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Abstract

This paper explores what history can tell us about the interactions between macroprudential and monetary policy. Based on numerous historical documents, we show that liquidity ratios similar to the Liquidity Coverage Ratio (LCR) were commonly used as monetary policy tools by central banks between the 1930s and 1980s. We build a model that rationalizes the mechanisms described by contemporary central bankers, in which an increase in the liquidity ratio has contractionary effects, because it reduces the quantity of assets banks can pledge as collateral. This effect, akin to quantity rationing, is more pronounced when excess reserves are scarce.

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I. Introduction

It is well known that monetary policy can complement macroprudential measures in the pursuit of financial stability, by "leaning against the wind" (Borio (2011), Adrian et al. (2018), and Svensson (2017)). Interestingly, the reverse also existed, but is much less known. Macroprudential tools have sometimes been used to influence money market rates in order to stabilize output and inflation, a role typically assigned to monetary policy.

Liquidity regulations similar the current Basel III Liquidity Coverage Ratio (LCR) have been used from the 1930s to the 1980s in many countries as monetary policy tools. They took the form of required deposits at the central bank ("cash reserve requirements") or minimum holdings of liquid securities ("securities reserve requirements"). As with 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 (Carlson (2015), Bindseil (2004), Bech and Keister (2017), and Romer (1985)), we are not aware of any study on "securities reserve requirements."

Our paper presents three contributions. First, based on detailed readings of historical central banks' reports and documents, we describe how and why liquidity ratios were used in many countries (especially Europe) from the 1930s to the 1980s , following the American experience. By emphasizing the distinction between "securities-reserve requirements" and "cash-reserve requirements," we provide details on central bank practices whose history is largely unknown, and shed light on the dual nature of liquidity ratios as prudential and monetary policy tools. Second, we show how "securities reserve requirements" were at the crossroad of monetary policy and sovereign debt management. It explains why they 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)). Securities-reserve requirements were typically used in a period when banks held a large share of government bonds, and they reinforced such phenomenon. Central banks increased liquidity ratios during times of restrictive monetary policy in order to prevent banks from selling government securities, which were the main type of assets eligible to fulfill the requirement. As such, banks were discouraged to shift their assets from government securities to corporate loans. Third, we build a theoretical model, and show that the mechanisms previously described can be rationalized with a simple model of the interbank market.[1] By this, our paper

[1] 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

introduces a new mechanism in the current literature on liquidity regulation and sheds new light on the history of monetary policy.

Acknowledging that direct quantitative controls on bank lending or reserves were a key element of central banks'toolbox in the past, a growing literature has looked at historical experience to estimate their macroeconomic effects and discuss similarities with current macroprudential tools (Elliott et al. (2013), Monnet (2014), Kelber et al. (2014), Carlson (2015), Calomiris and Carlson (2015), Koch (2015), Aikman et al. (2016), and Richter et al. (2018)).[2] 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 are these empirical results. Contrary to this literature, we draw on historical experience of central banks to investigate theoretical mechanisms through which liquidity ratios interact with monetary policy.[3]

Greenwood et al. (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 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.[4] Taking stock of how liquidity ratios were used in history, we present a new mechanism, where liquidity ratios work as a collateral constraint for banks, preventing them from borrowing at the central bank. Thus, an increase in liquidity ratios has a contractionary effect, raising the interbank rate. It is akin to a quantity rationing effect, where the central bank imposes a limit on how much banks can borrow.

The potential tightening of monetary condition induced by liquidity requirement has been identified as a key risk by European Central Bank (ECB) and Federal Reserve (Fed) officials (Coeuré (2016) and Quarles (2018)). Their proposed policy response involves keeping the central bank's balance sheet at elevated level or to expand liquidity provision in a way or another. It is consistent with our result that securities reserve requirements have less contractionary effects

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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.

[2] A precedent to this literature can be find in Romer and Romer (1993) which distinguished between credit actions and monetary policy measures of the United-States Federal Reserve.

[3] There are still some debates on whether liquidity ratios are macroprudential tools. Some view them as only performing microprudential functions. However, it seems that the current consensus is to include them in the set of macroprudential instruments, ECB (2016).

[4] Bonner, Clemens and Eijffinger, Sylvester C. W. (2016) and Fuhrer et al. (2017) present evidence of such an effect, based on the implementation of the LCR in the Netherlands and in Switzerland.

when the central bank balance sheet is large (because excess reserves are large). This policy response however leads to a key paradox: although the LCR was introduced to limit the role of central banks as liquidity providers (BCBS (2013) and Carlson et al. (2015), central banks may in fact have to increase their liquidity provision to offset the contractionary effects of liquidity regulation.[5] Greenwood et al. (2016) and Bech and Keister (2017) reach similar conclusions although their mechanisms act through different channels. This paradox seems therefore to be fairly general.

Section II provides the historical narrative of reserve requirement, section III develops the model and tests it using historical data and section IV concludes.

II. Cash and Securities-Reserve Requirements in History

The basic idea behind reserve requirements is to impose to banks to hold a quantity X of liquid assets (central bank reserves or securities) for every unit of deposit collected (or any pre-defined liability). X is then called the reserve requirement ratio. The central bank reserves or the securities are called the "reservable assets" of any specific requirement. The deposits collected are the " reserve base."

Reserve requirements are very similar to today's LCR, which impose that banks keep a certain amount "high quality liquid asset (HQLA)," the more short-term liability they have. The LCR as a modern version of reserve requirements is more sophisticated. The set of eligible reservable assets is wider, and notably includes some foreign currency debt, subject to haircuts. The way short-term liabilities are calculated is only more complex. Notably, it is allowed to deduct some projected liquidity inflows from the reserve base. Economically, this is equivalent to including these inflows into the set of reservable assets. In this sense, the LCR can be considered as very similar to previous "securities reserve requirements."

Reserve requirements is probably one of the most complex policy tool at the disposal of central banks. Reserve requirements are sometimes hard to understand due to the fact that they can be used for very different reasons, and that these reasons vary substantially across time and

[5] Increasing the size of the balance sheet implies that the central bank takes additional interest rate risk and/or credit risk (Bhattarai et al. (2015)).

countries. Reserve requirements can be used either as a banking regulation, a monetary policy tool, a tax or a "Financial repression" instrument.[6]

- Banking regulation: Reserve requirements intend to force banks to keep a minimum amount of liquid assets to withstand bank run (Feinman (1993), and Carlson (2015)).
- 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 M. Ennis and Todd Keister (2008))).
- Tax: Reserve requirements can be used as a direct tax on banks (Romer (1985)), for pure fiscal reasons. The tax can also be used as a pigouvian tax on issuance of short-term deposits Kashyap and Stein (2012). The tax can also be used on foreign deposits to discourage inflows, or on foreign currency deposit, to discourage financial dollarization and/or penalize currency risk.
- "Financial repression" instrument: Reserve requirements have sometimes been used as a mean to force banks to lend to the government or to some defined sector of the economy (De Kock (1974), Jonung (1993), Reinhart and Sbrancia (2015), and Monnet (2018)).

Obviously, a central bank may use reserve requirements for more than one reason at a time.

Although these terms are often confounded, there is a key conceptual and historical difference between "*cash-reserve requirements*" which are exactly what we usually call today "reserve requirements" (i.e., a minimum amount of balances at the central bank) and "*securities-reserve requirements*." This second category included all the ratios that forced banks to hold a proportion of their assets (most of the time expressed as a ratio of some forms of liabilities) as "liquid assets." They differed from the first category because these forced holdings were not deposited with the central banks and they included a broader set of assets (usually mostly government securities). The current Basel III's LCR is a form a securities-reserve requirements which 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 past securities-reserve requirements .

Cash and securities reserves requirements are distinct instruments but they are often labeled together as liquidity requirements. It is worth studying their history and their theoretical effects

[6] For an alternative classification, see Bindseil (2004).

together. We will see that both were first introduced as prudential regulatory instruments before being treated as monetary policy tools. In some countries (prominently in the U.S. and Germany), central banks used only cash-reserve requirements. In many others, various securities-reserve requirements were in place, sometimes - but not always - combined with cash-reserve requirements. The use of securities-reserve requirements was however abandoned in the 1980s (Bindseil (2004), Bisignano (1996), Jonung (1993), Monnet (2018), and Borio (1997)), mostly because of their complexity, because banks had found ways to circumvent them, and because central banks moved away from quantitative instruments. Today, many central banks still use cash-reserve requirements for monetary policy implementation (O'Brien (2007), and Gray (2011)). By contrast securities-reserve requirements have disappeared from the standard toolbox of central banks.

A. The Birth of Liquidity Requirements as a Monetary Policy Tool: Cash Requirement in the U.S. and its International Influence

To appreciate the main evolution of central banking practices and objectives from the 1930s to the 1970s, it is useful to compare the several different editions of the reference text on the matter during this period: *Central Banking*, by M.H de Kock (1939, 1946, 1954, and 1974).

The 1st edition, published in 1939, devoted three chapters to the policy instruments of central banks: "discount rate policy," "open-market operations", and "other methods of credit control."[7] In the latter, there was a short section on "changes in minimum cash reserves of commercial banks." Such an instrument was viewed as a very recent but important addition to the set of central banks tools:

> "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)

[7] The other chapters covered the other functions of central banks (bank of issue, government's banker, lender of last resort, settlement) and the history and the objectives of the monetary authorities.

At the time he was writing, only New Zealand and Sweden had introduced similar techniques (in 1936 and 1937), and they had done so to follow the U.S. innovation. However, 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).

The birth of cash-reserve requirements as a monetary policy tool in the U.S. in the 1930s is well-documented (Friedman and Schwartz (1963), Meltzer (2010), and Carlson and Wheelock (2014)). Interestingly, "cash reserve requirement" had a long history in the U.S. as a banking regulation tool before becoming a monetary policy tool (Goodfriend and Hargraves (1983), Calomiris (2012), Carlson (2015), and Calomiris and Carlson (2017). They existed before the creation of the Fed, and, between 1913 and 1933, the Fed system kept a fixed cash-reserve requirement for a purpose of banking regulation only. However, Fed officials soon realized that this ratio had an effect on credit and, thus, had a *de facto* monetary policy role:

> "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"[8]

and

> "The most important function served by member bank reserve requirements is the control of credit. [...] It is the function of reserve requirements to restrain such overexpansion by making it necessary for banks to provide for additional reserves before they expand their credit." (Federal Reserve System, Annual Report 1931).

Then, in 1933, it was decided to pass a law to make cash-reserve requirements adjustable in order to control credit in a way consistent with the policy objectives of the Fed. In 1936–1937, reserve requirements became the main policy tool of the restrictive policy of Fed (Friedman and Schwartz (1963)).[9]

[8] The Fed stated clearly (cf. 1931 report of the Federal Reserve System Committee on Bank Reserves quoted in Goodfriend and Hargraves (1983): 37 and Carlson and Wheelock (2014)): "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 member banks by providing for the rediscount of their eligible paper, than by the possession of legal reserves."

[9] Their effectiveness has however been challenged by Goodfriend and Hargraves (1983) and Calomiris et al. (2015).

One reason why the evolution of reserve requirements from banking regulation to monetary policy instrument occurred first in the U.S. is certainly that, in the 1930s, this country had the most developed and long-lived banking regulation in the world, dating back to the mid-19th century. Reserve requirements had been established in 1863 with the passage of the National Bank Act. On the contrary, in most countries (including European countries which had long-lived central banks), banks were not regulated before the mid-1930s or even before WWII. Banks were registered as any other limited liability company, and were not constrained by any regulation on capital or liquidity. Only banks of issue were regulated and had to keep reserves in function of their note issuance (Toniolo and White (2015)).[10] Without banking regulation, it was of course impossible that a banking regulation tool became a monetary policy tool. The use of cash-reserve requirements then quickly spread worldwide in the 1930s and 1940s as countries were implementing banking regulations and were, at the same time, widening their set of monetary policy instruments. Much less known, however, is the history of securities-reserve requirements which developed widely outside of the U.S.

B. Cash-Reserve Requirements vs. Securities-Reserve Requirements

Let's turn to the fourth edition of de Kock's book on central banking, published in 1974. Two differences with the 1st edition are striking. First, as anticipated in the 1939 edition, reserve requirements indeed had become an instrument of first importance for central banks (De Kock (1974), p. 207), so that 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." Second, the definition of "reserve requirements" has widened. In 1974, it includes two narrower 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 deposit at the central banks (as a proportion of some or total assets or liabilities). The latter is different since it does not involve cash deposits in any institution: "liquid-asset requirement" means that a fixed proportion of total assets must be held in liquid assets (the definition of "liquid assets" being different across countries and periods; see below). The distinction between "cash reserve requirement" and "liquid asset requirement" (i.e., "securities reserve requirements") is not found only in De Kock's books. 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), EEC (1972), Tamagna (1963), Thurow (1971), Hodgman (1973), and OECD (1975)). In these

[10] Sweden is an exception that will be discussed below.

studies, “liquid asset requirements” were also called “securities reserve requirements” or “liquidity ratios.” When some authors (especially U.S. economists) used the more general term “reserve requirements” to denote “cash-reserve requirements” only, they also noted that they complemented “liquidity ratios” (i.e., “securities-reserve requirements”).[11] For example, in an essay on reserve requirements outside the U.S., George Garvy writes:

> “In several leading industrial countries where [cash] reserve requirements were introduced relatively recently, they have been integrated with the existing fairly complex systems of monetary control, notably liquidity ratios.” (Garvy (1973), 1973, p. 256)

In any case, as Garvy, all authors clearly included these two types of liquidity requirements (cash and securities) within the set of monetary policy instruments.[12] As cash-reserve requirements in the U.S., securities-reserve requirements had been first introduced as banking regulation tools in the few countries that had a banking regulation before the mid-1930s, namely Sweden in 1911 and then Switzerland in 1934. They shared a similar story. Fixed liquidity ratios implemented for prudential purposes later became (or were complemented by) adjustable liquid asset ratios and then were used for monetary policy purposes:

> “Initially, minimum liquidity ratios 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)”

Cash and securities requirements were deemed similar because both of them forced banks to invest a proportion of their assets in some legally defined assets, whether they were deposited at the central bank or kept in the bank. There were seen as having as similar restrictive effects on monetary conditions:

> “Reserve requirements limit the total expansion of bank credit and the secondary expansion of bank deposits that can occur on the basis of any primary increase in

[11] The New York Fed economist Fousek (1957) devoted one separate chapter to each of them “Chapter IV: commercial bank cash reserve requirements” and “chapter V: commercial bank liquidity ratios”, while calling the latter “securities reserve requirements.”

[12] Or “credit control” instruments, as this term was often used as a synonymous to monetary policy at that time.

> deposits. [...] [They] limit the extent to which bank loans and investment can, or must, change when there is an increase or decrease in the cash resources of banks as a result of rediscounts at the central bank or a change in another nondeposit item in the balance sheet. [...] *Reserves in forms other than cash deposits with the central bank can also serve the purpose of limiting the expansion of bank credit and the money supply. If the reserves take the form of government bonds or other securities than must be obtained from the central bank, their credit-limiting function is identical with that of cash reserves.*" (Goode and Thorn, 1959, p. 10–13)

Some authors, however, acknowledged that securities-reserve requirements had a distinctive effect which was different from the one of cash-reserve requirements. To this we now turn our attention.

C. Key Purposes and Rationale of Securities-Reserve Requirements

Securities requirements were used to complement any instrument of monetary policy - including cash-reserve requirements - because central banks wanted to avoid that banks circumvented restrictive measures by selling government securities to obtain liquidity. This argument was formulated explicitly by many central banks (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)

In this case, securities-reserve requirements (which force banks to hold government securities as liquid assets) are 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:

> "At times in Australia, however, the restraining effect of these [cash-reserve] requirements was largely nullified by the commercial banks' liquidation of their

> government securities holdings in a market supported by the central bank. In 1954 such selling of government securities by the Australian banks prompted the central bank to propose that the banks observe a ratio of 25 percent between liquid assets (including government securities) and their total deposits; the central bank stated that this would make its monetary more effective." (Fousek (1957), p. 58)

Similar mechanisms are described about French monetary policy and the effect of a liquidity ratio that forced banks to hold a fixed share of their assets as Treasury bills:

> "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" (" planchers") for government paper, [...] is an automatic restraint on the volume of loans the banks can make to their customers. " (EEC (1962), p. 121)

An alternative strategy would have been to let the price of government securities fall, but central bank were not willing to act against governments. An acute observer of postwar U.S. monetary policy summed up these issues in the following way:

> "The control of credit is a problem because the present holdings of government securities by commercial banks permit the expansion of credit to inflationary levels. 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 requirement, or it let the yield on government bonds rise. For this reason, there were some proposals to give enough power to the Fed to impose securities-reserve requirements, as it was done in many countries. .

D. The U.S. Debate on Securities-Reserve Requirements

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.[13] However, 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), and Meltzer (2003) p. 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)). As in other countries, these proposals aimed to define a set of liquid assets (Treasury bills, 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. The objective of such tools were clearly to control inflation through credit restrictions; in the postwar context, financial stability was not an issue but credit expansion was seen as the primary source of inflation:

> "In order to provide a more effective means of restraining inflationary expansion of bank credit, the Board of Governors of the Federal Reserve System proposes that Congress pass legislation granting the System's Federal Open Market Committee temporary authority to impose gradually as conditions may warrant a requirement that all commercial banks hold a special reserve. "(Federal Reserve Bulletin, January 1948, p. 14)

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 to support expansion of credit to private borrowers." (ibid)

[13] The Bundesbank, however, used rediscount quotas (i.e., bank-by-bank ceilings limiting the amount borrowed at the discount window) which, as we show in our model of the next section, are equivalent to securities-reserve requirements.

As explained by (Burkhead (1947)), quoted above, such a tool was deemed necessary because of the large holding of government securities in banks' balance sheet (about 60 percent) during and after the war. In such context, it was a key measure aiming at "reconciling monetary management and debt management policies" (Miller (1950)). It was intended to complement other tools of monetary restraints (discount window, open-market operations and cash-reserve requirements) whose effects were made ineffective by the sales of government securities by banks.[14]

E. Why these Tools were Abandoned

This section explores why liquidity ratios were phased-out. We highlight two main reasons: (i) the effect of these tools in terms of government financing and (ii) their complexity and distributive effects.

1. Government Financing

U.S. debates on the proposals to introduce securities-reserve requirements reveal that such tools stood at the crossroads between monetary policy and fiscal policy since government securities were the major type of liquid assets to be included in the liquidity requirements. It was generally recognized that liquidity requirements increased the effectiveness of monetary restraints:

> "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))

[14] "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). In many ways, today's situation (post 2007–2008 crisis) 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.

Hence, most of the debates revolved around the usefulness to reconcile or, on the contrary, isolate, monetary policy and fiscal considerations. This was not specific to the U.S. and it was widely acknowledged in countries which had chosen to rely on securities-reserve requirements (see also the discussion of the French case in the appendix):

> "The purpose for which the ratios have been instituted, however, has varied among individual countries. Thus, soon after World War II, and again during the post-Korea inflation, a number of European countries turned to them in an effort to halt the excessive expansion of bank credit; in certain cases, the ratios also resulted in channeling bank funds into the financing of budget deficits." (Fousek (1957), p. 57)

The dilemma that central banks faced was the following. Either they stopped providing liquidity against government securities, which would decrease the price (i.e., increase the interest rate) of government debt. Or they imposed liquidity requirements to force banks to hold a certain proportion of government securities in their portfolio. In the 1980s however some asked whether it was legitimate to protect government financing from the overall credit restriction. Such implicit taxes were associated with "financial repression" (Reinhart and Sbrancia (2015)), and were phased-out in the wake of the financial liberalization reforms that took place in many parts of the world in the 1980s (Reinhart and Kaminsky (1999)).[15]

The same reasoning may also apply to the LCR. Indeed, government bonds are treated generously by the Basel committee. 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 idea to tweak liquidity regulation to ensure a stable demand for some government asset can also be found in the current discussion around the creation of a European safe asset. Liquidity requirements that forced banks to hold a certain amount of government securities performed a dual role: they controlled banks' liquidity while securing financing to the government.

[15] Cash reserve requirements however continued to exist, but at much lower level, and solely as a tool to stabilize money market rate (Bindseil (2004)).

2. Complexity of Tools and Distributive Effects

Reserve requirements—both cash and securities—performed several roles, beyond their function as monetary policy tools (Goode and Thorn (1959), Jonung (1993) and Monnet (2018)). As explained above, they were often born as banking regulation tools, and later were used to combat inflation. In most countries, however, they kept their banking stability function - although it was not anymore their main objective - 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. Their effect on the composition of assets was also used 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 reader interested in the details of monetary policy implementation and in the other functions performed by liquidity requirements should turn to the appendix where we describe in length the use of liquidity ratios in three countries: France, Germany, and Sweden. More specifically, the French case illustrates the interaction between liquidity requirements and public debt as well as the acknowledged redistributive effect of liquidity ratios. The Swedish case shows how liquidity ratios originally designed as banking regulation tools were later integrated into the set of monetary policy instruments aiming to fight inflation and affect the quantity of credit in the economy. It also provides an example of liquidity ratios that differed according to the size of the banks. Finally, Germany offers a paradigmatic example of the use of reserve requirements for external purposes: sterilization of capital inflows and capital controls.

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 et al. (2013), Monnet (2018), Kelber et al. (2014), and Aikman et al. (2016)). 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 overtime in order to remain binding, so that their value had to adapt to the composition of banks' balance sheets, which may evolve overtime 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):

> "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).

A similar argument is expressed by Capie (2010), in his masterful study of the Bank of England, about special deposits in the 1960s (i.e., cash-reserve requirements):

> "It is not easy to say what special deposits achieved because a number of factors were at work. For example, the clearing banks were under-lent when compared with their pre-war position and had been gradually rebuilding advances during the 1950s and 1960s. Even where advances did fall, as they did after July 1961, special deposits were only one element in a package. It is also difficult to disentangle the precise reasons for a decision." (Capie (2010), p. 274).

As a consequence, Romer and Romer (1993), Monnet (2014) and Aikman et al. (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 macro-economy.[16]

For decades, central banks favored such tools that had a distributive impact, in order to direct credit to priority sectors and the government. This changed in the 1970s, and more so in the 1980s and 1990s, when central banks became independent and turned to market-oriented tools

[16] Elliott et al. (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.

for monetary policy implementation, in particular open market operations (Borio (1997),Jonung (1993) and Monnet (2018)).

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

III. 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. As proposed in today's LCR, funds deposited with the central bank were included in the "securities-reserve requirements", even when the central bank did not impose compulsory cash reserves. All the channels studied in this section are then potentially relevant when considering the effects of the Basel III LCR. The LCR takes the form of a broad liquidity requirement that include both safe securities and deposits at the central banks (whether such deposits are mandatory or not).

A. 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 draws on Huberto M. Ennis and Todd Keister (2008), Bech and Keister (2013), and Vari (2019). A key modeling assumption of our model is that securities can be pledged to borrow from the central bank. They can also be used to fulfill securities reserve requirements. This dual role implies that an increase in securities reserve requirements reduces the stock of

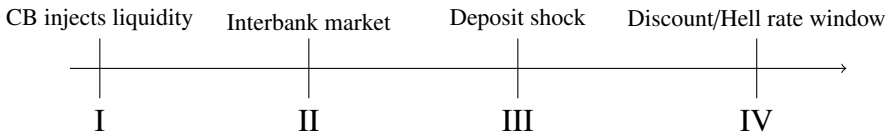
[17] As shown in Monnet (2014) the effect of quantitative controls on money and credit could be disconnected from the effect of interest rates. In such context, interest rates cannot be used as a reliable proxy for the monetary policy stance.

collateral that banks can use to borrow at the central bank. We are to our knowledge the first ones to introduce liquidity regulation and collateral constraints in a model of the money market. By contrast Bech and Keister (2013) have modeled liquidity regulation in a context where there is no collateral constraint. In their model banks may chose to borrow on the interbank market or from the central bank to obtain central bank reserves, which would accrue to their liquid asset and improve their liquidity ratio.

1. The Timing of the Model

The model intends to capture the determination of short-term money market rates, by modeling banks' decisions during a typical trading day. The timeline of the model is the following: first, the central bank can injects liquidity. Second, the trading session for interbank loans occurs. Third, once the interbank market is closed, banks experience a "late" deposit shock. Fourth, banks go to the central bank discount window at which the they can borrow overnight limited amount of funds. 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 Fed.[18] We call the penalty rate the "hell rate," as it used to be at the Bank of France in the 1950s (Monnet (2014)). Finally, consistent with post-war central banking practices, we assume that required or excess balances of banks are not remunerated.

Diagram 1. Timing of the Model



[18] 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.

2. The End of the Day: the Reserve Requirements Constraints

All the liquidity management of the bank is dictated by its need to have enough liquidity at the end of the day to satisfy reserve requirements.[19]

Cash reserve requirements, impose that the end-of-day balance of bank "i" is greater than some number K^i.[20] 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.

3. Period IV: Discount Window Borrowing

Banks need some collateral in order to borrow at the discount window rate. If they do not have enough collateral they need to borrow at the "hell rate."[21]

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

One can solve the bank's problem backward, starting with the demand for discount window loan and "hell rate" loans.

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[19] Note that if there was no reserve requirements, the bank would need to ensure that it has non-negative balance on its central bank account. Otherwise, it would mean that it is effectively borrowing from the monetary authority.

[20] Many central banks require banks to fulfill their reserve requirements obligations over a a so-called "maintenance period" (Gray (2011)). As pointed by Bech and Keister (2017) this averaging provision complicates considerably the analysis Bindseil (2004) but not change the results qualitatively. The reason is that these models can be thought as the last day of the maintenance period (when the averaging provision does not play a role). Interest rates on previous days should be aligned with the last day, by arbitrage.

[21] 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 requirements, 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.

Using equation ((1)), this implies that:

$$X = max\{0; min\{C^i; K^i - (R^i + B^i - \epsilon^i)\}\} \tag{2}$$

and

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

Given ((2)) and ((3)), the profit of bank "i" writes:

The profit of the bank then writes:

$$\Pi^i = Lr_L + r_s S^i - r_D(D^i - \epsilon^i) - r_B B^i - r_H H^i - r_X X^i \tag{4}$$

Where r_L, r_s, r_D, r_B, r_X, r_H are respectively the rate on loans, government securities, deposits, interbank loans, discount window loans and finally the hell rate. The first three rates are market rates. The two lasts are set by the central bank. For simplification, we assume: $r_D = r_B$.

4. Period III: Profits for a Given Distribution of Payment Shocks

Profits will vary as a function of the payment shock, which is a random variable with mean 0, and with density function g(.) and cumulative distribution function G(.). This payment shock captures the idea that banks cannot perfectly predict their end-of-day position and may receive late payment orders, that they cannot compensate by borrowing/lending on the interbank market (see Huberto M. Ennis and Todd Keister (2008), or Vari (2019))).

5. Period II: Profit Maximization for a given Distribution of Payment Shocks

Combining ((2)), ((3)), and ((5)) and taking expectations yields:

$$E(\Pi^i) = Lr_L + r_s S^i - r_D(D^i) - r_B B^i - r_H \int_{R^i-K^i+B^i+C^i}^{\infty} g(\epsilon^i)(\epsilon^i - (R^i - K^i + B^i + C^i))d\epsilon^i$$
$$- r_X\Big(\int_{R^i-K^i+B^i}^{R^i-K^i+B^i+C^i} g(\epsilon^i)(\epsilon^i - (R^i - K^i + B^i) + \int_{R^i-K^i+B^i+C^i}^{\infty} g(\epsilon^i)C^i d\epsilon^i \Big) \quad (5)$$

Where $g(.)$ is the density function of the random variable ϵ^i.[22]

Profit maximization with respect to the amount of interbank loans (B^i) implies:

$$\frac{\partial E(\Pi^i)}{\partial B^i} = 0 \quad (6)$$

6. Equilibrium on the Interbank Market

Combining ((6)) with ((5)), and making the assumption that all banks are symmetric yields:[23]

$$r_B^\star = (1 - G(R - K + C))r_H + (G(R - K + C) - G(R - K))r_X \quad (7)$$

Where G(.) is the cumulative distribution function of ϵ^i. One can express the position of the interbank rate compared to the discount rate, as follows:

$$\frac{r_X - r_B^\star}{r_X} = (\frac{r_H}{r_X} - 1)(G(R - K + C) - 1) + G(R - K) \quad (8)$$

7. Securities Reserve Requirements

From here, we introduce securities-reserve requirements in the model as a constraint on this collateral. In fact, the amount of collateral that banks can use at the central bank is the amount of

[22] We assume that this function is identical for all banks.

[23] If all banks are symmetric $B^i = 0$ for all "i." Our results would be unchanged if we introduced non-symmetric banks.

liquid assets that they hold and that are not used to fulfill securities-reserve requirements.[24]
Banks use deposits to fund investment in securities and in loans. In the absence of any requirement, they would invest a share λ_S of their deposits in securities. Those securities can be used as collateral to borrow from the central bank discount window or be used to fulfill liquidity regulation, but not both at the same time. λ_S is a function of ρ, which is the the excess return between making a loan and the interbank rate. We take ρ as given and in particular assume that it does not depend on the level of other interest rates.[25] Thus, the quantity of collateral that can be used at the central bank discount window is: $C = D(\lambda_S - \tau - k)$, where τ is the securities-reserve requirement and k the cash-reserve requirements.
For the sake of clarity, we distinguish clearly between the cash-reserve requirement and the securities-reserve requirement. That is τ is on the top of the cash-reserve requirement (k); compulsory reserves at the central bank are not included in τ. Cash-reserve requirements is defined as a fraction k of deposits[26]:

$$K = kD \tag{9}$$

We are now able to study the respective effects of τ and k on the interbank rate.
Following Huberto M. Ennis and Todd Keister (2008), we assume that G is the cdf of a uniform distribution, with support $[\overline{P}; \underline{P}]$. Further, we assume that the support of the payment shock is a linear function of deposits, and be symmetric around 0, such that:

$$\overline{P} = pD \tag{10}$$

And

$$\underline{P} = -pD \tag{11}$$

We have then:

$$r_B^\star = r_H \frac{\overline{P} - R + K - C}{\overline{P} - \underline{P}} + r_X \frac{C}{\overline{P} - \underline{P}} \tag{12}$$

[24] We ignore the issue of haircuts for simplification. They could easily be added to the model.
[25] Our results would still hold if λ_S was influenced by the level of τ, as long as $\frac{\partial \lambda_S}{\partial \tau}$ is not too large.
[26] Here we are following the operational modalities of the post-was version of reserve requirements, where there was little or no lags between deposits and reserve requirements.

$$r_B^\star = r_H \frac{\overline{P} - R + K}{\overline{P} - \underline{P}} + (r_H - r_X) \frac{D(\tau + k - \lambda_S)}{\overline{P} - \underline{P}} \tag{13}$$

Using ((10)) and ((11)), the previous equation can be rewritten:

$$r_B^\star = r_H \frac{p - R/D + k}{2p} + (r_H - r_X) \frac{(\tau + k - \lambda_S)}{2p} \tag{14}$$

B. Policy Experiments

Since, by definition, $r_H > r_X$, equation ((14)) implies that an increase in either k or τ leads to a rise of the interbank rate.

Equation ((14)) shows that cash reserve requirements and securities reserve requirements have similar effects on interest rates, although they act through different channels. On one hand, cash-reserve requirements increase directly the demand of banks for central banks liquidity. They 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 high interest rates on the market. This effect is a well known feature of Poole-type of model. Our model shows an additional effect of reserve requirements (securities and cash). In our model the two type of reserve requirements restrict *de facto* the access of banks to the central bank discount window—through a decrease of available collateral—and forces them to borrow at a higher rate. 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.[27] In a discount ceiling system, the central bank controls directly C, the maximum amount that a bank can borrow from the discount window. Note that 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. On the contrary, cash-reserve requirements still have an effect in this case (as in the standard models described previously).

Consistent with the interpretation of liquidity ratios as quantity rationing, we observe that in our model, there is no effect of securities reserve requirements if excess reserves at the central bank

[27] 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.

are very large. In equation ((14)), we see that if $R - K + C$ is greater than P, the interbank rate is equal to zero. This is due to the uniform distribution which has $G(N) = 1$ when $N > P$. This is the case of a flat demand curve, which corresponds to the case when holdings reserves has no opportunity cost. It implies that liquidity requirements will have a stronger effect when excess reserves are scarce.

Cash and securities reserve requirements could be used in different circumstances. As explained in the previous section, securities reserve requirements have the additional advantage of avoiding that banks sell their government bonds to the central bank to obtain the liquidity required to fulfill cash reserve requirements. Since at the time central banks usually supported government bonds by buying (or discounting) them from banks at a pre-determined price, any bank selling its bonds created additional central bank liquidity.[28] Cash reserve requirements could be used to sterilize the interventions of central banks on the foreign exchange market, as shown for the case of Germany in Appendix C or interventions on the domestic government bond market. Overall, many of the channels we have disused using our partial equilibrium model seem relevant for today's monetary policy. Like securities reserve requirements, today's Basel III regulation reduce 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.

C. A Simple Test of the Model

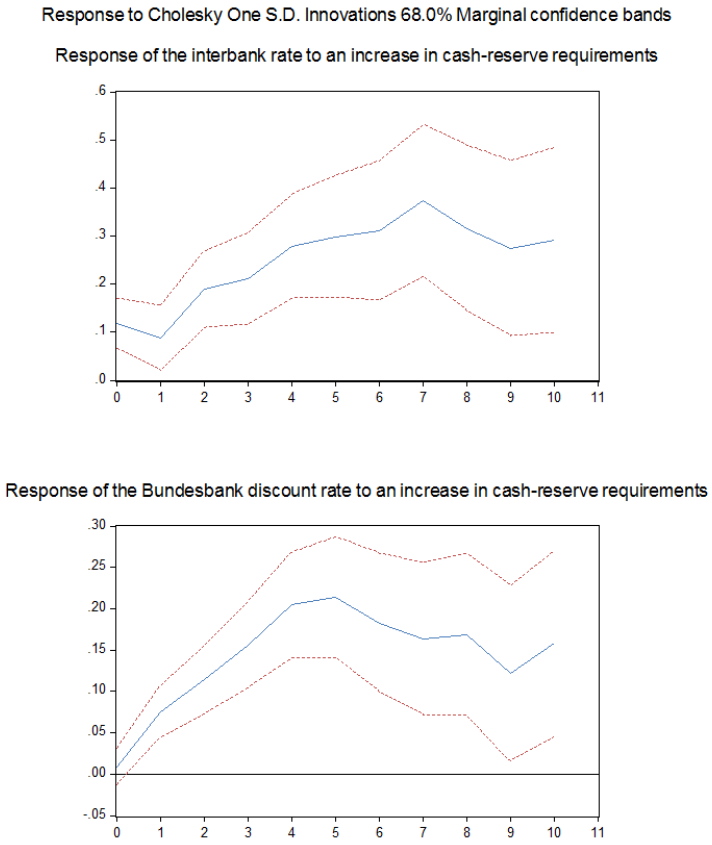
For both types of reserve requirements, the model predicts that tightening the liquidity requirement will increase the interbank market rate.We test such prediction by looking at two different historical cases. First, West Germany, which relied exclusively on cash-reserve requirements. Second, France which—as described in the appendix—combined over time various types of securities reserve requirements. In both cases, we want to check whether the interbank rate increased (controlling for movements in the central bank discount rate). The German case is the most obvious to investigate empirically since the Bundesbank used one cash-reserve requirement ratio (among others which were used less frequently, cf. EEC (1962), EEC (1972)) as its main instrument over several decades. We use the local projection methods introduced by Jordà (2005) (results are qualitatively similar when using a VAR) with three variables: the

[28] This mechanism is different from the one when reserve requirements are used to prevent banks to sell their securities to the non-banks.

interbank rate, the discount rate, and the ratio of reserve requirements. It is estimated over the period 1955–1973, using monthly data.

Then we simulate the impact of a shock on reserve requirements. The results on Figure 1 show that the effect on the interbank rate is immediate and long lasting. Indeed, cash-reserve requirements impacted the money market.[29]

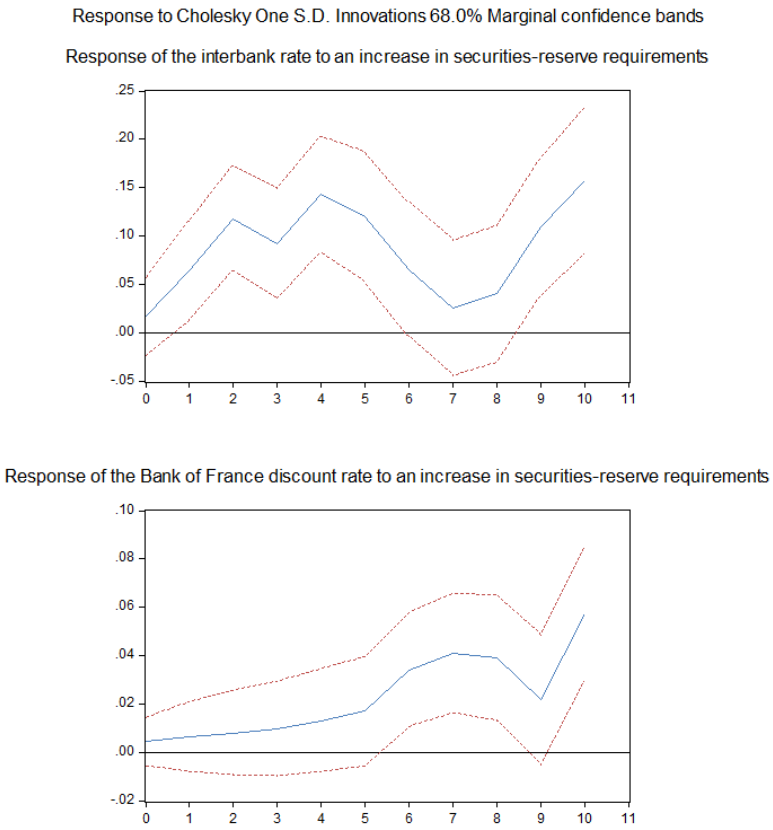
Figure 1. Effect of a Change in Reserve Requirements. Germany, 1957–1973



Source: Bundesbank and authors' calculations

[29] The response of the central bank rate is also indicative of the fact that the Bundesbank used much more the interest rate as an instrument of monetary policy (in combination with liquidity requirements) than the Bank of France Monnet (2018).

Figure 2. Effect of a Change in Securities Reserve Requirements (*coefficient de tresorerie*). France, 1960–1966



Source: Bank of France and authors' calculations

For France, we focus on the period 1960–1966, when only one single ratio of securities-reserve requirement was used and modified frequently. This allows for a cleaner identification of the effect of securities-reserve requirements. In this case, our measure is simply the change in the value of this liquidity ratio. We simulate the impact of an increase in securities reserve requirement on the interbank rate and the central bank discount rate. Our simple model includes 3 variables (the measure of liquidity requirements, the interbank rate and the Banque de France discount rate) and 2 lags for each of them (following the AIC criteria). The results confirm that the money market rate increases when the securities reserve requirements are tightened (Figure 2). When the securities-reserve requirements (which de facto varied between 30 and 36 percent) increases by 100 basis points, the interbank rate increases by about 10 basis points in the two months after the shock.

IV. Conclusion

This paper has explained how and why liquidity requirements were used in the past as monetary policy tools. It was the case not only for cash-reserve requirements but also for securities-reserve requirements. Whereas the history of the former was already well known (especially in the U.S.), 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 from the central bank during tightening phases. 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 increase the interest rates on government debt. Hence, as recognized by contemporary, the use of liquidity ratios was a way to run contractionary monetary policy while maintaining low interest rates on government debt.

Appendix A. The French Liquidity Ratios and their Evolution

After World War II, the French central bank—in charge of the new banking regulation set up in 1941—implemented a liquidity ratio that required that banks maintained a ratio of 60 percent between their liquid assets and their short-term liabilities. This ratio was never changed and it was viewed only as a micro prudential tool. But it was complemented by another type of liquidity requirement on the composition of liquid assets — whose definition evolved overtime — and was adjusted for monetary policy purposes. Until 1967 it took various forms and definitions changed overtime. Then it was replaced by a cash-only reserve requirement (deposits at the central bank), first as a proportion of sight liabilities, and second (starting 1970), as proportion of sight liabilities and credit. In itself, the French case illustrates that policymakers thought that there was a continuity between the liquidity ratio based mostly on securities reserve requirements and the mandatory cash-reserve requirement. The main reason why the Bank of France moved from broad liquidity requirements to cash-only reserve requirements at the central bank in 1967 was that the latter were deemed more "neutral" whereas the former were accused of creating distortions in the banking system (Monnet 2015). It was usually not binding. The ratio of 60 percent between banks'liquid assets and short-term liabilities was not moved and not intended to be a monetary policy tool. However, the choice of assets to be included in the ratio was consistent with monetary policy implementation and objectives:

> "The obligation for the deposit banks to comply with a "liquidity ratio" ("coefficient de liquidite") serves requirements other than those of monetary policy. According to this rule, the deposit banks' liquid holdings, i.e., till money, balances with the Treasury, with the postal cheque system and with the Central Bank, Treasury bills, paper mobilizable at the Central Bank and negotiable securities - must represent at least 60 percent of the sight and short-term (up to three months) liabilities of the institution concerned. This provision was devised simply as a safety rule to ensure that depositors will be able to withdraw their money at any time. It has none the less helped the Banque de France in its control over the banks' credit policy, since the Banking Control Commission, which has the task of seeing that these decisions are complied with, allows finance bills (as opposed to commercial bills) to be included in the calculation of this ratio only if they are eligible for rediscount at the Banque de France " (EEC, 1962, p. 126)

Another type of securities requirement, called the "Treasury floor" ("planchers") was introduced in 1948. Banks were forced to hold a proportion of their assets in government bonds (as a proportion of deposits). Borrowings from the central bank were subtracted from the numerator. It aimed to complement rediscount ceilings, which were the main instruments of monetary policy in the 1950s:[30]

> "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" (" planchers") for government paper, [...] is an automatic restraint on the volume of loans the banks can make to their customers. " (EEC, 1962, p. 121)
>
> "The technique of "floors" for government paper and rediscount "ceilings" seemed an adequate means of controlling the volume of credit in the ten years from 1948 to 1958" (EEC, p. 127)

In the late 1950s, however, banks started to make more special medium-term loans, that could be rediscounted at the central bank discount window without any limit. This created an adverse effect for policy implementation:

> "From the point of view of control of bank liquidity, the freedom to rediscount medium-term paper without restriction gives the banks back part of the room for maneuver they lost when the machinery of rediscount ceilings was instituted. In periods when their liquidity is contracting, the banks will tend to mobilize medium-term paper automatically without holding it themselves" (EEC, p. 126)

As a consequence, the central bank introduced a new ratio ("coefficient de trésorerie") that forced the banks to hold a wider set of liquid assets. The numerator comprised components from the liabilities side (sight deposits) and the denominator comprised balances at the central bank, Treasury bills and all other kinds of bill that could be discounted without limits at the central

[30] A (re)discount ceiling is the maximum that a bank can borrow at the central bank discount window. The were set for each bank in a discretionary way, but were reduced altogether (say by 10 percent) in times of restrictive monetary policy (Monnet (2014)).

bank. According to contemporary accounts, it gave "the monetary authorities an effective instrument for preventing any heavy increase in bank liquidity from engendering an excessive rise in lending to the economy, just as, conversely, it might be used to avoid too steep a decline in the volume of this lending as a result of a tightening of the cash position of the banks." (EEC, p. 127) [31]

Cash-only reserve requirements were introduced only in 1967 and replaced the previous broad liquidity requirements as key policy tools. They were deemed essential for monetary policy until the mid-1980s (Borio 1997). Modeled on the U.S. and German experience, they were preferred to securities reserve requirements because they implied less distortions in the asset composition of the banking system. Securities requirements were viewed as unduly favoring government bonds and the big banks specialized in medium-term credit. Over the years, the cash-only reserve requirements took various forms, as they were adapted to changing monetary policy objectives and tools. In addition to requirements calculated as a proportion of liabilities, the central bank also introduced requirements as a proportion of credit, in 1971–1973, in order to complement credit ceilings.[32] Some "supplementary reserve requirements" were also applied when banks exceeded their credit ceilings; they were similar to the "Corset" (supplementary special deposits) in the U.K. (Capie (2010)). Finally, in 1973, cash reserve requirements also played the role of capital controls: they were set as a proportion of the growth rate of foreign assets (even at a rate of 100 percent in March 1973) in order to avoid capital destabilizing inflows (Lehmann, 1979, p. 360).

The French example is of course peculiar. The definition and scope of liquidity requirements varied a lot across countries, depending on the characteristics of the banking system. But, as emphasized by Fousek (1957), the mechanics underlying the effects of such ratios was similar in other countries. Fousek also highlighted, as we do, that given the nature of such ratios (which included primarily government securities as liquid assets), the interconnectedness between fiscal policy and monetary policy was key:

> "The effectiveness of the liquidity ratios as a quantitative credit controls instrument has varied widely, mainly according to the circumstances at the time of their introduction as well as the subsequent budget and debt-management policies of

[31] Such tools were especially used actively during the 1963-1965 episode of restrictive monetary policy (Monnet (2014)).

[32] Such credit ceilings were aimed to curb inflation. Today, similar forms of credit controls, are included in the set of potential macroprudential tools.

> the governments. In Belgium, France, Italy and the Netherlands, the ratio were successful in accomplishing their immediate purpose of restraining bank credit through a locking-in of the banks' government securities holdings. Even though the commercial banks in these countries had some leeway in their operations at the time that the ratios were established, the point soon arrived when they no longer were able to sell government securities in order to expand loans to private borrowers. The banks were thus forced to have recourse to central bank credit, the rates for which were increased to discourage such borrowing, and the expansion of bank loans slowed down markedly." Fousek (1957, p. 63)

Appendix B. Liquidity Requirements in Sweden

Sweden is an interesting example because—together with the United States—it clearly shows how liquidity ratios originally designed as banking regulation tools were later integrated into the set of monetary policy instruments aiming to fight inflation and affect the quantity of credit in the economy. Sweden was one of the only countries to adopt a full-fledge banking regulation before the 1930s: in 1911, a solvency (capital) ratio and a liquidity ratio were implemented (Ogren, 2010). The liquidity ratio forced banks to hold liquid funds (treasury bills or cash at the central bank) as a proportion of their sight deposits. In 1937, following the example of the U.S. in 1935, a new law gave more flexibility to the central bank to change reserves, but such a possibility was not used. Only after WWII, in a report written in 1948, the Riksbank thought that the liquidity ratio (broad reserve requirements) could be used to combat inflation (Jéquier (1966) and Jonung (1993)). This was first done in 1950, during the world inflation peak caused by the Korean War, and was particularly effective through 1952. Liquid assets were government securities and, as in France, they subtracted from the commercial bank's liquid assets the bank's borrowing from the central bank before calculating the ratio of liquid assets to liabilities (Fousek, 1957). Another interesting feature of the Swedish system was that, as in Belgium, the ratio differed across categories of banks ((Jéquier (1966) and Jonung (1993))): banks were classified in 5 groups depending on their size and the ratios were proportional to the relative size of the banks (15, 20, 25, 29, and 33 percent). Its effectiveness was recognized and it became an essential instrument for Swedish monetary policy in the 1950s and 1960s:

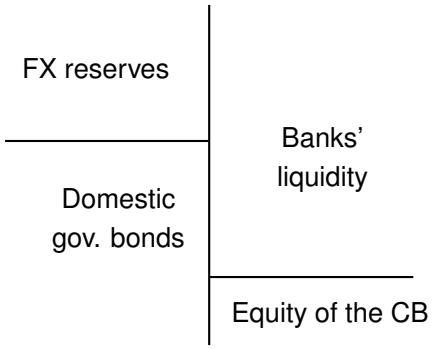
> "The liquidity ratio has been a meaningful countercyclical weapon, having been set as high as 50 percent when particularly stringent monetary conditions were desired" (Thurow, 1971).

In 1969, banks were allowed to include mortgage bonds in the liquid assets; this was a way to help the development of the housing industry and push housing investment up. As in France and Italy, liquidity requirements were sometimes used to favor certain types of assets (as an interventionist credit policy) besides government securities.

Appendix C. The Bundesbank and the Sterilization of Capital Inflows under Bretton Woods

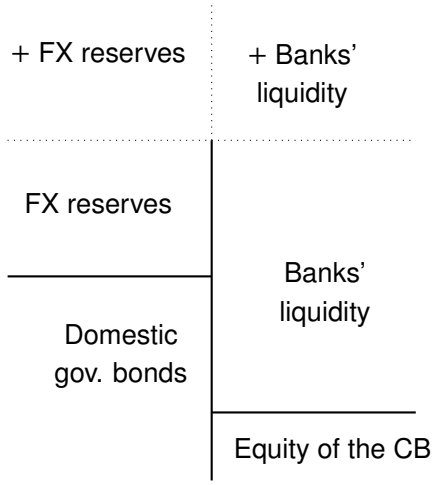
As it is well known, most developed countries under the Bretton Arrangements were in a fixed exchange rate system from 1944 to 1973. Under this agreement central banks maintained a fixed exchange rate against the U.S. Dollar. To enforce the system, they stood ready to buy or sell any amount of foreign currency against the domestic currency, should banks demand them (Monnet and Puy, 2016). In the event of a balance of payments "surplus", official flows were needed to clear international transactions. Let's take the example of Germany, which had recurrent current account surpluses (Emminger 1977, Obstfeld 1980, Bordo 1993). It meant that German residents would receive net payments from the rest of the world. Let's assume that these payments occurred in USD . In today's world, German residents would have to keep these dollars in their banks. Their banks would in turn invest the Dollars in the U.S. The current account surplus of Germany would be mirrored by private capital flows out of Germany into the U.S. However, in the Bretton Wood system, German residents instead of keeping the U.S. dollar could bring them to the central bank to obtain Deutsch Marks. They rather used this second option in a context of restricted capital flows (Emminger (1977)). To accommodate these demand for domestic currency, the central bank had to create more of the domestic currency in order to purchase foreign currencies from the public. Alternatively, it had to buy back some domestic currency (which is equivalent to destroy some of the domestic currency) against the foreign currency. This had the consequence of exerting constant fluctuations on the money supply (Figure 3 and Figure **??**).

Figure 3. Stylized Balance Sheet of a Central Bank



Source: Authors

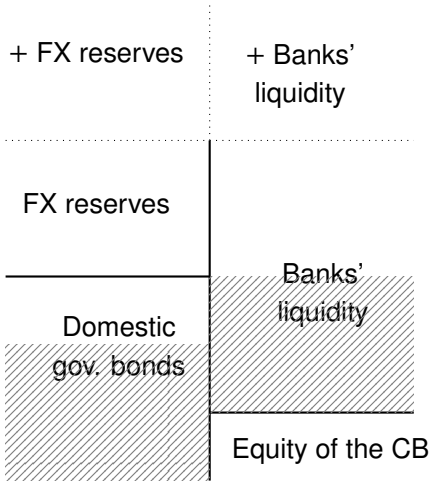
Figure 4. Balance Sheet of the Central Bank After an Increase of FX Reserves



Source: Authors

These fluctuations were the counterparts of variations in the size of the foreign exchange reserves of central banks. Of course, such movements in the money supply, if kept unchecked had a disturbing impact on interest rates, which would then influence real activity. Central banks fortunately had some means to counteract such variations of the liquidity of the banking system. They could typically compensate the impact of the accumulation of Foreign Exchange Reserves, a practice known as "sterilization" (Obstfeld 1980). Central banks could sterilize essentially in

Figure 5. Sterilization Through Sales of Domestic Assets



Source: Authors

two different ways. First they could sell/buy domestic assets in the same amounts as they accumulated/depleted reserves (Figure 5).

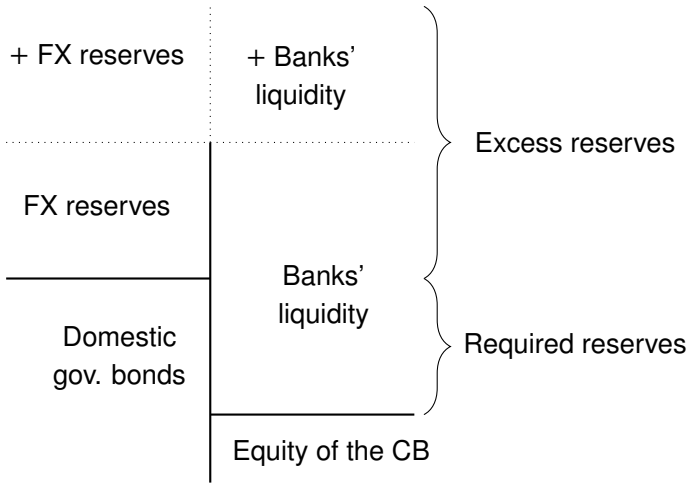
The second way was to increase Reserve Requirements (Figure 6).

Increasing reserve requirements had the effect of keeping "excess reserves" unchanged after an increase of liquidity, and thus keep interest rates at the same level:

> "This situation enabled the Central Bank to reduce the minimum reserve ratio in periods when there was a deficit on the balance of payments, as in 1956-1957, to raise it again in periods of balance of payments surplus (which increased the liquidity of the banks and also that of the economy) and to maintain it at a high level in periods of more or less balanced development." (EEC 1972, p. 302)

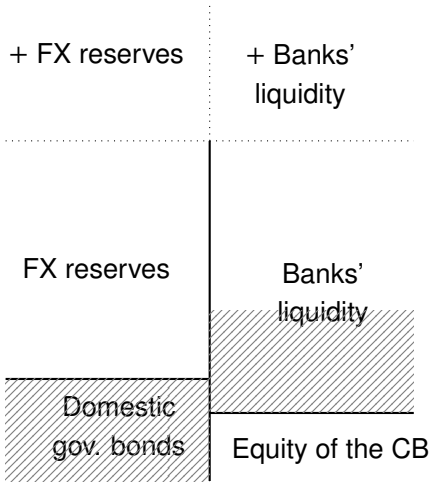
Notably, increasing reserve requirements could be used when the central bank had an insufficient amount of domestic assets for sale (Figure 7).

Figure 6. Sterilization Through Increase of Reserve Requirements



Source: Authors

Figure 7. Sterilization when the Central Bank has a Small Portfolio of Domestic Assets

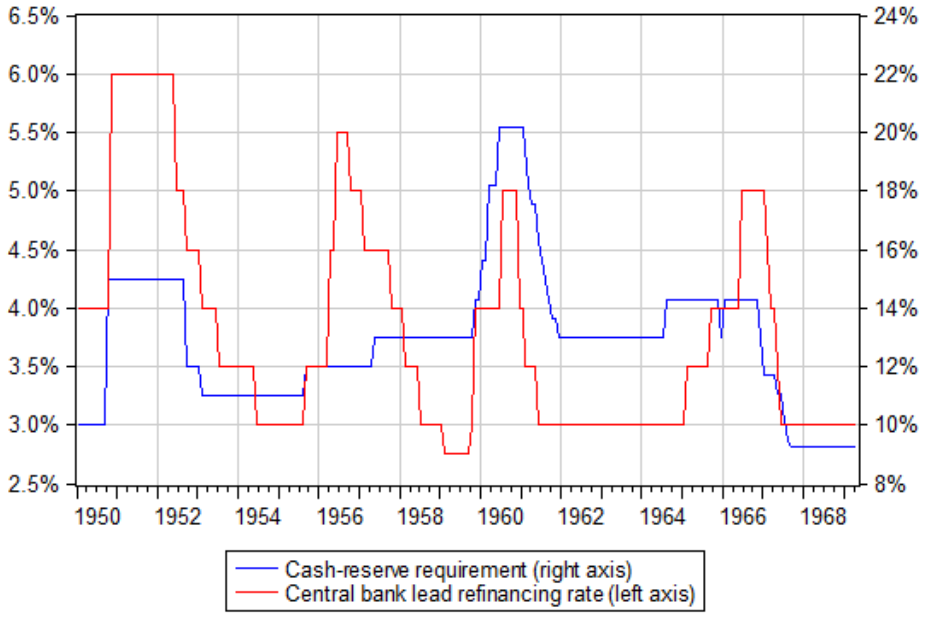


Source: Authors

In 1959-1961, the Bundesbank relied on cash-reserve requirements to sterilize capital inflows instead of revaluing its currency (Katz 1969, Kaufmann 1969, Emminger 1977). Reevaluation occurred only in March 1961. As can be seen on Figure 8, the ratio of reserve requirements from late 1959 to early 1961 increased at unprecedented levels, whereas the discount rate of the

Bundesbank increased with a magnitude comparable to previous periods. During this short-period, the reserve requirements performed a function of sterilization besides its standard monetary policy role.

Figure 8. Bundesbank Leading Interest Rate and Cash-Reserve Requirements



Source: Bundesbank

This use of cash-reserve requirements for sterilization is still effective today in countries such as China (Ma et al., 2013). This way of using liquidity requirements is not to be confused with capital controls.

Liquidity ratios and more particularly reserve requirements were also used during the post-war period to deter capital inflows, amid balance of payment surplus in many industrialized countries. The underlying idea was to impose a tax on foreign depositors by making sure that the receiving banks would have to set aside a portion of the funds in an interest-free account. Such policy could be extremely aggressive, and the reserve ratio could reach 100 percent for foreign liabilities: In order to regulate the volume of money in circulation and of credit granted, the Deutsche Bundesbank may require that credit institutions shall maintain with it balances on

current account (minimum reserve) representing a fixed percentage of their liabilities in respect of sight deposits, time deposits and saving deposits and also short- and medium-term borrowing with the exception of liabilities to other credit institutions which are subject to minimum reserve regulations. The percentage: fixed by the Bank shall not exceed 30 percent for sight deposits, 20 percent for time deposits and 10 percent for savings deposits; for liabilities to non-residents (Section 4 (1, point 4) of the Foreign Trade and Payments Act) the Bank may, however, fix a percentage of up to 100 percent." (the Deutsche Bundesbank Act, 22 July 1969, cited by EEC 1972, p. 97)[33]

To our knowledge this function of reserve requirements is much less frequent today, except in some developing countries where it discourages foreign debt holding (and volatile capital flows) as part of the macro prudential arsenal (Montoro and Moreno 2011, Arslaner et al.2015). Basel III regulation does not fulfill this type of function, since it does not discriminate depositors on the basis of their location.

Appendix D. Liquidity Ratios as a Tax on Banks

The relationship with debt management was not the only fiscal issue raised by the use of reserve requirements. As emphasized later by a theoretical literature (Fama (1980); Kashyap and Stein (2012)) unremunerated reserve requirements impose a tax on banks. Cash-reserve requirements, when unremunerated, represent an interest free liability for the central bank. The central bank can issue this liability to purchase securities that yield the market rate, and pocket the difference. In this sense, it is equivalent to a tax on deposits. Such a tax can have different goals. It can be used as a contractionary tool on lending, as it was mainly the case after WWII. However, it may also be a way to finance the government if central banks' profits are transferred to the Ministry of Finance. Finally, it is also a Pigouvian tax on deposits, to prevent banks from issuing short term liabilities as shown in Kashyap and Stein (2012). [34] When cash-reserve requirements are in place, banks that wish to expand lending needed to raise the necessary deposits, plus some additional deposits to satisfy reserve requirements. This last bit have to be collected at market rates but would just sit at the central bank, earning no interest. An increase in reserve requirement should result in higher lending rates to the real sector because banks cannot adjust the rate on

[33] See also the French example discussed in section 1.

[34] In their model reserve requirements decrease the equilibrium amount of deposits and loans. It follows that such reserve requirements can be used to restrict loan supply and thus, economic activity, just like modern monetary policy.

deposits.[35] This reasoning also applied to securities-reserve requirements as long as required liquid assets earn interest rates lower than market rates. Such a contractionary mechanism was well-known by central banks:

> "When minimum reserve percentages are raised, the banks try to offset the deterioration in their profitability by putting up their charges to borrowers [...] (EEC 1962, p. 100) "

It was even more explicit when reserve requirements were combined with credit ceilings, as in the Netherlands, England or in France. Such tax (usually called "'supplementary reserve requirement"') was used to punish banks which were exceeding official credit ceilings:

> "It is to be noted however that the Bank [of Netherlands] is empowered in certain circumstances to demand that the banks should maintain interest-free deposits in its books. It is to support the policy of restriction of credit that the Bank frequently imposes this requirement as a penalty on the banks which have overstepped the norms laid down in the matter of credits." (EEC 1962, p. 63)

A drop in banks'profit was believed to be an effective way to restrain lending:

> "According to the Bank of Canada, the primary purpose of the liquidity ratios is to increase the effectiveness of credit restraint by limiting the scope for commercial bank liquidation of Treasury bills to support an expansion of bank loans. The commercial banks, thus restrained from running down their secondary reserves of liquid assets, would quickly be confronted with the necessity of selling off less liquid assets, such as government bonds, to finance loan expansion. In such circumstances it is expected that the capital losses that are likely to be incurred on such sales would compel the banks to scrutinize loan applications more carefully and would generally temper the inducement to expand loan portfolios" (Fousek 1957, p. 59)"

[35] In the post-war period, banks could not change their rates on deposits because such rates were regulated. Note however that a similar mechanism may occur in the context of a competitive banking sector when banks are price takers on the deposit market. This rate should be equal to other money market rates (controlled by the central bank). A zero profit condition in the banking sector dictates that banks have to increase the rate they charge on loans. See Romer (1985).

Thus, it was widely acknowledged that the accumulation of lower yielding assets weighted on the profitability of the banking sector and on its loan creating capacity.[36]

Appendix E. The money multiplier and fixed reserve requirements as automatic stabilizers

Required reserves may be equal to the total stock of bank deposits in the economy (D), multiplied by a reserve requirement coefficient (k). If the hell rate is the same as discount rate, in a Pool model, then the interbank market rate becomes:

$$r_B^\star = r_X(1 - G(R - kD)) \tag{15}$$

It means that:

$$\frac{dr_B^\star}{dD} = g(R - kD) > 0 \tag{16}$$

Through their effect on interest rates, liquidity requirements are 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 of the interbank interest rate. This tightening of monetary conditions should in turn dampen economic activity. This is the main reason why a fixed ratio of cash requirement was recognized as having a monetary policy effect and central banks then decided to use variable reserve requirements as a policy tool (see previous section). Put differently, as long as aggregate deposits fluctuate, a fixed cash-reserve requirement has an effect on money market rates.[37]

[36] This discussion is important for today's potential combination between liquidity ratios and macroprudential credit controls. The Kashyap and Stein (2012) model features a bank that can raise additional deposits at will. The size of the tax is then equal to the difference between the interest rate on liquid assets and deposits. If the liquid assets are unremunerated reserve at the central bank, the tax is serious. In the case of securities reserve requirements (a case closer to the LCR) as long as deposit rates are close to interest rates on liquid assets. In this sense, there is no such tax involved with the LCR. However, in the more realistic case where deposits are fixed in the short run (like in Bech and Keister (2017) for instance), in the face of an increase of reserve requirements, banks would have to shed some of their illiquid assets. This is because the total amount of assets is then also fixed in the short run. Then, banks suffer a reduction of their profits equal to the difference in the risk-adjusted remuneration of illiquid assets and the one for liquid assets.

[37] Hence, 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

This mechanism is similar to the money multiplier model that prevails in models exposed in undergraduate macroeconomic textbook (e.g., Miskin 2010, chapter 14)) whereby the credit-creation capacity of banks is limited by reserve requirements. In the mechanism just described however, there is adjustment trough interest rates. It is also important to note that in recent years this mechanism has been most likely inoperative in industrialized countries. There are indeed at least two conditions for the money multiplier mechanism to be operative. First, it must be the case that the level of central bank liquidity is fixed. However, since their shift to inflation targeting, central banks have accommodated movements in the required reserves to ensure that interest rates remain at some chosen level. In other words, when deposits were increasing and the amount of required reserves expanding, central banks were providing more liquidity, preventing the money multiplier to be exert any restraint (Benes and Khumof 2012). Second, for a low level of reserve requirements or when reserve requirements can be avoided by banks using other types of liabilities, there might be other constraints preventing the expansion of loans, such as the amount of solvent projects that need financing or other regulatory constrains such as capital requirements (Martin et al. (2016)).[38]

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)

[38] The most spectacular cases of avoidance can probably to be found in the U.S. Many financial products, economically similar to traditional deposits were created by banks in order to avoid the tax (swipe accounts, Eurodollar, etc.). At the time were banks membership to the Federal Reserve System was optional, reserve requirements led many banks to leave the system (Feinman (1993)).

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