DOI: 10.1111/jmcb.12930

ERIC MONNET
MIKLOS VARI

A Dilemma between Liquidity Regulation and Monetary Policy: Some History and Theory

History suggests a conflict between current Basel III liquidity ratios and monetary policy, which we call the liquidity regulation dilemma. Although forgotten, liquidity ratios, named "securities-reserve requirements," were widely used historically, but for monetary policy (not regulatory) reasons, as central bankers recognized the contractionary effects of these ratios. We build a model rationalizing historical policies: a tighter ratio reduces the quantity of assets that banks can pledge as collateral, thus increasing interest rates. Tighter liquidity regulation paradoxically increases the need for central bank's interventions. Liquidity ratios were also used to keep yields on government bonds low when monetary policy tightened.

JEL codes: E43, E52, E58, G28, N10, N20
Keywords: liquidity ratios, reserve requirements, Basel III, monetary policy implementation, liquidity coverage ratio (LCR), central bank history, quantitative easing, availability doctrine

After the Global Financial Crisis, policymakers designed global standards to improve financial stability, under the name of Basel III banking regulations. These standards include liquidity regulations, whose explicit goal is to reduce the need for central bank's interventions when banks lose access to

The views expressed in this paper are those of the authors and do not necessarily reflect those of the IMF. We are grateful to Morten Bech, Matthieu Bussière, Agnès Bénassy Quéré, Frederic Boissay, Mark Carlson, Lucas Marc Fuhrer, Anna Grodecka, Jean Imbs, John Kandrac, Christoffer Koch, Romain Veyrune, David Wheelock, Tim Willems, and participants of the joint workshop by the Research Task Force of the BCBS and the CEPR, the 2018 annual meeting of the CEBRA, the 2018 annual workshop of the ESCB Research Cluster, the 2018 T2M conference, the ASSA meetings 2020 and seminar participants at the Bank of France, the International Monetary Fund, and the Bank for International Settlements. We thank an anonymous referee for providing key suggestions that greatly improved the clarity and value of the paper.

Eric Monnet *is a Professor at the Paris School of Economics, EHESS and CEPR research affiliate* (*E-mail*: eric.monnet@psemail.eu). Miklos Vari *is an Economist at Banque de France* (*E-mail*: miklos.vari@banque-france.fr).

Received May 20, 2020; and accepted in revised form November 8, 2021.

Journal of Money, Credit and Banking, Vol. 55, No. 4 (June 2023)

the money market.[1] It has become apparent, however, that there could be some tensions between this new regulation and the implementation of monetary policy.[2] As various liquidity ratios were phased-in, central bankers started to recognize that liquidity regulation raises permanently banks' demand for liquidity. This demand might have to be satisfied by central banks themselves. Otherwise, the price of liquidity (that is, short-term interest rates) may increase, possibly out of sync with the monetary policy stance (Quarles 2018). This problem became even more visible in the United States as the size of the Fed's balance sheet decreased. It culminated in September 2019, when liquidity regulation was believed to be responsible for a peak of short-term money market rates around 10% above the Fed target (Powel 2019). The Fed responded to this spike by offering up to USD 490 bn in loans to the financial system on December 31st, 2019.

This sequence of events shows the new dilemma that central bankers may face due to liquidity regulation: either they accept that monetary conditions tighten, or they expand their balance sheet to combat upward pressures on interest rates, which involves taking some degree of risk and goes precisely against the original goal of liquidity regulation.[3] This dilemma will reappear when central banks attempt to withdraw from accommodative policies. For this reason, it is key to understand precisely how and why liquidity regulations create this tension.

Our starting point is that, contrary to a common assumption, liquidity regulation is not new.[4] Based on detailed readings of historical central banks' reports and documents, this paper first documents that liquidity regulations—similar to the current Basel III Liquidity Coverage Ratio (LCR)—have been used from the 1930s to the 1980s in many countries as monetary policy tools. Lessons can be learned from their history. These ratios took the form of required deposits at the central bank ("cash-reserve requirements") or minimum holdings of liquid securities ("securities-reserve requirements"). As with modern liquidity ratios such as the LCR, these two types of liquidity requirements (cash and securities) were computed as a percentage of short-term deposits. While the history and theory of "cash-reserve requirements" are well known (Romer 1985, Bindseil 2004, Kashyap and Stein 2012, Carlson 2015), we are not aware of any study on "securities-reserve requirements." The existence of

1. For instance, Jeremy Stein, then Governor of the Federal Reserve Board stated: "The introduction of liquidity regulation after the crisis can be thought of as reflecting a desire to reduce dependence on the central bank" (Stein 2013). The ECB printed in its monthly bulletin: "The objective of the liquidity regulation framework is to reduce the shortcomings of liquidity risk management […] by ensuring that banks can rely more on their own liquidity resources" (ECB 2014). The Basel Committee on Banking Supervision motivated the introduction of the LCR in the following way: "[During the GFC] The banking system came under severe stress, which necessitated central bank action to support both the functioning of money markets and, in some cases, individual institutions" (BCBS 2013).

2. For instance, Benoît Coeuré declared in 2013: "In my view, the interaction is expected to be complex and liquidity regulation may require adjustments to central banks' operational frameworks" (Coeuré 2013). See also CGFS (2015).

3. Increasing the size of the balance sheet, even without lending directly to financial institutions (e.g., by buying long-term Treasuries) implies that the central bank takes additional interest rate risk. This type of risks can be economically important (Bhattarai et al. 2015, Greenwood et al. 2015).

4. For instance: "Liquidity regulation is a relatively new, post-crisis addition to the financial stability toolkit" (Stein 2013).

securities-reserve ratios is particularly important because they are closer to current Basel III liquidity ratios, than "cash-reserve requirements."

Second, we show that the mechanisms put forward by past central bankers can be rationalized with a simple model of the interbank market, considering that securities-reserve and cash-reserve requirements worked through different channels. Our model is in the tradition of Poole (1968) where banks experience a "late" deposit shock, after the interbank market has closed and may force them to borrow from the central bank. The novelty of our model is that we introduce a securities-reserve requirement, where banks have to hold a minimum amount of securities. A security cannot be pledged as collateral to borrow from the central bank at the same time as it is used to fulfill the liquidity ratio (i.e., it needs to be unencumbered). Thus, a higher liquidity ratio means that banks are more collateral constrained. The more likely the collateral constraint is to be binding, the higher the price of liquidity and thus the higher money market interest rates. Our effect is also at work when the liquidity ratio is fixed but the demand for liquidity increases because of an economic expansion (i.e., the ratio works like an automatic stabilizer).[5] The model shows that increasing securities-reserve requirements leads to a rise in government bond yields as all interest rates go up. However, the spread between money market rates and government bond yields decreases. Securities-reserve requirements thus mitigate the effect a monetary policy tightening on the financing cost of the government.

The main historical lesson is that liquidity ratios were used to influence money market rates to stabilize output and inflation, a function that today would typically be assigned to monetary policy. In other words, the effects of liquidity ratios on money market rates were so obvious to past central bankers that they did not even try to use these liquidity ratios separately from other monetary policy instruments. Securities-reserve requirements also had the advantage of stimulating the demand for government debt, which was another objective of central banks in the postwar context. This potential "fiscal footprint of [modern] macroprudential policy" has been recently raised and discussed theoretically by Reis (2020). Our paper is the first to show that historical liquidity ratios were designed to increase the demand for government securities. Central banks increased liquidity ratios during times of restrictive monetary policy to prevent banks from selling government securities, which were the main type of asset eligible to fulfill the requirement. Liquidity ratios were akin to a collateral constraint. As such, banks were discouraged to shift their assets from government securities to corporate loans. This feature also explains why these ratios were phased out by central banks in the 1980s, as they had been associated with the so-called "financial repression" era (Reinhart and Sbrancia 2015).

We contribute to several strands of literature that look at the interactions between monetary and macroprudential policies. Acknowledging that direct quantitative controls on bank lending or reserves were a key element of central banks' toolbox in

5. Securities-reserve requirements operate through a different channel compared to cash-reserve requirements in our model. However, under certain conditions, they are observationally equivalent. Another intuitive but important result of our model is that—contrary to standard cash-reserve requirements—securities-reserve requirements have no effects when the central bank acts fully as a lender of last resort.

the past, a growing literature has looked at historical experience to estimate their macroeconomic effects and discuss similarities with current macroprudential tools (Elliott, Feldberg, and Lehnert 2013, Kelber et al. 2014, Monnet 2014, Carlson 2015, Koch 2015, Aikman, Bush, and Taylor 2016, Calomiris and Carlson 2017, Richter, Schularick, and Shim 2018).[6] Being essentially empirical, this literature leaves aside a precise theoretical understanding of the mechanisms and channels of such a complex set of instruments. It follows that it is difficult to assess how context-specific these empirical results are. Contrary to this literature, we draw on historical experience of central banks to investigate theoretical mechanisms through which liquidity ratios interact with monetary policy.

Greenwood, Hanson, and Stein (2016) argue that the LCR will fundamentally affect monetary policy. It will force central banks to maintain a large balance sheet to provide banks enough liquidity to comply with regulation, in direct contradiction with the initial goal of the LCR. In the only formal model of interaction between the LCR and monetary policy, Bech and Keister (2017) show that a binding LCR decreases the overnight interbank rate relative to term interest rates. Bonner and Sylvester (2016) and Fuhrer, Müller, and Steiner (2017) present evidence of such an effect, based on the implementation of the LCR in the Netherlands and in Switzerland. Kandrac and Schlusche (2017) show that cash-reserve requirement had a contractionary effect before the crisis. None of these papers discuss the collateral constraint mechanism that our historical narrative and theoretical model put forward.

Recently, several theoretical paper have explored the benefits of liquidity regulation in terms of financial stability (Calomiris, Heider, and Haerova 2015a, Diamond and Kashyap 2016, Imhof, Monnet, and Zhang 2019). While our paper is less interested in the financial stability aspect of liquidity ratios than in its monetary policy function, we note that there seems to be no paper modeling simultaneously liquidity regulation and the lender of last resort. From the theoretical standpoint, the debate remains open as to whether *ex-ante* regulation is really superior to the promise of *ex-post* central bank lending against sound collateral. This puts into question the original motivation of postcrisis liquidity regulation. For this reason, at least, it is key to understand the implication of new liquidity ratios for monetary policy implementation.

Section 1 provides the historical narrative of past reserve requirements. Section 2 develops the model and Section 3 concludes.

1. CASH AND SECURITIES-RESERVE REQUIREMENTS IN HISTORY

The basic idea behind reserve requirements (also named "liquidity ratios") is to require banks to hold a quantity X of liquid assets (central bank reserves or securities) for every unit of deposit (or any predefined liability or asset). X is then called the reserve requirement ratio. The central bank reserves or the reservable securities

6. A precedent to this literature can be found in Romer and Romer (1993) that distinguished between credit actions and monetary policy measures of the United States Federal Reserve.

are called the "reservable assets" of any specific requirement. The denominator of the ratio is called the "reserve base." There is a key conceptual and historical difference between two types of reserve requirements: "*cash-reserve requirements*," which are, in fact, what we usually call today "reserve requirements" (i.e., a minimum amount of bank balances at the central bank), and "*securities-reserve requirements*." This second category differs from the first because the liquid assets are not deposited with the central banks and they can include a broader set of assets (usually government securities). The current Basel III's Liquidity Coverage Ratio (LCR) is a form a securities-reserve requirement that also accepts central bank's liabilities as liquid assets. As such, when excess reserves at the central bank equal zero, the LCR is equivalent to securities-reserve requirements.

There is an extensive literature on the history and mechanics of cash-reserve requirements, and many central banks still officially use them for monetary policy implementation (O'Brien 2007, Gray 2011). The existing literature has identified four main functions of cash-reserve requirements:[7]

(i) *Banking regulation*: Reserve requirements intend to force banks to keep a minimum amount of liquid assets to withstand bank runs (Feinman 1993, Carlson 2015).
(ii) *Monetary policy tool*: Reserve requirements can be used to constrain credit, and to control interest rates, either to control the demand of banks for central bank money or to stabilize interest rates (Huberto and Keister 2008)
(iii) *Tax*: Reserve requirements can be used as a direct tax on banks, for pure fiscal reasons (see Romer 1985 for an explicit tax and Reinhart and Sbrancia 2015 for an implicit tax under financial repression). The tax can also be used as a pigouvian tax on issuance of short-term deposits (Kashyap and Stein 2012).
(iv) *Capital controls*: A common form of cash-reserve requirement is to require banks to deposit with the central bank a percentage of the money they borrow from abroad (De Gregorio, Edwards, and Valdés 2000, Monnet 2018). The purpose is to limit capital inflows or discourage currency risk.

By contrast, securities-reserve requirements have disappeared from the standard toolbox of central banks and their history has received little or no attention.[8]

As we shall see, securities-reserve requirements often had similar functions as cash-reserve requirements, although they work through different mechanisms. In some countries (prominently in the U.S. and Germany), central banks used cash-reserve requirements only. In many others, various securities-reserve requirements were in place from the 1950s to the 1980s, sometimes—but not always—combined with cash-reserve requirements. Among OECD countries, the central banks of Australia, Belgium, Canada, France, Italy, Netherlands, New-Zealand, Sweden, and the United Kingdom were notable users of liquidity ratios taking the form of

7. For an alternative classification, see Bindseil (2004).

8. Today, some central banks in emerging markets (India, Philippines) still use them in order to control interest rates.

securities-reserve requirements and having an explicit monetary policy function (Fousek 1957, Goode and Thorn 1959, De Kock 1974, and additional references below). We rely on the writings of contemporary economists who described monetary policy tools, as well as on reports published by central bank themselves. Our goal is not to provide an exhaustive history of these tools; we cannot give a full account of the experience of each country that used them. Instead, our stylized presentation highlights the main reasons why they were introduced and—most of all—how contemporaries understood their effects. Each of the three following subsections highlight three important aspects of securities-reserve requirements: (i) cash and securities-reserve requirements were first introduced for regulatory purposes (in a limited number of countries), but were later incorporated into the central banks' monetary policy toolbox (in a large number of countries); (ii) the expected effect of securities-reserve requirements was to prevent banks from selling government securities (or using them as collateral to borrow more); and (iii) these tools were abandoned because of their complexity and criticisms of their distributional effects (prioritizing public debt over lending to private corporations).

1.1 From Prudential to Monetary Policy Functions

Cash-reserve requirements were first introduced in the United States in the nineteenth century as banking regulation tools, for prudential reasons (Goodfriend and Hargraves 1983, Calomiris 2012, Carlson 2015). Then, the U.S did not have a central bank: cash reserves had to be deposited in other banks, the "reserve city banks." Recurrent banking crises, and the failure of liquidity regulation alone (reserve requirements) to avoid them, led to the introduction of the lender of last resort, in the form of the Federal Reserve System in 1913 (Feinman 1993). Contrary to the United States, other advanced economies had a central bank before 1913 but no banking regulation: banking regulation and central bank liquidity provision were perceived as substitutes.[9] In the interwar period, the U.S Federal Reserve started to use reserve requirements as monetary policy tools. It was a noted and influential shift that started in the early 1930s and was accomplished in 1936 (Friedman and Schwartz 1963, Meltzer 2010, Carlson and Wheelock 2014).[10]

This shift had been motivated by the recognition that cash-reserve requirements had an effect on credit and money creation and thus could no longer be deemed prudential tools only. The 1931 report of the Federal Reserve System Committee on Bank Reserves stated:

> "The committee takes the position that it is no longer the primary function of legal reserve requirements to assure or preserve the liquidity of the individual member bank. Since the establishment of the Federal Reserve System, the liquidity of an individual bank is more adequately safeguarded by the presence of the Federal Reserve banks, which were organized for the purpose, among others, of increasing the liquidity of

9. Only banks of issue—that is, central banks —were regulated and had to keep reserves in function of their note issuance (Toniolo and White 2015).

10. Their effectiveness has, however, been challenged by Goodfriend and Hargraves (1983) and Calomiris, Heider, and Hoerova (2015b).

> member banks by providing for the rediscount of their eligible paper, than by the possession of legal reserves." (quoted in Goodfriend and Hargraves 1983, p. 37, and Carlson and Wheelock 2014).

Soon after, New Zealand and Sweden introduced similar cash-reserve requirements for monetary policy (in 1936 and 1937) to follow the U.S. innovation. The leading textbook on central banking during this period documented this important innovation:

> "In recent years a new method has been devised for the purpose of increasing or decreasing the available supply of bank cash […]. This method was first introduced in the United States in 1933 and amended in 1935 […] as an additional means of enabling the Reserve Banks to control the money market and to contract or expand the credit-creating capacity of the member banks. It was brought into use for the first time in August 1936." (De Kock 1939, p. 266)

A visionary man, De Kock, anticipated that "this method of changes in reserve requirements will probably tend to be more widely adopted and further developed" (De Kock 1939, p. 267). He was right: cash-reserve requirements became a major tool of monetary policy after the Second World War in most countries, together with open market operations, discount window lending and direct credit controls. It is only in the 1980s that open market operations displaced the others (Borio 1997, Bindseil 2004, Monnet 2018). The history of securities-reserve requirements started later, but it shows a similar shift, from prudential tools to monetary policy tools. As cash-reserve requirements in the U.S., securities-reserve requirements had been first introduced as prudential tools in the few other countries that adopted banking regulations before the mid-1930s, namely, Sweden in 1911 and then Switzerland in 1934. Fixed liquidity ratios implemented for prudential purposes later became (or were complemented by) adjustable securities-reserve requirements and then were used for monetary policy purposes. Contrary to cash-reserve requirements, this shift did not occur in the 1930s but after the Second World War. A study written at the New York Fed in the 1950s on the "instruments of monetary policy" in countries outside the United States describes this development well:

> "Initially, minimum liquidity ratios [securities-reserve requirements] were established to safeguard bank liquidity and to protect bank depositors. Thus, in 1920's and 1930's, such ratios became a feature of commercial banking legislation in the Scandinavian countries and Switzerland." (Fousek 1957, p. 57)

The United States never implemented securities-reserve requirements (although the proposal was discussed, as we shall see below). Their history and rationale as monetary policy tools after 1945 in other countries have received much less attention than the history of cash-reserve requirements. To this, we now turn our attention.

1.2 The Rationale for Securities-Reserve Requirements: Collateral Constraint and the Price of Government Securities

Let us turn to the fourth edition of de Kock's book on central banking, published in 1974. Two differences with the first edition of 1939 are striking. First, as anticipated in 1939, reserve requirements indeed had become an instrument of first importance for central banks (De Kock 1974, p. 207).[11] Second, the definition of "reserve requirements" has widened. In 1974, it includes two types of instruments which De Kock names "cash-reserve requirement" and "liquid-asset requirement." The former is the same as the U.S. cash-reserve requirements presented in the 1939 edition: demand deposits at the central banks. The latter is what we call "securities-reserve requirements": a fixed proportion of total assets must be held in liquid assets (the definition of "liquid assets" being different across countries and periods). In other surveys of central banking practices in several countries, these two instruments were also viewed as two distinct types of "reserve requirement" (Fousek 1957, Goode and Thorn 1959, EEC 1962, Tamagna 1963, Thurow 1971, EEC 1972, Hodgman 1973, OECD 1975). "Securities-reserve requirements" were clearly distinguished from "cash-reserve requirements," and alternatively called "liquid asset requirements" or "liquidity ratios." For example, Fousek (1957)'s international study on instruments of monetary policy devoted one separate chapter to each of them "Chapter IV: commercial bank cash-reserve requirements" and "Chapter V: commercial bank liquidity ratios." Another U.S economist, George Garvy, observed that outside the U.S, cash-reserve requirements were sometimes introduced as monetary policy tools after securities-reserve requirements ("liquidity ratios") were already in use. Some economists argued that securities-reserve requirements had a similar effects (Goode and Thorn, 1959, pp. 10–13). By contrast, others acknowledged that securities-reserve requirements had a specific effect that was different from the one of cash-reserve requirements. Economists and central bankers realized that cash and securities-reserve requirements were not substitutes but could be used to complement each other. More generally, securities requirements were usually used to complement any quantitative instrument of monetary policy (credit controls, rediscount ceilings, cash-reserve requirements, etc.) because central banks wanted to avoid that banks circumvented restrictive measures by selling government securities to obtain additional liquidity. This argument was formulated explicitly in many central bank reports (EEC 1962, EEC 1972) and was also at the core of the proposals to introduce securities-reserve requirements in the U.S., as we will see below. Fousek, among others, explained it very clearly:

> "Still another common problem arises in countries where banks hold large amounts of government securities and, by selling them or letting them run off, may be able to obtain additional reserves." (Fousek 1957, p. 55)

Securities-reserve requirements could be used to avoid asset substitution in banks portfolio that would limit the effectiveness of cash-reserve requirements. This interaction is well described for instance in the case of Australia (Fousek 1957, p. 58). Similar mechanisms are presented about French monetary policy and the interaction between securities-reserve requirements and other monetary policy tools

11. They now deserved a full chapter, entitled "variable reserve requirements," alongside the three surviving chapters "discount-rate policy," "open-market operations," and "other methods of credit controls."

(rediscount ceilings in this case, that is, bank-by-bank quotas on borrowing from the central bank):

> "The fixing of rediscount ceilings would have lost its point if the banks, disposing as they did at the end of the war of a large portfolio of Treasury bills, had been left free to rediscount them with the central bank or not to renew them on their maturity. The banks were therefore called on at the same time to retain a minimum portfolio of Treasury bills. The imposition of "floors" for government paper, [...] is an automatic restraint on the volume of loans the banks can make to their customers." (EEC 1962, p. 121)

In other words, central banks were afraid that the constraints they imposed on bank lending—that is, contractionary monetary policy tools—would have led to banks selling their Treasury securities. Such strategy to circumvent the restrictive measures would have led to fall in the price of government securities (an increase in their yields). A careful observer of postwar U.S. monetary policy summarized these issues as follows, and thus argued for the introduction of securities-reserve requirements in the United States:

> "Banks can always sell securities to increase reserves and thus nullify [cash] reserve requirements. With its existing legal powers over reserve requirements the Federal Reserve is powerless to halt the process as long as it must stand ready to purchase government securities at prices which will keep yields and interest rates at their present low levels." (Burkhead 1947, p. 1)

The conclusion for monetary implementation was straightforward: either the central bank imposed securities-reserve requirements as monetary policy tools, or it let the yield on government bonds rise. From this perspective, securities-reserve requirements were supposed to function as a collateral constraint: they prevented banks from increasing their short-term funding by selling Treasury securities. They were also means of securing government funding and maintaining a stable interest rate on government debt when money markets and lending rates increased. The U.S. is one of the only countries, with West Germany, that relied extensively on cash-reserve requirements for monetary control, without using securities-reserve requirements. Both countries used some type of rediscount quota. The Bundesbank used bank-by-bank ceilings limiting the amount borrowed at the discount window, and as shown by Hanes (2019), the Fed put restrictions on the borrowings of large U.S. banks. As we show in our model of the next section, such limits can have similar effect to securities-reserve requirements.

Proposals to introduce securities-reserve requirements within the Fed policy instruments were made several times. First proposed by academics in 1940 (Riddle and Reierson 1946), it was then endorsed by Fed officials in 1945 and 1948, under the names "special" or "secondary" reserve requirement (Federal Reserve Bulletin, January 1948, Willis 1948, Romer and Romer 1993, Meltzer 2003, pp. 645–650), but the U.S. Congress turned it down. Finally, such proposals emerged again in the late 1950s, especially motivated by European central banks experience with liquidity ratios (Fousek 1957, Ascheim 1958, McLeod 1959).[12] The objective of such tools was to control inflation through credit restrictions. As in foreign countries, the main rationale behind a U.S. securities-reserve requirement was to avoid that banks sold government securities to obtain additional liquidity and increase their loans to the rest of the economy:

> "This special requirement would make it possible for the Federal Reserve System to immobilize a portion of these assets. This immobilization, however, would be only for the purpose of preventing their use for the purpose of obtaining additional reserves." (Federal Reserve Bulletin, January 1948, p. 10)

In the U.S. debate, it was also clear that securities-reserve requirements could complement more traditional tools of the central bank (as opposed to the widespread credit controls measures introduced after the war, especially in Europe; see Monnet 2018), such as the discount rate and open market operations:

> "From the monetary point of view the principal purpose of the proposed new requirement is to make possible the more effective use of the existing instruments in offsetting changes in bank reserves – particularly open market operations and discount rates – without seriously upsetting the Government securities market and unduly raising the interest cost on the public debt." (Federal Reserve Bulletin, January 1948, p. 18)

Securities-reserve requirements were deemed necessary because of the large holdings of government securities in banks' balance sheet (about 50%) during and after the war (Burkhead 1947). Its proponents saw this as a key measure aiming at "reconciling monetary management and debt management policies" (Miller 1950). Indeed, tightening liquidity ratios was a way to pursue a restrictive monetary policy stance without affecting the price of government debt:

> "the view has been expressed that it would be both feasible and desirable to insulate government securities, in whole or in part, from the impact of restrictive monetary policies on the private credit market. One proposal commonly mentioned in this connection is to require government securities as part of the reserve to be held by commercial banks against their deposits, supplementary to the prevailing cash-reserve requirements." (Ascheim 1958)[13]

Because government debt was such a large share of total bank assets, isolating this debt from monetary tightening was a also a way to reduce aggregate lending without impairing the profit of the banking sector. Everywhere after Second World War, banks held a significant share of public debt (Abbas et al. 2014, Reinhart and Sbrancia 2015). In Sweden, liquidity ratios were introduced in the early 1950s when the share of government bonds in bank balance sheets reached 30% (Jonung 1993). In France,

12. As in other countries, these proposals aimed to define a set of liquid assets (Treasury securities, certificates, or notes, balances with Federal Reserve Banks, cash, etc.) and impose a requirement of such liquid assets calculated as a percentage of the deposits of banks.

13. See also, for example: "Thus, soon after World War II, and again during the post-Korea inflation, a number of European countries turned to them [securities-reserve requirements] in an effort to halt the excessive expansion of bank credit; in certain cases, the ratios also resulted in channelling bank funds into the financing of budget deficits" (Fousek 1957, p. 57).

the share of public sector securities was 20% in 1948 when the first liquidity ratio was introduced (26,1% if we include deposits at the Treasury and central bank).[14]

Considerations about the high share of public debt in bank balance sheets were not limited to debate on securities-reserve requirements. It was also, for example, at the basis of the *availability doctrine*, the most influential theory guiding the policy of the Fed in the early 1950s (Volcker 2002). According to proponents of the availability doctrine, first formulated by Robert Roosa at the New York Fed (Roosa 1951, Tobin 1953), the large share of government securities in bank balance sheet created an additional channel for the transmission of monetary policy. As perfectly summarized by Paul Volcker, "a change in interest rate would so disturb the banks that they would refuse to liquidate any securities because they would not want to report losses. Therefore, they would have to restrain their lending activity. And that would be the mechanism by which Federal Reserve policy would be effective" (Volcker 2002, p. 8). Proponents of the availability doctrine were not always defenders of the introduction of secondary reserve requirements in the United States (Roosa was not), but both emphasized the consequences of the potential fluctuations in the price of government securities for monetary policy implementation. The theoretical reasoning underlying the availability doctrine differed from the arguments that supported the use of securities reserve requirements as monetary policy tools, but both doctrines emerged in the same context that was characterized by a large share of government securities in bank balance sheets.

In many ways, today's situation is reminiscent of the post-WWII period because of the large volume of government securities in banks' balance sheet and the commitment of central banks to purchase government bonds and keep their interest rates at low level. Furthermore, government bonds are treated generously in Basel III banking regulation framework. For instance, the Basel committee includes in the most liquid category of assets: "sovereign or central bank debt securities issued in domestic currencies by the sovereign or central bank in the country in which the liquidity risk is being taken or in the bank's home country" BCBS (2013). It implies that sovereign debt issued by a government in default could be counted as liquid assets (ESRB 2015).

The effect of securities-reserve requirements on the composition of assets was also intended to allocate funds to the priority sectors or to act as capital controls (distinguishing between domestic and foreign assets). Depending on the objectives of the central bank and on the characteristics of the banking sector, all these functions could be combined in one instrument. The securities reserve requirements could have important desired distributional effects—including securing government funding. Because the securities reserve requirements had this dual role of monetary policy and credit allocation, the securities subject to the liquidity requirements and those eligible for the lower discount window rate were identical. This important feature was not only consistent with the policy priority (i.e., subsidy) given to certain assets, but it was also essential to making the securities reserve requirements effective, as our model illustrates in the next section. If the securities reserve requirements had included

14. *Rapport de la Commission de contrôle des banques*, 1949, p. 22.

assets against which banks could only borrow at a penalty rate, banks would have fully satisfied the requirements with that type of asset and the requirements would have had no effect on the money market rate.

In the vast majority of countries that used securities-reserve requirements, the required securities were only those issued by the government (Fousek 1957, EEC 1962, 1972). Government securities were everywhere considered as the safest collateral for central bank lending, to which the lowest Lombard or discount rates applied. Few countries included a larger set of securities in the liquidity ratio. In France, for example, the securities reserve requirement included medium-term credit to priority sectors (in addition to government securities) after 1960 (Monnet 2018, pp. 91–95 and chapter 4). The types of medium-term credit included in reservable assets were the same as those accepted as collateral by the central bank at the lower rate (they were called "rediscountable"). In Canada, a federal state, in addition to the usual government securities, the securities-reserve requirement included day-to-day loans—the most liquid overnight loans—as well as securities of all the Canadian provinces (Neufeld 1958). They could also be rediscounted at the central bank at the lowest discount rate, as securities of the Federal government. The eligibility of guarantees to the central bank and the definition of reservable assets went hand in hand. The Swedish case shows very clearly how liquidity ratios originally designed as banking regulation tools were later integrated into the set of monetary policy instruments aiming to fight inflation. It also provides an example of liquidity ratios that differed according to the size of the banks, since larger banks were more likely to hold government securities (Jonung 1993).

1.3 Why These Tools Were Abandoned

This section explores why liquidity ratios were phased out. We highlight two main reasons: (i) the distributive effects of these tools on government financing were no longer accepted and (ii) their complexity and the difficulties to assess their specific effects.

Reserve requirements—both cash and securities—performed several roles, beyond their function as monetary policy tools (Goode and Thorn 1959, Jonung 1993, Monnet 2018). As explained above, they were often born as banking regulation tools, and later were used to combat inflation and secure government financing. In most countries, however, they kept their banking stability function—although it was not their main objective anymore– -since they acted on the riskiness of assets, or because a fixed ratio was kept in addition to the flexible liquidity requirements used for monetary policy. While some viewed the effect on public debt management and priority sectors as a positive by-product, others complained about such adverse distributive effects, and criticisms about "financial repression" became widespread from the 1970s onwards (Reinhart and Sbrancia 2015).

Reserve requirements had to be binding to become effective monetary policy tools. It meant that they had to adapt to the characteristics of the banking system and to other policy instruments. Moreover, it was popular at the time to make monetary policy redistributive (“selective”), that is, to offer advantageous credit conditions to some institutions or sectors. In practice, it meant that the securities of some important subsidized sectors, such as housing, could be legally defined as liquid assets. These two constraints (effectiveness and selectivity) made the use of liquidity requirements extremely complex and very diverse across countries. All contemporary economists noticed such a complexity and variety of tools (e.g., De Kock 1974, p. 223), and it has been restated in current studies of monetary policy and credit controls during the postwar era (Romer and Romer 1993, Elliott, Feldberg, and Lehnert 2013, Kelber et al. 2014, Aikman, Bush, and Taylor 2016, Monnet 2018). Another important consequence of such features, especially discussed in Monnet (2014), is that it makes it impossible to measure the stance of monetary policy by simply looking at the value of the different ratios in place. The nominal value of the ratio (whether reserve requirement, discount ceilings or credit ceilings) is not informative in itself about the stance of monetary policy for two reasons. First, the ratios evolved over time in order to remain binding, so that their value had to adapt to the composition of banks’ balance sheets, which may evolve over time for structural reasons. Second, the strength of these ratios depended on how they were combined together and with other tools (such as the discount rate or ceiling on credit growth). As explained in a 1975 studies about monetary policy from the Organisation for Economic Cooperation and Development (OECD):[15]

> “the use of policy instruments is evolving constantly in the light of the experience gained, and there is always the danger of misinterpreting a temporary relaxation of policy as a more basic modification in the use of the instruments.” (OECD 1975, p. 25)

As a consequence, Romer and Romer (1993), Monnet (2014), and Aikman, Bush, and Taylor (2016) provide a general assessment of the impact of monetary policy and credit controls during those years—for the U.S., France, and England, respectively—based on a narrative approach or, when possible, a common component of instruments, but they cannot isolate the separate effect of each quantitative instruments on the macroeconomy.[16]

The complexity and inherent difficulties associated with estimating the macroeconomic effect of liquidity requirements (contrary to the effect of interest rate changes) are probably one reason why we know so little about their effectiveness, and it added to the arguments for phasing them out.[17] Hence, we need better theory to identify the potential channels through which they could have monetary effects and be combined with other instruments.

For decades, central banks favored tools that had a distributive impact, to direct credit to priority sectors and the government. This changed in the 1970s, and more

15. A similar argument is expressed by Capie (2010, p. 274).

16. Elliott, Feldberg, and Lehnert (2013) look at the effect of separate instruments (especially cash-reserve requirements) on credit, but for the reasons mentioned above, cannot find any robust effect.

17. As shown in Monnet (2014), the effect of quantitative controls on money and credit could be disconnected from the effect of interest rates. In such context, interest rates cannot be used as a reliable proxy for the monetary policy stance.

so in the 1980s and 1990s, when central banks became independent and turned to market-oriented tools for monetary policy, in particular open market operations (Jonung 1993, Borio 1997, Monnet 2018).

The trend in economic thinking toward greater central bank independence made the use of these ratios anachronistic, as they were perceived as government's pressure to control the price of public debt and repress the development of private markets (Reinhart and Sbrancia 2015). According to central bank economists of the 1950s, the use of liquidity ratios increased the central bank's ability to respond to rising inflation. These ratios were modified (among several other instruments) to implement a restrictive monetary policy. However, their ability to control inflation was questioned in the 1970s and 1980s for two main reasons. First, their use was partly based on the outdated assumption that government debt was less inflationary than bank credit, so that restricting the latter and increasing the former would reduce inflation.[18] This argument was based on the idea that bank credit was financed by short-term deposits (money), while government debt was financed by illiquid savings. This distinction was challenged in the 1970s (Batini and Nelson 2005, Monnet 2018). Second, fighting inflation with tools that isolated public debt from contractionary monetary policy was in stark contradiction with the new economic theory of central bank independence that was emerging in the 1970s and that emphasized the important difference between rules and discretion (Kydland and Prescott 1977, Barro and Gordon 1983). Although—as far as we know—these economists did not discuss the use of securities reserve requirements, it is easy to see that these tools belong to a discretionary regime because they align the central bank's objective with the government's. In the rules versus discretion perspective, a central bank that prioritizes government debt in contractionary times would be more likely to create more inflation than expected in the expansionary phase to relieve the government's budget.

2. A MODEL OF LIQUIDITY RATIOS AS MONETARY POLICY TOOLS

This section uses a simple theoretical model to clarify the precise mechanisms through which liquidity requirements affected interest rates on the money market.

As explained previously, liquidity requirements could take the form of cash-only reserve requirements or securities-reserve requirements. The channels through which these various ratios operated differed. Our model will show that binding liquidity ratios increase money market rates, which forces the central bank to choose between expanding its balance sheet to counteract this effect, or to accept to run a contractionary policy stance. This is what we call the liquidity regulation dilemma.

18. For example, discussing the use of liquidity requirements in Canada, Neufeld (1958) noted that "The gain to monetary policy seems to rest in part on the somewhat questionable assumption that bank lending through the extension of loans is more inflationary than bank lending through the purchase of securities" (p. 340).

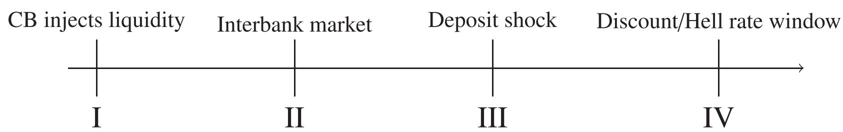

Fig 1. Diagram 1. Timing of the Model.

2.1 Securities-Reserve Requirements and the Money Market Rate

In this section, we discuss how securities-reserve requirements impact short-term money market rates. Our model is in the tradition of Poole (1968).[19] A key assumption of those models is that banks experience a "late" deposit shock. This assumption captures the fact that banks need to process payments at any time when they are open, and they might not know in advance about incoming or outgoing payments. These payment shocks may occur late in the day after the interbank market has closed. Another important assumption that we introduce is that securities can be pledged to borrow from the central bank, or be used to fulfill securities-reserve requirements like the LCR. But one unit of securities cannot be used for these two purposes at the same time. This reflects both historical experience and modalities of today's liquidity ratios, where liquid assets need to be "unencumbered." This dual role implies that an increase in securities-reserve requirements reduces the stock of collateral that banks can use to borrow at the central bank. To our knowledge, we are the first ones to introduce liquidity regulation and collateral constraints in a model of the money market. By contrast, Bech and Keister (2017) have modeled liquidity regulation in a context where there is no collateral constraint.

The Timing of the Model. The model looks at banks' decisions during a typical trading day (Figure 1). The timeline of the model is the following: first, the central bank can inject liquidity.[20] Second, the market for interbank loans occurs. Third, once the interbank market is closed, banks experience a "late" deposit shock. Fourth, banks can go to the central bank to borrow overnight if they need to. They may either borrow at the discount window, up to a limit, which is dictated by the amount of collateral they have. When the limit is reached, banks can still borrow at the central bank, but at a penalty rate that is higher than the normal discount rate. Such penalty rates were common in most countries that relied on liquidity requirements (Garvy 1968). Today, penalty rates are still a feature of central banks' discount window like at the U.S. Federal Reserve System.[21] We call this penalty rate the "hell rate," as it was named

19. More recent papers in this tradition of modeling include Huberto and Keister (2008), Bech and Keister (2017), or Vari (2020)

20. This assumption captures the fact that the amount of central bank liquidity is known to banks at the beginning of the day. This assumption can easily be changed, and the central bank could inject liquidity at any time during the day as long as banks know when they trade and how much the central injected on the previous day.

21. The Fed discount window offer several accesses for banks: primary and secondary credit. Secondary credit is available to depository institutions that are not eligible for primary credit. It is available at a rate 50 basis points above the primary credit rate.

by the Bank of France in the 1950s (Monnet 2014). Finally, consistent with postwar central banking practices, we assume that required or excess balances of banks are not remunerated.[22]

The End of the Day: the Reserve Requirements Constraints. At the end of the day, banks need to satisfy their cash-reserve requirements. Cash-reserve requirements impose that the end-of-day balance of bank "i" is greater than some number K^i.

Thus, the constraint takes the following form:

$$R^i + B^i - \epsilon^i + X^i + H^i \geq K^i, \tag{1}$$

where R^i is the amount of central bank liquidity that bank "i" holds at the central bank before the interbank market starts (period I). B^i is the amount of interbank borrowings of bank i. ϵ^i is a random deposit shock with mean 0, to which bank "i" is subject to after the interbank market has closed (period III). X^i is the amount borrowed by bank "i" at the discount window. H^i is the amount of borrowings at the "hell rate" (i.e., a penalty rate). Borrowing at the hell rate and at the discount window both take place in period IV.

Banks need collateral in order to borrow at the discount window rate. If they do not have enough collateral, they can only borrow at the "hell rate."[23]

Let C^i be the amount of collateral that bank i can pledge to borrow at the normal discount rate.

Banks have to fulfill a securities-reserve requirement T^i, such that the amount of securities held by bank "i" (denoted as S^i) must be greater than T^i ($S^i > T^i$). The securities-reserve requirement has a direct impact on the capacity of banks to borrow from the central bank. The amount of collateral they can pledge is:

$$C^i = S^i - T^i \tag{2}$$

Period IV: Discount Window Borrowing. One can solve the bank's problem backward, starting with the demand for discount window loans and "hell rate" loans. Using equation (1) implies that the demand for central bank facilities is:

$$X = \max\{0; \min\{C^i; K^i - (R^i + B^i - \epsilon^i)\}\}, \tag{3}$$

$$H = \max\{0; K^i - (R^i + B^i - \epsilon^i) - C^i\}. \tag{4}$$

That is, banks will borrow from the central bank discount window every unit of money needed to cover a cash-reserve requirement shortfall $K^i - (R^i + B^i - \epsilon^i)$, up to its stock of eligible collateral (C^i). If the shortfall is below zero, the bank does not borrow

22. This assumption can easily be relaxed, but allow to simplify notations.

23. Our model is more general than a situation with a "hell rate." Our results would hold in a situation where banks, once they run out of collateral, cannot borrow at any rate from the central bank triggering a reserve deficiency, that the central bank punishes by a fine. If the fine for each unit of currency of deficiency is equal to "r_H," results in the two models are, in fact, identical.

anything. Any shortfall in excess of the amount of collateral $((R^i + B^i - \epsilon^i) - C^i)$ needs to be borrowed from the hell window.

Given (3) and (4), the profit of bank "i" writes:

$$\Pi^i = Lr_L + r_s S^i - r_D(D^i - \epsilon^i) - r_B B^i - r_H H^i - r_X X^i, \tag{5}$$

where r_L, r_s, r_D, r_B, r_X, and r_H are the interest rates on loans (L^i), government securities (S^i), bank deposits (D^i), interbank borrowings (B^i), discount window borrowings, and the hell window borrowings (H^i). The first four rates are market rates. The two lasts are set by the central bank.

Period III: Profits for a Given Distribution of Payment Shocks. Profits of banks will vary as a function of the payment shock. The payment shock ϵ^i has mean 0, and its density function is denoted as g(.). Its cumulative distribution function (cdf) is denoted as G(.). Typically, G(.) can be thought as the cdf of the normal distribution or the uniform distribution. We assume that this function is identical for all banks.

Combining (3)–(5), the expected profit function writes:

$$\begin{aligned} E(\Pi^i) &= Lr_L + r_s S^i - r_D(D^i) - r_B B^i - r_H \\ &\left(\int_{R^i - K^i + B^i + C^i}^{\infty} g(\epsilon^i)(\epsilon^i - (R^i - K^i + B^i + C^i))d\epsilon^i\right) \\ &- r_X\left(\int_{R^i - K^i + B^i}^{R^i - K^i + B^i + C^i} g(\epsilon^i)(\epsilon^i - (R^i - K^i + B^i) + \int_{R^i - K^i + B^i + C^i}^{\infty} g(\epsilon^i)C^i d\epsilon^i\right). \end{aligned} \tag{6}$$

The term associated with r_H represents the expected value of H^i. It is positive only when the deposit shock is larger than the threshold $(R^i - K^i + B^i + C^i)$, meaning that the shock has exhausted all the liquidity of the bank and its collateral. The term associated with r_X is the expected value of X^i and is nonzero, whenever the shock is moderately large (i.e., whenever the shock is between $R^i - K^i + B^i$ and $R^i - K^i + B^i$).

Period II: Profit Maximization with respect to the Amount of Interbank Loans. Profit maximization with respect to the amount of interbank loans (B^i) implies:

$$\begin{aligned} r_B = (1 - G(R^i + B^i - K^i + C^i))r_H + (G(R^i + B^i - K^i + C^i) \\ - G(R^i + B^i - K^i))r_X. \end{aligned} \tag{7}$$

Banks will equate the marginal gain from lending one more unit of liquidity on the interbank market (interest rate r_B) with the marginal expected cost of having one less unit of liquidity. This cost is the interest paid on one more unit of liquidity in the state of the world where the deposit shock is so large that the bank's collateral is exhausted $(1 - G(R^i + B^i - K^i + C^i))$, times the hell rate, plus the probability that the shock is large, but not large enough to exhaust the bank's collateral $G(R^i + B^i - K^i)$ times the discount window rate r_X.

Period I: The Central Bank's Injections. The central bank chooses R, the total amount of central bank reserves outstanding. We analyze in Section 2.2 how exactly this is done. Note that the liquidity borrowed from the discount window or the hell window can only be used to cover end-of-day shortfalls. It is very different from R, in the sense that liquidity borrowed at the end of the day has to be paid back to the central bank before the following morning.

Equilibrium. At equilibrium, it must be the case that interbank loans are in zero net supply across the mass one of banks:

$$\int_0^1 B^i di = 0. \tag{8}$$

Variables, when aggregated across all banks , are denoted without their index it i. For instance, aggregate central bank reserves are denoted in the following way:

$$\int_0^1 R^i di = R. \tag{9}$$

To find the equilibrium, we use (7) and sum the equation across the mass 1 of banks. Assuming that G(.) is linear (e.g., a uniform distribution function) and making use of (8), we find the following:[24]

$$r_B^\star = (1 - G(R - K))r_X + (1 - G(R - K + S - T))(r_H - r_X). \tag{10}$$

The equilibrium interbank rate depends on two components. The first term represents the traditional component that is present in most models of the money market: the interbank rate is equal to the probability that the banking system becomes short of central bank liquidity $(1 - G(R - K))$ times the discount window rate. The second term represents our new collateral channel. It is the additional cost for banks to borrow "$r_H - r_X$" should they be short of collateral. Via this second term, the central bank can run a policy equivalent to quantity rationing, by indirectly restricting bank's access to the discount window.

2.2 Policy Discussion

Liquidity Ratios as Quantity Rationing. Equation (10) shows that cash-reserve requirements and securities-reserve requirements have similar effects on interest rates ($\frac{\partial r_B^\star}{\partial K}$ and $\frac{\partial r_B^\star}{\partial T}$ are both greater than 0), but they act through different channels.

These two channels can be represented graphically. Figure 2 plots (10) for different parameter values. The vertical bar represents the level at which the central bank sets the amount of excess reserves "R-K." One can see that when the amount of cash-reserve requirements K is increased, interest rates increase along the demand curve.

24. Note that this result hold even if G(.) is not linear, if all banks are symmetric.

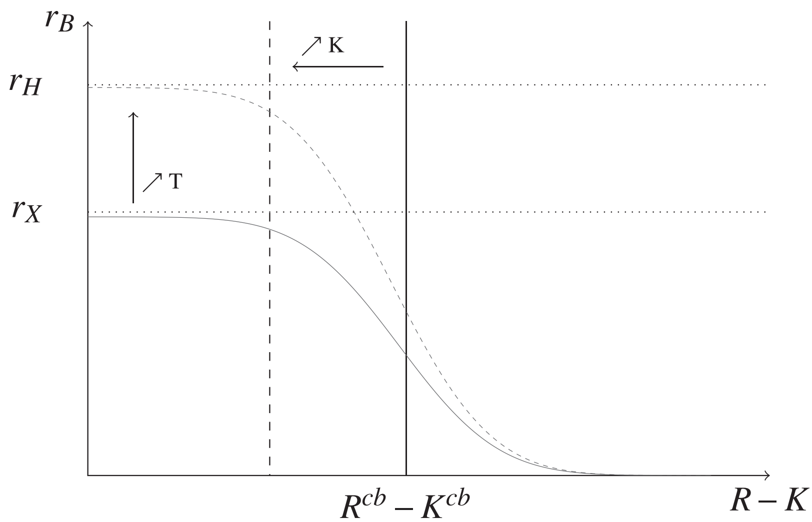

Fig 2. Diagram 2: Changing Money Market Rates through Increases of Reserve Requirements.

When the amount of securities-reserve requirements (T) increases, the demand curve goes up, increasing interest rate for a given amount of excess reserves.

On the one hand, cash-reserve requirements increase directly the demand of banks for central bank liquidity. Banks need this liquidity to comply with the requirement, and excess liquidity on the money market is then reduced. It means that banks have a higher probability to borrow at one of the central bank penalty rates. This effect is a well-known feature of Poole-type models. Our model shows an additional effect of (securities) reserve requirements. In our model, securities-reserve requirements restrict *de facto* the access of banks to the central bank discount window—through a decrease of available collateral ($C = S - T$)—and forces them to borrow at the hell rate.[25] In this sense, securities-reserve requirements have the same effects as so-called rediscount ceilings, whereby the central bank limits *de jure* the access of banks to the discount window (see Monnet 2014). Securities-reserve requirements are equivalent to quantity rationing at the discount window.[26] In a discount ceiling system, the central bank controls C, the maximum amount of collateral that a bank can pledge from the discount window. In a world where the central bank provides unlimited access to its discount window (that is, $r_H = r_X$), securities-reserve requirements have no effect.

25. It is important to note that we have taken the amount of securities that banks hold as exogenous. We show in Appendix A that if banks can endogenously choose their securities holdings, when the central bank increases T, they do increase their securities holdings but less than one for one. In other words, the central bank can decrease the amount of banks' collateral by increasing T.

26. Interestingly, the Bundesbank never used securities-reserve requirements but relied on rediscount quotas. In France, securities-reserves requirements were used actively after 1960, once rediscount quotas were deemed less effective than in the 1950s because banks were less indebted towards the central bank.

On the contrary, cash-reserve requirements still have an effect in this case (as in the standard models described previously).

How to Counteract the Effect of Liquidity Ratios?. The effect of (cash and securities) reserves requirements on interest rates can always be counteracted by increasing the amount of central bank reserves R. An increase in R can be achieved through various ways that expand the central bank balance sheet (quantitative easing, open discount window policy, etc.). Whatever the tools used to expand R, our main conclusion is that an increase in (cash and securities) liquidity requirements pushes the central bank either to accept a restrictive monetary policy stance, or to increase its balance sheet to nullify the restrictive effects of liquidity requirements. This second policy option is contradictory with the statements of central banks that recently adopted liquidity requirements to reduce banks' dependence on central bank liquidity. It is this tension that creates what we call the liquidity regulation dilemma. The opposite effects of reserve requirements and central bank liquidity were already visible during the postwar period that we studied in Section 1. The difference with contemporary policies is that past central banks did not intend to make a separation between monetary policy and liquidity requirements. Rather, they saw these two concepts as inseparable and were using the latter as instruments to implement the former.

To study the trade-off, we extend our model and maximize the profit function with respect to the amount of securities banks hold (S).[27] Aggregating this new First order condition (FOC) across the mass one of banks yields following condition:

$$r_S^\star = r_D + (1 - G(R - K + S - T))(r_X - r_H). \tag{11}$$

This condition shows that the interest on securities (i.e., government bonds) is priced by banks as a spread over deposit rates. The spread (second term of equation (11)) represents the liquidity service that securities provide in the state of the world where banks are short of liquidity (which happens with probability $1 - G(R - K + S - T)$. In such a case, securities allow banks to borrow from the central discount window and save them from going to the "hell" window. Thus, for each unit of additional securities held, the bank saves $(r_X - r_H)$.

According to this equation, increasing securities-reserve requirements (T) leads to an increase in the yields on securities as all rates go up when the central bank tightens. However, the spread between securities and the interbank rate declines, that is, the interest rate on securities actually rises less than money market rates, when T increases. This can be seen when combining equations (11) with equation (9) and:

$$r_S^\star - r_B^\star = r_D + 2(r_H - r_X)G(R - K + S - T) + r_X G(R - K + B) - 2r_H. \tag{12}$$

27. For simplicity, we assume that banks fund an increase in securities holdings by raising more deposits. Alternatively, we could assume that deposits remain fixed. This would change slightly condition (11) but would not affect our results qualitatively. Moreover, we assume for this specific exercise that banks hold all government bonds and that the aggregate amount of securities S is therefore decided by the aggregate debt of the government, which depends on current fiscal considerations and past fiscal considerations (not modelled here).

This equation shows that the spread between the interest on securities (r_S) and money market rates (r_B) is decreasing in T, with $\frac{\partial(r_S^\star - r_B^\star)}{\partial T} = -2(r_H - r_X)g(R - K + S - T) < 0$

In words, the increase of securities reserve requirements mitigates the effect a monetary policy tightening on the financing cost of the government.

Moreover, equation (12) shows that quantitative restrictions and increasing the hell rate are complements. If the central bank increases its policy rates (either the discount window rate (r_X) or the hell rate (r_H)), the spread between government securities interest rates and money market rate decline.[28] Then, it is straightforward to note that $\frac{\partial^2(r_S^\star - r_B^\star)}{\partial T \partial r_H} < 0$ and $\frac{\partial^2(r_S^\star - r_B^\star)}{\partial T \partial r_X} > 0$

These two partial derivatives are not null because as the hell rate increases, the securities reserve requirement becomes more penalizing. This is because securities reserve requirements may create a collateral shortage for banks, which will prove more costly as the hell rate increases. At the opposite, when the discount window rate increases, banks suffer less of a penalty if they are short of collateral, because the discount window rate is now closer from the hell rate. The additional penalty (equal to the difference between hell and the discount rate) that banks incur by being short of collateral gets smaller as the discount window rate gets higher.

Automatic Stabilizers. Are the contractionary effects of liquidity requirements only at work when these requirements are tightened? Or does the mere existence of these requirements have an effect on interbank interest rates? Our partial equilibrium model provides an answer to this question. It might, however, be used with caution, keeping in mind that additional general equilibrium mechanisms may be at work.

To answer this question, it is worth extending the model into another direction: if cash and securities-reserve requirements are set as a fraction of deposits, denoted as, respectively, k and t (that is, $T = t.D$ and $K = k.D$). Equation (10) then becomes:

$$r_B^\star = (1 - G(R - kD))r_X + (1 - G(R - kD + S - tD))(r_H - r_X). \tag{13}$$

With :

$$\frac{\partial k r_B^\star}{\partial D} = k r_X g(R - K) + (k + t)(r_H - r_X)g(R - K + C) > 0. \tag{14}$$

If the central bank does not change the value of k, t, or R, liquidity requirements become akin to automatic stabilizers. When economic activity expands, loans (and therefore deposits) expand as well. For a given coefficient of reserve requirements, the total amount of required reserves increases. This leads to an increase in the interbank interest rate. This tightening of monetary conditions should, in turn, dampen economic activity. As discussed in Section 1, this is the main reason why, in the 1930s, a fixed ratio of securities (in Sweden and Switzerland) or cash (in the United States) reserve requirement was recognized as having a monetary policy effect, and central

28. This can be seen by looking at $\frac{\partial \Pi}{\partial r_X}$ and $\frac{\partial \Pi}{\partial r_H}$ and note that G(R-K+) <G(R-K)>1.

banks then decided to use adjustable reserve requirements as a policy tool. Put differently, as long as aggregate deposits fluctuate, a fixed reserve requirement has an effect on money market rates.[29] This conclusion is, in fact, already well known and documented for cash-reserve requirements, as it is akin to the money multiplier model that prevails in undergraduate macroeconomic textbook whereby the credit-creation capacity of banks is limited by bank deposits with the central banks. In our model, however, the adjustment works through interest rates and—most of all—is also true for securities-reserve requirements. Note that the money multiplier model (whereby the adjustment works through quantities) usually called upon to describe the effect of cash-reserve requirements has been most likely inoperative in industrialized countries in recent years.

Banks' Holding of Government Securities. As explained in our historical narrative, securities-reserve requirements have an additional advantage over cash-reserve requirements in avoiding that banks sell their government bonds to the central bank to obtain the liquidity required to fulfill cash-reserve requirements. In Appendix A, we solve formally for banks portfolio choice and show that securities-reserve requirements increase banks' holding of government securities. This increase is stronger as the spread between the hell rate and the discount window rate $(r_H - r_X)$ rises. This is because banks balance the probability of being short in securities and pay the hell rate and the benefit of granting loans, which are more profitable for banks. Said otherwise, banks accumulate more securities in precaution, against liquidity shocks.

Past central banks usually supported government bonds by buying (or discounting) them from banks at a predetermined price, any bank selling its bonds created additional central bank liquidity.[30] Cash-reserve requirements could also be used to sterilize the interventions of central banks on the foreign exchange market or interventions on the domestic government bond market. Overall, many of the channels we have discussed using our partial equilibrium model are relevant for today's monetary policy. Like securities-reserve requirements, Basel III regulation reduces the stock of collateral that banks can use to borrow from the central bank (BCBS 2013). Similarly, today's government might find it convenient that regulation increases demand for their debt.

3. CONCLUSION

This paper has explained how and why liquidity ratios were used in the past as monetary policy tools. It was the case not only for cash-reserve requirements but also

29. Central bankers recognized that an expansion of credit would be associated with an increase of required reserves at the central bank: "However, changes in the country's official gold and foreign exchange reserves need not necessarily lead to offsetting changes in the reserve requirements. The bank has stated that there would, for instance, be no ground for a reduction in the requirements if a fall in the gold and foreign exchange reserves were linked with credit expansion" (Fousek 1957, p. 54).

30. This mechanism is different from the one when reserve requirements are used to prevent banks to sell their securities to the nonbanks.

for securities-reserve requirements. While the history of the former was already well known (especially in the United States), the history of the latter (and the interactions between both types of instruments) had received no attention in the recent literature.

Central banks used securities-reserve requirements as a monetary policy tool to avoid that banks borrow during phases of restrictive monetary policy. When the liquidity ratio was binding, banks had no longer available collateral to borrow at the central bank discount window. As our model has shown, this was a quantity rationing effect, akin to imposing borrowing limits. An alternative option for the central bank would have been to sell government securities (the typical liquid asset) or to refuse to purchase them from banks. But this would have increased the interest rates on government debt. Hence, as recognized by contemporaries, the use of liquidity ratios was a way to run contractionary monetary policy while maintaining low interest rates on government debt.

One may reject any parallel between the current environment and historical precedents, on the ground that central banks currently hold a large share of government debt and thus relieved banks from the obligation to finance the state through reserve requirements. However, one should keep in mind that central bank's assets purchases put more reserves in the hands of banks. These reserves are short-term liabilities of the public sector and can be considered as public debt. Holding this debt, even if it has shorter maturity than regular bonds, still has a cost for banks (Martin, McAndrews, and Skeie 2016) and impact their behavior (Christensen and Krogstrup 2019). With liquidity regulations and assets purchases, central banks may actually have several tools at their disposal to ensure that banks continue holding public debt.[31]

APPENDIX A: ENDOGENOUS PORTFOLIO CHOICE BETWEEN LOANS AND SECURITIES

To endogenize the portfolio choice of banks, it is necessary to add an additional period to the model, where banks can chose how much securities and loans they wish to hold. Let us call it period 0.

Banks maximize their profits with respect to the amount of securities they hold. They take as given quantity of deposits (D^i) and use any additional deposit to invest either in loans (L^i) or in securities (S^i), such that:

$$D^i = S^i + L^i. \tag{A.1}$$

In other words, we assume that banks decide on their loan supply according to the amount of deposits they receive, and allocate their deposits between different types of assets. We assume that banks use overnight loans only to cover short-term liquidity needs, and decide on their portfolio allocation between loans and securities on a longer term basis. Thus, banks do not use overnight loans to make up for the differentials between their deposits and their long-term assets such as loans and securities.

31. We would like to thank an anonymous referee for this insight.

Such assumption can be rationalized either by prudent risk management constraints or by regulation such as the Net Stable Funding Ratio (NSFR).

Replacing L^i by $D^i - S^i$ in the profit function, and maximizing it with respect to collateral holdings (C^i) yields a second FOC:

$$r_L - r_S = (r_H - r_X)(1 - G(R^i - K^i + B^i + S^i - T^i)). \tag{A.2}$$

Banks will equate the expected benefit of granting an additional loan over holding securities ($r_L - r_S$) and the expected potential cost of having less collateral to pledge. This expected cost is the probability that the shock is larger than the bank's liquidity and its collateral holdings $(1 - G(R^i - K^i + B^i + C^i)$, times the penalty for being short of collateral $r_H - r_X$.

Using (A.2) and aggregating across a mass one of symmetric banks yield:

$$r_L^\star = r_S + (r_H - r_X)(1 - G(R - K + S - T)). \tag{A.3}$$

The equilibrium loan market rate is equal to the interest rate on securities plus a spread that is decreasing in the securities holdings of the banking system (S) and increasing in securities-reserve requirements (T).

Assuming that yields on securities are the same as the interbank market rate: $r_S = r_B$, yields:[32]

$$r_L^\star = 2(r_H - r_X)(1 - G(R - K + S - T)) + r_X(1 - G(R - K). \tag{A.4}$$

To find the equilibrium amount of securities and loans, it is necessary to assume a linear loan demand function:

$$L = L^{\max} - Ar_L, \tag{A.5}$$

where $L^{\max}$ is a shifter that represents the quantity of loans demanded when interest rate is at zero, and parameter A represents the sensitivity of loan demand to interest rates.

Combining the two previous equations yields:

$$L = L^{\max} - A(2(r_H - r_X)(1 - G(R - K + C)) + r_X(1 - G(R - K)). \tag{A.6}$$

To obtain a closed-form solution, we assume that $G(.)$ is a uniform distribution over $[P; -P]$, where P is the maximum value of the shock.

This implies:

$$L^\star = \frac{PL^{\max} + A[(r_H - r_X)(D - T) + (R - K - P)(r_H - \frac{r_X}{2})]}{P + A(r_H - r_X)}. \tag{A.7}$$

32. This assumption could be explicitly derived in equilibrium if we were to model explicitly the portfolios choices of nonbanks. They would then arbitrage between the return on securities and deposits. The rate offered by banks on deposits under perfect competition is equal to the interbank market rate. Thus, $r_B = r_D = r_S$.

Using equation (A.1), one can find the amount of securities banks hold:

$$S^{\star} = \frac{P(D - L^{\max}) + A[(r_H - r_X)T + (K - R + P)(r_H - \frac{r_X}{2})]}{P + A(r_H - r_X)}. \tag{A.8}$$

The collateral banks own is then:

$$C^{\star} = \frac{P(D - L^{\max} - T) + A(K - R + P)(r_H - \frac{r_X}{2})}{P + A(r_H - r_X)}. \tag{A.9}$$

As can be seen in equations (A.8) and (A.9), when the central bank increases T, banks increase their securities holdings (S), but less than one-for-one. Thus, the amount of collateral that can be pledged at the discount window (C) decreases.

LITERATURE CITED

Abbas, S.M. Ali, Laura Blattner, Mark De Broeck, Asmaa El-Ganainy, Malin Hu, and Abdelhak S. Senhadji. (2014) “Sovereign Debt Composition in Advanced Economies: A Historical Perspective.” IMF Working Papers, 2014.

Adrian, Tobias, and Nellie Liang. (2018) “Monetary Policy, Financial Conditions, and Financial Stability.” *International Journal of Central Banking*, 14, 73–131.

Afonso, Gara, and Ricardo Lagos. (2015) “Trade Dynamics in the Market for Federal Funds.” *Econometrica*, 83, 263–313.

Aikman, David, Oliver Bush, and Alan M. Taylor. (2016) “Monetary versus Macroprudential Policies: Causal Impacts of Interest Rates and Credit Controls in the Era of the UK Radcliffe Report.” NBER Working Papers, National Bureau of Economic Research.

Ascheim, Joseph. (1958) “Supplementary Security Reserve Requirements Reconsidered.” *Journal of Finance*, 13, 473–87.

Barro, Robert J., and David B. Gordon. (1983) “Rules, Discretion and Reputation in a Model of Monetary Policy.” *Journal of Monetary Economics*, 12, 101–21.

Batini, Nicoletta, and Edward Nelson. (2005) “The U.K.’s Rocky Road to Stability.” Federal Reserve Bank of St. Louis, Working Papers.

BCBS. (2013) “Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools.” Basel Committe on Banking Supervision.

Bech, Morten, and Todd Keister. (2017) “Liquidity Regulation and the Implementation of Monetary Policy.” *Journal of Monetary Economics*, 92, 64–77.

Bech, Morten, and Cyril Monnet. (2016) “A Search-Based Model of the Interbank Money Market and Monetary Policy Implementation.” *Journal of Economic Theory*, 164, 32–67.

Bernanke, Ben S., and Alan S. Blinder. (1988) “Credit, Money, and Aggregate Demand.” *American Economic Review*, 78, 435–9.

Bhattarai, Saroj, Gauti B. Eggertsson, and Bulat Gafarov. (2015) “Time Consistency and the Duration of Government Debt: A Signalling Theory of Quantitative Easing.” NBER Working Papers 21336, National Bureau of Economic Research, Inc.

Bindseil, Ulrich. (2004) *Monetary Policy Implementation: Theory, Past, and Present*. Oxford: Oxford University Press.

Bisignano, Joseph. (1996) "Varieties of Monetary Operating Procedures: Balancing Monetary Objectives with Market Efficiency." BIS Working Papers 35, Bank for International Settlements.

Blommestein, Hans J., and Philip Turner. (2012) "Interactions between Sovereign Debt Management and Monetary Policy under Fiscal Dominance and Financial Instability." In *Threat of Fiscal Dominance?*, edited by Bank for International Settlements, volume 65 of BIS Papers chapters, pp. 213–37. Basel: Bank for International Settlements.

Boissay, Frederic, and Fabrice Collard. (2016) "Macroeconomics of Bank Capital and Liquidity Regulations." BIS Working Papers 596, Bank for International Settlements.

Bonner, Clemens. (2016) "Preferential Regulatory Treatment and Banks' Demand for Government Bonds." *Journal of Money, Credit and Banking*, 48, 1195–221.

Bonner, Clemens, and Sylvester C. W. Eijffinger. (2016) "The Impact of Liquidity Regulation on Bank Intermediation." *Review of Finance*, 20, 1945–79.

Borio, Claudio. (2011) "Central Banking Post-Crisis: What Compass for Uncharted Waters?" BIS Working Papers 353, Bank for International Settlements.

Borio, Claudio E.V. (1997) "Monetary Policy Operating Procedures in Industrial Countries." BIS Working Papers 40, Bank for International Settlements.

Brooke Willis, J.. (1948) "Secondary Reserve Requirements." *Journal of Finance*, 3, 29–44.

Burkhead, Jesse V. (1947) "Full Employment and Interest-Free Borrowing." *Southern Economic Journal*, 14, 1–13.

Calomiris, Charles, Florian Heider, and Marie Haerova. (2015a) *A Theory of Bank Liquidity Requirements*. Columbia Business School Research Paper.

Calomiris, Charles W. (2012) "Getting the Right Mix of Capital and Cash Requirements in Prudential Bank Regulation." *Journal of Applied Corporate Finance*, 24, 33–41.

Calomiris, Charles W., and Mark Carlson. (2017) Rediscovering Macro-Prudential Regulation: The National Banking Era from the Perspective of 2015. In *Studies in Macroeconomic History*, edited by Aurel Schubert, Michael Bordo, Forrest Capie, and Angela Redish, pp. 232–82. Cambridge: Cambridge University Press.

Calomiris, Charles W., Florian Heider, and Marie Hoerova. (2015b) "A Theory of Bank Liquidity Requirements." Mimeo.

Capie, Forrest. (2010) *The Bank of England: 1950s to 1979*. Cambridge: Cambridge University Press.

Carlson, Mark. (2015) "Lessons from the Historical Use of Reserve Requirements in the United States to Promote Bank Liquidity." *International Journal of Central Banking*, 11, 191–224.

Carlson, Mark A., Burcu Duygan-Bump, and William R. Nelson. (2015) "Why Do We Need Both Liquidity Regulations and a Lender of Last Resort? A Perspective from Federal Reserve Lending during the 2007-09 U.S. Financial Crisis." Finance and Economics Discussion Series 2015-11, Board of Governors of the Federal Reserve System (U.S.).

Carlson, Mark A., and David C. Wheelock. (2014) "Navigating Constraints: the Evolution of Federal Reserve Monetary Policy, 1935-59." Working Papers 2014-13, Federal Reserve Bank of St. Louis.

CGFS. (2015) "Regulatory Change and Monetary Policy." Cgfs Papers No 54, Report Prepared by a Study Group Established by the Committee on the Global Financial System.

Christensen, Jens H. E., and Signe Krogstrup. (2019) "Transmission of Quantitative Easing: The Role of Central Bank Reserves." *Economic Journal*, 129, 249–72.

Christensen, Jens H.E., Jose A. Lopez, and Glenn D. Rudebusch. (2015) “A Probability-Based Stress Test of Federal Reserve Assets and Income.” *Journal of Monetary Economics*, 73, 26–43.

Clement, Piet. (2010) “The Term ‘Macroprudential’: Origins and Evolution.” *BIS Quarterly Review*, March, 59–67.

Coeuré, Benoît. (2016) “The ECB’s Operational Framework in Post-Crisis Times.” In *Speech by Benoît Cœuré, Member of the Executive Board of the ECB, at the Federal Reserve Bank of Kansas City’s 40th Economic Policy Symposium, Jackson Hole, 27 August 2016*.

Coeuré, Benoît. (2017) “Asset Purchases, Financial Regulation and Repo Market Activity.” In *Speech by Benoît Cœuré, Member of the Executive Board of the ECB, at the ERCC General Meeting, Brussels, 14 November, 2017*.

De Gregorio, José, Sebastian Edwards, and Rodrigo O. Valdés. (2000) “Controls on Capital Inflows: Do They Work?” *Journal of Development Economics*, 63, 59–83.

De Kock, Michel H. (1939) *Central Banking*. London: PS King & Son, Ltd.

De Kock, Michel H. (1946) *Central Banking*. London: Staples Press.

De Kock, Michel H. (1956) *Central Banking*. London: Staples Press.

De Kock, Michel H. (1974) *Central Banking*. London: Crosby Lockwood Staples.

Diamond, Douglas W., and Anil K. Kashyap. (2016) “Liquidity Requirements, Liquidity Choice and Financial Stability.” NBER Working Papers 22053, National Bureau of Economic Research, Inc.

EEC. (1962) *Monetary Policy in the Countries of the European Economic Community*. Bruxelles: EEC.

EEC. (1972) *Monetary Policy in the Countries of the European Economic Community*. Bruxelles: EEC.

Elliott, Douglas J., Greg Feldberg, and Andreas Lehnert. (2013) “The History of Cyclical Macroprudential Policy in the United-States.” Finance and Economics Discussion Series 2013-29, Board of Governors of the Federal Reserve System (U.S.).

Ennis, Huberto M., and Keister, Todd. (2008) “Understanding Monetary Policy Implementation.” *Economic Quarterly*, 943, 235–263.

ESRB. (2015) “ESRB Report on the Regulatory Treatment of Sovereign Exposures.”

Feinman, Joshua N. (1993) “Reserve Requirements: History, Current Practice, and Potential Reform.” *Federal Reserve Bulletin*, 79, 569–89.

Filardo, Andrew, Madhusudan Mohanty, and Ramon Moreno. (2012) “Central Bank and Government Debt Management: Issues for Monetary Policy.” *BIS Papers n°67*, 51.

Fousek, Peter G. (1957) *Foreign Central Banking: the Instruments of Monetary Policy*. New York: Federal Reserve Bank of New York.

Friedman, Milton, and Anna J. Schwartz. (1963) *A Monetary History of the United States, 1867-1960*. Number frie63-1 in NBER Books. National Bureau of Economic Research, Inc.

Marc Fuhrer, Lucas, Benjamin Müller, and Luzian Steiner. (2017) “The Liquidity Coverage Ratio and Security Prices.” *Journal of Banking & Finance*, 75, 292–311.

Garvy, George. (1968) *The Discount Mechanism in Leading Industrial Countries Since World War II*, Volume 5. Washington, DC: Board of Governors of the Federal Reserve System.

Garvy, George. (1973) “Reserve Requirements Abroad.” *Monthly Review, Federal Reserve Bank of New York*, pp. 256–265.

Goode, Richard, and Richard S. Thorn. (1959) "Variable Reserve Requirements against Commercial Bank Deposits." *Staff Papers (International Monetary Fund)*, 7, 9–45.

Goodfriend, M., and Hargraves M.. (1983) "A Historical Assessment of the Rationales and Functions of Reserve Requirements." *FRB Richmond Economic Review*, 69(2), 3–21.

Gorton, Gary B., and Guillermo Ordoñez. (2013) "The Supply and Demand for Safe Assets." NBER Working Papers 18732, National Bureau of Economic Research, Inc.

Gray, Simon T. (2011) "Central Bank Balances and Reserve Requirements." IMF Working Papers 11/36, International Monetary Fund.

Greenwood, Robin, Samuel Hanson, Joshua S. Rudolph, and Lawrence Summers. (2015) *Debt Management Conflicts between the U.S. Treasury and the Federal Reserve*, pp. 1–41. Washington, DC: Brookings Institution Press.

Greenwood, Robin, Samuel G. Hanson, and Jeremy C. Stein. (2016) "The Federal Reserve's Balance Sheet as a Financial-Stability Tool." In *Jackson Hole Symposium: Federal Reserve Bank of Kansas City*.

Hanes, Christopher. (2019) "Explaining the Appearance of Open-Mouth Operations in the 1990s U.S." *North American Journal of Economics and Finance*, 48, 682–701.

Hodgman, Donald R. (1972) "Selective Credit Controls." *Journal of Money, Credit and Banking*, 4, 342–59.

Hodgman, Donald R. (1973) *Credit Controls in Western Europe: An Evaluative Review*, pp. 137–61 Boston: The Federal Reserve Bank of Boston, Credit Allocation Techniques and Monetary Policy.

Hodgman, Donald R. (1974) *National Monetary Policies and International Monetary Cooperation*. Boston: Little, Brown.

Imhof, Stephan, Cyril Monnet, and Shengxing Zhang. (2019) *The Risk-Taking Channel of Liquidity Regulations and Monetary Policy*. Mimeo.

Jéquier, Rémi. (1966) *La politique des réserves obligatoires: étude de politique monétaire*. Librairie Droz.

Jonung, Lars. (1993) *The Rise and Fall of Credit Controls: The Case of Sweden, 1939–89*, pp. 346–70. Cambridge: Cambridge University Press.

Keister, T., and M. L. Bech. (2012) "On the Liquidity Coverage Ratio and Monetary Policy Implementation." *BIS Quarterly Review*, December, 49–61.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor. (2016) "Sovereigns Versus Banks: Credit, Crises, and Consequences." *Journal of the European Economic Association*, 14, 45–79.

Kandrac, John, and Bernd Schlusche. (2017) "Quantitative Easing and Bank Risk Taking: Evidence from Lending." Finance and Economics Discussion Series 2017-125, Board of Governors of the Federal Reserve System (U.S.).

Kashyap, Anil K., and Jeremy C. Stein. (2012) "The Optimal Conduct of Monetary Policy with Interest on Reserves." *American Economic Journal: Macroeconomics*, 4, 266–82.

Kaufmann, Hugo M. (1969). "A Debate over Germany's Revaluation 1961: A Chapter in Political Economy." *Weltwirtschaftliches Archiv*, 103, 181–212.

Kelber, Anna, and Eric Monnet. (2014) "Macroprudential Policy and Quantitative Instruments: A European Historical Perspective." *Financial Stability Review*, 18, 151–60.

Koch, Christoffer. (2015) "Deposit Interest Rate Ceilings as Credit Supply Shifters: Bank Level Evidence on the Effects of Regulation Q." *Journal of Banking & Finance*, 61, 316–26.

Kumhof, Michael, and Jaromir Benes. (2012) “The Chicago Plan Revisited.” IMF Working Papers 12/202, International Monetary Fund.

Kydland, Finn E., and Edward C. Prescott. (1977) “Rules rather than Discretion: The Inconsistency of Optimal Plans.” *Journal of Political Economy*, 85, 473–91.

Landau, Jean-Pierre,. (2016) “A Liquidity-Based Approach to Macroprudential Policy.” In *Macroprudential Policy*, edited by Bank for International Settlements, volume 86 of BIS Papers Chapters, pp. 147–56. Basel: Bank for International Settlements.

Lehmann, Paul-Jacques. (1979) *Le système des réserves obligatoires et le contrôle de la masse monétaire*, Rouen: Presses Universitaires de Rouen.

Martin, Antoine, James McAndrews, and David Skeie. (2016) “Bank Lending in Times of Large Bank Reserves.” *International Journal of Central Banking*, 12, 193–222.

McLeod, A. N. (1959) “Security-Reserve Requirement in the United-States and the United-Kingdom: A Comment.” *Journal of Finance*, 14, 531–42.

Meltzer, Allan H. (2003) *A History of the Federal Reserve. Vol. 1: 1913-1951*. Chicago: University of Chicago Press.

Meltzer, Allan H. (2010) *A History of the Federal Reserve, Volume 2, Book 2, 1970-1986*. Number 9780226213514 in University of Chicago Press Economics Books. Chicago: University of Chicago Press.

Miller, Donald C. (1950) “Reconciling Monetary Management and Debt Management Policies.” *Journal of Finance*, 5, 368–86.

Monnet, Eric. (2014) “Monetary Policy without Interest Rates: Evidence from France’s Golden Age (1948 to 1973) Using a Narrative Approach.” *American Economic Journal: Macroeconomics*, 6, 137–69.

Monnet, Eric. (2015) “La politique de la Banque de France au sortir des Trente Glorieuses: un tournant monétariste?” *Revue d’histoire moderne et contemporaine*, 147–74.

Monnet, Eric. (2018) *Controlling Credit: Central Banking and the Planned Economy in Postwar France, 1948–1973*. Cambridge: Cambridge University Press.

Monnet, Eric, and Damien Puy. (2016) “Has Globalization Really Increased Business Cycle Synchronization?” IMF Working Papers 16/54, International Monetary Fund.

Neufeld, E. P. (1958) “The Bank of Canada’s Approach to Central Banking.” *Canadian Journal of Economics and Political Science/Revue canadienne d’Economique et de Science Politique*, 24, 332–44.

O’Brien, Yueh-Yun C. (2007) “Reserve Requirement Systems in OECD countries.” Finance and Economics Discussion Series 2007-54, Board of Governors of the Federal Reserve System (U.S.).

OECD. (1975) *The Role of Monetary Policy in Demand Management: The Experience of Six Major Countries*. Paris: OECD Monetary studies.

Ögren, Anders. (2010) “The Causes and Consequences of Banking Regulation: The Case of Sweden.” Past, Present and Policy, CEPR and Norges Bank, Geneva.

Ongena, Steven, Alexander Popov, and Neeltje Van Horen. (2019) “The Invisible Hand of the Government: Moral Suasion during the European Sovereign Debt Crisis.” *American Economic Journal: Macroeconomics*, 11, 346–79.

Òscar, Jordà. (2005) “Estimation and Inference of Impulse Responses by Local Projections.” *American Economic Review*, 95, 161–82.

Poole, William. (1968) "Commercial Bank Reserve Management in a Stochastic Model: Implications for Monetary Policy." *Journal of Finance*, 23, 769–91.

Powel, Jeromel. (2019) *FOMC Press Conference*. Federal Reserve Board.

Quarles, Randal K. (2018) "Liquidity Regulation and the Size of the Fed's Balance Sheet." In *Speech at "Currencies, Capital, and Central Bank Balances: A Policy Conference a Hoover Institution Monetary Policy Conference"*, Stanford University.

Reinhart, Carmen M., and Graciela L. Kaminsky. (1999) "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems." *American Economic Review*, 89, 473–500.

Reinhart, Carmen M., and M. Belen Sbrancia. (2015) "The Liquidation of Government Debt." *Economic Policy*, 30, 291–333.

Reis, Ricardo. (2020) "The Fiscal Footprint of Macroprudential Policy." Mimeo.

Richter, Björn, Moritz Schularick, and Ilhyock Shim. (2018) "The Costs of Macroprudential Policy." CEPR Discussion Papers 13124, C.E.P.R. Discussion Papers.

Riddle, John H., and Roy L. Reierson. (1946) "An Analysis of the Certificate Reserve Plan." *Journal of Finance*, 1, 27–51.

Romer, Christina D., and David Romer. (1993) "Credit Channel or Credit Actions? An Interpretation of the Postwar Transmission Mechanism." In *Proceedings-Economic Policy Symposium-Jackson Hole*, pp. 71–149. Federal Reserve Bank of Kansas City.

Romer, David. (1985) "Financial Intermediation, Reserve Requirements, and Inside Money: A General Equilibrium Analysis." *Journal of Monetary Economics*, 16, 175–94.

Roosa, Robert V. (1951) "The Revival of Monetary Policy." *Review of Economics and Statistics*, 33, 29–37.

Stein, Jeremy C. (2013) "Liquidity Regulation and Central Banking." *2013 Credit Markets Symposiums*, 4, 266–82.

Svensson, Lars E.O. (2017) "Cost-Benefit Analysis of Leaning against the Wind." *Journal of Monetary Economics*, 90, 193–213.

Tamagna, Frank M. (1963) "Processes and Instruments of Monetary Policy: A Comparative Analysis." In Warren L. Smith, Clark Warburton, Michael D. Reagan, Charles P. Kindleberger, and Robert Z. Aliber (eds.), *Monetary Management*, edited by R. Aliber, et al., pp. 1–174. New Jersey: Prentice-Hall.

Thurow, Lester C., ed. (1971) *Activities by Various Central Banks to Promote Economic and Social Welfare Programs*. Washington: US Government Printing Office.

Tobin, James. (1953) "Monetary Policy and the Management of the Public Debt: The Patman Inquiry." *Review of Economics and Statistics*, 35, 118–27.

Toniolo, Gianni, and Eugene N. White. (2015) "The Evolution of the Financial Stability Mandate: From Its Origins to the Present Day." NBER Working Papers 20844, National Bureau of Economic Research, Inc.

Vari, Miklos. (2020) "Monetary Policy Transmission with Interbank Market Fragmentation." *Journal of Money, Credit and Banking*, 52, 409–40.

Volcker, Paul A. (2002) "Monetary Policy Transmission: Past and Future Challenges." *Economic Policy Review*, 8, 7–11.