fed funds rate (the policy rate) consistent with real GDP equaling its potential level (potential GDP) in the absence of transitory shocks to demand. Potential GDP, in turn, is defined to be the level of output consistent with stable price inflation, absent transitory shocks to supply. Thus, the natural rate of interest is the real fed funds rate consistent with stable inflation absent shocks to demand and supply.

This definition of the natural rate takes a "long-run" perspective in that it refers to the level expected to prevail in, say, the next five to ten years, after any existing business cycle "booms" and "busts" underway have played out.

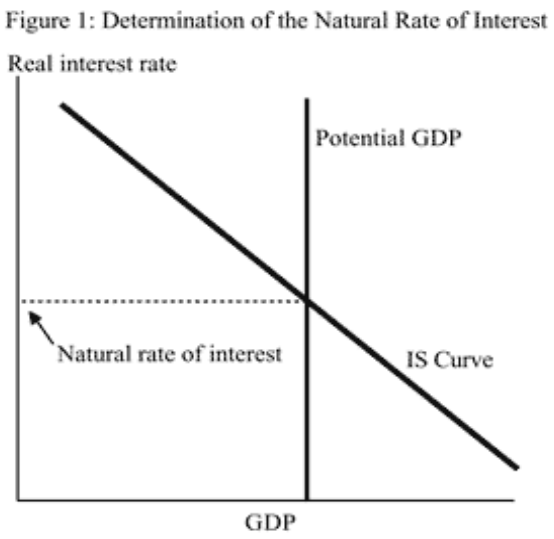

Figure 3: Determination of the Natural Rate of Interest

Figure 3 shows what determines the natural rate in a stylized form. The downward-sloping line, called the IS (investment = saving) curve shows the negative relationship between spending and the real interest rate. The vertical line indicates the level of potential GDP, which is assumed to be unrelated to the real interest rate for this diagram. (In principle, potential GDP is also a function of the real rate, but this modification does not affect the basic point.) At the intersection of the IS curve and the potential GDP line, real GDP equals potential, and the real interest rate is the natural rate of interest.

Importantly, the natural rate of interest can change, because highly persistent changes in aggregate supply and demand can shift the lines. For example, in a recent paper, Laubach (2003) finds that increases in long-run projections of federal government budget deficits are related to increases in expected long-term real interest rates; in Figure 1, an increase in long-run projected budget deficits would be represented by a rightward shift in the IS curve and a higher natural rate. In addition, economic theory suggests that when the trend growth rate of potential GDP rises, so does the natural rate of interest (see Laubach and Williams (2003) for supporting evidence).

Critique of the idea of a 'Natural' Rate of Interest

Economists from various perspectives would agree that at least to some extent, the "natural" rate of interest and the long-term growth potential of an economy can be influenced by fiscal and monetary policy, on top of its structural features and policies, and is therefore less, or not at all, a predefined variable to which monetary and fiscal policy should conform. This belief has led some schools of thought to make small adjustments to the concept and refer to it as a neutral or non-accelerating rate of interest, and some to reject it outright. The belief that government policy can affect the "natural" rate of interest (as suggested above by the current vice chair of the Federal Reserve's monetary policy committee) has led some economists - particularly those in the Post-Keynesian tradition - to reject the concept. Many Post Keynesians argue that monetary policy should not be so heavily influenced by a variable that is both unmeasurable and itself influenced by policy. They would instead prefer for monetary policy to focus more directly on supporting employment and investment.

2.3 *Box 2: What is the Monetary Transmission Mechanism? by Corporate Finance Institute (2021)*

The monetary transmission mechanism refers to the process through which monetary policy decisions affect economic growth, prices, and other aspects of the economy. Figure 4 illustrates a simplified monetary transmission mechanism, which will be further described here.

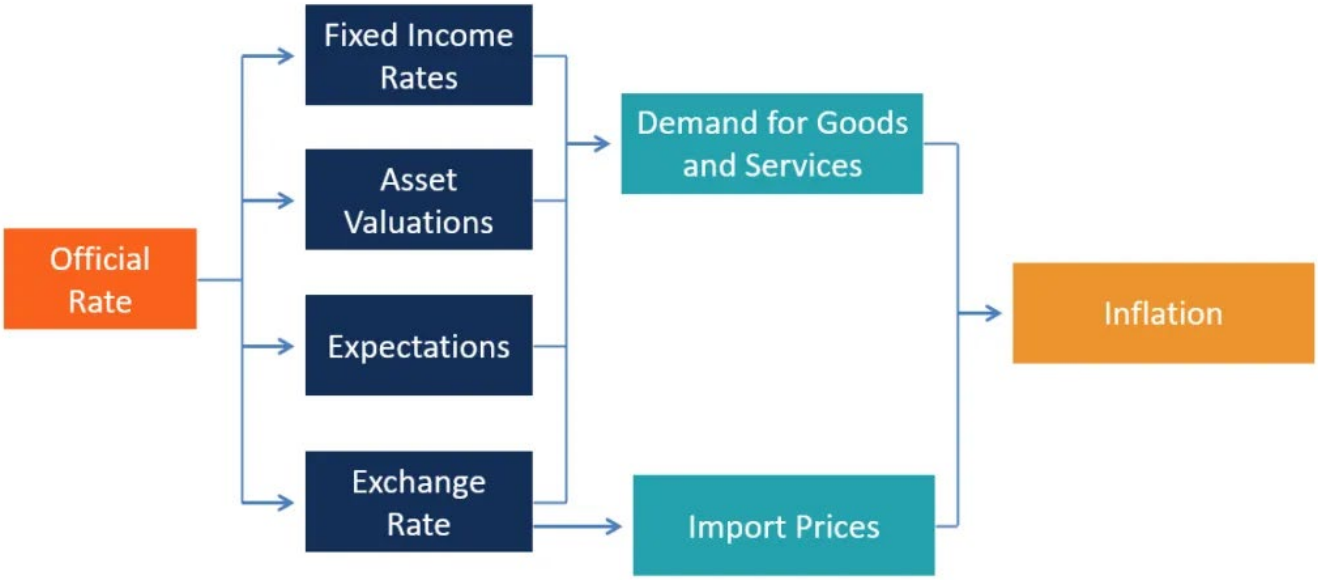

Figure 4: Monetary Transmission Mechanism

Central Bank Action

Central banks throughout the world share similar objectives. The predominant objective of central banks is price stability, but low unemployment and sustained economic growth are often important objectives as well.

To reach their goals, central banks can count on several monetary policy tools, such as interest rates, quantitative easing/tightening, reserve requirements, and interest on reserves.

The effects of monetary policy on the economy may not be obvious, especially if the principle of money neutrality is accepted. However, the actions of central banks to try to affect the economy suggest that central bankers believe that, at least in the short term, monetary policy can affect the economy and not just the levels of inflation.

Interest Rates as a Key Monetary Transmission Mechanism

The official interest rate is the most popular tool through which central banks influence the economy. We are going to analyse the monetary transmission mechanism mainly via the analysis of the official interest rate.

The change in the official interest rate is usually transmitted to the economy via four different but interconnected channels – market rates, expectations, asset prices, and exchange rates.

Official Interest Rates and Market Rates

If central banks raise (lower) the official interest rate, bank lending rates, and bond yields would rise (fall) as a consequence. Central banks try to affect the cost of borrowing for businesses and consumers, mainly via changes in the official interest rate.

Official Interest Rate and Asset Prices

Changes in the official interest rate affect the discount rates used to calculate the present value of cash flows, which are used to estimate the value of securities.

It happens because changes in the official interest rate affect the yield of fixed-income securities and the opportunity cost of capital. Other conditions held equal, an increase (decrease) in the yield of fixed-income securities would make stocks less (more) attractive.

Official Interest Rate and Expectations of Economic Agents

Changes in the official interest rates exert a significant effect on the expectations of economic agents. If the official interest rates are lowered, economic agents would expect the amount of lending to increase as a result of lower borrowing costs or asset prices to increase as a result of lower discount rates and expectations of better growth.

Conversely, rising interest rates could negatively affect the expectations, as economic agents may expect the amount of lending to decrease due to the increased borrowing costs and asset prices to decline as a result of higher discount rates and expectations of lower economic growth.

Official Interest Rate and Exchange Rates

Changes in the official interest rate affect exchange rates, as well. Other conditions held equal, when interest rates in a country rise (decline), investing in that country becomes more (less) attractive.

As a result, the demand for the country's domestic currency increases (decreases) vs. other currencies.

Monetary Transmission Mechanism on Demand

At least in the short term, the changes in the four channels analysed affect the demand for goods and services.

- Changes in market rates impact the cost of borrowing, which affect the demand for credit and related consumption. For example, other conditions held equal, a decline in interest rates may increase the attractiveness of a mortgage for the purchase of a house or make consumer credit more affordable.
- Changes in asset prices affect people's consumption through the wealth effect. A person who sees his/her portfolio of assets increase in value may feel richer and be more willing to spend, or even sell some of his/her assets to finance spending or take credit using their increased assets as collateral.

- Changes in confidence and expectations can affect demand as well. For example, expectations of economic growth may make people less cautious and more willing to spend on goods and services.
- Changes in exchange rates can affect imports and exports. A decline in the value of the domestic currency can result in a positive impact on exports, while an increase in its value can benefit imports.

Monetary Transmission Mechanism and Inflation

As mentioned above, changes in the official interest rates can affect demand via several channels. Changes in demand ultimately affect prices, increasing or decreasing inflation pressures. For example, other conditions being equal, a decline in interest rates would result in an inflationary effect, mainly because:

- Increases in asset prices, improvement of confidence, and greater availability of credit would help increase consumption. If demand adjusts faster than supply, prices would be pushed up.
- Lower interest rates would help the domestic currency depreciate vs. foreign currency, which would cause an increase in import prices. The impact of an increase in the official interest rate would be the opposite.

2.4 Composition of the Central Bank Balance Sheet

The central bank balance sheets shown so far have been simplifications with regards to two important aspects that now need to be differentiated further.

Autonomous Factors

Autonomous factors are those factors affecting the central bank balance sheet and the amount of deposits of banks with the central bank which are **not monetary policy operations**. They are not under direct control of the monetary policy implementation function, although they have a potential impact on liquidity conditions, and on short-term market interest rates. Autonomous factors are: (i) banknotes. (ii) Governments often deposit their cash with the central bank, implying that on tax collection days, government deposits with the central bank may increase steeply, while they decline on days the government pays out wages of its employees. (iii) The central bank may intervene in foreign exchange markets, or act as foreign exchange agent of the government, and thereby increases or decreases its foreign reserves holdings. (iv) The central bank may buy or sell financial assets for investment purposes. (v) the IMF may have credit lines with the central bank and may occasionally draw on those.

The starting level and fluctuations of any of these autonomous factors affect the necessary recourse of banks to central bank credit, which can matter both from a monetary policy perspective and from a bank funding/financial stability perspective.

Monetary Policy Instruments

Monetary policy instruments are the tools used by the central bank to reach its operational target. Central banks mainly use three such tools: standing facilities, open market operations, and reserve requirements.

Table 1: Overnight lending facility's and deposit facility's name in selected central banks

	Overnight lending facility	**Deposit facility**
Bank of England	operational standing lending facility	operational standing deposit facility
Bank of Japan	complementary lending facility	complementary deposit facility
European Central Bank	marginal lending facility	deposit facility
Federal Reserve	Primary credit facility Secondary credit facility	Term deposit facility

Standing facilities are **central bank financial transactions at the initiative of banks**, on the basis of a commitment of the central bank to enter such operations at certain conditions. Three variants have to be distinguished: An **overnight lending facility allows banks to borrow** at any time against eligible collateral at the rate specified by the central bank, with overnight maturity. It sets the upper limit of the interbank rate, as no bank would borrow at a higher rate than the rate offered by the central bank. A **deposit facility allows banks to deposit** funds at any time with the central bank on a specific account where it gets remunerated at a specific rate. It sets the lower limit for the interbank rate, as no bank would lend at a lower rate than the one it can obtain by safely depositing its reserves at the central bank. In the past central banks offered a **discount facility**: banks could **sell** certain short-term securities to the central bank at any time, whereby the discount rate specified by the central bank was applied to calculate the price on the basis of the securities' cash-flows. It was the main tool of central bank liquidity provision in the nineteenth century, but is no longer in use today. Table 1 provides the relevant names of these facilities across some major central banks.

Open market operations are central bank financial transactions with banks at the central bank's initiative, whereby two subtypes can be distinguished: (i) Outright purchases or sales of assets (normally debt securities) from banks; (ii) Lending (or "credit", "reverse" or "temporary") operations with banks. Loans are provided through well-defined procedures: in a "fixed-rate tender", the central bank announces the interest rate and maturity at which it will provide credit, banks then express the intended quantity they wish to obtain, and finally the bank announced a full or partial allotment. In a "variable-rate tender", banks are allowed to submit bids at different interest rates and the central bank decides on a cut-off interest rate.

Reserve requirements oblige banks to hold in a certain period (per day, or on average over a two weeks or one-month period, for example) a certain minimum level of sight deposits (which customers can quickly convert into cash) on their account with the central bank. Fulfilment is measured only on the basis of end of day snapshots (i.e. intra-day levels of reserves are not relevant). The size of the reserve requirement of a specific bank is normally set as a percentage of specific liability items of its balance sheet which need to be reported on a monthly basis. In the case of the European Central Bank, the requirement for each bank amounts to 1% of its liabilities to non-banks with a maturity below two years. This means that for every 100 euros in a deposit account (such as savings and current accounts) the commercial bank needs to hold 1 euro in reserves. Even if reserve requirements are zero, there is still a sort of reserve requirement in the sense that banks need to hold at day end at least a zero balance on their deposit account with the central bank.

Liquidity Providing and Liquidity Absorbing Items

Both monetary policy operation and autonomous factors can each be further subdivided into liquidity providing and liquidity absorbing. If an asset item increases (be it a monetary policy item or an autonomous factor), then, everything else unchanged, the deposits of banks with the central bank (i.e. their "liquidity") will increase, such as for example if the central bank purchases securities for monetary policy purposes, or if the central bank intervenes in foreign exchange markets to purchase a foreign currency. If a liability item increases, and all the other monetary policy items and autonomous factors are unchanged, then the deposits of banks with the central bank will decrease. This happens if for example the central bank collects fixed term deposits from banks, or if the circulation of banknotes goes up. Vice versa, if asset and liability items decline, the opposite effects on the level of bank deposits with the central bank will occur. In practical terms, the effect on deposits of banks with the central bank materialise because the banks are the counterparties of the central bank when the related financial operations are undertaken, and their accounts with the central bank are debited or credit as a consequence of the operations. The Table 2 reflects this slightly more differentiated representation of the central bank balance sheet, ordered according to the three main types of balance sheet items.

Whilst central banks do sometimes buy and sell financial assets outright, it is more common for them to conduct policy through repurchase agreements – often shortened to "repos". Rather than permanently transferring ownership they do so temporarily, with a contractual obligation to resell or repurchase that asset in the future. This makes it easier for them to normalise their monetary policy stance after the shock has passed - normally this means reselling assets back to commercial banks once the need for excess liquidity has passed.

*Table 2**:** The central bank balance sheet ordered according to the monetary policy implementation perspective*

Central Bank	
Liquidity providing items	*Liquidity absorbing items*
Autonomous factors • Net Foreign assets • Investment portfolios	**Autonomous factors** • Banknotes • Government deposits
Monetary policy operations • Open market operations— outright purchases • Open market operations— credit to banks • Borrowing facility	**Monetary policy operations** • Fixed term deposits or repo • Issuance of debt certificates • Deposit facility
	Deposits of banks

2.5 *Monetary Policy Implementation Techniques*

Here we describe the prevalent floor approach to controlling the short-term interest rate through monetary policy operations. In the book, the ceiling and symmetric corridor approaches are also described.

The Floor Approach

The **floor approach** has been used by all major central banks after 2009, and is now considered a new normal. In the floor approach, the interbank interest rate will be close to the liquidity absorbing standing facility (the deposit facility; or the rate of remuneration of excess reserves) offered by the central bank. The central bank needs to ensure (through the choice of the two variables it controls), with a sufficient margin, that:

Open market operations > Autonomous factors + reserve requirements

Moreover, the central bank needs to set the rate of the deposit facility (or the remuneration of excess reserves) to the level of the intended policy target interest rate. **Given the abundance of reserves, commercial banks will be willing to lend them in the interbank market at any rate marginally higher than the remuneration of the deposit facility**. The central bank chooses the size of its outright portfolio OMO ("open market operations") such that it is smaller than banknotes and deposits, but bigger than banknotes and reserve requirements.

Sometimes central banks have implemented **one-sided facility approaches with two facilities offered in the same direction** (i.e. either two liquidity absorbing facilities under the floor approach, or two liquidity-providing facilities under the ceiling approach). Since 2005 the Fed has applied a floor system with the overnight policy rate being lower than the interest rate on excess reserves (IOER), but higher than the reverse repo rate (the rate at which the central bank borrows money from commercial banks).These systems require that the more attractive of the two facilities is somehow constrained in terms of access (discount facility possibly through scarcity of available eligible paper, IOER through limiting access to banks, excluding non-banks).

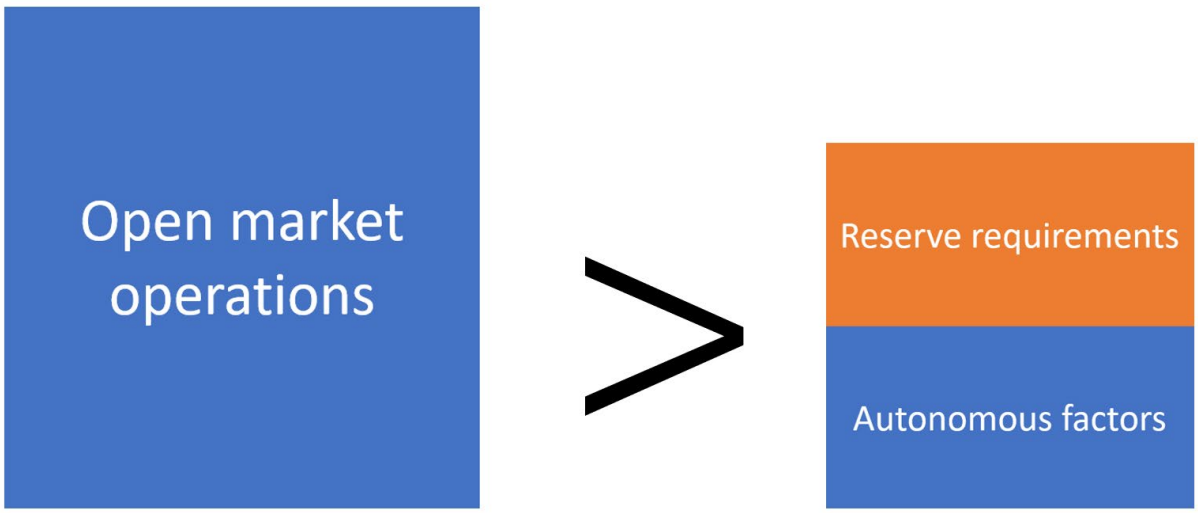

Figure 5: When the floor approach applies

2.6 The Central Bank Collateral Framework

Why Collateral?

Central banks conduct open market operations both in the form of purchases and sales of securities, and in the form of credit operations with banks. For the latter, central banks require collateral, i.e. the pledging of certain eligible securities, called collateral, to protect its credit exposures to banks. The central bank will sell the collateral in the market if the borrowing bank does not repay the credit. When the bank, however, reimburses the credit from the central bank, the collateral is returned in its full value.

The value of collateral required by the central bank will exceed the credit provided by the central bank because **central banks apply "haircuts"**. Haircuts are the difference between the market value of an asset and the value of the asset as collateral for a loan. Haircuts are larger when the underlying asset is riskier, depending on its price volatility, its liquidity, and possibly on its credit risk. For each security pledged as collateral, the haircut will be deducted to determine the maximum amount of central bank credit that can be obtained against it from the central bank. The collateral protects the central bank from a default of the commercial bank.

There are several reasons why a central bank should not offer uncollateralised credit. (i) the central bank must ensure transparency and equal treatment, and uses uniform policy rates, but the credit worthiness is not the same for all institutes. (ii) the central bank is not specialised in assessing credit risk. (iii) the central bank must deal with a high number of banks, and also banks with a low rating must have access to liquidity. Collateral solves all these problems to a very large extent.

The **collateral framework potentially influences the relative price of financial assets and thereby potentially the allocation of credit**, as Nyborg (2017) has recently emphasised. Bindseil et al. (2017) also review the economics and practice of a collateral framework. The long history of collateral issues in central banking is also discussed in Chapter 4 of Bindseil (2019).

What Makes an Asset Suitable as Collateral?

Financial assets should fulfil certain qualities to be suitable as central bank collateral, in particular:

- legal certainty of the validity of the pledge
- minimum liquidity to ensure the ability of the central bank to easily sell the collateral in case of counterparty default
- ease of pricing (through market prices or reliable theoretical prices)

Government bonds often serve as collateral in credit operations. So while your collateral, when you get a mortgage is your house, the collateral of the commercial bank when it lends from the central bank is government debt.

Principles of a Collateral Framework

First of all, the collateral framework should ensure a high degree of protection of the central bank from credit risk. Second, it should ensure **sufficiency of collateral** to

implement monetary policy through credit operations, i.e. collateral scarcity should not lead to a distortion of interest rates or constrain the access of the banking system as a whole to the necessary amount of central bank credit. Third, the collateral framework should ensure **sufficient access** of all parts of the banking system considered important for the transmission of monetary policy. Third, the collateral framework should avoid that the **collateral eligibility premium** is so high that collateral scarcity and the relative treatment of assets by the collateral framework could influence rela-tive asset prices in a way that unduly affects resource allocation in the economy. A larger collateral set supports a lower collateral eligibility premium and hence reduces the risks of distortions. Fourth, the collateral framework should avoid pro-cyclicality: haircuts and eligibility criteria should be specified in good times in a conservative way so that they do not need to be tightened in crisis times.

The Risk Control Framework

The **risk control framework** for central bank collateral essentially consists in the haircut schedule and possible limits on the use of certain types of collateral. Gonzalez and Molitor (2009) and ECB (2015) present methodologies for deriving a central bank risk control framework for credit operations, such as haircuts, daily valuations, and margin calls. For example, the haircut scheme is a mapping of three features of each security into a haircut, namely (see ECB Press Release of 18 July 2013): **Rating**: BBB rated assets have higher haircuts than A-AAA rated assets (assets with ratings below BBB are normally not eligible at all); **Residual maturity**: the longer the residual maturity of bonds, the higher the price volatility and hence the higher the haircut; **Institutional liquidity category** of assets: The ECB has established six such categories, which are supposed to group assets into homogenous institutional groups in terms of liquidity. To keep the risk control framework simple, central banks rarely impose concentration limits on collateral portfolios, i.e. limiting the share of individual issuers, or the share of a certain asset type (concentration limits would have the advantage that in case of liquidation of a collateral portfolio, the price impact on the individual assets would likely be lower).

3. Unconventional Monetary Policy

This section introduces the reader to unconventional monetary policy, i.e. monetary policy using instruments going beyond the steering of short-term interest rates as described in the previous section on conventional monetary policy. We start by providing the rationale of unconventional monetary policy, i.e. essentially pursuing an effective monetary policy when conventional policies are not able to provide the necessary monetary accommodation because of the zero lower bound. We then discuss negative interest rate policies, and explain why rates slightly below zero have proven to be feasible despite the existence of banknotes. We also discuss possible unintended side-effects of negative interest rates. We continue with a discussion of unconventional credit operations: lengthening of their duration, the use of fixed-rate full allotment, the widening of the access of counterparties to the central bank's credit operation, targeted operations, credit in foreign currency, and widening the collateral set. Finally, we turn to the purposes and effects of securities purchase programmes.

3.1 Rationale and Definition of "Unconventional" Monetary Policy

According to the Wicksellian logic of a natural rate of interest explained in box [X], inflation will increase if the actual short-term risk-free interest rate is below the natural level, while in the opposite case inflation will decrease, in math: if $i_t > i_t^* \Rightarrow \pi_t \downarrow$; If $i_t < i_t^* \Rightarrow \pi_t \uparrow$. In the most basic version, the neutral rate is simply the sum of the expected real rate and the expected inflation rate, i.e. $i_t^* = E(r_t) + E(\pi_t)$. If however the key issue is the funding costs of the real economy, and not just an abstract risk free interest rate, then it is more correct to define the neutral interest rate as: $i_t^* = E(r_t) + E(\pi_t) - \tau - \lambda$, with τ being a measure of the term spread and λ being a measure of the liquidity and credit risk spreads between the average short-term funding costs of the real economy and the short-term risk-free interest rate. The latter will increase in a financial crisis beyond normal levels and needs to be addressed through an additional easing of monetary policy.

In a **financial crisis,** with the associated economic slowdown, and starting from the low structural growth as prevailing in Japan or Europe, expected growth will easily be zero or negative, also implying low or negative real interest rates. If in addition, credit and liquidity spreads increase by 100 or 200 basis points relative to normal levels, as happened in 2008, and expected inflation is also close to zero, then the neutral interest rate i_t^* will be negative, meaning that an inflationary impulse will require either negative nominal interest rates, or the combination of zero/negative interest rates with "unconventional" measures that will exert downward pressure on τ and λ. Downward pressure on τ can be achieved through forward guidance[1] (committing to hold rates low for long) and through outright purchase programs of long term fixed rate securities to compress term spreads. Downward pressure on λ can be achieved through so-called credit-easing measures, including purchases of less liquid and more credit risky securities, and strengthening the lender of last resort support to the banking system such as to reduce perceived funding liquidity risks of banks. Here such unconventional monetary policies will be discussed, whereby policies relating to the lender-of-last-resort will be dealt with below. **Unconventional monetary policy measures are typically considered to have some potentially negative side effects**, while short-term interest rate policies in positive territory do not. For this reason, unconventional measures are used only if unavoidable, i.e. when $i_t^* < 0$, i.e. when short-term interest rate policies

alone are no longer sufficient. Negative side effects are likely to increase with the intensity of measures, such that combining different measures may often be optimal to achieve the adequate overall stance of monetary policy. We can think of each unconventional measure as having (i) a fixed set up /transition cost (need to analyse, specify, decide, communicate new measure); and (ii) an increasing marginal cost from "distortions" it creates.

It appears that **central banks have assessed the relative costs of the different unconditional measures differently**: for example, the Fed and the Bank of England have not hesitated to conduct large scale asset purchase programs as of 2009 but have not tried negative interest rates. In contrast, the ECB has taken a while before launching a true "quantitative easing" asset purchase program, but did not hesitate to move interest rates into negative territory. Of course, the perceived negative side effects of unconventional measures always depend on circumstances, i.e. may be different from one jurisdiction to another, or from one episode to another.

The reasoning above assumes that the choice and specification of non-standard measures can basically be mapped into a single number: the additional accommodation needed beyond the zero lower bound. However, one may question this, and instead see non-trivial issues in the interaction of non-standard measures that imply that one cannot just add up the accommodation that each measure brings.

3.2 Negative Interest Rate Policy (NIRP)

Four European central banks have applied negative interest rate policy in recent years, namely those of Denmark, Switzerland, Sweden and the euro area (for a survey of the implementation of negative interest rate policy by these central banks, see e.g. Bech and Malkhozov (2016). In addition, the Bank of Japan introduced negative interest rate policy in early 2016. In principle, the rationale for applying negative rates under some circumstances is obvious from the Wicksellian logic above. It could be argued that in 2008, the policy-adequate short-term interest rate would have been as low as between 3 to 5%, i.e. if central banks had been able to implement negative rates at these levels, the crisis would have been more short-lived (avoiding the large scale economic contraction and associated welfare damage) and further unconventional monetary policies (such as large scale asset purchase programs) with their complexities and side effects would not have been needed. Strong supporters of negative interest rates as an obvious policy tool are for instance Buiter (2009) and Rogoff (2017), who also discuss how to make negative rates possible.

Reasons for a Lower Bound

Lower Bound Created by the Zero Remuneration of Banknotes

Deeply negative interest rates should eventually lead to an explosion of the demand for banknotes, as banknotes have a zero remuneration. Indeed, it could be argued that all economic agents (banks, investors, households) can escape negative interest rates by substituting negatively remunerated financial assets with banknotes (which have zero remuneration). This is a powerful and obvious argument against deeply negative interest rates, and the only solution to it would be to discontinue the existence of physical banknotes, e.g. by fully replacing them with central bank digital currency, which could be

remunerated negatively when needed. However, critics argue that this would create a tool for central banks to expropriate savers (by imposing negative interest rates, see e.g. Bindseil et al. (2015) and that discontinuing banknotes would also destroy, a la George Orwell's "1984", the freedom provided by anonymous payments. In addition, banknotes are resilient to cyber-attacks and power outages and they score high in terms of financial inclusion, as they do not require even a mobile phone. These arguments prevail for the time being in most countries, and therefore banknotes will continue to limit the scope for negative interest rates to the levels reached over the last few years, i.e. not lower than around 100 basis points. This seems to be the level at which banknote demand could start to have substantial momentum and undermine the effectiveness of negative interest rates.

Negative interest rates dynamics would change if retail central bank digital currency is introduced, as this allows normal citizens to not only have a bank account (digital money) at commercial banks, but also at the central bank. In this case, people might move their money from commercial bank accounts to their central bank account in search of safety. This would result in a ballooning of central bank money holdings of households, which would imply that banks would lose large amounts of deposits and become more and more dependent on central bank credit. This would deplete collateral buffers and could put banks under liquidity stress, making it unlikely that bank lending rates will decline, i.e. undermining the effectiveness of negative interest rate policy. Banks may not want to pass on negative rates to household deposits to avoid triggering such a run on deposits. However, then, banks' profitability suffers, as discussed further under point 2 below. In principle, the banknote hoarding argument also applies, for example, to banks, who could, in an environment of excess reserves, such as prevailing typically in the negative interest rate countries, start to hoard cash.

Lower Bound Due to Negative Effects on Profitability of Banks

It has been argued that negative rates undermine bank profitability and undermine the transmission of negative rates as banks would be unable to pass on negative rates to retail depositors. People do not want to lose a part of their savings every period. Therefore banks are afraid that if they will try to impose a (too large) negative interest rate their customers will close their account and move elsewhere. This means that even if central banks set a negative policy rate, commercial banks may avoid imposing a negative interest rate on their customers. The cost of funding through deposits being higher (less negative) than the interest rate paid on central bank reserves, also called the negative interest margin, will squeeze bank profitability, potentially reducing their stability and soundness.

Criticism of the Negative Interest Rate Policy

Financial Market Functioning Under Negative Interest Rates

Before the introduction of negative rates, there were some fears over whether money and other key financial markets can function at all with negative interest rates. As also noted by Bech and Malkhozov (2016, 37), steering short term interest rates into negative territory has not been particularly challenging, nor did financial markets change their behaviour in negative territory. One may add that the combination of negative interest rate policy and asset purchase programmes also pushed longer term bond yields into negative territory, e.g. for Switzerland, Japan and Germany for the entire risk-free yield

curve, even beyond 10 years. This means that investors were paying more than the nominal value of the bond when they purchased it. Again, there was no indication of negative effects on market functioning.

General Counterproductive Effects of Low/Negative Interest Rates

Finally, a number of critical authors have argued that central banks' low (and by implication, also negative) interest rate policies are ineffective or, at the very least, have major negative side effects that central banks tend to underestimate. These authors also seem to suggest that acknowledging the problem of low interest rate policies could lead to the conclusion that central banks should increase nominal interest rates without delay. The main arguments are as follows:

- Low interest rates would **weaken the life-time income prospects of savers**, and therefore lead to more saving and less consumption, and this would be negative for aggregate demand.
- Low interest rates would **create bubbles and therefore contribute to creating the next crisis** and undermining the efficiency of resource allocation.
- Low interest rates and elastic central bank liquidity supply weaken hard budget constraints because of their supportive effect to funding market access for indebted companies, households and the state. They therefore would lead to **zombification and low growth**, creating a vicious circle.

Bindseil et al. (2015) and others discuss and refute these arguments. The European Systemic Risk Board (2016) and the BIS (2018) have prepared extensive studies on macroprudential issues related to low interest rates. Overall, it seems that problems arise if economic agents deny the new reality of low real and nominal interest rates, and therefore either continue making unsustainable return promises to investors, or try, through unsound risk taking, to generate returns that are unrealistic. Also, if agents did not see the low interest rate environment coming and therefore took positions (or run a business model) that in the low interest rate scenario undermine their solvency, a transition issue arises that needs to be addressed in a way that minimises damage for society while keeping in mind moral hazard issues.

In sum: **negative interest rates may be viewed as an obvious continuation of Wicksellian interest rate policies** when the neutral level of interest rates falls into negative territory, as has become more likely in an environment with low growth potential and high central bank credibility as inflation fighters. In this sense, negative interest rate policy could be classified as a conventional monetary policy approach, reducing the need for unconventional policy measures in the narrow sense with their possible more problematic side effects (such as large-scale asset purchase programmes). That negative interest rate policy is effective has been demonstrated by its strong effects on both capital market rates and bank lending rates. At the same time, two lower bound problems have to be acknowledged, namely (i) the one where banknote demand would explode; (ii) the one in which bank profitability would be undermined in such a way that a further lowering of central bank interest rates no longer leads to decreases in bank lending rates, as partially observed in Switzerland. While the former is also determined by storage and insurance costs of banknotes, the latter also depends on the willingness and ability of banks to pass on negative rates to different types of depositors and the amount of excess reserves that banks hold with the central bank at negative interest rates. While the two lower bounds are partially linked (through the decision of banks on whether to pass on

negative rates to depositors), they are not necessarily the same. Both lower bounds could be overcome through a discontinuation of banknotes and their full replacement by central bank digital currency—which however is not considered for a number of reasons as banknotes still have specific advantages.

3.3 Unconventional Credit Operations

Central banks have taken a variety of measures during the crisis to make their open market operations more supportive. Some of these measures relate to the lender-of- last-resort function, but even those are relevant from the monetary policy perspective. If the zero-lower bound is binding, strengthening the lender-of-last-resort implies a reduction of funding stress to banks, which reduces pressure on them to deleverage or to increase the role of expensive funding sources. The lender-of-last-resort therefore contributes to maintain the readiness of banks to provide credit to the economy at a moderate mark up to short-term risk-free rates.

First, central banks have **lengthened the duration of their lending operations** to banks, with the ECB going as far as four-year credit operations. Banks may consider a sequence of short-term borrowings from the central bank as inferior, from a liquidity risk perspective, to one longer-term borrowing operation. Consider three reasons for this: (i) Banks could perceive as uncertain the conditions under which central banks will provide short-term funding in the future (rates, access conditions, etc.). (ii) Even if the central bank commits to keep conditions for short-term access stable, e.g. it commits to full allotment at a given rate for its short-term operations for the next twelve months, banks may, as a matter of principle, find revolving short-term central bank refinancing less certain than twelve-month refinancing. (iii) Banks may be subject to some liquidity regulation, which treats longer-term refinancing from the central bank more favourably.

Second, central banks have replaced auction procedures to allocate central bank credit with **'fixed rate full allotment' (FRFA) operations**. The ECB has done so in October 2008 and ever since then has applied this simpler allotment procedure, which has the following advantages.

- It is more automatic and simpler than variable-rate tenders. This is per se a positive feature, as automatism means simplicity and transparency and hence fewer potential mistakes by the central bank and the commercial banks.
- In a liquidity crisis, the reduction of banks' uncertainty about the results of the tender assuages liquidity risk.
- It makes it possible to avoid aggressive bidding via high rates as it may take place with variable-rate tenders, thereby avoiding high and volatile marginal interest rates, which could imply unintended signals.
- The central bank no longer needs to estimate which allotment amount would ensure that market rates remain close to target rates. Carrying out fixed-rate full allotment tenders is almost equivalent to setting the standing facility rate at the level of the target rate, with the only difference that an open market operation is not continuously open.

Third, central banks have **widened the access of counterparties to their credit operations**. When interbank markets break down, then financial institutions without recourse to central bank credit are in trouble, as they can no longer manage their day-to-day funding needs through credit operations with banks and capital market access.

Allowing direct central bank access makes them independent from the functioning of interbank and capital markets.

Fourth, central banks have introduced **"targeted" credit operations** which make favourable lending terms (or access in general) conditional on some desirable behaviour of banks, such as providing more lending to the real economy. The ECB has done this through its so-called TLTRO operations, the Bank of Japan through its "Loan support programme" (LSP) and the Bank of England through its "Funding for lending scheme" (FLS).

Fifth, central banks have started to provide **credit in foreign currency, notably in USD**. The ECB and the Bank of Japan have done so since the end of 2007, based on swap lines established between central banks (see e.g. Goldberg et al. 2010). If USD spot and swap markets are impaired, this ensures that banks have sufficient USD funding to meet their obligations in USD (see Sheets et al. 2018).

Finally, widening the central bank collateral set applicable to credit operations is both a monetary policy and a lender-of-last-resort measure, and will be discussed in more detail below. However, as Bindseil (2013) argues, it is also an unconventional monetary policy measure as it supports the ability of banks to continue providing credit and lowers the intermediation spread between short-term risk-free rates and bank lending rates. At the ZLB, compressing this spread or at least counteracting its increase can be decisive in preventing the economy from gliding into a deflationary trap.

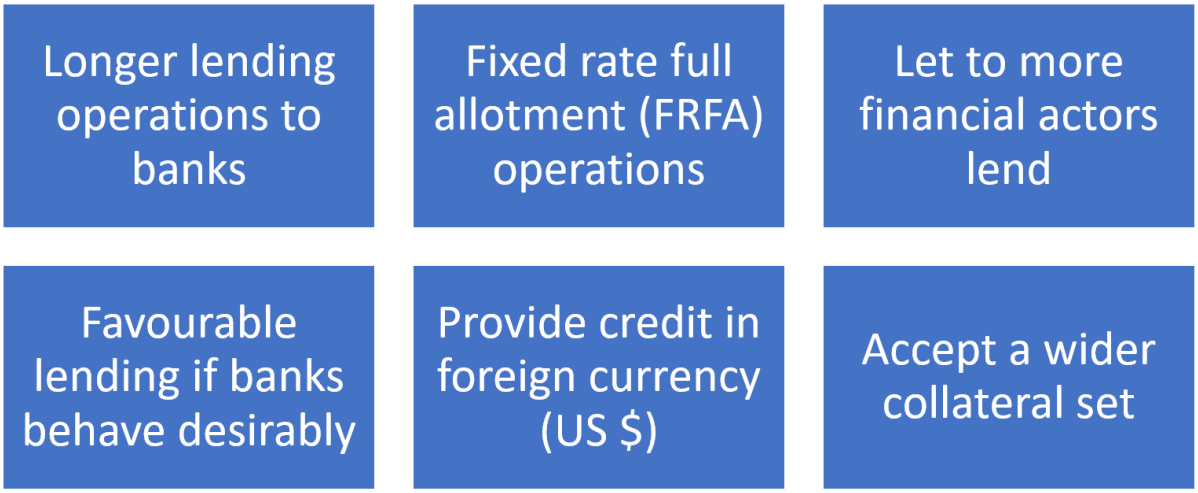

Figure 6: Types of unconventional credit operations

3.4 Asset Purchase Programmes

Outright purchases are transactions in which the central bank buys bonds from private investors in secondary markets without any contractual obligations to resell them at a later date. All major central banks at some stage of the crisis that started in August 2007 established outright purchase programs for financial assets. The following eight objectives of such measures can be identified. The effects (3), (4), (6) and (7) can also be partially achieved through credit operations, but as credit operations are temporary, they may give less confidence to banks that the measure and the effects will be permanent.

(1) **Reducing long-term risk-free interest rates**

The transmission of monetary policy takes place via longer term rates, as most economic decisions (e.g. building a house or a new factory) depend on longer term rates. Longer term rates can be decomposed into an average of expected short term rates, plus a term premium (according to the expectations hypothesis of the term structure of interest rates). If the zero lower bound constrains reductions in short-term interest rates, then the central bank may want to provide further accommodation by at least reducing term premia through purchases of long-term bonds. This argument has been key to the Fed and the Bank of England programs that started in 2009.

(2) **Compress credit and liquidity spreads ("market maker of last resort")**

In a financial crisis, risky assets' prices may be depressed due to **asset fire sales and the absence of opportunistic buyers (i.e. buyers who buy whenever they feel an asset has become cheap)**. Moreover, arbitrage between asset classes may no longer work because of high bid-ask spreads, liquidity and capital constraints, systemic uncertainty, and self-fulfilling fears. In such an environment, the central bank can through purchases support depressed assets prices directly ease funding costs and constraints. Of course, central banks should not lower spreads below an adequate risk premium. Assessing what is an appropriate spread is of course challenging, in particular during a crisis.

(3) **Inject excess reserves to strengthen banks' liquidity buffers**

Large scale outright purchase programmes push the banking system into a liquidity surplus position towards the central bank. This facilitates central bank liquidity management and the control of the overnight rate (which will be close to the deposit facility rate, or to the rate of remuneration of excess reserves). More importantly, a situation of general excess reserves may support financial stability as most banks will feel re-assured in their short-term liquidity position.

(4) **Inject excess reserves to increase the money supply via the money multiplier**

Excess reserves targets play a role in the "money supply" approach to monetary policy implementation, as promoted in the official communication of the **Bank of Japan** between 2001 and 2016. This approach seems to be in line with traditional monetarist thinking.

(5) **Absorbing risks from banks' into the central bank balance sheet and easing capital constraints of banks**

The central bank may reduce total risk in banks' balance sheets by buying risky assets from them. Therefore, if banks feel constrained in terms of economic or regulatory capital, outright purchases by central banks may attenuate these constrains and thereby support their lending behaviour and thereby ease monetary conditions. Taking credit risk into the central bank balance sheet, e.g. in the form of purchases of a corporate bond portfolios, implies the need for the central bank to develop relevant expertise on credit risk management for this asset class. Moreover, in case of debt restructurings, the central bank will have to vote in bond holder assemblies, i.e., contribute to decisions which are remote to its core functions, and which entail reputational risks.

(6) **Substituting banks' illiquid with liquid assets to improve overall liquidity of banks**

Purchasing illiquid assets outright improves liquidity of banks, particularly if these assets

were previously not eligible as central bank collateral, or only at a high haircut.

(7) **Directly supporting through primary market purchases the funding liquidity of banks and/or other firms**

By purchasing in the primary market bonds from issuers (unsecured bank bonds, covered bank bonds, corporate bonds, etc.), the central bank supports directly the funding of these institutions. Central bank purchases of debt of non-financial corporates (NFC), if done in the primary market, directly refinance the real sector and thus can offset the unwillingness of banks to provide their usual lending and liquidity services.

(8) **Threat to "purchase all real assets in the world" to counter perception of deflationary trap**

Central banks are in principle able to purchase all assets of the world with the money that they can issue without constraints—in particular in a deflationary context. When central banks launch such potentially infinite purchase programs, the other economic agents will become less willing to sell all their assets (including equity, commodities, etc.), and they will thus require higher and higher prices, and hence the purchasing power of the currency will fall. In the case of a credible central bank, this will be anticipated, and the announcement of such a purchase program should immediately defeat deflation.

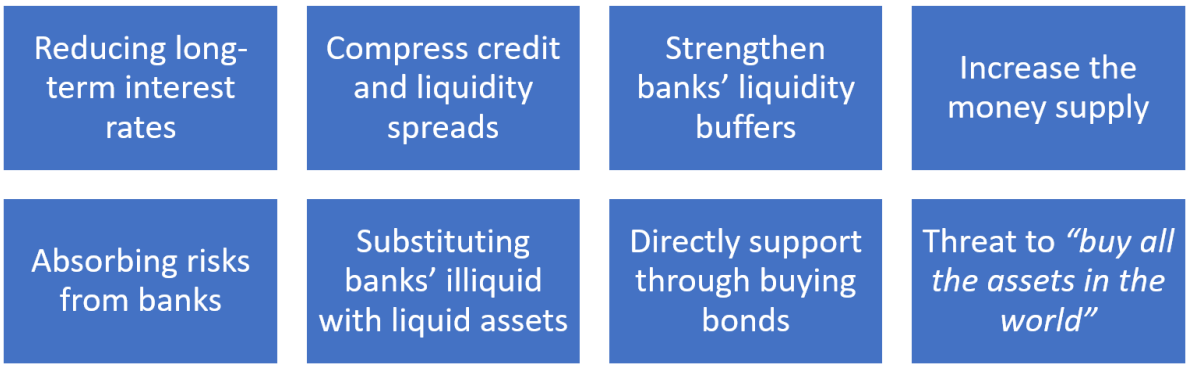

Figure 7: Objective of Asset Purchase Programmes

Impact of purchase programmes on yield levels

There is a growing empirical literature estimating the effects of large-scale asset purchase programmes on the risk-free yield curve and its further transmission to other interest rates and the real economy (a comprehensive recent study covering the programmes of the US, UK, Japan and the euro area is Agostini et al. 2016). Effects on long-term interest rates of recent large-scale asset purchase programmes are generally believed to be in the area of up to 100 basis points. In combination with negative interest rate policy, this would mean that these two policies together could achieve reductions of long-term funding rates of up to 200 basis points, which obviously means substantial further easing (negative interest rate policy also contributes to reduce long-term rates as expectations on future short-term interest rates decrease). When looking more precisely at the effects of purchase programmes on asset prices and long-term yields, it is important to distinguish between the following three effects (D'Amico and King 2011 were the first to investigate theoretical and empirical aspects of flow vs stock effects of the US Fed's asset purchase programmes):

Stock effect: if there are static demand and supply elasticities for different types of securities (based on investors' static preferred habitats), then one would expect that the eventual stock of securities purchased in a programme will determine the price impact.

Flow effect: if the price of an asset is driven essentially by the daily demand and supply conditions and if agents' ability to bridge prices across time through intertemporal arbitrage is limited, then the daily flows of purchases and sales would matter. The strength of flow effects of an asset purchase program will therefore depend on (i) the pace of purchases (purchased volume per unit of time); (ii) the efficiency and flexibility of market makers and investors to do intertemporal arbitrage and warehouse positions accordingly; (iii) the speed at which investors are able or willing to adjust their stocks, which also depends on who in particular holds the assets (a pension fund vs a bank in its trading book); (iv) the time between the announcement of the programme and its start (more time allows investors to prepare for selling assets and dealers to accumulate stocks waiting for the central bank).

Announcement effect: if asset prices in principle reflect at any moment in time all available information, it can be expected that most of the impact on prices and yields materialises immediately when the central bank announces an asset purchase program. The announcement effect should be an anticipation of the stock effect, and not of the flow effect. The announcement effect will mainly depend on (i) the degree to which the announcement has not been anticipated (for example, when the ECB's PSPP was announced, markets hardly moved as it had been anticipated); (ii) the credibility of the central bank (determined, for example, by its history of meticulously implementing what it promises); (iii) how remote in the future the promised measures are (with non-perfect central bank credibility, more remote measures will have a lesser announcement effect than measures which are relatively nearby), (iv) the clarity of the announcement.
Central bank purchases with too short lead times (after the program's announcement) and at a too high pace distorts markets, in the sense of letting yields temporarily undershoot more than necessary. It also implies that the central bank will over-pay. Buying with too long lead times and with a too low pace unnecessarily delays the desired easing of financial conditions. Interestingly, in the case of limited central bank credibility, stronger flow effects may be desirable as they contribute to a quick price adjustment, i.e. a faster effectiveness of monetary easing, without this implying that the central bank purchases at excessive prices. A less credible central bank should therefore buy at a higher pace and start faster than a credible central bank, which can immediately achieve stock effects.

4. The Central Bank as Lender of Last Resort

In this section, we review the function of the central bank as lender of last resort. We recall long-established lender-of-last-resort principles: proactive lending, inertia of the central bank risk control framework, and risk endogeneity. Because of its systemic role, a central bank should not tighten its collateral framework in a crisis, as restrictive policies are likely to not only increase the overall damage done by a crisis to society, but to even increase central bank losses. We explain in more detail the main reasons why a central bank should act as lender-of-last-resort: prevent negative externalities from fire sales; its unique status as institution with unlimited liquidity; its status as a risk-free counterparty making others accept to deliver collateral to it even at high haircuts; and its mandate to preserve price stability. We distinguish three different forms of lender-of-last-resort: elements built into the regular operational framework; readiness to relax parameters in a crisis; and provision of emergency liquidity assistance to individual firms. We then discuss what could be the optimal propensity of a central bank to engage in lender-of-last-resort activities and outline possible trade-offs.

4.1 Principles and Rationale for the Central Bank Acting as Lender of Last Resort

Origin and Principles of lender-of-last-resort

While large-scale and successful lender-of-last-resort measures of central banks can be traced back to at least 1763 (e.g. Bindseil 2019), today's thinking on the lender-of-last-resort function is still strongly inspired by nineteenth century experience, and in particular Walter Bagehot's *Lombard Street* of 1873 (see also e.g. Goodhart 1999; Goodhart and Illing 2002). Consider three key insights of nineteenth century experience which still appear valid today.

Lend pro-actively while preserving the safety of the central bank. In a hearing of the Lords' Committee in 1832, Bank of England director Jeremiah Harman summarised the Bank's actions in the panic of 1825 as follows (see Bagehot 1873):

> *We lent… by every possible means, and in modes that we never had adopted before; we took in stock of security, we purchased Exchequer bills, we made advances on Exchequer bills, we not only discounted outright, but we made advances on deposits of bills to an immense amount; in short, by every possible means consistent with the safety of the Bank;… seeing the dreadful state in which the public were, we rendered every assistance in our power.*

Harman presents the Bank of England's action as having been *creative and pro- active*, i.e. to have innovated to find the best ways to support funding liquidity of financial institutions, the only constraint to creativity being the need to preserve the "safety of the Bank", i.e. limit additional risk taking.

Inertia of risk control framework. Bagehot (1873) himself advises the Bank of England that, in a crisis, it should maintain its risk control framework broadly unchanged, and not tighten it similarly to private lenders as a reaction to a worsened asset quality and liquidity, as well as higher volatility, etc.:

> *If it is known that the Bank of England is freely advancing on what in ordinary times is reckoned a good security and on what is then commonly pledged and easily convertible, the alarm of the solvent merchants and bankers will be stayed. But if securities, really good and usually convertible, are refused by the Bank, the alarm will not abate, the other loans made will fail in obtaining their end, and the panic will become worse and worse.*

Bagehot refers to various episodes in which the Bank of England did not follow this principle and ended up making the crisis worse than it would have needed to be.

Risk Endogeneity. Bagehot argues that supportive liquidity provision could be necessary *to minimise* the Bank of England's eventual own financial risks, because it would be the only way to prevent a financial meltdown with unavoidable large losses also for the Bank of England.

> *(M)aking no loans as we have seen will ruin it (Bank of England); making large loans and stopping, as we have also seen, will ruin it. The only safe plan for the Bank is the brave plan, to lend in a panic on every kind of current security, or every sort on which money is ordinarily and usually lent. This policy may not save the Bank; but if it does not, nothing will save it.*

In other words, the riskiness of exposures would itself be endogenous to the central bank measures. Liberal central bank lending could imply lower central bank financial risk taking than tight risk controls, turning upside down the logic of private lenders.

Why Should Central Banks Be Lenders of Last Resort?

We identify five reasons for a central bank to act as lender of last resort in a financial crisis.

Negative Externalities of Funding Liquidity Stress

Public authorities may intervene in markets in case of negative externalities. A major negative externality of bank stress relates to the fire sale spiral induced by liquidity problems of individual banks. If banks are forced to sell assets to generate liquidity, these sales likely depress market prices. In turn, this generates renewed solvency and liquidity stress for banks, possibly triggering further fire sales, etc. Central bank loans which reduce the need for asset fire sales can prevent such a downward spiral. Asset fire sales are not the only form of negative externalities of bank funding stress and illiquidity-induced default. Other negative externalities are, for example, the contagion of depositors' fears if they observe a bank run, possibly leading to further bank runs such as observed in the early 1930s.

Central Banks Have Unlimited Liquidity (in a Paper Standard)

Unlike leveraged private entities, a central bank is not threatened by illiquidity in the currency it issues. Modern central banks are endowed with the monopoly and freedom to issue legal tender. It is therefore opportune that, in case of a liquidity crisis when all financial and non-financial institutions tend to hoard liquidity, central banks remain willing to lend and to hold illiquid assets outright or as collateral. This is unrelated to negative externalities, and even if a central bank were purely profit-oriented, its unique access to liquidity justifies lending and purchases of illiquid assets in a crisis.

Haircuts Are a Particularly Effective Risk Mitigation Tool for Central Banks

Haircuts are an effective tool if the collateral provider is more credit risky than the cash investor. In contrast, haircuts are less effective if cash provider and collateral provider are equally credit risky since the implied protection of the cash provider is at the expense of the collateral provider (Ewerhart and Tapking 2008). Therefore, simply increasing haircuts in symmetric interbank repo markets is not an adequate solution to provide more risk protection, while it is for asymmetric relationships, such as the one between a prime bank lending to a hedge fund. From the perspective of the collateral provider, a central bank is a risk-free counterparty as it cannot default and will always return pledged collateral. Central bank credit against illiquid collateral can be well-protected through high haircuts, without the collateral provider feeling unduly exposed. Against any other cash provider, i.e. against any credit risky cash provider, the collateral provider would likely be unwilling to accept the exposure implied by high haircuts.

Central Banks May Have Superior Information

A central bank may have, as bank supervisor, better information on the credit worthiness of banks in need of liquidity, compared with other market participants. Moreover, as a public entity not competing with banks, banks may be willing anyway to share private information with a central bank to establish their creditworthiness. In contrast, banks may be unwilling to reveal private information to competitors or private investors, even if this is made a pre-condition to obtaining funding from them. This may be particularly relevant when decisions need to be taken urgently.

Lender-of-Last-Resort as an Unconventional Monetary Policy at the ZLB

Taking lender-of-last-resort measures may be decisive for a central bank to achieve its mandate to maintain price stability and to prevent the economy from falling into a deflationary trap. Lender-of-last-resort measures can prevent bank intermediation spreads from increasing in a crisis situation, which may be essential from a monetary policy perspective if the central bank has exhausted conventional monetary policy because of the zero lower bound (ZLB) on interest rates.

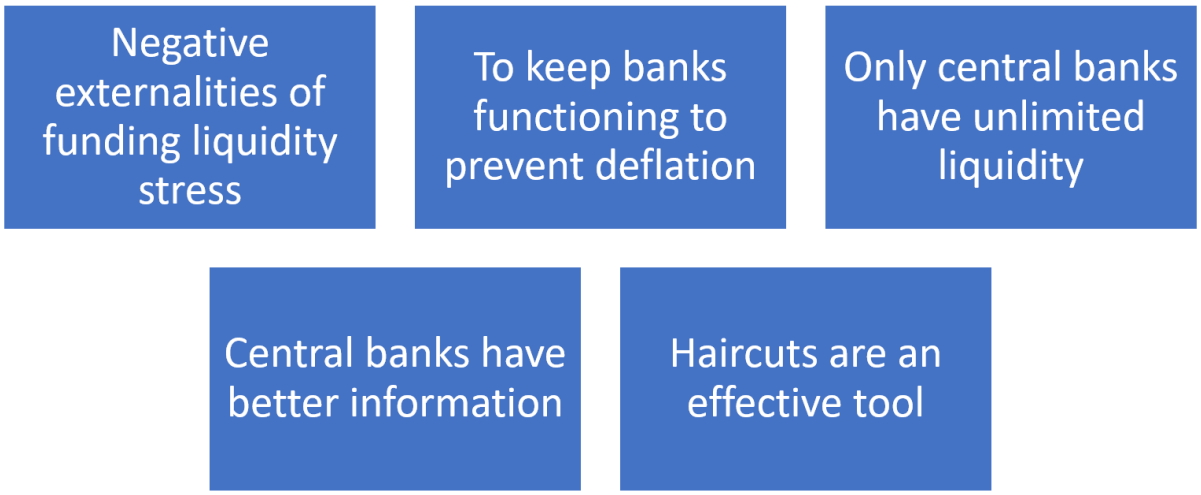

Figure 8: Reasons for central banks to act as lender of last resort

4.2 Forms and Propensity to Act as lender-of-last-resort

Forms of lender-of-last-resort

The central bank lender-of-last-resort function can take three forms: (a) lender-of-last-resort built into the regular operational framework of the central bank; (b) lender-of-last-resort added through changes of the framework and additional lender-of-last-resort operations for all banks in crisis times; (c) emergency liquidity assistance to individual banks or, more rarely, even to non-banks. We consider these three one after the other.

Lender-of-Last-Resort built into the regular operational framework

The following elements determine the lender-of-last-resort content of the regular operational framework.

- As mentioned earlier, **collateral availability** provides a first natural limit to central bank credit at the individual bank level. The volume of eligible collateral should also be viewed in relation to the liquidity deficit of the banking system to be covered by central bank credit operations. For example, in the case of the Eurosystem, the nominal value of eligible marketable assets has had a value of around EUR 14 trillion since 2012 (ECB 2020b), of which around EUR 5 trillion is held by banks, against a (pre-crisis, i.e. pre-2008) EUR 0.5 trillion liquidity deficit of the euro area banking system to be covered by credit operations. This implies that an average representative bank could extend, before hitting collateral constraints, recourse to central bank credit approximately 10 times relative to proportionality.
- The **ease at which central bank credit can be accessed**. In credit open market, the so-called "fixed-rate full allotment" procedure ensures that banks always get what they bid for. In a competitive auction, banks run a risk to not receive credit if they underestimate the aggressiveness with which other auction participants are bidding.
- Active **stigmatisation or de-stigmatisation** through central bank communication will impact on the propensity of banks to rely on the lender-of-last-resort.
- It matters **who is able to access central bank credit and benefit directly from the lender-of-last-resort**. Normally, only commercial banks have access to central bank credit, i.e. neither non-bank financials, nor non-financial corporates have.

Readiness of central banks to add lender-of-last-resort content to the operational framework in crisis times

The impact of the lender-of-last-resort on bank behaviour will not be limited to the lender-of-last-resort content of the operational framework in normal times. What matters as well is the bank's liquidity in a scenario of financial market stress. Anticipating this case also includes building expectations on the readiness of the central bank to adjust the above-mentioned parameters that determine the lender-of-last-resort content of the operational framework. Expectations will be determined by historical experience and forward-looking central bank communication.

Readiness of central banks to provide emergency liquidity assistance (ELA) to individual banks

ELA can be defined as a non-rule based lender-of-last-resort activity for the benefit of individual banks. Of course, ELA also needs to take place within some legal framework, within the mandate of the central bank and ideally in a consistent manner. Limitations to ELA provision can result from:

(i) ELA collateral requirements (normally ELA collateral sets should be wider than the standard collateral set).
(ii) Pricing of ELA, i.e. what surcharge relative to monetary policy credit operations is imposed (some surcharge is typically applied).
(iii) Relevance to preserve systemic financial stability may be a precondition for granting ELA. The higher the hurdle set by the central bank in declaring a systemic financial stability interest before granting ELA, the less a bank can rely ex-ante on it, in particular if a bank is small.
(iv) Limitations on the duration of ELA (ELA is typically assumed to be of limited duration).
(v) Possible requirement that ELA is only granted if the central bank is protected in addition by a government guarantee. Beyond additional risk protection, this may be considered useful as it requires an elected government to confirm its backing of ELA operations (but it should not delay very urgent and obvious ELA provision by the central bank).
(vi) ELA counterparty set: While normal central bank credit is only granted to banks, ELA could also be granted to any other financial corporate (or in theory even to any debtor).

Overall Propensity of a Central Bank to Act as lender-of-last-resort

It is conceptually useful to first consider two extreme lender-of-last-resort choices of the central bank.

- ***Maximum lender-of-last-resort***: accept in the normal-times operational framework all assets of banks as collateral at fair values without haircut. This would allow solvent banks to finance all their assets with the central bank, if desired, and no solvent counterparty could ever default for liquidity reasons. Furthermore, central bank credit is provided at a high frequency through fixed rate full allotment operations at the monetary policy target interest rate.
- ***Minimum lender-of-last-resort***: the central bank implements monetary policy only against risk-free assets, say AAA-rated Government paper. It largely covers its asset side through outright holdings of these AAA assets, and only conducts at the margin repos against the same assets. It conducts these small repos only with the highest rated counterparties. In this operational framework, banks have no discretionary access to central bank credit at all, i.e. the operational framework has no lender-of-last-resort element. Moreover, the central bank would fully pre-commit to never change the lender-of-last-resort content of its operational framework nor to ever provide ELA.

Central bankers believe that the optimal lender-of-last-resort is in **between these two extremes**. The lender-of-last-resort strengthens the ability of the financial system to provide maturity and liquidity transformation as services to society. At the same time, putting some limits to the lender-of-last-resort role is beneficial for society, to have some

protection against information asymmetries and moral hazard, to avoid relying excessively on the abilities of supervisors and auditors, and generally to preserve stronger incentives to maintain funding market access and thereby market discipline. Proponents of a tight approach may argue that a supportive lender-of-last-resort will lead to as many financial crises as a very tight one, but crisis will be messier because when they occur the financial leverage will be much higher ("four-wheel vehicles make you get stuck in areas which are more difficult to access when you need to be rescued").

Assume for a moment that **we capture in the unit interval [0,1] the supportiveness of the lender-of-last-resort framework** of a central bank and let the most restrictive framework described above be represented by 0 and the most forthcoming framework by 1 (it is of course a simplification to assume that designing the lender-of-last-resort framework is a one-dimensional problem). One can map the lender-of-last-resort unit interval into at least five effects, which should not be expected to be identical, although often this seems to be implicitly assumed:

(1) **Social welfare** is the ultimate measure of interest and can be equated, for example, with the extent to which the lender-of-last-resort framework contributes to financial conditions leading to maximum economic growth in the medium to long term, i.e. through the financial and economic cycle. For example, Keister (2016) maps the lender-of-last-resort supportiveness into social welfare, and Bindseil and Jablecki (2013) map it into growth. They show that it is likely that the relationship is a concave function with interior maximum (i.e. an intermediate lender-of-last-resort maximises growth).

(2) **Risk taking** is normally expected to increase monotonously for normal lenders when the readiness and ease of lending increases. For central banks, risk taking may be non-monotonous in the lender-of-last-resort unit interval [0,1]. Bindseil and Jablecki (2013) provide an example in which the relationship is a convex function with interior minimum. As Bagehot's insight that sometimes "only the brave plan is the safe plan" suggests, the central bank cannot base its lender-of-last-resort choices on the basis of the risk considerations that would apply for an "atomistic" investor not influencing the properties (e.g. default probabilities) of the system. Often, being more forthcoming as a lender-of-last-resort after a negative financial stability shock (e.g. broadening the eligible collateral set to include less liquid assets) will decrease financial risk taking by the central bank, instead of increasing it. Risk endogeneity should lead to a more forthcoming lender-of-last-resort, i.e. the welfare maximising lender-of-last-resort framework will be more supportive than the one obtained if risk endogeneity is ignored.

(3) **Leverage of banks** and their ability to provide liquidity and maturity transformation should increase monotonously with the supportiveness of the lender-of-last-resort. Regulation may limit leverage to lower levels.

(4) **Financial fragility** will probably first decrease, and then increase across the lender-of-last-resort unit interval, suggesting that a measured lender-of-last-resort can stabilise the financial system while a too liberal one could eventually lead to particularly deep financial crises.

(5) **Market discipline and funding market functioning** can be thought of as either falling monotonously, or as mirroring the financial fragility curve, i.e. it would benefit from some moderate lender-of-last-resort, but is undermined if the lender-of-last-resort is excessive. Section 6.5 shows that when asset liquidity deteriorates after an exogenous shock, then the lender-of-last-resort can preserve funding

market access for solvent banks, but not for insolvent banks, while a restrictive lender-of-last-resort will imply a run also on solvent banks. In this sense a more supportive lender-of-last-resort can allow for a more effective market mechanism than a very restrictive one.

Moral hazard and central bank losses

A popular theme in papers on the lender-of-last-resort is moral hazard, but the concept often remains vague. One pragmatic view is that moral hazard only materialises in the context of the lender-of-last-resort if the central bank faces actual losses from its credit operations. This interpretation also has the advantage that it would reduce the complexity of the lender-of-last-resort design problem by one dimension and map something vague and complex (moral hazard) into something concrete and more measurable (central bank risk taking—even if complicated by endogeneity). If central banks are worried about moral hazard, they could tighten risk control measures (in normal times, to not be pro-cyclical) so that the probability of central bank credit losses declines even further.

Excessive stigmatisation of the lender-of-last-resort?

Sometimes central banks worry that banks attach excessive stigma to recourse to the lender-of-last-resort. For example, recourse to the Discount Window is considered to remain stigmatised in the US although the Fed has wanted to change this since 2002 (Armantier et al. 2015). Also, in a number of credit open market operations of central banks during the financial crisis, aversion of banks to participate materialised so that the accommodation that the operations aimed at could not be achieved. Excessive stigmatization seems to go in the opposite direction of moral hazard. Central banks should therefore have tools in hand to adjust *in both directions* the willingness of banks to come to lender-of-last-resort operations