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DUAL LIQUIDITY CRISES UNDER ALTERNATIVE MONETARY FRAMEWORKS

A FINANCIAL ACCOUNTS PERSPECTIVE

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Abstract

This paper contributes to the literature on liquidity crises and central banks acting as lenders of last resort by capturing the mechanics of dual liquidity crises, i.e. funding crises which encompass both the private and the public sector, within a closed system of financial accounts. We analyze how the elasticity of liquidity provision by a central bank depends on the international monetary regime in which the relevant country operates and on specific central bank policies like collateral policies, monetary financing prohibitions and quantitative borrowing limits imposed on banks. Thus, it provides a firm basis for a comparative analysis of the ability of central banks to absorb shocks. Our main results are as follows: (1) A central bank that operates under a paper standard with a flexible exchange rate and without a monetary financing prohibition and other limits of borrowings placed on the banking sector is most flexible in containing a dual liquidity crisis. (2) Within any international monetary system characterized by some sort of a fixed exchange rate, including the gold standard, the availability of inter-central bank credit determines the elasticity of a crisis country's central bank in providing liquidity to banks and financial markets. (3) A central bank of a euro area type monetary union has a similar capacity in managing dual liquidity crises as a country central bank operating under a paper standard with a flexible exchange rate as long as the integrity of the monetary union is beyond any doubt.

Non-technical summary

Dual liquidity crises, i.e. funding crises which encompass both the private and the public sector of a country, have particularly devastating consequences for the real economy in the country concerned. Hence, it is of utmost importance to understand how dual liquidity crises unfold and how policies can manage those crises successfully. To this end, we capture the mechanics of dual liquidity crises within a closed system of financial accounts involving households/investors, corporates and government, banks and the central bank. Within this rigorous framework of analysis we are able to track how initial liquidity shocks feed through the financial system. Thus, our approach maps the financial flows the narrative literature on the unfolding and containment of liquidity crises loosely refers to in a systematic manner. Moreover, we can clearly identify the system's constraints to absorb those shocks before they translate into forced deleveraging and asset fire sales. Based on this, we are able to categorize different cases of financial crises depending on the initial liquidity shock and on the institutional framework, including the international monetary regime, the country facing a dual liquidity crisis operates in.

History provides ample illustration that the regular occurrence of liquidity crises is an inherent feature of modern market economies. Accordingly, we link our analytical framework to concrete crisis cases thereby testing its relevance in assessing policy options and constraints. The cases we refer to are the US subprime and Lehman collapse crisis of 2007/2008, the German banking and currency crisis in 1931 and the crisis in the euro area that started in 2010. They reflect that liquidity crises – although always showing the same crises dynamics – have occurred under a variety of institutional settings. Thus, we distinguish between central banks that issue money (i) under the paper standard and with a flexible exchange rate, (ii) with a fixed exchange rate (a) to gold, (b) to another country's currency and (c) in the framework of a currency union. Our discussion of fixed exchange rate systems focus on asymmetric crisis cases, i.e. we distinguish between member countries within the system that face a dual liquidity crisis ("financially distressed countries") and other member countries who are perceived as "safe haven countries". Historical cases of distressed countries include Germany in 1931 and euro area periphery countries in 2010/11. France and the US in 1931 and Germany in 2010/11 represent the safe haven countries, respectively. Accordingly, we also contribute to the extensive literature on currency crises and central bank cooperation.

Finally, we illustrate for all cases how specific central bank policies like (a) collateral policies, (b) monetary financing prohibitions and (c) quantitative borrowing limits imposed on banks define additional constraints on the elasticity of a central bank's liquidity provision in response to a sudden fall in investor demand for assets issued by banks and government.

The results of our analysis are as follows:

- A central bank that operates under a paper standard with a flexible exchange rate and without a monetary financing prohibition and other limits of borrowings placed on the banking sector is most flexible in containing a dual liquidity crisis.

- Raising interest rates to attract funding / capital inflows, while being the standard economic mechanism in normal times, may fail to equilibrate demand and supply in a confidence crisis as higher interest rates make it less likely that borrowers will be able to serve the debt. As a result, within any international monetary system characterized by some sort of a fixed exchange rate, the availability of *inter-central bank credit* determines the elasticity of a crisis country's central bank in providing liquidity to banks and financial markets, notably government bond markets. Thus, the sustainability of fixed exchange rate systems depends on the elasticity of inter-central bank credit, i.e. the ability and willingness of the central banks of "safe haven countries" to provide loans to central banks of countries in financial distress (gold standard and peg to another country's currency) and on the elasticity of liquidity provision by the common central bank (monetary union).

- In a monetary union, like the euro area, international arrangements are replaced by a common central bank that provides lender-of-last-resort lending to banks. In the institutional set-up of the euro area where national central banks are in charge of the actual conduct of central bank

operations with a country's banking system, this provision of liquidity is reflected in the "TARGET2 balances". At the same time, the comparison of a central bank of a euro area type monetary union with a country central bank operating under flexible exchange rates and a paper standard, like the US Federal Reserve, shows that central banks under the former framework have a similar capacity in managing dual liquidity crises as long as the integrity of the monetary union is beyond any doubt.

- Collateral constraints matter systematically under all monetary frameworks. As a result, a central bank confronted with a dual liquidity crisis has to be in a position to adjust collateral constraints in order to enhance the elasticity of its liquidity provision and to limit bank defaults and a deepening of the crisis. If done prudently, this may actually reduce central bank risk taking.

- Banks and securities markets can be subject to a liquidity crisis. However, while lender of last resort activities vis-à-vis banks are a widely accepted toolkit of a central bank, outright purchases of securities have been a controversial tool of central bank liquidity provision in financial crisis since the days of the real bills doctrine. Monetary financing prohibitions (regarding Governments) are a specific case of banning direct lending or primary market purchases of securities, namely securities issued by governments. If the central bank is either not allowed, or it is unwilling to conduct outright purchases of securities, the banking sector – supported by the central bank – can in principle act as the lender of last resort for debt securities markets. However, this is subject to additional constraints, i.e. the banks' ability and willingness to perform this role. Moreover, it has specific drawbacks as, for instance, the possibility of diabolic solvency loops between banks, the issuers of debt securities, including the government and the real economy may arise.

- Borrowing limits of banks, i.e. quantitative credit constraints deliberately imposed by the central bank to limit the borrowing of banks from the central bank, accelerate a crisis because – if enforced – they signal to banks and markets that at those limits the central bank's elasticity of liquidity provision ends. As a result, those limits push all banks (potentially) affected into a state of fear of becoming illiquid and hence into a state of strict liquidity hoarding.

Overall, we conclude that a central bank that is largely unconstrained in its provision of liquidity has more policy choices. This potentially allows an independent, competent and long-term social welfare maximizing central bank to choose better policies. By contrast, domestic as well as external constraints that strictly limit the elasticity of liquidity provision, whatever the merits that originally motivated their introduction, might imply that a country is unable to respond appropriately to liquidity shocks. In this paper we provide the analytical tools that allow for an in-depth study of the effects of the main constraints imposed by the international monetary and financial system as well as self-chosen restrictions that may influence central banks in addressing liquidity crises.

1. Introduction

Dual liquidity crises, i.e. funding crises which encompass both the private and the public sector of a country, have particularly devastating consequences for the real economy in the country concerned. Examples encompass the German crisis in the early 1930s, the Asian crisis in 1998, and the crisis in some euro area countries that started in 2010. This paper shows how a dual liquidity crisis unfolds and how the elasticity of liquidity provision by a central bank, i.e. its ability to respond to liquidity shocks in various markets by providing credit to or purchasing assets issued by private and public sector entities, depends to a significant extent on the international financial and monetary regime in which the relevant country operates. Concretely, we distinguish between central banks that issue money (i) under the paper standard and with a flexible exchange rate, (ii) with a fixed exchange rate (a) to gold, (b) to another country's currency and (c) in the framework of a currency union. Our discussion of fixed exchange rate systems focus on asymmetric crisis cases, i.e. we distinguish between member countries within the system that face a dual liquidity crisis ("financially distressed countries") and other member countries who are perceived as "safe haven countries". In addition, we illustrate for all cases how specific central bank policies like (a) collateral policies, (b) monetary financing prohibitions and (c) quantitative borrowing limits imposed on banks define additional constraints on the elasticity of a central bank's liquidity provision in response to a sudden fall in investor demand for assets issued by banks and government.

We capture the mechanics of dual liquidity crises within a closed system of financial accounts. The system provides a rigorous framework for analysis. It tracks how initial liquidity shocks feed through the financial system and identifies the system's constraints to absorb those shocks before they translate into forced deleveraging and asset fire sales. This systematic approach to the modeling of liquidity shocks has the advantage of making precise the otherwise vague interpretations of liquidity flows and policy options, and in particular how the various constraints interact. Thus, it provides a firm basis for a comparative analysis of the ability of central banks under alternative monetary regimes and policy constraints to absorb shocks.

The results of our analysis are as follows:

- A central bank that operates under a paper standard with a flexible exchange rate and without a monetary financing prohibition and other limits of borrowings placed on the banking sector is most flexible in containing a dual liquidity crisis. The Federal Reserve and its policy response to the 2008 financial crisis provide an example of how under those conditions a central bank is able to fight a dual liquidity crisis successfully.

- Raising interest rates to attract funding / capital inflows, while being the standard economic mechanism in normal times, may fail to equilibrate demand and supply in a confidence crisis as higher interest rates make it less likely that borrowers will be able to serve the debt. As a result, within any international monetary system characterized by some sort of a fixed exchange rate, the availability of *inter-central bank credit* determines the elasticity of a crisis country's central bank in providing liquidity to banks and financial markets, notably government bond markets. Thus, the sustainability of fixed exchange rate systems depends on the elasticity of inter-central bank credit, i.e. the ability and willingness of the central banks of "safe haven countries" to provide loans to central banks of countries in financial distress (gold standard and peg to another country's currency) and on the elasticity of liquidity provision by the common central bank (monetary union).

- In this respect, the gold standard represents the most binding constraint as in a crisis all central banks may start to hoard gold and hence are likely to refuse to extend inter-central bank loans out of fear of becoming subject to a liquidity crisis themselves. The German crisis of 1931 and its disastrous consequences serve as a prominent example for this case.

- The elasticity of inter-central bank credit is enhanced in a fixed exchange rate system under a paper standard and the use of international arrangements for emergency lending. For example, via the IMF (IMF 2012), safe haven countries provide liquidity to central banks and

governments of member countries in distress. This has been the standard response to emerging market crises in the 1990s, for example in the Asian crisis.

- In a monetary union, like the euro area, international arrangements are replaced by a common central bank that provides lender-of-last-resort lending to banks. In the institutional set-up of the euro area where national central banks are in charge of the actual conduct of central bank operations with a country's banking system, this provision of liquidity is reflected in the "TARGET2 balances". At the same time, the comparison of a central bank of a euro area type monetary union with a country central bank operating under flexible exchange rates and a paper standard, like the US, shows that central banks under the former frameworks have a similar capacity in managing dual liquidity crises as long as the integrity of the monetary framework, i.e. the monetary union, is beyond any doubt.

- Collateral constraints matter systematically under all monetary frameworks. The scarcity of collateral make banks engage in efforts to reduce their funding needs through a shortening of their balance sheet, which contributes to a credit crunch and damages growth dynamics. As a result, a central bank confronted with a dual liquidity crisis has to be in a position to adjust collateral constraints in order to enhance the elasticity of its liquidity provision and to limit bank defaults and a deepening of the crisis. If done prudently, this may actually reduce central bank risk taking.

- Banks and securities markets can be subject to a liquidity crisis. However, while lender of last resort activities vis-à-vis banks are a widely accepted toolkit of a central bank, outright purchases of securities have been a controversial tool of central bank liquidity provision in financial crisis since the days of the real bills doctrine. Those purchases appear theoretically unlimited in their power for providing central bank funding to distressed debtors and hence may create undue financial risks to the central bank, raise moral hazard issues, or may lead to inflation. At the same time, the use of this instrument may be crucial in mitigating crises, in particular when they arise in securities markets, like in the US in 2007/2008.

- If the central bank is either not allowed, or it is unwilling to conduct outright purchases of securities, the banking sector – supported by the central bank – can in principle act as the lender of last resort for debt securities markets. However, this is subject to additional constraints, i.e. the banks' ability and willingness to perform this role. Moreover, it has specific drawbacks as, for instance, the possibility of diabolic solvency loops between banks, the issuers of debt securities, including the government and the real economy may arise.

- Monetary financing prohibitions (regarding Governments) are a specific case of banning direct lending or primary market purchases of securities, namely securities issued by governments. Monetary financing prohibitions characterized the legal framework of central banks for example in Germany in 1931 and also prevail – to a somewhat more moderate extent – for the Eurosystem in 2010/12. In both cases they played a key role in the evolution of the crisis. In Germany in 1931, they severely limited the Reichsbank's elasticity in providing liquidity to the German financial system. In 2010-12, the provisions of the Maastricht Treaty may explain why the Eurosystem was less engaged in sovereign bonds purchases than peer central banks despite facing a more far-reaching liquidity crisis in euro area sovereign debt markets.

- Borrowing limits of banks, i.e. quantitative credit constraints deliberately imposed by the central bank to limit the borrowing of banks from the central bank, accelerate a crisis because – if enforced – they signal to banks and markets that at those limits the central bank's elasticity of liquidity provision ends. As a result, those limits push all banks (potentially) affected into a state of fear of becoming illiquid and hence into a state of strict liquidity hoarding. The German crisis of 1931 provides an example when the Reichsbank, facing strong pressures from creditor countries and diminishing gold reserves, was forced to impose credit constraints. In retrospect, this measure contributed, if anything, to the disaster of July 1931, instead of preventing it from happening.

Our paper relates to and contributes to *three* strands of economic literature.

The *first* is the narrative literature on the unfolding and containment of liquidity crises, such as Thornton (1802), Bagehot (1873), Priester (1931), King (1936), James (1984), or Kindleberger and Aliber (2005). Although these accounts are often regarded as classics and provide a continuous source of inspiration for understanding the universal laws of liquidity crises, they lack a translation into a coherent and complete system of financial accounts. As they do not map financial flows they are unable to categorize different cases of financial crisis depending on the initial liquidity shock and on the institutional framework that determines how the shock feeds through the system. As a result they fail to illustrate the eventual damage the shock may cause. We believe that these narratives can be translated into financial flows within a financial account system, which make them classifiable, comparable and better understood.

The *second* strand of literature we contribute to is the one on *funding* and *market* liquidity crises (Brunnermeier and Pedersen 2007). In a *funding* liquidity crisis the willingness of potential lenders to lend evaporates, triggering funding stress on all economic agents who depend on refinancing from others. Liquidity funding crises can manifest themselves on various markets, i.e. a) the market for bank deposits, b) the interbank market and c) bonds and other security markets involving debt titles. The key theoretical reference on bank runs by investors/households remains Diamond and Dybvig (1983). Whilethey remain silent as to the triggers that lead to a shift from the superior to the inferior equilibrium by referring to "sunspots" as crises origins, Calomiris and Gorton (1991) identify concerns about the solvency of individual banks (or debtors in general, Bagehot 1873) in an environment characterized by asymmetric information as being at the heart of liquidity crises. Thus, a greater perceived credit risk changes the strategic game from one with a unique stable superior equilibrium, to a prisoners' dilemma kind of situation: if other depositors run, it is best for me to run as well. Once a run on a bank starts, it can lead to the bank defaulting, confirming the individual wisdom of those who were first in the queue to withdraw their money. According to Laeven and Valencia (2008, 19), bank runs are a common feature of banking crises, with 62 percent of crises experiencing sharp and sudden reductions in total deposits. Bank to bank liquidity hoarding is a variant of the Investor to bank run problem described above and was at the heart of the global financial crisis in 2007/2008 (Gorton 2008). The mechanics of investor to bank and bank to bank types of crises can be generalized along three dimensions. First, self-fulfilling financial panics also apply to institutional investors (pension funds, sovereign wealth funds, etc.). Second, the logic also holds for other entities with funding needs, i.e. not only to banks, but also to corporates and sovereigns. Third, it also applies to capital market instruments, i.e. debt securities (Gorton 2008), including government bonds (Winkler 2011).

In a financial crisis, due to heightened uncertainty, information asymmetries and the shrinkage of the number and purchasing capacity of investors ready to buy at depressed prices, the liquidity of markets deteriorates significantly, which constitutes a *market liquidity* crisis. In such an environment, it is no longer possible to sell significant amounts of assets without accepting a large discount relative to some perceived fair value. In this case, a vicious spiral can materialize in which asset fire sales to obtain liquidity depress market prices of assets remaining on the balance sheet of financial and non-financial firms to such an extent that, after the fire sales, solvency and liquidity problems are worse and trigger a new round of fire sales, and so on (see e.g. Brunnermeier et al 2009). Moreover, the asset fire sales of one institution may also negatively impact on the mark-to-market value of other institutions' assets (and hence losses), leading to negative externalities (e.g. Cifuentes, Ferrucci and Shin, 2005). In a *market* liquidity crisis, turnover drops, bid-ask spreads go up and discounts rise when selling assets, in particular if sales volumes are large and if sales have to be conducted rapidly because cash is urgently needed. A market liquidity crisis contributes to a funding crisis as the possibility of funding through asset sales is impaired. In a liquidity crisis, economic activity shrinks not only because all agents focus more on funding survival instead of launching new liquidity consuming investment projects, but also because actual defaults and closures of companies occur. Default, company closure or restructuring imply destruction of organizational capital and the inactivity of productive resources leads to severe output losses.

Our paper contributes to this second strand of literature in three important aspects. First, we make use of a simplified system of financial accounts that is able to identify shocks to the system as well as liquidity buffers that can support financial stability in the wake of shocks, i.e. to contain a genuine

liquidity crisis. Second, we apply this system not only to the case of a single economy experiencing a dual liquidity crisis and operating a flexible exchange rate system, but also to economies facing such a crisis in some sort of fixed exchange rate system, with other members of the system still unaffected. By doing this, the paper presents a link between the liquidity crisis literature referred to above to that of central bank cooperation and crisis management (Clarke 1967, Eichengreen 1985, Toniolo 2005) as well as to the literature on currency crises and the stability of exchange rate regimes (Fischer 1999, Allen and Gale 2000, Chang and Velasco 2000). Third, we put the results of our analysis to a relevance test by applying them to three major financial crises: the US subprime and Lehman collapse crisis of 2007/2008, the German banking and currency crisis in 1931 and the crisis in the euro area that started in 2010.

Finally, our paper contributes to the literature on the central bank as a lender of last resort (Goodhart and Illing 2002, de Grauwe 2011). Again, our systematic use of a financial accounts system allows us to shed new light on many statements in the literature, most importantly on the constraints a central bank faces in performing this role under alternative monetary regimes.

The paper proceeds as follows. **Section 2** motivates the financial accounts framework and the underlying assumptions. It develops the general idea that the resilience of a system increases with the size of the shocks it can absorb before forced deleveraging and fire sales have to address funding stress. Against this background, we analyze dual liquidity crises in four different international financial frameworks. **Section 3 introduces** the case of an individual country operating within a flexible exchange rate environment where the central bank plays the role of a lender of last resort either for a) the banking and the government sector or b) the banking sector only. **Sections 4 to 6** each treat one case of two countries in some sort of fixed exchange rate regime in which currencies are linked to each other through a gold parity under the gold standard (section 4), through an exchange rate peg in a paper standard (section 5), and through a monetary union in a paper standard (section 6). As mentioned above, for the latter three cases we model an asymmetric crisis, with country 1 being perceived as the "safe haven" country, while country 2 experiences a financial crisis, as – with the exception of the gold standard regime – symmetric cases can be captured in the one country model of section 3. **Section 7** draws conclusions.

2. Dual liquidity crises and the merits of a closed financial accounts representation

2.1 Dual liquidity crises

Dual liquidity crises are confidence crises which involve the government and the banking sector. Given the quantitative importance of government debt in mature market economies and their financial systems respectively (Bini Smaghi 2010) – in the euro area government debt represents more than 50% of total outstanding debt securities (ECB 2010, 97-98) – they are particularly dramatic as they involve a larger part of the refinancing needs of the economy than "only" a banking/private sector funding crisis. There are important qualitative aspects as well as government debt usually plays an important role as the most secure debt in an economy. Sovereign default is the ultimate disaster for the functioning of financial markets in any country, as it undermines confidence in the solvency of almost any other debtor.

Dual liquidity crises are also pervasive in legal, social and economic terms. A government that is no longer able to fulfill its obligations towards its citizens and other stakeholders loses its key stabilizing functions. Only if creditors expect the Government to be able and willing to (i) recapitalize or take over insolvent financial institutions; (ii) guarantee exposures of the central bank and take responsibility for the risk taking needed to save the financial system through exceptional liquidity measures; (iii) maintain and possibly expand public expenditures, it can prevent the negative externalities of individual defaults, mitigate a panic and stabilize the financial system as well as economic activity, and hence prevent a depression.[1] The importance of the unimpaired ability to assume these roles makes actual or looming sovereign default so problematic (Schnabel 2004, Ritschl and Sarfarez 2006, Bini-Smaghi 2011).

The euro area sovereign debt crisis that started in 2010 can be regarded as a dual crisis in the sense that the sovereign and the national banking systems in a number of euro area countries lost access to capital markets. While the origins of a crisis may vary, they are of limited importance for its eventual unfolding.[2] Once the dual crisis is in full motion, "diabolic loops" (Brunnermeier et al 2011) between the two sectors operate and drag the country into this most comprehensive form of a liquidity crisis.

2.2 The role of system liquidity buffers, system resilience, moral hazard and central bank risk-taking

Liquidity crises can be avoided when the system is able to withstand liquidity shocks thanks to sufficient systemic liquidity buffers. Financial history has seen many attempts by the private and public sector, including central banks operating under the constraint of some form of a fixed exchange rate, to provide for such buffers (Goodhart 1988, Obstfeld, Shambaugh, Taylor 2008, Gourinchas and Obstfeld 2011). The larger the buffers the less likely it is that a confidence crisis arises and a run takes place testing the elasticity of a system. There are at least three reasons for this proposition: *First*, if we assume that the probability distribution of liquidity shocks is exogenous to the size of buffers, larger buffers make it less likely that they will be exhausted. *Second*, the probability distribution of liquidity shocks itself may partially depend on the size of buffers, i.e. is at least partially endogenous. For instance, if depositors know that a bank will default when only few depositors withdraw, then all depositors will be nervous and will start a run at the slightest sign of withdrawals by others. If in contrast depositors know that buffers are very large anyway, they will relax and will not even monitor

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[1] The importance of the government for financial stability has been highlighted by Goodhart (1998, 1999).
[2] For instance, in the euro area example the case of Ireland involved huge losses of a disproportionally sized banking system that dragged the perceived credit quality of the sovereign down. By contrast in Greece, the banking system was seen as comparatively solid at the outset, but the poor fiscal and structural policies of the sovereign led to a government debt sustainability problem that via several contagion channels also implied a loss of funding market access and eventually solvency problems for the banking system.

the behavior of others. *Third*, the existence of buffers and the associated confidence will incentivise market players, who are themselves potentially constrained, to provide liquidity in an elastic way.

For a closed economic system, having a central bank has become the key institutional device to provide those buffers in case of need (Bagehot 1873, Goodhart 1988), i.e. to provide an 'elastic currency` (Friedman, 1990, with reference to the Federal Reserve Act of 1913). For example, well-functioning interbank markets providing additional liquidity buffers in normal times have only been forthcoming on the basis of general confidence in the existence of system buffers provided by the central bank (Miron 1986).[3] Thus, liquidity buffers substantially reduce the volatility of short-term rates. This translates into a lower degree of volatility of longer-term rates reducing noise in economic decisions, and hence supporting the economy in reaching equilibrium (Bindseil, 2004, 237). Moreover, beyond the buffering function in normal times to counter the short term exogenous changes of the inelastic demand for liquidity, the merits of the central bank to act as a lender of last resort in the case of liquidity crises have been well documented (Bagehot, 1873, King, 1936, Goodhart 1988, 1999).

At the same time, large liquidity buffers provided by central banks also have potential drawbacks. Very elastic central bank liquidity supply may (i) create leeway for moral hazard as they undermine the incentives of debtors to properly ensure the liquidity of their debt titles, which is costly (see e.g. Bindseil and Lamoot 2011 for this as basis for liquidity regulation); (ii) support credit booms and asset price bubbles as investors feel confident to leverage strongly and quickly when economic opportunities arise. As such bubbles eventually burst, the associated crisis costs can be linked to the provision of liquidity buffers that allowed the emergence of the bubbles in the first place (Calomiris 2009, Mishkin 2010, Schularick and Taylor 2012); (iii) prevent that insolvent debtors are forced to default if the central bank is unable to distinguish between illiquid and insolvent borrowers (Goodhart 1999); (iv) create undue financial risks for the central bank, as an elastic supply of liquidity allows the weakest debtors, i.e. those facing the biggest challenges to refinance in markets, to take massive recourse to the central bank.

The drawbacks of large liquidity buffers could in extremis lead to the conclusion that private and sovereign debtors should (be forced to?) take care themselves of ensuring sufficient funding liquidity under all circumstances, and to forego having a central bank (Hayek 1976, 104-105). It is well known that this conclusion has not been drawn by policymakers in mature economies (Goodhart 1999), also because recurrent liquidity crises had been features of financial systems operating without a lender of last resort (Gorton and Mullineaux 1987, Goodhart 1988). However, the arguments have made an impact on central bank policies. Indeed, the issue of limiting the elasticity of central bank funding supply in normal, but even more in crisis times, has been a major topic of central banking ever since the 18th century (Bindseil 2004, Chapter 4). For example, there has been a long-standing debate whether access to borrowing facilities at the central bank should be regulated purely through the price mechanism (the borrowing facility rate) or, in addition, through deliberately narrowing collateral eligibility criteria, quantitative limits, administrative restrictions, or moral suasion. It reflects the insight that the provision of an elastic currency involves a trade-off which can be illustrated in terms of a classic two stage problem: first, establishing the efficient frontier, and then choosing the best point on the efficient frontier. Only few specific monetary frameworks will actually be on the efficient frontier and perform well in combining the benefits of elasticity in terms of making liquidity crises relatively unlikely thanks to sufficient buffers, while at the same time avoiding to the extent possible the costs related to moral hazard, undue risk taking, and destabilization due to excessive leveraging. The efficient frontier is reached through an optimum combination of (i) the choice of the overall monetary framework (in particular the exchange rate regime); (ii) risk control measures on collateral in central bank credit operations (collateral eligibility criteria, valuation, haircuts, concentration limits); (iii) price incentives against the use of special liquidity facilities by applying a system of adequate interest rate surcharges; (iv) the extent of monitoring and due diligence by central bank on

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[3] Balderston (1989) makes a similar point with regard to the development of liquid short-government debt markets, which was hampered in interwar Germany due to the strict monetary financing prohibitions the Reichsbank was subject to.

collateral issuers and counterparties; (v) the readiness of central banks to take pro-active discretionary support measures when needed.[4]

2.3 A financial accounts presentation

We model liquidity shocks in a closed system of financial accounts encompassing all major sectors of an economy. The systematic use of such a representation has a number of advantages. First, it provides general discipline in thinking and ensures that transactions are captured in their entirety. Second, it can illustrate how shocks feed through the entire system. Third, it allows to thoroughly identify the constraints that determine the shock absorbing capacity of the system, i.e. the elasticity of liquidity provision by the central bank and – in the case of monetary financing prohibitions – by the banking system. Finally, it provides a simple framework for analyzing the same concepts in a national and an international setting and, hence, for a precise comparison between different monetary regimes.

Our approach is complementary to the one of Gray, Merton and Bodie (2007), who focus on *solvency* interactions between the sectors of an economy on the basis of a structural credit risk model and option pricing theory. The structural model of credit risk explains the liability structure of economic entities as options with the assets of the entity as underlyings. Starting from distributional assumptions on asset values, it thereby prices the value of liabilities as options. This allows the modeling of changes in asset values and volatilities and how they impact liability values and hence asset values and thus solvency of all other sectors. We model how funding liquidity issues, in contrast to solvency issues, unfold through the financial accounts of an economy, and how they can best be addressed through an adequate monetary framework and active central bank measures. Thereby, we ask the question what conditions on the liquidity side trigger asset fire sales and the associated downward spiral of prices. Once they are triggered, the model of Gray, Merton and Bodie (2007) becomes applicable.

Our system of financial accounts is stylized along a number of dimensions.[5]

First, we only account for the most basic financial assets, namely banknotes, deposits at banks, sovereign bonds and bank loans. Moreover, in general we abstract from all intra-sector financial transactions. Households/investors are modeled as net creditors who have diversified their real assets into financial assets and who are not leveraged at all (i.e. their entire liability side consists of equity). Corporates and sovereigns are the real sectors that need funding. The banking sector performs intermediation services, while the central bank issues banknotes and may hold different types of financial assets.

Second, we abstract from genuine solvency problems and focus on liquidity aspects. This does not mean that we deny solvency problems. On the contrary, by focusing on the liquidity side and modeling flows in a closed system of financial accounts, we can precisely identify the conditions under which it can be precluded that liquidity shocks lead to asset fire sales or other forms of disruptive restructuring which typically is value destroying and hence has solvency implications.

Third, as already mentioned, we do not model the underlying triggers of liquidity shocks that may relate to doubts about solvency of debtors, or to any other reasons, even before the liquidity crisis has started. While these are certainly relevant and often the genuine original trigger of a liquidity crisis, they do not determine the further evolution of the liquidity crisis. The following figure captures the part of financial crises which this paper focuses on, namely part D as highlighted, which decides on whether the initial liquidity crisis can get neutralized or not.

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[4] In Bindseil (2011, 94) a two-dimensional example is provided for establishing a concrete efficient frontier between on one side the "probability of illiquidity" of banks, on the other side the financial risk taking of the central bank.

[5] In Annex 1, we present the actual financial accounts of the Eurosystem and reflect on how they compare with our stylized accounts.

Figure 1:   Financial stability, crises triggers, systemic buffers and financial crises

Development of a financial crisis
A. Financial stability ↓
B. Crisis trigger (shock to actual or perceived asset values, sudden solvency problems of major economic players) ↓
C. Liquidity hoarding, funding market freeze, bank runs, capital flight ↓
D. Systemic buffers in particular associated with the central bank providing elasticity of credit to prevent default due to illiquidity

↓	↓
E.1 Confidence returns, back to financial stability	E.2 Eventually constraints are hit and defaults, fire sale spirals, widespread contagion and solvency problems and a credit crunch materialize

Source: authors' compilation

Fourth, we capture liquidity problems by imposing that the banking, corporate and government sector perform maturity transformation. Banks, corporates and governments hold – to various degrees – illiquid assets, which are funded by relatively short term liabilities. We do not model the consequences of fire sales by banks of non-liquid assets, but analyze the conditions under which the system can, through its built-in elasticity, avoid the need of fire sales and the associated intensification of financial crisis dynamics. Households/investors lend short-term and trigger a financial crisis via an unstable demand for financial assets, exposing the banking and government sector to a liquidity shock. In the two country cases of fixed exchange rate systems discussed below the central bank of the distressed country can experience a liquidity shock as well. Original liquidity shocks can take in particular the following forms: (i) a withdrawal of household/investors deposits from or capital market funding to the banks ("-d"); a liquidation or non-roll over by the household/investor of sovereign debt ("-s"); (iii) the return of banknotes to the central bank, "-g", in exchange for gold and foreign exchange respectively. In each case, households/investors substitute these assets with some other financial asset which may be considered a "save haven" assets.

Fifth, in the two country case we only model *one* household/investor sector as – due to the assumption of an open capital account – the sector is free to invest in any sector of any country. By contrast, for all other sectors we distinguish between sectors located in country 1 and country 2 because they are assumed to be asymmetrically hit by a liquidity shock.

3. The case of one country in a flexible exchange rate environment

We start our analysis with the case of a single country facing a dual liquidity crisis, also to introduce thoroughly the logic of the representation of the financial system in a closed accounts system. We assume that the country is linked with the international financial system through a flexible exchange rate with no or limited borrowing in foreign currency. We use the following balance sheet positions and notation:

- E = household equity, equal to the real assets in the system
- D = deposits of households with banks
- S = debt securities
- B = Banknotes
- G = Gold
- FX = Foreign currency reserves of central bank

We introduce liquidity shocks into the model by small letters that refer to the relevant asset class (s a negative shock to sovereign debt demand; g a negative banknote demand shock (i.e. a positive shock to gold demand), d a negative shock to bank deposit, y an interbank market shock, k a deposit shift shock between banks of different types). The elastic provision of liquidity by the central bank (or – in the case of a monetary financing prohibition – by the banking sector) is denoted by the very same letters, however with a positive sign.

3.1 The central bank as universal lender of last resort

Runs on banks and securities markets

We follow standard macroeconomic analysis (e.g. Williamson 2011) by assuming that at the origin of the economy stands the household/investor sector. In the beginning, this sector only holds real assets of value E (equity). The household then diversifies into three financial assets, namely deposits with banks D, banknotes B, and sovereign debt S. To the extent that the household diversifies into financial assets, it sells real assets to the corporate and government sectors. However, households do not transact directly with corporates and the central bank but use the intermediary services of banks. Households are strictly non-leveraged i.e. their balance sheet length always remains E.

Corporates and the sovereign finance themselves via bank loans and debt securities issuance. We treat the government and the corporates most of the time as one sector, which is an adequate and parsimonious treatment in our model. We will distinguish between them when central bank actions relate to one, but not the other, as it is the case for a strict "monetary financing prohibition", i.e. no central bank credit to sovereigns. The real resources that the corporate and the government sector can appropriate correspond to what the household wants to diversify in the form of banknotes, deposits and securities. The corporate and the government sector use the real assets for idiosyncratic illiquid projects (machines, schools, etc.). If the corporate and government sector can no longer roll over the loans obtained from banks and the debt securities issued, they would have to sell their assets at loss-making prices (e.g. a sophisticated machine being sold as old metal). However, we do not model this case explicitly as we are looking for the conditions that this case can be avoided.

Debt instruments are issued by the corporate and government sector in exchange for real assets held by households. By contrast, the provision of credit based on the diversification of household assets into banknotes and bank deposits runs via banks. The banking sector is the intermediary between the remaining sectors. First, it offers deposits D to households and invests them into loans to corporates. Second, the sector is an intermediary to the operation between the households, the corporates/government and the central bank encompassing the issuance of banknotes B. Banks use banknotes to purchase real assets from households, which they sell on to corporates who finance them through a loan from the bank. Thus, total funding and hence total assets held by banks amount to B + D. Finally, banknotes are issued by the **central bank** who provides them to banks through collateralized credit operations.

The resulting financial structure of the economy is reflected in the accounts below (Figure 2). The capital letters reflect the positions introduced so far. The small letters reflect the liquidity shocks in the system related to the instability of household/investor demand for specific financial assets. Households may withdraw deposits from banks (*d*) or they may be unwilling to roll over (or they may sell) debt securities (*s*). In each case, we assume that they substitute these assets with banknotes, i.e. banknotes are seen by households/investors as the "save haven" asset.

Figure 2: A simple system of financial accounts

Households / Investors			
Real Assets	E - D − S - B	Household Equity	E
Deposits Bank 1	D - d		
Debt securities	S - s		
Banknotes	B + d + s		

Corporate / Government			
Real assets	$D + B + S$	Credits from banks	$D + B$
		Debt securities	S

Bank			
Lending to corporates	$D + B$	Household deposits / debt	D - d
		Credit from central bank	B + d

Central Bank			
Debt securities	s	Banknotes	B + d + s
Credit operations with banks	B + d		

Source: authors' compilation

The central bank is the **built in liquidity stabilizer** in this system. The central bank is able to issue banknotes demanded by households/investors and to compose its assets in line with the need to stabilize the financial system by preventing illiquidity. It does so by absorbing the excess supply of debt securities and deposits resulting from reduced investor demand ("*s*", "*d*") and by buying bonds and providing additional credit to the banking sector.

Deposit shift shocks between individual banks and the break down of the interbank market

The recent financial crisis has not been characterized by bank runs, with the case of Northern Rock as an important exception. Instead, households/investors shifted their investments/deposits across financial institutions/issuers. Accordingly, we have to extend the model depicted in Figure 2 by introducing two types of bank groups: safe banks and risky banks, with the solvency of risky banks being put in doubt. By doing this, we can account for an interbank market freeze and a deposit shift shock.

The interbank market position between the two types of banks is set initially to Y, with the safe banks (Bank 1) lending to risky banks (Bank 2). This could be the case because safe banks have comparative advantages in deposit collection, while risky banks have comparative advantages in originating and managing loans to corporates (see e.g. Bindseil and Jablecki, 2011). We introduce two new shocks to the model. Shock *k* is a deposit shift shock originating from households/investors. Households hear rumors about risky banks having problems and therefore transfer deposits from risky to safe banks (from Bank 2 to Bank 1). Shock *y* is the interbank market shock. As safe banks hear the same rumors about risky banks, they reduce their limits to risky banks such that interbank loans decrease by an amount of *y*. Thus, risky banks are under double funding stress and extend their central bank borrowing until they hit their collateral constraints. Also in view of the discussion of TARGET2

balances below it is interesting to note that there is a threshold for the joint shock $k + y$ beyond which safe banks (Bank 1) will have excess reserves with the central bank. Thus, instead of a liability position towards the central bank of $B/2 + d/2 - k - y$, safe banks will have a claim on the central bank of $-B/2 - d/2 + k + y$. In this case, the central bank balance sheet expands by the latter amount (Figure 3).

Figure 3:   Deposit shifts and liquidity crisis on the interbank market – a financial accounts presentation

Households / Investors			
Real Assets	$E - D - S - B$	Household Equity	E
Deposits Bank 1	D_1 -d/2 + k + s		
Deposits Bank 2	D_2 –d /2 -k		
Debt securities	S - s		
Banknotes	B +d		

Bank 1			
Lending to corporates	$D_1 + B/2 - Y$	Household deposits / debt	D_1 + k + s – d/2
Deposits with CB	max(0,-B/2+k+y+s-d/2)	Credit from central bank	max(0,B/2–k–y– s+d/2)
Lending to Bank 2	Y-y		

Bank 2			
Lending to corporates	$D_2 + B/2 + Y$	Household deposits / debt	D_2 -k -d/2
		Credit from central bank	B/2+k+y +d/2
		Liabilities to Bank 2	Y - y

Central Bank			
Debt securities	s	Banknotes	B+d
Credit oper. B/2+k+y+d/2 +max(0,B/2–k–y– s+d/2)		Deposits banks max(0,-B/2+k+y+s-d/2)	

Source: authors' compilation

3.2 Constraints on the elasticity of liquidity provision

Collateral constraints

The quantity and quality of *collateral* limit the borrowing potential of banks from the central bank. Thus, they represent a major constraint of any central bank when performing its stabilizing function. Risk control measures include (i) restrictive eligibility criteria (e.g. excluding certain non-transparent asset classes and setting a minimum credit quality for the collateral obligor), (ii) conservative collateral valuation (to reduce the risk of assuming too high collateral values), (iii) haircuts (to cater for losses in value during the liquidation period after a counterparty default), or (iv) quantitative limits (to address concentration and correlation risks).[6]

To simplify, we assume that all loans of banks to corporates are eligible collateral and are subject to a haircut of *h%*, implying that for one unit of collateral value, the bank can obtain a maximum of (*1-h%*)

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[6] The need to collateralize central bank lending has been discussed already in the 19th century central banking literature (e.g. Bagehot 1873), and is one of the most sacred principle of central banking. A detailed overview of principles, tools and calibration techniques of collateral frameworks can be found in Bindseil et al (2009; in particular chapters 7 to 10 on risk management of central bank credit operations).

units of central bank funding.[7] Thus the maximum lending of the central bank to the banking sector is determined as

$$(1) \quad (1-h)(D+B) \geq B+d \ .$$

If the shock d exceeds $(1-h)D - hB$, the banking sector hits the collateral constraint, and banks may become illiquid and default, unless the central bank is willing to either reduce haircuts or to lend further to banks, for example against a government guarantee.

In the extended model (Figure 3) an additional consideration on collateral eligibility arises as traditionally (see e.g. Friedman and Schwartz 1965, Goodhart 2010) central banks have been reluctant to accept as collateral "financial bills". Instead they accept "real bills" only, i.e. loans from banks to the real economy, i.e. corporates.[8] This "real bills" doctrine is still alive in more or less stringent variants.[9] This puts a limit to the interbank lending Y from bank 1 to bank 2. Concretely, the collateral constraint of safe banks (bank 1) under the "real bills doctrine" is

$$(2a) \quad (1-h)\bigl(D_1 + B/2 - Y\bigr) \geq B/2 - k - y - s + d/2 \ .$$

Without the real bills doctrine, and assuming that the interbank financing takes the form of eligible collateral (e.g. bank bonds), the constraint amounts to

$$(2b) \quad (1-h)\bigl(D_1 + B/2 - y\bigr) \geq B/2 - k - y - s + d/2 \ .$$

Borrowing limits

Apart from collateral constraints, the central bank could in principle impose a **borrowing limit** on banks. It could for instance set (i) an identical limit across all banks; (ii) a proportional limit, i.e. that each bank can only finance a share of $q\%$ of its balance sheet through borrowing from the central bank; (iii) an amount that is capped by the maximum borrowing of individual banks from the central bank on a specific past date. In the specification of the system of financial accounts depicted in Figure 2 with only one bank, such a lending constraint would be either binding and make the collateral constraint irrelevant, or vice versa. However, in the extension of the financial accounts model with more than one bank (Figure 3), this redundancy of one of the two constraints no longer holds as different banks may become subject to one or the other of the two constraints.

Monetary financing prohibition

Outright purchases of securities, in particular in the case of sovereign debt, are often viewed critically. Already in the late 19th century outright purchases of distressed assets were regarded as a particularly dangerous rescue measure for moral hazard reasons.[10] More recently, outright purchases of securities have also been criticized because they might interfere with central bank independence.[11]

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[7] In this simplified setting, h also implicitly covers conservative valuation of bank assets when being submitted as collateral, and the fact that not all assets are eligible as central bank collateral.

[8] Securities were accepted only for Lombard loans, while interbank loans were not accepted at all.

[9] Most central banks do not accept bank bonds or any other claims to banks as collateral. The Eurosystem accepts bank bonds, but foresees certain limits on the use of unsecured bank bonds by other issuers to prevent issuance spirals, and it does not accept interbank loans (while it accepts loans to corporates as collateral).

[10] "The committee for emergency matters was able to stay away from one danger we had particularly warned it about: the outright purchases of securities. The most extensive secured lending, the most liberal discounting, even the provision of loans against collateral involving commercial goods are not as problematic as the purchase of securities. We must not recommend a medication of which the excessive consumption had itself caused the disease. Through outright purchases, one removes the responsibility of speculators, and one offers them the chance to restart playing the same game. The reasons for the crisis are not removed by that, the liquidation is only postponed to eventually return in an even more threatening form. After a while, it will appear that even this tool no longer works. In contrast, through collateralized lending, one achieves the strictly necessary, the

The implications of a monetary financing prohibition for financial stability can be identified in a modified financial accounts framework (Figure 4). As the central bank refuses or is not allowed by law to operate as a lender of last resort, any liquidity shock on debt securities markets (*s*) has to be addressed by the banking sector if stability shall be maintained. Thus, the banking sector becomes the lender of last resort for the securities markets. We assume that risky banks (bank 2) are not able or willing to expand their balance sheet and that the debt securities purchases of safe banks (bank 1) increase deposits with the two groups of banks equally. This captures the issue that banks loose liquidity when they buy assets outright.

Figure 4: Monetary financing prohibition and its implication in time of crises – a financial accounts representation

Households / Investors			
Real Assets	$E - D_1 - D_2 - S$ - B	Household Equity	E
Deposits Bank 1	D_1 -d/2 + k + s/2		
Deposits Bank 2	D_2 - d /2 – k + s/2		
Debt securities	S - s		
Banknotes	B +d		

Bank 1			
Lending to corp/Gvt	$D_1 + B/2 - Y$	Household deposits / debt	D_1 + k + s/2 – d/2
Lending to Bank 2	Y-y	Credit from central bank	B/2 – k – y + s/2 +d/2
Debt securities	s		

Bank 2			
Lending to corp/gvt	$D_2 + B/2 + Y$	Household deposits / debt	D_2 -k -d/2 + s/2
		Credit from central bank	B/2+k+y +d/2 – s/2
		Liabilities to Bank 2	Y - y

Central Bank			
Credit operations	B	Banknotes	B

Source: authors' compilation

The inability or refusal of the central bank to act as lender of last resort through outright purchases increases the risk of a liquidity crisis because stabilizing efforts face additional constraints.

First, the central bank will have to be willing to expand its lending to banks to allow banks to fund their additional purchases of debt securities in their function as lender of last resort. The extent of central bank lending to banks will depend on the exact flow allocation, but often the entire increase of the banks' stock of securities will have to be refinanced by the central bank (in the accounts above this holds if both banks are dependent on central bank funding).

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confidence crisis and thereby the hoarding of cash is attenuated. … Even the most liberal collateralized lending and discounting maintain that speculators are forced to put their things in order." (Wirth, 1883, 528, authors' translation)

[11] While there is a rather balanced discussion of the dangers associated with outright purchases of government debt in the US (e.g. Walsh 2011), respective arguments have been used in particular by German officials and economists to prevent, limit and heavily criticize the Eurosystem's purchase program for sovereign debt launched in May 2010 (see section 6, Bindseil and Modery 2011). Against this background, it is interesting to note that the Bank of England was granted the status of a central bank after it had provided a loan to the Government when the latter had been unable to fund itself from other sources (Goodhart 1988).

Second, like in the previous case, there are collateral constraints as the central bank applies a haircut on the collateral banks provide when demanding central bank credit. As just shown, the demand for central bank credit by banks rises when they act as lender of last resort for debt securities. Assuming that the haircut applied on debt securities h_s is lower than the haircut on loans h_L with $0 < h_S < h_L < 1$, the collateral constraint kicks in when the weighted sum of shocks exceeds a certain threshold as derived from the above balance sheet of the bank, namely:

(3) $h_S s + d > (1 - h_L)(D_1 + B) - B$.

Third, capital constraints on banks may become relevant. For the sake of simplicity, we have refrained from including capital as a balance sheet item of the banking sector in the system of financial accounts. However, this can easily be changed by transforming a part of household deposits into holdings of bank equity E_B (Figure 5).

Figure 5:   The banking system as a lender of last resort for (the government) securities market – a financial accounts presentation

Bank 1			
Lending to corporates	$D + B$	Bank equity	E_B
Debt securities	s	Household deposits / debt	$D - E_B$ - d/2+k+s/2
		Credit from central banks	B + s/2 + d/2 -k

Source: authors' compilation

Assume that regulatory or economic risk weights for loans is *a* and for debt securities is *b*, with $0 < a < 1$ and $0 < b < 1$, and that capital must be at least equal to 8% of risk weighted assets. Then, the following overall capital constraint applies:

(4) $0.08(aD + bs) < E_B$.

The constraint implies that the banking sector has a limit to perform the lender of last resort for securities, and this limit is reached if *s* reaches $(E_B - aD)/b$. As in principle the banking sector can expand its security purchases by shrinking its loan book, this assumes that the banking sector is unwilling to reduce its exposure to the corporate sector to avoid costly restructuring when the constraint gets binding.

Observers viewing outright purchase programs critically may argue that the central bank taking over the role of lender of last resort for government bonds is a way to circumvent the fact that when purchasing risky assets, capital buffers should be explicitly foreseen. Proponents of central bank outright purchase programs may counter that capital scarcity is a crucial ingredient of contagion in financial crises. Accordingly, in this view, outright purchase programs are particularly effective in containing a liquidity crisis as they make available the implicit capital associated with the unique privileges of the central bank: the future certain profit stream stemming from seignorage and the guaranteed liquidity (see e.g. Stella 2002 and Bindseil et al, 2004).

Overall, the system of accounts for an economy operating under a paper standard and with a flexible exchange rate reflects two key features of central banking. On the one hand, there are no limits set by the international monetary system that – in principle – prevent the central bank to provide an 'elastic currency'. On the other hand central bank lending to banks and outright purchases on securities markets may be potentially constrained by central bank financial risk management, i.e. its collateral policy, or other policies. Example of other policies would be the real bills doctrine, the imposition of borrowing limits on banks and the monetary financing prohibition regarding sovereign debt.

3.3 Example: The US during the financial crisis 2007 - 2010

The extended model of the financial accounts presentation (Figure 3) can be used to explain the evolution of the Federal Reserve balance sheet in the global financial crisis. In doing this, we follow the literature[12] by distinguishing between three crisis phases. The first one covers the period from July 2007 until the Lehman default in September 2008. During this phase the size of the Fed balance sheet basically did not change, but credit operations with banks substituted outright holdings of sovereign debt. In a second phase, from the Lehman event to around April 2009, the balance sheet of the Fed lengthened massively due to special credit operations to entities that had lost market access to US dollar funding (banks, but also insurance companies such as AIG, as well as other central banks). In a third phase (since April 2009), special credit operations have been reduced gradually, but this has been more than compensated by large scale securities purchases including both sovereign paper and agency debt / mortgage bonds. Looking at the liability side, the Lehman default is the start of the built up of remunerated excess deposits of banks with the central bank, reflecting the liquidity injections first due to special credit operations and then due to outright purchases.

To map the evolution of the actual Fed balance sheet into the stylized balance sheet of a central bank depicted in Figure 3, a number of issues need to be noted. First, we introduce an item called "other autonomous factors" that summarizes all positions in the balance sheet which do not fall under any of the categories introduced so far. We assume that changes to other autonomous factors (a) feed like banknote shocks (d) through the system. Second, we are aware that sovereign debt purchases by the Fed were motivated by monetary policy considerations ("quantitative easing"). Lender of last resort considerations did not play a role. Third, deposits of banks with the central bank partially reflect reserve requirements. So even if the interbank market functions well and the banking system in total has a liquidity deficit towards the central bank, deposits of banks to cover reserve requirements will be held with the central bank. Having made these remarks, we can interpret the Fed balance sheet as follows in our simplified structure (Figure 6).

Pre-crisis, 30 June 2007 (Figure 6, Panel A). The pre-crisis Fed balance sheet was "lean" in the sense that its size was basically determined by the amount of banknotes in circulation. The large holdings of sovereign debt – only around 2.5% of assets took the form of credit operations with banks – reveal that there is no '*Angst*' at all of interaction with sovereign debt markets. In fact, the approach reflects the idea to hold sovereign debt paper as counterpart to banknotes in circulation. It should not be misinterpreted as reflecting lender of last resort action for the sovereign.

The logic of this balance sheet is as follows: Banknotes (decided by households), other autonomous factors (decided by whatever actor is behind the underlying items), and deposits of banks (equal to reserve requirements) are exogenous.[13] The Fed at this time targeted neutral money market conditions in the sense that deposits would be close to required reserves. Hence it automatically adjusted the sum of its two policy assets (securities and credit operations) to be such as to achieve deposits equal to reserve requirements. The remaining decision of the central bank is then the composition of the asset side which has a length equal to the sum of the three exogenous liability items. The Fed decided to hold most of its assets as securities.

13 September 2008 – pre Lehman (Figure 6, Panel B). In this phase of the crisis, the Fed reduced its sovereign debt holdings and provided more central bank credit to banks against less liquid collateral. This change was motivated by the fact that the US government debt titles were seen by households/investors as a "safe haven asset" (Bordo and James 2008). Thus, the government had no problems to place debt in the markets. By contrast, banks faced acute funding needs that they were allowed to cover through repo operations with the central bank with less liquid collateral, namely the collateral set usually reserved for the discount window (the TAF operations).

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[12] Stabilizing measures by the Federal Reserve in the recent financial crisis have been analyzed extensively (Madigan 2009, Stella 2010, Hilton and McAndrews 2010), including overviews provided by the Fed itself (e.g. at http://www.federalreserve.gov¬/monetarypolicy/bst.htm).
[13] With regard to the last of the three, the notion of 'exogenous' has to be understood as follows: the reserve requirements are exogenous at any specific moment in time.

The balance sheet logic is similar to the one in the pre-crisis period. 'Credit operations with banks' were determined by the banks which had lost access to funding sources and hence needed to fund themselves by borrowing from the Fed. The Fed responded to this need by reducing its outright holdings of government debt – the residual item – such as to keep deposits with banks equal to reserve requirements.

Figure 6: The evolution of the Federal Reserve Balance Sheet during the financial crisis

Panel A: Fed balance sheet – pre-crisis – 30 June 2007			
Debt securities purchased	790	Banknotes	775
Credit operations banks	20	Other autonomous factors	19
		Deposits banks	16
Total	810	Total	810

Panel B: Fed balance sheet – pre-Lehman – 13 September 2008			
Debt securities purchased	479	Banknotes	795
Credit operations banks	286	Deposits banks	25
Other autonomous factors	55		
Total	820	Total	820

Panel C: Fed balance sheet – post-Lehman – 7 January 2009			
Debt securities purchased	495	Banknotes	848
Credit op. banks/others finance. inst.	852	Deposits banks	846
Other autonomous factors	344		
Total	1694	Total	1694

Panel D: Fed balance sheet – 16 November 2011			
Debt securities purchased	2625	Banknotes	1016
Credit op. banks/others finance. inst.	38	Deposits banks	1578
		Other autonomous factors	79
Total	2663	Total	2663

Sources: Federal Reserve and authors' compilation

Post-Lehman – 7 January 2009 (Figure 6, Panel C)**.** In the post Lehman situation interbank market dislocations became obvious. As a result, the Fed balance sheet rapidly doubled reflecting the need to lend massively to financial institutions and close their funding gap.

The logic of this balance sheet needs to be based on a disaggregate model with – for simplicity – only two types of banks, "safe" and "risky" banks. The balance sheet of the central bank should be understood as follows (Figure 7).

Figure 7: The Federal Reserve post-Lehman balance sheet – a financial accounts perspective

Central Bank			
Debt securities	$S+s$	Banknotes	$B+d$
Credit oper. $B/2+ A/2 - S/2 + k+y + d/2 + a/2$ $+\max(0,B/2+A/2 -S/2 -k-y- s +d/2 + a/2)$		Other autonomous factors	$A+a$
		Deposits banks $\max(0,-(B/2+A/2 -S/2 - k-y- s +d/2 + a/2))$	

Source: authors' compilation

Safe banks (Bank 1) record liquidity inflows and as a result their access to the central bank switches balance sheet sides. As we can directly observe *s*, *d*, and *a* (as there are single balance sheet positions in our stylized balance sheet which only contain as change factor one of each of those), we can use the

formula for the deposits of banks to identify $k+y$, and obtain USD 927 bn for the sum of these shocks. The meaning of this should not be interpreted further, since the US banking system is not strictly split in two types of banks. However, based on the two types of banks assumption we are able to identify the shock $k+y$ on the basis of the Federal Reserve balance sheet within our system of financial accounts.

Post crisis: 16 November 2011 (Figure 6, Panel D). Finally, we turn to the post crisis, post LSAP (large-scale asset purchase program) situation. Since April 2009, large scale asset purchase programs have lengthened the Fed balance sheet considerably, while lending to institutions with an impaired market access has receded, suggesting that financial institutions could regain market access. As mentioned, the securities purchases are not motivated by lender of last resort considerations. However, had they been strictly motivated in that way, one could have derived the shock s within the system of financial accounts.

When describing this phase of the crisis, we can return to an aggregate balance sheet logic, i.e. we can ignore the interbank market dimension. The key policy decision of the Fed was how much outright purchases of assets to make. Banknotes and other autonomous factors remain exogenous variables. The endogenous variable is the amount of deposits of banks with the central bank. They reflect debt securities purchased by the Fed minus the sum of banknotes and other autonomous factors.

Table 1 summarizes the evolution of the shocks (for s assuming that there would indeed have been such an underlying shock and that securities purchases would not have been motivated by quantitative easing).

Table 1:   Liquidity shocks in the United States during the global financial crisis – a financial accounts presentation

	ASSETS		LIABILITIES			Liquidity shocks - relative to 30 June 2007			
	Debt	Credit		Deposits	Other				
	Securities	operations	Banknotes	Banks	AF	s	d	a	k+y
30. June 07	790	20	775	19	16				
13. Sep 08	479	286	795	25	-45	-311	20	-61	-
07. Jan 09	495	852	848	846	-344	-295	73	-360	926,5
16. Nov 11	2625	38	1016	1578	79	1835	241	63	-

Source: Federal Reserve and authors' compilation

Overall, one may conclude that the Federal Reserve represents a central bank that is in principle unconstrained in addressing a liquidity crisis. No particular *lending limits* were imposed on banks. No constraints relating to a *gold* or *exchange rate parity* or to *foreign currency reserves* applied, as the Fed operates in a flexible exchange rate environment. Finally, there were no constraints to *outright purchases*, including government debt. In the absence of those constraints, the FED acted strongly through various measures to support the funding liquidity of the economy. The only exception to the rule was the self-imposed constraint on collateral acceptance reflecting adequate risk control measures. Moreover, this constraint became endogenous in the crisis, as demands on *collateral quality* were adjusted.

4. The two countries case (I): The gold standard

4.1 The elasticity of liquidity provision under the gold standard

The gold standard imposes the most stringent constraints on a central bank's ability to safeguard financial stability.[14] Under the gold standard central banks guaranteed the convertibility of banknotes into gold at the gold parity. This is why central bank statutes usually specified a minimum gold coverage ratio (GCR), i.e. a minimum percentage of banknotes issued that had to be covered in the form of gold reserves at the gold parity. For example, in the interwar period the *Reichsbank* was subject to a minimum GCR of 40%.[15] The minimum GCR presented an additional constraint to the elasticity of liquidity provision discussed above, as central banks were not able to issue additional banknotes if the GCR fell below the minimum prescribed.

To capture dual liquidity crises under the gold standard in the system of financial accounts the analysis is broadened to two countries representing the system (Figure 8): a safe haven country (country 1) and a financially distressed country (country 2). Each country has a banking sector and a central bank that issue deposits and banknotes to a single household/investor sector, as there is free capital mobility between the two countries.[16] Moreover, our stylized central bank balance sheet now includes gold as an asset (G_{CB}).ˈ

The convertibility guarantee at a given rate implies that the central bank itself can become subject to a liquidity shock (g) because gold replaces banknotes as the ultimate "safe haven" asset. Households/investors may want to sell banknotes and buy gold from the central bank as they fear that banknotes of the financially distressed country (country 2) may become "illiquid" with regard to gold. Another shock would be a simple increase of banknote demand at the expense of deposits with banks ($-d$). Finally, a deposit shift shock k may occur as depositors at banks of country 2 transfer their funds to the banks in safe haven country 1.

The shocks are reflected in the financial accounts system depicted in Figure 8.[17] The elasticity of liquidity provision by the central bank of the distressed country (central bank 2) depends on (i) its ability to supply gold in responding to deposit shifts and gold demand; and (ii) its ability to supply banknotes when facing an increase in banknote demand. Clearly, the amount of gold reserves and the excess of reserves of gold reserves in terms of the gold coverage ratio define the ultimate quantitative constraints on the central bank's ability to provide liquidity under the gold standard. When it hits the gold coverage ratio, it is unable to issue additional banknotes and to sell gold in order to respond to shocks g, d and k. This is the case when

$$(5) \qquad (B_2 - g) < GCR(G_{2,CB} - k - g).$$

If there is no gold cover ratio, gold reserves must always be non-negative, i.e.

$$(6) \qquad G_{2,CB} - k - g > 0.$$

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[14] The gold standard is often portrayed as a stable, smoothly functioning system as it embodies an automatic adjustment mechanism between member countries. If these adjustment mechanisms were allowed to play, financial stability could be maintained for the system as a whole. However, most observers agree that this view did reflect the realities of the pre- and post-WWI periods of the gold standard (see e.g. Eichengreen 1985).

[15] In the UK, the Peel's Act allowed for a fiduciary note issue of a maximum of 14 million pounds. Any additional note issue required a 100% marginal gold cover ratio (Dornbusch and Frenkel 1984). See also Bernanke and James (1991).

[16] We ignore the government sector as the model can be easily expanded to include two government sectors subject to a monetary financing prohibition or operating with central banks being the ultimate lender of the sovereign as well. As such, the internationalization of the model represented in Figure 3 does not materially affect the implications of the existence (or non-existence) of monetary financing prohibtions.

[17] In the financial accounts, it is a presentational question whether we see the household or the central banks as the original holder of gold. To maintain the idea that at the origin, there is only the household, and that the financial sector follows afterwards from scratch, we attribute the initial gold endowment to the household, and the central bank will buy the initial gold endowment via banks from households.

Figure 8:   The gold standard – a financial accounts presentation

Households / Investors			
Real Assets	$E - D_1 - D_2 - B_1 - B_2$	Household Equity	$E + G$
Gold	$G - G_{1,CB} - G_{2,CB} + g$		
Banknotes 1	B_1		
Banknotes 2	$B_2 - g$		
Deposits Bank 1	$D_1 + G_{1,CB} + k$		
Deposits Bank 2	$D_2 + G_{2,CB} - k$		

Bank 1			
Lending to corporates	$D_1 + B_1$	Household deposits / debt	$D_1 + G_{1,CB} + k$
		Credit from central banks	$B_1 - G_{1,CB} - k$

Bank 2			
Lending to corporates	$D_2 + B_2$	Household deposits / debt	$D_2 + G_{2,CB} - k$
		Credit from central banks	$B_2 - G_{2,CB} + k$

Central bank 1			
Gold	$G_{1,CB} + k$	Banknotes	B_1
Credit operations with banks	$B_1 - G_{1,CB} - k$		

Central bank 2			
Gold	$G_{2,CB} - g - k$	Banknotes	$B_2 - g$
Credit operations with banks	$B_2 - G_{2,CB} + k$		

Source: authors' compilation

Facing this constraint, the central bank will aim to influence the gold and deposit allocation parameters g and k via its interest rate policy. In theory the gold coverage ratio can always be maintained by changing the relative attractiveness of gold versus deposits (deposits in country 2 versus deposits in country 1), i.e. inducing households/investors to forego the holding of gold in favor of deposits (to forego the deposits in country 2 in favor of holding deposits in country 1). However, this implies that the central bank is exposed to the impossible trinity, i.e. the short term interest rate can no longer be used as an independent monetary policy instrument to achieve price and output stability (Obstfeld, Shambaugh and Taylor 2005). Most importantly, in the case that a gold outflow is due to a confidence crisis and to capital flight, the need to hike rates goes typically in the opposite direction of what would be needed in terms of achieving price and output stability. Real economic activity is likely to decline, raising or reinforcing doubts about the solvency of any borrower in the economy and hence triggering or aggravating a financial crisis.[18] Indeed, a situation may arise in which even at very high interest rates, a central bank can no longer attract gold as the confidence crisis deepens with a higher interest rate. The perspectives for the domestic economy and hence for political stability become so poor that households/investors expect the country to suspend the convertibility of banknotes into gold at the

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[18] See Dornbusch and Frenkel (1984) for an early example. In line with this argument, the gold standard period was characterised by a series of recurrent financial crises (Dornbusch and Frenkel 1984, Calomiris and Gorton 1991) that have not been observed in countries operating under the paper standard with flexible exchange rates and with no or little dollarization in terms of government, bank and private sector borrowing, i.e. avoiding „original sin" (Eichengreen and Hausmann 1999).

given parity. However, if the gold standard itself is questioned the rate of interest is unable to equilibrate supply and demand for gold (Eichengreen 1995) as market participants demand gold purely out of fear that banknotes might become illiquid in terms of gold.[19] As a result, the worst expectations will become self-fulfilling and the central bank will eventually run out of gold. Thus, the likelihood of a liquidity crisis increases substantially when a central bank faces an external constraint like the gold coverage ratio to issue banknotes.

Loans from central banks of safe haven countries represent a final instrument to increase the elasticity of liquidity provision by the central bank of the distressed country. A precondition for the availability of this instrument is the availability of excess gold reserves in the safe haven countries, i.e. the absence of a "global scarcity of gold".[20] As long as there is no global scarcity of gold, but only an imbalance across central banks, the gold coverage ratio of any individual central bank participating in the system can in principle be maintained by **cross-border gold loans** from central banks that hold gold reserves in excess of the minimum coverage ratio (Figure 9). In the example below, the inter-central bank gold loan corresponds exactly to the deposit shift between the banks (the rest of financial accounts do not change). Central bank 1's gold reserves will be stable as it experiences a gold inflow reflecting the deposit shift from banking sector 2 to banking sector 1 and provides lending to central bank 2. Central bank 2's reserves suffer from the general gold drain to households. However, the outflow of gold triggered by the deposit shift gets compensated by the inter-central bank loan.[21]

Figure 9: Inter-central bank lending under the gold standard – a financial accounts presentation

Central bank 1			
Gold	$G_{1,CB}$	Banknotes	B_1
Credit operations with banks	$B_1 - G_{1,CB} - k$		
Gold loans to central bank 2	k		

Central bank 2			
Gold	$G_{2,CB} - g$	Banknotes	$B_2 - g$
Credit operations with banks	$B_2 - G_{2,CB} + k$	Gold borrowing from central bank 1	k

Source: authors' compilation

There are five major reasons that may constrain the willingness of central bank 1 to provide loans to central bank 2 under a gold standard: First, as mentioned above, a global scarcity of gold reserves may apply and central bank 1 may itself feel uncomfortable with its gold reserves. Second, central bank 1 may fear becoming subject to a similar crisis as country 1 in the future, i.e. it considers having a larger buffer to be appropriate. *Third*, central bank 1 may be unwilling to lend as it may feel that lending to central bank 2 runs counter to domestic stability as it could imply rising inflationary pressures in the

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[19] In principle, this is the macroeconomic equivalent to the situation in credit markets analyzed by Stiglitz and Weiss (1981) leading to credit rationing; see also Stiglitz (1987).

[20] In case of a global scarcity of gold, households must be pushed through high interest rates to forego the holding of gold. Again, this requires a level of the rate of interest that is above the "natural" level which is neutral towards prices. This would mean that a deflationary environment would be created, which would eventually drive down prices, i.e. nominal values, and hence also the demand for banknotes in circulation. This should eventually allow to restore the gold cover ratio at lower interest rates, i.e. to reach an equilibrium with stable prices. However, the adjustment path is likely to be harsh. If the world is close to this gold-constrained state, and for instance a sudden shock of loss of confidence in banks occurs, such that deposits are substituted with gold and banknotes, then this must be counterbalanced by a strong interest rate increase and deflationary pressures – which is itself unlikely to overcome the confidence crisis vis-à-vis the banking system as in a deflationary environment bank balance sheets will be weakened.

[21] Of course, inter-central bank loans could also be $d + g/2$, or $d+g$, the latter if e.g. central bank 1 was initially more distant to its gold coverage ratio constraint than central bank 2, and is willing to help also in a way that even reduces its gold holdings relative to the pre-crisis starting point.

future. Thus, central bank 1 may feel that central bank 2 should, instead of asking for a loan, raise further its discount rate, or limit its lending to banks (undertake "Credit restrictions", or that the sovereign has to take economic policy measures (e.g. of a fiscal or structural kind) that restore confidence). *Fourth*, central bank 1 may be unwilling to lend to central bank 2 for financial risk management reasons, i.e. it may feel uncertain about whether it would ever be repaid. *Fifth*, central bank 1 may be unwilling to lend to central bank 2 for political reasons, or the gold loan may be provided only conditional on some concessions of country 2 on related or unrelated issues that country 2 may be unwilling to accept.

Before proceeding with the case study of Germany 1931 we want to acknowledge that in the system of accounts pure capital flows cannot be distinguished from current account flows. Thus, the shock k may also represent a net balance of trades and services. To illustrate this point, Figure 10 differentiates the household sector into two country parts, assuming, only for presentational reasons that each household deals only with the banking system in its own country. We assume a trade flow in the sense that household 1 sells a real asset to the household 2. The good is paid for by a transfer of deposits.

For the banking system, the flow k is identical to the one of a pure capital flow and hence it is also identical for all financial accounts. Thus, it is not possible within the financial accounts representation to distinguish whether a transaction of "real assets" (or goods) is behind the deposit shift, or a decision of investors to move their deposits from a bank account in one country, i.e. the risky banks, to bank accounts of another country, i.e. the safe banks. To do so an analysis of the balance of payment statistics, i.e. capital and current account flows, is needed.

Figure 10: Current account transactions – a financial accounts presentation

Households / Investors COUNTRY 1			
Real Assets	$E_1 - D_1 - B_1 - k$	Household Equity	$E_1 + G_1$
Gold	$G_1 - G_{1,CB}$		
Banknotes 1	B_1		
Deposits Bank 1	$D_1 + G_{1,CB} + k$		

Households / Investors COUNTRY2			
Real Assets	$E_2 - D_2 - B_2 + k$	Household Equity	$E_2 + G_2$
Gold	$G_2 - G_{2,CB}$		
Banknotes 2	B_2		
Deposits Bank 2	$D_2 + G_{2,CB} - k$		

Source: authors' compilation

4.2 Application of the financial accounts model to the German dual crisis of 1931

The early 1930s and in particular the case of Germany in July 1931 provide ample evidence on the mechanics of dual liquidity crises under the gold standard. A detailed account of the German crisis is provided in annex 2, with a special focus on July 1931 and with references to views expressed by policymakers and observers in that critical period. In this section we want to apply the financial accounts presentation to

- identify the shocks that led to the crisis and to

- discuss the various constraints the Reichsbank was subject to in managing the crisis.

To this end, we distinguish between the specific gold standard constraints, i.e. the gold coverage ratio, the Reichsbanks' interest rate policy as well as its efforts to secure emergency loans from the safe haven countries central banks, and constraints that may apply to central banks irrespective of the

exchange rate regime, namely the collateral constraint, borrowing limits and monetary financing prohibitions.

Identification of liquidity shocks hitting the German financial system and the gold standard constraints

On July 15 1931 Germany *de facto* left the gold standard by introducing capital controls. The decision was motivated by a run on German banks. The Reichsbank had been unable to contain the run as the gold standard severely limited the elasticity of liquidity provision via the minimum gold coverage ratio the Reichsbank hit at end June 1931. We start with an analysis of the evolution of the Reichsbank balance sheet between 1926 and 1934 and calculate annual changes of key balance sheet items according to the stylized system of financial accounts (Table 2).[22] Clearly, the year 1931 is an exceptional one in various aspects:

- Gold and foreign exchange reserves drop by more than 50% (from 2.7 to 1.2 billion Reichsmark)

- The gold cover ratio falls from 56% to 24% and thereby below the 40% minimum.

- Total central bank credit provision (Discount bills and Lombard loans) increase from 2.6 to 4.4 billion Reichsmark as the Reichsbank discounts huge amounts of bills to ease the strains on banks' balance sheets (Schnabel 2004).

- Total assets of the Reichsbank rise by less than 10%, from Rm 6.25 to Rm 6.86 bn, indicating that interbank intermediation by the central bank was not a large scale phenomenon.

- Other time series, including the banknotes in circulation, remain relatively stable.

Table 2: Changes of key items of the Reichsbank's balance sheet, RM million, 1927 - 1934

Year	Delta FX/gold	Delta CB credit	Delta Banknotes	Delta autonom. factors	Delta total assets	Memo: gold coverage ratio
1927	-203	1294	828	263	1076	47,0%
1928	737	-404	366	-33	457	58,5%
1929	-197	56	114	-255	84	53,3%
1930	-2	-237	-266	27	-282	56,2%
1931	**-1529**	**1767**	**-2**	**240**	**615**	**24,2%**
1932	-236	-1408	-1215	-429	-1454	25,8%
1933	-525	379	84	-230	-285	10,8%
1934	-311	806	256	239	756	2,2%

Sources: Deutsche Bundesbank (1976), authors' calculations

A comparison of the end 1931 Reichsbank balance sheet to the one of end 1930 allows us to identify the shocks at work (Figure 11). The financial accounts representation suggests that the change in the key balance sheet positions can be decomposed into shocks as follows:

- Δ Credit operations = 1767 = k - a

- Δ Banknotes = 2 = g

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[22] We consider discount and Lombard loans as central bank credit operations and combine foreign exchange with gold reserves. Finally we treat outright holdings of securities as an autonomous factor (we could also have kept it as a separate item).

- Δ other autonomous factors = 240 = -a => a = -240

- Δ Gold = - 1529 = - g – k

We have four equations with one linear interdependence resulting from the balance sheet identity and can easily solve for the remaining unknown $k = 1527$. The dominating shock was thus the shift of household/investor capital from Germany, the financially distressed country, to safe haven countries, i.e. France, some other European countries and the United States. [23]

Figure 11:   The Reichsbank's balance sheet in the German crisis of 1931 – a financial account presentation

Reichsbank balance sheet end 1930			
Gold (and FX reserves)	2685 - g - k	Banknotes	4778 -g
Credit operations with banks	2622 + k - a	Other autonomous	529 - a

Reichsbank balance sheet end 1931			
Gold (and FX reserves)	1156	Banknotes	4776
Credit operations with banks	4389	Other autonomous	769

Source: authors' compilation

Table 3:   Reichsbank Discount and Lombard rate, June 1930 to end of World War II

Date	Discount rate	Lombard rate
1930		
21 June	4%	5%
9 October	5%	6%
1931		
13 June	7%	8%
16 July	10%	15%
1 August	15%	20%
12 August	10%	15%
19 August	10%	12%
2 September	8%	10%
10 December	7%	8%
1932		
9 March	6%	7%
9 April	5.5%	6.5%
28 April	5%	6%
22 September	4%	5%
1940		
9 April 1940	3.5%	4.5%

Source: Deutsche Bundesbank 1976)

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[23] As Germany recorded a current account surplus in 1931 the shock *k* represents a pure capital account phenomenon. It may also be noted that a large non-assignable residual dominates the balance of payment in 1931. As also explained in Deutsche Bundesbank (1976), this is due to the poor capturing of capital account transactions at that time. Presumably, the large negative residual constitutes non-captured capital outflow.

The deposits shift occurred although the Reichsbank raised interest rates (Table 3). However, as argued above, the normal response of capital supply and demand to a rise in interest rates,[24] with investors exploiting arbitrage opportunities in a fixed exchange environment that trigger capital inflows, or at least reverse capital outflows, did not materialize. The gold parity and the gold standard had lost their medium term credibility. Thus, investors feared that the interest rate differential will eventually be overcompensated by a devaluation of the currency. The fear was grounded in the observation that interest rate increases made disruptive economic and political developments more likely (Eichengreen 1995), i.e. they were inconsistent with internal stability. This was the case in Germany in 1931 as interest rates were raised in an environment characterized by strong deflation that prevailed since 1930 leading to extremely high real interest rates at a time of extreme recession.

Finally, the Reichsbank failed in securing emergency loans from fellow central banks, with the exception of a short-term USD 100 million loan granted jointly by the Bank of England, the Banque de France, the Federal Reserve Bank of New York and the BIS (Toniolo 2005, 102). Requests for additional loans were rejected also because fellow central feared that they could become subject to a run as well and thus wanted to protect their reserves. Moreover, political tensions among the countries involved were severe, which led to political conditionality requests that were perceived to be unacceptable to Germany. Finally, a general feeling of uncertainty prevailed of what needs to be done economically. While Bank of England Governor Norman was aware of the contagion effects if members were forced to leave the gold standard (James 2002, 166; Toniolo 2005, 102), others, notably France and the US, were of the opinion that the solution to the crisis had to be found in the crisis country only, i.e. in this case: Germany. Indeed, the failure of the German authorities to stop the run was seen as evidence that the German authorities were not doing enough. Thus, the safe haven countries argued that Germany should first introduce borrowing limits to banks before any further emergency loan could be seriously negotiated. In view of approaching the gold coverage ratio, the Reichsbank (had to) follow(ed) this advice. This proved to be highly counterproductive as restoring deliberately a tight collateral policy in combination with borrowing limits contributed to the failure of Danat bank, which in turn triggered the general bank run. In the end the authorities responded to the run by effectively ending the convertibility of the Reichsmark to gold, i.e. abolishing the gold standard.

On the German side the economic implications of the Reichsbank crisis management strategy were subject to an intensive debate (see e.g. Ahamed, 2010, Born, 1967, Ferguson and Termin, 2001, James 1984, 2010, Ritschl and Safarez, 2006, Schnabel, 2004]). Most prominently Hjalmar Schacht (1953, p. 358-365), Reichsbank President from 1924 to 1930, and from 1933 to 1939, argued that he would have advocated an early payment moratorium for foreign debt as a reaction to the outflows of foreign currencies because the very fact that gold (and foreign exchange) reserves by the Reichsbank are limited by definition aggravated the panic.[25] Capital outflows were reinforced by the weekly publication of the Reichsbank's balance sheet as households/investors knew exactly the size of buffers available. Ignoring that domestic residents were involved in capital outflows as well, Schacht noted that the strategy of the Reichsbank had to fail because „*the more the foreigners noted that the foreign reserves of the Reichsbank were being depleted, the more they rushed to withdraw their money before that actually materialised. As suggested by an old saying, the dogs always bite the last one. The depletion of German foreign exchange reserves coincided with the failure of a major German bank (the Danat bank)*.*"* The latter could have been avoided if the Reichsbank had just focused on internal stability and had given up convertibility. In the end, the Reichsbank was forced to follow this option and left the gold standard.

The main counterargument in defense of the Reichsbank is a legal, not an economic one. Maintaining convertibility was a duty of the Reichsbank that had been imposed upon it through the Dawes and Young plans. Reichsbank President Luther probably hoped that he could still turn around the situation

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[24] "7 percent will draw gold from the moon" was a standard saying under the pre-WWI gold standard (Dornbusch and Frenkel 1984, 254).

[25] Implicitly, Schacht distinguished between shocks „*d*" and „*k*" of our model, and argued, consistently with the model, that while the Reichsbank in principle could address *d*, it faces constraints in handling *k* (p. 359).

before exhausting gold reserves, maybe also with the help of foreign central bank loans. As long as he hoped, he probably did not want to breach this pillar of the international agreements.

Constraints unrelated to the gold standard

Collateral constraints

In 1931 banks also hit their collateral / eligible assets constraints. However, the Reichsbank kept banks liquid by adjusting the collateral requirements in order to enhance the elasticity of liquidity provision (Priester 1932). For example, the real bills doctrine was not strictly applied as the Reichsbank began accepting "to some extent financial bills. She also financed production by agreeing to discount ... bills relating to industrial exports to the Soviet Union, of which everyone knows that the true self-liquidation only arises in the course of two years, when being paid by Russia." Moreover: "With the agricultural bills, we are also doing something that a central bank should do only extremely limitedly, namely to finance goods that have not yet been sold. Fact is that at end 1931 around one third of bills discounted by the Reichsbank would not have been accepted in normal times, in particular finance bills and Russia bills." (Luther (1964, 252/253) Collateral constraints were softened further after July when „the finance bills resulted mainly from the rescue measures for banks and saving associations " (ibid).[26]

In sum, the collateral constraint never became strictly binding. Confronted with the choice of enforcing those constraints, which would have implied the collapse of the German financial system, and circumventing them, in the end the Reichsbank took the necessary measures of collateral enlargement to close the ever increasing funding gaps.[27] Only at end June, when confronted with the immediate perspective of a depletion of gold reserves, collateral tightening and borrowing limits were introduced.

Monetary financing prohibitions

In 1930/31, monetary financing prohibitions played a key role in deepening the crisis (see e.g. Bordo 1986) for two reasons.[28] First, they forced the government to do whatever is needed to minimise the recourse to monetary financing, including draconian austerity measures, with their strong negative effects on the economy. Brüning (1970, p. 293) describes how close Germany was to default in June 1931 also because of this prohibition, and how he had to painfully convince Reichsbank President Luther to circumvent it marginally to be able to pay salaries of state employees. Second, the possibility of a German sovereign default led to a further decline in confidence and hence fostered capital flight.

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[26] See also Brüning (1970, 350), Schnabel (2004, 860), and Bundesbank (1976, 41).

[27] Against this background, Luther (1964, 247) argues that the Reichsbank did everything it could in terms of supportiveness, i.e. whatever was not strictly imposed as constraint on it, it tried. He quotes himself from an intervention made at a conference in [July 1931]: *"There is so much talk about active central bank policy. I would be very grateful to get a concrete answer to the question: what should the central bank do? In particular, what should she do beyond what she has already done?"* He also notes the Reichsbank went far beyond what a central bank does in normal times without making noise about it (Luther 1964, 250). He feels that he receives unjustified criticism from two opposing sides: *„While today and at that time, I was attacked from various sides because the Reichsbank would not be doing enough, also, partially by the same people, I was confronted with bitter allegations that I would not respect the sacred principles of central banking."*

[28] The Dawes and Young plans imposed a strong monetary financing prohibition on the Reichsbank, which went beyond those foreseen in the Maastricht Treaty for the ECB. They were reflected in the Reichsbank Law of 1924, which – according to Reichsbank (1925, 161, own translation) – "exp*licitly excluded, and this being of utmost importance, the previous close business relationship between the Reich and the Reichsbank, which had lead to an extensive credit recourse of the Reich. Apart from some immaterial exceptions, the Reichsbank must not, directly or indirectly, grant credit to the Reich, the Ländern, or to local public authorities."* Moreover, (p. 163), *"the Reichsbank has lost the permission to discount treasury bills with a maximum three months maturity".*

During the crisis the prohibitions were at least partly cricumvented and after the introduction of capital controls finally discarded. Brüning (1970, p. 307) describes how eventually, through a placement of sovereign debt with banks, and their use for Reichsbank credit operations, another way to circumvent the monetary financing prohibition was found: „In case the plan to obtain a foreign credit would definitely fail, the Reich would provide to banks bills in the amount of several hundred million Reichsmark that they would rediscount with the Reichsbank." In July 1931, bank recapitalisation was eventually financed with central bank money as well (Brüning 1970, 349).

In sum, the monetary financing prohibition was eventually to some extent circumvented by the Reich and the Reichsbank before it would itself have led to the ultimate disaster of a sovereign default. However, this does not mean that this constraint was not highly relevant as Brüning did whatever it took to minimise the recourse to this instrument, including his austerity policy with its strong negative effects on the economy.

Borrowing limits

In June 1931, the Reichsbank limited central bank borrowing of banks to levels observed for each individual bank as of 19 June 1931. In the climax of the crisis, on 11 July 1931, Reichsbank President Luther announced that he would tighten these restrictions further. The imposing of limits intensified the panic and general liquidity hoarding. Thus, instead of defusing the crisis, it played a crucial role in driving Danat bank into illiquidity and causing the bank runs and bank holidays in the week of 13 July 1931. As already mentioned the Reichsbank were pressured by its fellow central banks to introduce those limits for the sake of stopping the German capital flight and hence for preventing large borrowing needs of the Reichsbank vis-à-vis foreign central banks. Thus, there had been a general lack of awareness in all major capitals and central banks, not only in Berlin and the Reichsbank, of the insight already highlighted by Bagehot (1873) sixty years earlier, namely that only a "brave plan", i.e. a courageous approach of the central bank, i.e. "to lend in a panic on every kind of current security" and take associated risks, can save the banking system, including the central bank itself (and in retrospect, in case of Germany in 1931, the state and civil society in general).

5. The two countries case (II): Paper standard and fixed exchange rates

A paper standard operating under a fixed exchange rate replaces the gold constraint by a foreign exchange reserve constraint. In the asymmetric crisis case we discuss, this constraint only applies to the central bank of the distressed country. By contrast, the central bank of the safe haven country is formally unconstrained and could provide unlimited emergency lending in its own currency which – by definition – households/investors perceive as the "safe haven asset". Thus, one major constraint of the gold standard does not apply in a fixed exchange rate system under a paper standard: There is no external constraint that prevents *all* central banks to expand their consolidated balance sheet, and there is no issue such as a global scarcity of reserves. However, this does not imply that the constraint could not become binding for one of the other reasons that made safe haven central banks unconstrained by the minimum gold cover ratio hesitant in providing international loans to distressed central banks under the gold standard. Those constraints include:

- *First*, central bank 1 may be unwilling to lend as it may feel that lending could be macro-economically destabilizing and could imply rising inflationary pressures in the future. In other words, central bank 1 may feel that central bank 2 and the Government of country 2 should first do their economic homework in order to restore confidence. The IMF, acting as an intermediary between central banks and imposing programs and conditionality, may be understood to address this concern.

- *Second*, central bank 1 may be unwilling to lend to central bank 2 for financial risk management reasons, i.e. it may feel uncertain about whether central bank 2 may be able or willing to pay back at maturity. This fear may be particularly justified if overall, country 2 is in a disastrous state and politically unstable. Again, the IMF as an intermediary may address also risk management concerns.

- *Third*, central bank 1 may be unwilling to lend to central bank 2 for political reasons. This may be a less relevant constraint today than it was in the 1930s. Nevertheless, it should not be underestimated.

Most importantly, the economics of dual liquidity crises are unchanged compared to the gold standard case: fixed exchange rates are guaranteed by the central banks, and cross country flows need to be balanced by changes of foreign exchange reserves of central banks. Against this background, various dual crises during the 1990s fall under this category, such as the Asian crisis in 1997/1998.[29]

In illustrating the two countries, paper standard, fixed exchange rate case in the system of financial accounts (Figure 12), we assume that FX reserves (*FX*) take only the form of deposits of central banks with foreign banks. The initial establishment of foreign reserves by central banks derives from existing cross-border interbank claims and liabilities.[30] We also reintroduce sovereign debt, assuming that sovereign debt is not held cross-border by central banks to keep notation simple. Deposits with banks of country 1 are considered as a save haven asset, when capital flight arises from deposits with banks of country 2, and for sovereign debt of country 2. Finally, we assume that the central bank of country 2 performs the lender of last resort function for the banking system only. For the government, domestic banks have to act as lender of last resort.

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[29] James (2010, 227) highlights the parallels between 1931 and 1997/8, as both crises were related to a sort of fixed exchange rate and previous large capital inflows.
[30] An alternative way to establish an initial endowment of foreign reserves for central bank 2 would be to accumulate reserves from current account surpluses.

Figure 12: A fixed exchange rate regime under a paper standard – a financial accounts presentation

Households / Investors		
Real Assets $E - D_1 - D_2 - S_1 - S_2 - B_1 - B_2$	Household Equity	E
Banknotes 1 B_1		
Banknotes 2 B_2		
Deposits Bank 1 $D_1 + k + s$		
Deposits Bank 2 $D_2 - k$		
Sovereign debt country 1 S_1		
Sovereign debt country 2 $S_2 - s$		

Corporate	
Real assets $D_1 + D_2 + B_1 + B_2$	Credits from banks $D_1 + D_2 + B_1 + B_2$

Sovereign 1	
State assets S_1	Sovereign debt S_1

Sovereign 2	
State assets S_2	Sovereign debt S_2

Bank 1	
Lending to corporates $D_1 + B_1$	Household deposits / debt $D_1 + k$
	Deposits from foreign CB $FR_2 - k$
	Credit from home central bank $B_1 - FR_1$
Claims to foreign banks $Max(0, -FR_1 + FR_2)$	Liabilities to foreign banks $Max(0, FR_1 - FR_2)$

Bank 2	
Lending to corporates $D_2 + B_2$	Household deposits $D_2 - k$
Sovereign debt country 2 s	Deposits from foreign CB FR_1
	Credit from home central bank $B_2 - FR_2 + k + s$
Claims to foreign banks $Max(0, FR_1 - FR_2)$	Liabilities to foreign banks $Max(0, -FR_1 + FR_2)$

Central bank 1	
Credit operations with Bank 1 $B_1 - FR_1$	Banknotes B_1
Foreign reserves FR_1	

Central bank 2	
Credit operations with banks $B_2 - FR_2 + s + k$	Banknotes B_2
Foreign reserves $FR_2 - k - s$	

Source: authors' compilation

Two constraints may eventually cause a liquidity crisis. First, again the **collateral constraint**, which in this case is specified as: $h_s s + h_P(D_1 + B_2) \geq B_2 - FR_2 + k + s$. Second, **central bank 2's foreign reserves impose a limit to deposit outflows**. Any deposit shift shock k out of country 2 must not

exceed the foreign reserves of the central bank, FR_2 (Obstfeld, Shambaugh and Taylor 2008). If foreign exchange reserves are exhausted, fresh cross-border interbank credits are needed to compensate further deposit shifts without triggering asset fire sales of the banking system 2. However, under financial stress, interbank markets typically are not a source of compensating flows – if anything the contrary. Again, as in the case of the gold standard, constraints can be overcome by cross-central bank lending: bilateral, or, what has been more frequent over the past decades, multilaterally via an institution like the IMF (Corsetti et al. 2006).

Some remarks on the case of flexible exchange rates and a dollarized economy

In the case of widespread unofficial dollarization, the central bank of a stressed country will care considerably about its exchange rate. Exchange rate volatility quickly leads to solvency problems of the domestic private and public sector, as some entities (corporates, banks, households, the government) will unavoidably have an asset/liability currency mismatch (Eichengreen and Hausmann 1999, Chang and Velasco 2000). Therefore, devaluations lead to over-indebtedness problems of the economic agents that are funded over-proportionally in foreign currency. As a result, countries with dollarized economies and a flexible exchange rate will behave similarly to countries operating a paper standard with fixed exchange rates (Calvo and Reinhart 2002, Calvo, 2006). Distressed central banks will use their foreign reserves to stabilize the exchange rate. When reserves are exhausted, they also depend on emergency loans from other central banks or the IMF to prevent asset fire sales and deleveraging. [31]

Foreign banks that have access to funding from their parent banks in mature economies might serve as a substitute for IMF borrowing. Indeed, the massive entry of foreign banks in banking sectors of Latin American and emerging European countries observed since the mid- to late 1990s was welcomed by several observers as a contribution of financial stability in the respective countries (Mishkin 2001, 2006). Evidence on the stabilizing role of foreign banks in emerging markets from the global financial crisis is mixed and regionally different ((De Haas et al. (2011), Vogel and Winkler (2012), Claessens and van Horen (2012)), ,also because the crisis had a negative impact on the ability of parent banks to provide funding and keep exposures. As a result, in emerging Europe, the IMF, together with EU institutions, other international financial institutions, home and host country governments and central banks as well as major foreign banks operating in the region established the Vienna Initiative to prevent forced deleveraging and spirals of asset fire sales (IMF 2012).

Overall, a central bank operating in a dollarized financial system faces constraints for lender of last resort operations as in a fixed exchange rate system where financial intermediation and assets are denominated in domestic currency. Thus, we do not cover this case in more detail.

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[31] Chiţu (2012) presents evidence suggesting that the global financial crisis was more pronounced in dollarized economies than in other emerging markets due to currency mismatches, reduced monetary policy autonomy and limited lender of last resort ability.

6. The two countries case (III): euro area style monetary union

6.1 The system of financial accounts

The case of a monetary union between two countries is constructed based on the euro area example. This example is characterized by a common central bank that is based on a system of central banks and unconstrained cross-central bank transferability of deposits of banks. We ignore the rest of the world as the currency union is embedded in the global financial system through flexible exchange rates. Hence, neither the common central bank nor the the system of monetary union central banks face any external constraints in providing liquidity. Thus, they do not have to worry about becoming subject to a liquidity shock itself and the common central bank can be compared to a central bank that operates in a setting as discussed in section 3.

Figure 13: Monetary union – a financial accounts presentation

Households / Investors			
Real Assets	$E - D_1 - D_2 - S_1 - S_2 - B_1 - B_2$	Household Equity	E
Banknotes 1	B_1		
Banknotes 2	B_2		
Deposits Bank 1	$D_1 + k + s$		
Deposits Bank 2	$D_2 - k$		
Debt securities country 1	S_1		
Debt securities country 2	$S_2 - s$		

Corporates + sovereigns			
Real assets	$D_1 + D_2 + B_1 + B_2 + S_1 + S_2$	Credits from banks	$D_1 + D_2 + B_1 + B_2 + S_1 + S_2$

Bank 1			
Lending to corporates	$D_1 + B_1$	Household deposits / debt	$D_1 + k + s$
		Credit from home central bank	$B_1 - k - s$

Bank 2			
Lending to corporates	$D_2 + B_2$	Household deposits	$D_2 - k$
Debt securities country 2	s	Credit from home central banks	$B_2 + k + s$

National central bank 1			
Credit operations with Bank 1	$B_1 - k - s$	Banknotes	B_1
Target claims	$k + s$		

National central bank 2			
Credit operations with banks	$B_2 + k + s$	Banknotes	B_2
		Target liabilities	$k + s$

Consolidated currency union central bank			
Credit op. with banks 1 and 2	$B_1 + B_2$	Banknotes	$B_1 + B_2$

Source: authors' compilation

We model the monetary union case in the system of financial accounts by again assuming a confidence crisis in country 2 (Figure 13). There are two "national central banks" that counterbalance

any cross-border deposit shifts from country 2 to country 1. This counterbalancing is reflected in a change of intra-central bank claims and liabilities, the so-called TARGET2 balances in the Eurosystem. Finally, we assume that the banking sector of country 2 engages in stabilizing purchases of government bonds of country 2, as the common central bank is subject to the monetary financing prohibition constraint.

The implications of these intra-central bank transactions for the currency union as a whole are captured in the balance sheet of the common central bank, i.e. the consolidated balance sheet of central banks 1 and 2. By definition, TARGET2 balances are netted out. Hence, the system of accounts and how shocks feed through it becomes in principle identical to the one country case of section 3.

The representation above assumes that $B_1 - k - s > 0$, i.e. the liquidity flows from the banking system in country 2 to the banking system in country 1 are not exceeding the stock of banknotes in country 1. However, deposit and asset shifts may be larger, in particular given the arguments listed above. Once $k + s > B_1$, the banks in country 1 are in excess liquidity, and hence deposit their excess liquidity with the central bank. The affected accounts in country 1 then take the form depicted in Figure 14 (while there is no change to the accounts in country 2).

Figure 14: Banking sectors with a liquidity surplus in a monetary union – a financial accounts presentation

Bank 1			
Lending to corporates	$D_1 + B_1$	Household deposits / debt	$D_1 + k + s$
Deposit with CB 1	$-B_1 + k + s$		

National central bank 1			
Target claims	$k + s$	Banknotes	B_1
		Deposit of bank 1	$-B_1 + k + s$

Source: authors' compilation

Accordingly, the consolidated balance sheet of the system of national central banks lengthens by the amount of this excess liquidity (Figure 15). Contrary to some claims found in the literature (Sinn and Wollmershäuser (2011), Tornell and Westermann (2011)) this does not impose any particular constraint on any of the actors, i.e the national central banks and the common central bank (Bindseil and König (2011), Whelan (2011)). Like in the case of an individual country operating a paper standard under a flexible exchange rate, liquidity provision by the common central bank is only subject to policy constraints, like the collateral and the monetary financing prohibition constraint. Technically the common central bank is unconstrained in providing liquidity to any distressed banking sector of the currency area, irrespective of its size, as it is the case for any central bank operating under a paper standard with flexible exchange rates when providing liquidity to any distressed bank, irrespective of its size.

Figure 15: The balance sheet of a monetary union's central bank with some member countries' banking sectors showing a liquidity surplus

Consolidated currency union central bank			
Credit operations with banks	$B_2 + k + s$	Banknotes	$B_1 + B_2$
		Deposit of banks	$-B_1 + k + s$

A universal formulation of the central bank account is as follows:

Consolidated currency union central bank			
Credit op. with banks	$Max(B_1 + B_2, B_2 + k + s)$	Banknotes	$B_1 + B_2$
		Deposit of banks	$Max(0, -B_1 + k + s)$

Source: authors' compilation

Overall, the common central bank faces only the self-set collateral and monetary financing prohibition constraints when engaging in stabilizing activities. Thus, differences to the one country case mainly result from the existence of two separate national central banks that together constitute the central bank of the monetary union. As such they appear to be limited and only presentational. However, the euro area – in contrast to the case discussed in section 3 – does not represent a nation state. This difference has implications for the severity of liquidity shocks the monetary union may be subject to.

First, in the absence of common sovereign bond issuance ("Eurobonds"), the scope for self-fulfilling runs on the debt of Governments is much larger as debt is segregated and linked to the fate of individual member countries (Ang and Longstaff 2011, Winkler 2011).

Second, in the absence of sufficiently strong elements of a fiscal union, including a proper monitoring and sanctioning framework that involves some loss of sovereignity and the possibility of solidarity and fiscal transfers if needed, the probability rises of imprudent national governments causing national debt sustainability problems which subsequently cannot be addressed neither by fiscal transfers nor by currency devaluation. Hence, doubts about sustainability can create enormous challenges and, again, self-fulfilling confidence crises.

Third, the ease of cross-country capital flows in a currency union in good times, coupled with the illusion that current account imbalances do no longer matter (Giavazzi and Spaventa 2010), bears the risk of quickly emerging unsustainable imbalances. Once sufficiently bad news arise, and markets realize the extent of imbalances, a sudden stop occurs and the sovereign, banks, and corporates are trapped in negative feedback loops.

Fourth, the segregation of Government debt, combined with the absence of a common bank rescue funds – which is consistent with the absence of a banking union – create the potential for "**diabolic loops**" between sovereigns and banking systems which will face common liquidity and eventually solvency issues (Brunnermeier et al 2011).

Fifth and last, populist leaders of financially distressed countries may lead the country into default and exit from monetary union. In this case, exposures to this country would likely suffer additional losses. Investors may anticipate that and move pre-emptively, possibly in a self-fulfilling manner, also including other members of the union, giving rise to widespread contagion within the monetary union.[32]

As will be shown below, those peculiarities of monetary union have implications on the elasticity of liquidity provision by the common central bank.

6.2 Constraints on the central bank's liquidity provision

Collateral constraints

The common central bank is subject to the familiar collateral constraint which in the case of a monetary union amounts to

$$(7) \qquad h_s s + h_L (D_1 + B_2) \geq B_2 + k + s .$$

It is basically the same collateral constraint that applies to the case of two separate monetary areas with fixed exchange rates. Still, there may be one reason why in a monetary union, this constraint is more binding: the sovereign and private debt securities issuers of the financially distressed country 2 are likely to suffer, in the context of a "diabolic loop", from rating and valuation losses, which reduce the total value of eligible collateral that can be used to obtain central bank. If h_s, h_L apply for the highest rating category (say AAA), while lower rated assets imply higher haircuts, once ratings decline

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[32] Contagion effects have also been features of the gold standard and fixed exchange rate systems under a paper standard, explaining why financial crises usually occur in clusters (Reinhart and Rogoff 2009). For example, the interwar gold standard basically collapsed in one year: Eight (out of) 22 countries operating under the gold standard at end 1930 had the regime suspended in the course of 1931; in addition five countries, including Germany, kept the gold parity but introduced exchange rate controls (Bernanke and James 1991).

in country 2 the collateral constraint is likely to become more binding. In a normal fixed exchange rate regime, the central bank of the distressed country would probably adapt gradually its haircut matrix to avoid that the general downgrading of the country by rating agencies leads to an ever growing scarcity of collateral. In a monetary union, this is less evident as the strong countries may feel that common risk management standards should be preserved, or that the collateral constraint is an effective way to indirectly impose hard budget constraints and limit the potential increase of TARGET2 balances.

Monetary financing prohibitions

It is well known that in the case of the euro area the common central bank does not act as an unconstrained lender of last resort *to euro area governments*, in particular in view of legal constraints imposed by the monetary financing prohibition in Article 123 of the Treaty establishing the European Union. However, starting in May 2010 the Eurosystem undertook some purchases of debt securities for monetary policy purposes in the context of its "Covered Bond Purchase Programmes" (see ECB press releases of 4 June 2009 and 3 November 2011) and "Securities Market Program" SMP (see ECB press releases dated 10 May 2010 on "ECB decides on measures to address severe tensions in financial markets").

Figure 16: Monetary financing prohibition in a monetary union – a financial accounts perspective

Bank 2			
Lending to corporates	$D_2 + B_2$	Household deposits	D_2 - k
Debt securities country 2	(1-q)s	Credit from home central banks	B_2 + k + (1-q)s

Central bank 2			
Credit op. with banks	B_2 + k + (1-q)s	Banknotes	B_2
Debt securities country 2	qs	Target liabilities	k + s

Source: authors' compilation

We can model this modification of the constraint by introducing q as the share of the total flight of households/investors out of government bonds of country 2 that the common central bank purchases for monetary policy reasons. By implication, the banks of country 2 would take the share (*1-q*). The system of accounts takes the form depicted in Figure 16. As we assume that both banking systems would still be in a liquidity deficit towards the central bank, Figure 16 is a modification of Figure 13. To save space we only present those accounts that change, namely the ones of Bank 2 and Central Bank 2. Moreover, the value of q has no impact on the level of TARGET2 balances.

The TARGET2 balances

TARGET2 balances do not provide a technical constraint to the common central bank's ability to provide liquidity. However, this does not imply that there are no valid concerns about extremely high TARGET2 balances. Those concerns have their correspondence in the concerns voiced towards central bank exposures to individual banks or debt issuers in a single country case (section 3), inter-central bank loans under the gold standard (section 4) or under fixed exchange rates under a paper standard (section 5). They can be summarized as follows.

First, extending intra-system loans in the form of TARGET2 may be felt to be macro-economically inappropriate as they could imply rising inflationary pressures in the future, in particular in the safe haven country. As a result, TARGET2 balances would be interpreted as reflecting economic imbalances that in the end must be addressed by counter-measures of the government of country 2 depicted in Figure 16. Accordingly, the relevant government should do its economic homework in order to restore confidence into the banking system and into the government (fiscal consolidation, structural reforms that support growth, recapitalizing and restructuring the banking system, etc.), arguments which echo those made by the US and France when debating the request from Germany for

emergency lending in the 1931 crisis. Moreover, allowing for unlimited TARGET2 claims to accumulate may be perceived as a removal of an important hard budget constraint and as creating moral hazard.[33] In the case of inter-central bank loans under a fixed exchange rate regime, cross border loans at least have to be taken consciously and actively. Thus, they are almost always attached to some conditions addressing the concerns of the lending central bank, or, in the case of multilateral approaches, of some institution, like the IMF, representing the interests of the international community. Moreover, IMF loans are typically limited, as every country has in principle some maximum quota for drawing on IMF loans. Such a quantitative constraint does not exist in a monetary union, contributing to fears that the elasticity of TARGET2 balances undermines pressure for restoring economic viability.[34] However, evidence in the case of the euro area does not appear to validate this fear, as ambitions reform programs have been adopted and implemented, which may as much appear too restrictive as too lax.

Second, Country 1 may again be unwilling to accept large central bank credits by the common central bank (in the form of TARGET2 claims) for financial risk management reasons, i.e. it may feel uncertain about whether central bank 2 may be able or willing to repay TARGET2 liabilities. This fear may be based on the assessment that country 2 is in a disastrous state and that it cannot be excluded that it may eventually want to default and to exit monetary union (Sinn and Wollmershäuser 2011)

Third, Country 1 may be unwilling to accept growing TARGET2 balances for political reasons, i.e. the threat to limit TARGET2 balances may be linked to the request of political concessions. While this may be in theory an issue (and has been key in 1931 for preventing France to be willing to provide central bank loans to Germany), it has not been articulated yet in the case of monetary union.

While these concerns are understandable – and where at least implicitly raised before the adoption of European Monetary Union (Deutsche Bundesbank 1990) – it must be recognized that the unlimited and unconditional character of TARGET2 balances is at the very heart of monetary union. The ability of banks to transfer deposits across national central banks *constitutes* the genuine single currency. Imposing a limit to such transfers and thus making those transfers impossible would de facto imply a reintroduction of two currencies with presumably different prices, marking the end of monetary union.

In sum, the elasticity of liquidity provision depends on the readiness of central banks to compensate deposit shifts and runs on capital markets by providing sufficient central bank credit to banks. The consolidated system of central banks can provide credit freely, in the same way as the single central bank in the paper standard under flexible exchange rates. The decomposed two national central banks are also unconstrained as inter-central bank balances are automatically created via TARGET2, a synonym of a genuine monetary union. However, large TARGET2 imbalances indicate that the monetary union is characterized by a weak fiscal union and the lack of a banking union with substantial capital flight dynamics.

6.3 Identification of shocks and constraints for the case of the euro area

The identification of shocks hitting the euro area faces several challenges which have to be met by further simplifications. First, it is impossible to identify q and s separately by an analysis of the central bank balance sheet alone. One would need in addition to look at the evolution of banks' balance sheets. We leave this identification to future research and treat ECB securities purchases below as

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[33] Of course, similar arguments apply to any standard LOLR activities by a single country central bank in favour of individual banks and other financial institutions (Goodhart 1999).

[34] At the same time, it has to be noted that the conditions and the associated slow speed of the IMF response to emerging market crises of the past had triggered a discussion to reform the IMF into a proper international lender of last resort (Fischer 1999, Meltzer 2000). Those reforms, if they had been implemented, would have enhanced the elasticity of liquidity provision by the IMF and thus its capabilities to manage a dual liquidity crisis in one or several of its member countries against the background of an increasingly integrated global financial system.

falling into the residual category of other factors. Second, for simplicity, we reduce the system of financial accounts to three balance sheet positions (Figure 17). We merge banknotes and other factors in order to avoid a discussion of the rather complex accounting treatment of banknotes in the Eurosystem. T are the initial TARGET2 positions. Third, the variables a_1, a_2 are innovations in other factors, encompassing also any banknote demand shock.

Figure 17: Balance sheets of national central banks in a monetary union facing asymmetric liquidity shocks

National central bank 1			
Credit operations with Bank 1	$B_1 - k + a_1$	Banknotes and other factors	$T + B_1 + a_1$
Target claims	$T+k$		

National central bank 2			
Credit operations with banks	$B_2 + k + a_2$	Banknotes	$-T + B_2 + a_2$
		Target liabilities	$T+k$

Source: authors' compilation

Table 4 provides end year figures of TARGET2 balances for selected countries. Moreover, we broadly distinguish between creditor countries (Germany, the Netherlands, Finland and Luxembourg) and debtor countries (all other euro area countries).

Table 4: TARGET2 balances in the euro area

	DE	ES	IT	PT	FR	GR	IE	DE-NL-FI-LU	Rest
2007	71	-3	36	-6	-12	-11	-1	70	-70
2008	115	-35	23	-19	-118	-35	-44	144	-144
2009	178	-41	55	-23	-62	-49	-54	255	-255
2010	326	-51	3	-60	-28	-87	-145	454	-454
Sep 11	450	-81	-91	-61	-58	-98	-125	608	-608

Sources: ECB and NCB data, authors' calculations

Table 5 provides for the same set of countries the change of central bank credit provision (Panel A) and information on other balance sheet factors (Panel B), including banknotes. Figures for central bank credit provision include current accounts of banks with the Eurosystem, recourse to the deposit facility, and recourse to term deposits of the Eurosystem.[35] By contrast, credits under the emergency liquidity assistance (ELA), which are in principle similar to central bank credit (apart from the collateral accepted and the absence of loss sharing within the Eurosystem, see the 1999 Annual Report of the ECB, page 98, and the ECB Monthly Bulletin, February 2007, page 73) are not covered. Rather, the ELA funds are reflected in "other autonomous factors", reflecting the non-availability of public data on ELA (i.e. not the logic of the financial accounts system). The Eurosystem credit provision figure is netted of current accounts of banks with the Eurosystem, recourse to the deposit facility, and recourse to term deposits of the Eurosystem.[36]

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[35] Holdings of required reserves could have been handled separately. However, they are irrelevant for the sake of identifying the respective shocks. Thus, we merge them for presentational simplification.

[36] Holdings of required reserves could have been handled separately. However, for the sake of identifying the respective shocks they do not matter. Thus, we merge them for presentational simplification

Table 5: Eurosystem credit provision and other balance sheet factors, 2007 – 2011
Panel A: *Eurosystem credit provision (excl. ELA, netted out against absorbing operations, overnight/term deposits), all figures in EUR billion end of period.*

	DE	ES	IT	PT	FR	GR	IE	DE-NL-FI-LU	Rest
2007	158	19	-15	-7	-1	2	18	199	60
2008	111	38	15	5	43	31	74	105	263
2009	111	55	-7	7	59	42	78	82	272
2010	-43	35	25	36	-10	87	121	-119	288
Sep 11	-174	50	82	42	32	74	94	-346	374

Panel B: *All other balance sheet factors (calculated as liability side residual), in EUR billion, end of period*

	DE	ES	IT	PT	FR	GR	IE	DE-NL-FI-LU	Rest
2007	-229	-16	-21	13	13	9	-17	-270	10
2008	-226	-3	-38	14	74	5	-30	-249	-119
2009	-289	-14	-48	16	3	7	-24	-337	-17
2010	-282	16	-28	24	38	0	25	-334	166
Sep 11	-275	31	10	19	27	25	31	-262	234

Sources: ECB, NCB data and authors' calculations

Based on Figures 17 and Table 5, we can identify the three shocks in our closed system of financial accounts for the two country groups (Table 6), i.e. creditor countries (DE-NL-FI-LU) and debtor countries (remaining euro area countries).

Table 6: Identification of annual shocks in assumed two monetary area sub-groups (creditor and debtor countries), in billion of euro (relative to previous year)

	k	a_1	a_2
2008	73	-21	130
2009	111	88	-102
2010	198	-3	-183
Sept. 2011	154	-73	-68

Source: authors' calculations

The identified shock *k* documents a systematic capital flight into the four save haven countries, out of the rest of the euro area, year after year since 2008. The interpretation of the shocks a_1 and a_2 is in view of their residual character less obvious. One would need to review carefully the disaggregate balance sheet items behind this residual balance sheet item, and also look at the developments in individual National Central Banks.

The elasticity of the Eurosystem's liquidity provision was largely determined by (i) its so-called "fixed rate full allotment policy" (i.e. banks needed to express in each operation a demand for central bank credit at a given interest rate and this demand was always fully satisfied) and (ii) its collateral policy. In pursuing the latter policy, the Eurosystem benefitted from the fact that it has always accepted a rather broad collateral set (see e.g. Tabakis and Weller, 2009, also for a comparison with the pre-crisis collateral frameworks of othercentral banks). Most importantly, it had only *one* collateral set for both regular repo tenders and the marginal lending facility for overnight loans at a penalty rate. Thus, in contrast to other central banks (e.g. the Federal Reserve), the Eurosystem did not have to widen its

collateral set in the first phase of the global crisis.[37] Only in October 2008, the ECB announced a number of measures widening the set of eligible collateral (15 October 2008, Press Release "Measures to further expand the collateral framework and enhance the provision of liquidity"). In early 2009, the ECB raised its rating threshold for ABS to "two AAA ratings at issuance" from "one A rating" and lowered the rating threshold for all securities except ABS from A- to BBB-. In the subsequent years, the ECB continued to combine both tightening and loosening measures in its collateral frameworks with a view to remain on the efficient frontier in the possibility space of supportiveness towards central bank funding and financial risk taking (see section 4 of Bindseil et al 2012).

The crisis response of the Eurosystem underlines again that during a profound financial crisis adjustments to the collateral framework are necessary in view of the ever changing financial conditions, risk factors and bank refinancing needs. Adjustments included the suspension of the rating threshold for sovereign debt and sovereign guaranteed debt in the countries subject to an EU/IMF program, Greece, Portugal and Ireland (see e.g. press release of 3 May 2010, "ECB announces change in eligibility of debt instruments issued or guaranteed by the Greek Government") and loosening of the rating threshold for ABS from AAA to A (December 2011). The former move was justified with a view to maintain available collateral in the respective countries, and that adjustment programs were in place in these countries which were signed off by the ECB. The latter move reflected the adjusted, more conservative rating methodologies of banks and the fact that concentration of collateral around Government exposures appeared to emerge as a more relevant concern than the reliance on ABS as collateral (8 December 2011, Press release "ECB announces measures to support bank lending and money market activity").

With regard to the TARGET2 balances we exclude the idea of imposing limits on TARGET2 balances because it is inconsistent with the concept of monetary union. The moment the limit would be hit, deposits across central banks would no longer be perfect substitutes, and hence there would no longer be a single currency. However, two price incentive mechanisms might in theory be considered once capital market access has been restored.

First, **increasing marginal rates of remuneration on TARGET2 balances**. Marginal remuneration rates could increase, whereby the marginal rate curve would be defined e.g. in relation to GDP (it is recalled that currently, the remuneration of any TARGET2 balance is equal to the rate of the main refinancing operations – MRO). For example, for TARGET2 balances up to e.g. 25% of GDP, the normal MRO rate would apply, but then for each subsequent 25%, it would increase by say 0.5 percentage point. As the remuneration would be paid by the central bank, and hence be at the expense of the profits transferred to the Government, this would create economic incentives for the Government to address the reasons for the capital flight. A backdrop of such a measure would be that debt sustainability of the country under stress would be slightly weakened, unless a counterbalancing measure is taken.[38]

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[37] Indeed, immediately before the Lehman event, in early September 2008, the ECB *tightened* collateral eligibility criteria and risk control measures by increasing haircuts on ABS and bank bonds and prohibiting certain ABS types (Press release of 4 September 2008 on "Biennial review of risk control measures in Eurosystem credit operations"). They did not prevent the Eurosystem from having to build a risk provision at year end to address possible losses from the default of Lehman, in view of the complex and eventually impaired ABS that this bank had submitted to the ECB to address its ever intensifying funding stress during 2008 (see ECB Press release of 5 March 2009 on "Eurosystem monetary policy operations in 2008).

[38] A similar approach applies to the IMF's so called non-concessional facilities. All IMF non-concessional facilities are subject to the IMF's market-related interest rate, the "rate of charge". The rate of charge is uniform for all members, as stipulated by Article V, Section 8(d) of the Articles of Agreement. In addition, the Fund applies a system of graduated surcharges according to the amount and length of time credit is outstanding. The system aims at providing the right incentives to the debtor country, i.e. to discourage large access over a prolonged period of time. The rate of charge is equal to the weekly revised SDR interest rate, plus a margin of currently 100 basis points. The surcharge has two components: first, for access to facilities above 300% of the quota, a 200 basis points surcharge is paid. In addition, for access above 300% exceeding more than 3 years, another 100 basis points surcharge is imposed.

Second, a similar framework of increasing marginal costs of borrowing could **apply to banks when borrowing from the Eurosystem**. For example, if borrowing were to exceed proportional borrowing by more than say 100%, then a surcharge of e.g. 0.5 percentage points could apply, and for each additional 100 percentage points of over-proportionality, the surcharge would increase linearly. The extra income would be monetary income and hence would have to be shared within the system of central banks.

A system of such surcharges would give the term "elastic currency provision" a more intuitive interpretation: "Elastic" would mean that there is no hard limit (in contrast to the approach proposed by Sinn and Wollmershäuser 2011), but the more remote currency provision is from "equilibrium", the more some gradually increasing force (in the form of a financial incentive) emerges that pulls the system back to the equilibrium.

7.   Conclusions

In this paper, we develop a closed system of financial accounts to capture the mechanics of liquidity crisis under various monetary regimes. In particular, we compare the case of a single country (embedded in a flexible exchange rate context) and three variants of a two country setting with a fixed exchange rate, namely the gold standard and the paper standard with fixed rates, as well as a monetary union as the euro area. Moreover, we distinguish the cases in which the central bank is only the lender of last resort for banks, and the one in which it is also the lender of last resort for securities issuers, including the sovereign. In each case, we focus on understanding how a confidence crisis feeds through the accounts of the financial system. We compare the different cases with regard to the liquidity buffers available to avoid that the original liquidity shocks translating into either default or an asset fire sales spiral. The key results can be summarized as follows.

Under a paper standard and with flexible exchange rates, liquidity buffers are in principle unlimited as the domestic central bank only faces constraints set by its own risk management policy when dealing with a financial crisis. If the central bank is prohibited from or refuses to be the lender of last resort to debt securities markets and in particular to its government, debt issuers have to rely on the domestic banking sector to perform this stabilizing function. This implies additional risks to financial stability, for example because the banking sector may encounter capital limitations in acting as a lender of last resort. Moreover, even if the banking sector performs this role, the central bank has to provide the banking sector with the needed additional liquidity and allow the banks to submit securities for which they assume the role of lender of last resort as central bank collateral.

Under the gold standard and an associated fixed exchange rate regime, the domestic central bank of the distressed country is limited in its lending by its gold reserves, in particular if the drain is driven by capital flight out of the currency. If gold reserves are hitting the lower bound, the domestic central bank needs an international lender of last resort activated by international monetary cooperation. However, under the gold standard, international monetary cooperation proved difficult to organize as all central banks are exposed to the risk of a liquidity shock and may therefore themselves reach binding limits or have, preemptively, themselves incentives to hoard reserves. Thus, other central banks will be reluctant to help a central bank subject to gold outflows through loans. Overall, the gold standard is the most constraining monetary regime in terms of the ability of central banks to provide the liquidity buffers needed.

Under a paper standard with a fixed exchange rate regime the central bank of the financially distressed country faces the constraint that its foreign exchange reserves may become exhausted. However, the cases of international scarcity of gold and gold hoarding of the non-distressed central bank no longer apply. Hence, one reason for the failure of international central bank co-operation through loans is overcome. The IMF has been the main conduit of inter-central bank loan provision over the last decades. The conditionality imposed in the context of IMF loans was supposed to address one of the potential concerns that are associated with lending between central banks to address capital flight which undermines the ability to sustain fixed exchange rates: that the public authorities of the stressed countries do not undertake efforts to overcome the source of the imbalance. Organizing inter-central bank loans through the IMF also seems to have favorable properties from a risk management perspective, as the IMF has not recorded losses on its loans up to now.

Cross country stabilizing operations by a central bank of a currency union can be interpreted as an institutionalized and automatic approach to monetary cooperation. In the case of the Eurosystem, automatic TARGET2 balances take over the role of loans between central banks in the gold standard and the paper standard with fixed exchange rates case. The automaticity of TARGET2 balances is both an advantage (as it provides credibility to the elasticity of national liquidity supply) and a necessary condition for classifying the monetary link between countries as a monetary union. Indeed, without a strict interchangeability of bank deposits with national central banks across the union system of central banks, and hence the possibility of creation of associated intra-central bank system balances, there is no real monetary union. At the same time, the automaticity of TARGET2 balances runs the risk that the necessary adjustment measures to overcome the situation that created

the capital outflows are postponed or simply not undertaken. This weakness could be overcome by implementing mechanisms ensuring that corrective measures are taken. In addition to further steps toward a fiscal and banking union, surcharges in case of very large and protracted imbalances could be built in similarly to the case of surcharges for certain IMF loans. In this sense, monetary union would allow for the benefits of automaticity and credibility of inter-central bank liquidity provision, while imposing a framework of governance and incentives to ensure adequate policies commensurate with a mean reversion of TARGET2 balances over time.

Collateral constraints are key in any central bank's response to dual liquidity crises. They became quickly binding for many German banks in 1931 and for many euro area banks in 2010/2011. Both the Reichsbank and the Eurosystem however adjusted the collateral constraint to avoid that it would in itself be the source of bank defaults. Both central banks adjusted their collateral rules in a way to allow banks to close their funding gaps through the necessary recourse to central bank credit, while still controlling central bank risk taking. At the same time, scarcity of collateral may unavoidably have contributed in both cases to a quick deleveraging of banks and hence to a credit crunch, as the fear or actual pressure associated with collateral constraints exert an influence on the behavior of stressed banks in the sense of creating a steady deleveraging / fire sales pressure. What lead to the closure of Danat bank was a deliberate discontinuation of this flexible collateral policy combined with credit restrictions, as imposed by the gold constraint and the inability of the Reichsbank to convince its fellow central banks to grant sufficient loans. In the case of the Eurosystem, a number of changes of collateral rules supported banks, while other elements of the collateral framework reduced the borrowing potential of banks (temporary tightening of ABS rating threshold, mark-to-market valuation of securities, increase of haircuts on BBB rated instruments). In addition, emergency liquidity assistance provided by national central banks allowed closing funding gaps at a penalty rate and without intra-system loss sharing. The fact that collateral constraints were eventually not the constraints that lead themselves to bank closures reflects the facts that (i) these were not imposed strictly on central banks through their statutes or other exogeneous factors, and that (ii) it can be self-defeating and probably not even financial loss minimizing for a central bank to let a bank default for that reason.

In the case of a currency union with unconstrained TARGET balances, the collateral constraint can be the indirect regulator of the extension of TARGET2 balances. In this sense, collateral eligibility and risk control measures become the eventual battlefield for deciding on the degree of support to stressed countries' banking systems and debt issuers (in case of a prohibition or aversion of the central bank to buy debt securities itself, the banks will have to do so, financed by the central bank). Thus, while central banks eventually soften collateral standards in a crisis (and should do so), central bank risk remains key, and that central banks must be well equipped to apply the best possible risk management technology to their exposures in particular if, in a crisis, they find themselves forced to widen their collateral set. This ensures that they get the best possible protection also out of non-conventional collateral, while avoiding that collateral constraints are themselves not the trigger of counterparty defaults.

Borrowing limits of banks / credit constraints do not contain a liquidity crisis, but accelerate it by pushing all banks (potentially) affected by the limit into a state of fear from becoming illiquid, and hence into a state of strict liquidity hoarding. The Reichsbank, facing strong pressures from creditor countries and vanishing gold reserves, was forced to impose credit constraints and hence its decision to eventually do so was voluntarily taken. In retrospect, it seems that this measure contributed, if anything, to the disaster of July 1931, instead of preventing it from happening.

With regard to **interest rates as a tool of ensure the "elasticity" of flows**, a number of cases need to be distinguished:

- **Raising interest rates to attract funding / capital inflows, while being the standard economic mechanism in normal times, may fail to equilibrate demand and supply in a confidence crisis** as higher interest rates make it less likely that borrowers will be able to serve the debt. This mechanism applies in slightly different variants to corporates, banks, sovereigns, and central banks in a fixed exchange rate regime. It is what happened

to Germany in 1931 (with the Reichsbank discount rates reaching 15% but capital outflows continuing), and to Greece, Portugal and Ireland in 2010/11 when they eventually had to request official sector loans. It has of course also happened to countless banks and corporates over time.

- **Raising *central bank interest rates* to make banks on *aggregate* refrain from borrowing with the central bank will not work as normally**. In a liquidity crisis, the aggregate demand of banks for central bank money is inelastic in the short term, as indeed the refinancing needs of banks towards the central bank depend on various factors outside the control of banks (as demonstrated in various variants in our financial accounts model). Raising central bank interest rates aggressively may then primarily put banks under additional stress, intensifying the crisis and reducing access to deposit and capital markets.

- **Raising central bank interest rates as applied to banks that are felt to have the potential to regain market access, but that prefer to rely excessively on central bank financing as it is cheap and easy, can be an effective and non-damaging tool** (Bagehot 1873). This logic would normally apply to individual banks that over-proportionally rely on the central bank although they could also access capital markets or attract more deposits with some efforts and accepting the related costs.

While the economic rationale of monetary financing prohibitions is clear, they might under some circumstances contribute to the unfolding of a confidence crisis. In the case of the Reichsbank, the inability to access Reichsbank funding (also indirectly via banks through the discounting of sovereign bills) and the implied lack of funds was one of the reasons for Brüning to adopt extreme austerity measures to prevent the Government from defaulting. In the case of the Eurosystem, the limited readiness of the Eurosystem to purchase sovereign bonds for supporting the monetary policy transmission mechanism (in contrast with the large scale asset purchase programs of the Federal Reserve and the Bank of England) has been viewed as one reason for the escalation of the crisis in the euro area, in contrast to the stabilization of the situation in the US and UK. Indeed, under a monetary financing prohibition, the banks have to take the burden to provide themselves the lender of last resort function to government (if other investors have been frightened away). This is however a less effective lender of last resort due to the collateral, liquidity, regulatory, and stigmatization constraints that limit banks, in contrast to central banks. Moreover, the additional exposure that banks load onto their books when acting as lender of last resort for Governments makes the country more vulnerable to diabolic solvency loops between the sovereign and the banks.

There are parallels between the cases of Germany 1931 and the euro area 2010-2012 with regard to crisis origins, as a combination of similar factors led to a sudden reversal of capital flows. The ingredients triggering the sudden reversal of capital flows can be summarized in five points: (i) High and possibly unsustainable public debt; (ii) High foreign debt both of the sovereign and of the banking and corporate sector; (iii) Uncertainty about the political commitment to honor debt; (iv) sudden perceived deterioration of creditor status of private investors relatively to other debt holders; and (v) loss of credibility in the integrity of the gold standard and the monetary union, respectively.

The two crises were managed fundamentally differently not only in terms of loans between sovereigns, but also in terms of central bank interest rate policies and borrowing limits. In Germany, central bank rates were set at very high levels in 1931, namely up to 20%, while deflation in that year was as high as 10%, leading to real interest rates of 30% in the context of a real GDP shrinkage of 7.2%. Moreover borrowing limits were imposed on banks. In contrast, in 2011/2012, interest rates were set to 1% by the ECB (with still positive inflation rates), and the so-called fixed rate – full allotment procedure encouraged central bank borrowing of banks, instead of limiting it. In so far, despite the existence of monetary financing prohibitions and fixed exchange rates in both cases, there is no necessity that 2011 should end like 1931.

Overall, it can be concluded that finding the best central bank policies toward liquidity crises remains the most important challenge of modern central banking. History provides ample illustration that the regular occurrence of liquidity crises is an inherent feature of modern market economies, and that

addressing the associated policy challenge successfully is decisive for prosperity and stability. In this paper, we have provided an analytical framework to capture, categorize and understand the effects of the main constraints that the international monetary and financial system and self-chosen restrictions impose on central banks in addressing liquidity crises. At the end we find that a central bank that is largely unconstrained in its provision of liquidity has more policy choices. This potentially allows an independent, competent and long-term social welfare maximizing central bank to choose better policies. By contrast, domestic as well as external constraints that strictly limit the elasticity of liquidity provision, whatever the merits that originally motivated their introduction, might imply that a country is unable to respond appropriately to liquidity shocks. In this paper we provide the analytical tools that allow for an in-depth study of the effects of the main constraints imposed by the international monetary and financial system and self-chosen restrictions that may influence central banks in addressing liquidity crises.

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Annex 1: Comparing the stylized system of financial accounts with theactual one – the example of the euro area

We focus on three types of actual statistical accounts.

A1.1 Euro area integrated economic and financial accounts

First, the "Integrated economic and financial accounts" of the euro area, as presented in section 3 of the ECB Monthly Bulletin (section 3.1, pages in particular page S28 in the December 2011 Monthly Bulletin). The methodology underlying these accounts has been explained in depth in a methodological document ("ECB Monthly Bulletin – Euro Area Statistics methodological notes, Chapter 3: Euro area accounts" 28 October 2010"). This is a comprehensive and consistent system of euro area financial accounts distinguishing the key institutional sectors similarly to our stylized system of financial accounts. (This and the subsequent balance sheet are in trillions of euro).

Table A1.1: Euro area integrated economic and financial accounts						
End Q2 2011. Source: ECB Monthly bulletin, pages S28-S29						
	Households	Non-financial corporations	MFIs (banks)	Other financial institut.	Govern-ment	Rest of World
Financial assets	**18,9**	**16,9**	**32,2**	**22,2**	**3,8**	**16,8**
Currency and deposits	6,7	1,9	9,1	3,2	0,8	3,6
Debt securities	1,4	0,3	6,5	5,4	0,5	4,6
Loans	0	3,2	13,4	4,1	0,5	1,9
Shares and other equity	4,4	7,9	1,9	8,8	1,3	6,0
Other financial assets	6,4	3,6	1,3	0,7	0,7	0,7
Liabilities	**18,9**	**16,9**	**32,2**	**22,2**	**3,8**	**16,8**
Currency and deposits			22,3		0,3	2,6
Debt securities		0,9	5,2	6,4	6,7	5,9
Loans	6,1	8,6		1,9	1,4	5,6
Shares and other equity		13,4	2,6	8,8		
Other liabilities	0,6	3,9	1,2	4,6	0,8	2,7
Net financial worth	12,2	-9,9	0,9	0,5	-5,4	0

The following key observations may be made:

- **Households** have indeed a large net worth, but also have financed through loans around one third of their total financial assets. These loans are mostly mortgage loans, but also consumer loans. Their largest single asset item are deposits (and currency), while their debt securities holdings are more limited, and actually less than one half of shares and equity.

- Shares and other forms of equity are the biggest source of funding of **non-financial corporations**, followed by loans, and to a much lesser extent debt securities. In our financial accounts representation we ignore equity as the vulnerability regarding liquidity shocks comes from the the large share of funding through bank loans. Only companies financed fully through equity would be resilient against liquidity crises.

- For the **Government** the main financing source is debt issuance, as it is depicted in our financial account representation.

- **MFIs (Banks)** fund mainly through deposit collection (as assumed in our financial accounts), but also through debt issuance. Banks largest asset type are loans, but also debt securities holdings and deposits (mainly with other banks) are relevant.

- Finally, the **rest of the world** provides large scale financer in the form of shares, debt securities and loans (in this order), and vice versa.

All sectors, including households, are structurally dependent on funding if engaging in maturity transformation and hence are vulnerable to funding crises.

A2.2 MFI aggregate balance sheet

Second, we consider the aggregate balance sheet of the euro area MFI sector, as shown in section 2.1 of the Statistical annex to the ECB Monthly Bulletin (page S10 and S14 in the December 2011 Monthly Bulletin; explanatory notes can be found in http://www.ecb.europa.eu/stats/money/aggregates/bsheets/html/index.en.html).

Table A1.2: MFI aggregated balance sheet

End Q1. Source: November MB, Page S10, S14

Assets		Liabilies	
Loans to euro area residents	**17,9**	**Deposits**	**16,6**
to Government	*1,2*	*from Government*	*0,3*
to MFIs	*5,5*	*from MFIs*	*5,7*
to other financial intermed.	*1,2*	*from others EA resid.*	*10,6*
to Households	*5,3*		
to Non-financial corporations	*4,7*		
Securities	**4,7**	**Securities**	**4,9**
Governments	*1,5*		
MFIs	*1,5*	**Money market funds**	**0,6**
Others	*1,7*		
Shares, equity holdings	**1,3**	**Capital and reserves**	**2,2**
External assets	**4,3**	**External liabilities**	**4,0**
Other assets	**3,6**	**Other liabilities**	**3,5**
Total assets	**31,8**	**Total liabilities**	**31,8**

The following additional points from this more detailed aggregate MFI balance sheet may be highlighted in the context of our stylized financial accounts representation.

- **MFI loans** are widely split across the other sectors, whereby loans to other MFIs and to households are the biggest obligors.

- **Securities holdings** of banks is less than a third of loans, and are almost equally split across the other sectors.

- On the liability side, **household deposits predominate**, but interbank loans and debt instruments issued are also of systemic sufficient size to create a funding crisis.

A1.3 Eurosystem weekly financial statement

Finally, we look at the Eurosystem balance sheet at the same point in time, or, to be more precise, its weekly publication as of 1 July 2011 (the Eurosystem publishes a weekly financial statement (source:

). It should be noted that this balance sheet is presented in billions, while the previous two were in trillion.

Table A1.3: Eurosystem balance sheet
(as of 1 July 2011)

Assets			Liabilities	
Gold	**363**		**Banknotes**	**849**
Net foreign currency	**229**		**Current accounts of banks**	**216**
Eurosystem credit operations	**455**		**Liquidity absorbing operations**	**98**
Marginal lending facility	*1*		*Deposit facility*	*24*
Main refinancing operation	*141*		*Fixed term deposits*	*74*
Longer term refinancing op	*313*			
Securities issued by EA resid.	**485**		**Revaluation accounts**	**316**
Held for monetary policy purposes	*134*		**Capital and reserves**	**81**
Held for other purposes	*350*			
Other assets	**412**		**Other liabilities**	**384**
Total assets	**1944**		**Total liabilities**	**1944**

The following points may be highlighted in the context of our stylized financial accounts representation:

- **Gold and foreign exchange reserves** are relatively limited, reflecting that the euro area has a flexible exchange rate regime towards the rest of the world and does not need to steer its foreign exchange rate (actually the gold position is not so limited because of the large increases of gold prices over recent years – see also the size of revaluation accounts on the liability side).

- The Eurosystem held both **monetary policy portfolios** of debt securities and for investment (= "other") purposes.

- The **total length of the balance sheet is 230% of banknotes in circulation**. It is to be recalled that in our system of financial accounts, only central bank intermediation between banks lengthened the central bank balance sheet beyond the amount of banknotes issued. However, at this point in time, the intermediation by the Eurosystem was very limited: current accounts of banks with the Eurosystem were practically equal to reserve requirements, and recourse to the Eurosystem deposit facility was below 1.5% of the balance sheet.

Since that date, the money market and deposit shocks across banks has been much stronger, and indeed currently (January 2012), the Eurosystem is heavily engaged in interbank intermediation (with cash rich banks depositing around EUR 450 billion). The figures in annex 2.3 and 2.4 show the evolution of the Eurosystem balance sheet across time.

Annex 2: The German financial crisis of 1931 – background and development

Run up: 1921 - 1929

The origin of financial instability characterizing the Weimar Republic was largely related to the reparation debt and the inability and unwillingness of Germany to deliver on it (Fleisig 1976, Ritschl 1996). The **war reparation** eventually imposed on Germany in early 1921 was 132 bn Goldmark (12 billion US dollar, or 47000 tons of Gold), i.e. an **estimated 250% of 1913 German GDP**[39]. The reparation bill let to an outcry and resistance in Germany, which triggered the French 1922 Ruhr occupation and hyperinflation in 1923.[40]

In 1924, the mark could be stabilized, and the **Dawes Plan** constituted the starting point of a number of prosperous years. The Dawes Plan foresaw "transfer protection" ("Transferschutz") as a prioritization concept regarding the use of Reichsbank reserves. The transfer of reparations would be conditional to the protection of the central bank's reserves. Therefore, in the event of a foreign exchange shortage, commercial claims would be served first to avoid a run on the Reichsbank. In this sense, private claims had preferred creditor status relative to public claims stemming from reparations. Against this background, and supported by macroeconomic stabilization, Germany recorded an inflow of private capital in the amount of 21 billion Reichsmark between 1924 and 1929.[41]

In 1927/28, official reparation creditors became increasingly concerned about their junior status and started to press for abandoning transfer protection. Negotiations on the Young Plan, later endorsed under the name of the Hague convention of 20 January 1930, started in February 1929 in Paris. A Plan of 12 experts was presented in June 1929, but became already known in March 1929. Six months before the Wall Street crash investors realized that transfer protection might end, i.e. private claimants would no longer have priority in terms of the recourse to the Reichsbank's gold reserves, triggering a a sudden stop of capital inflows into Germany to which the Reichsbank responded by interventions on the foreign exchange market.

1929 marked the turning point in the Weimar Republic's financial and economic development (Table 2) recording the last year without negative growth and deflation. At the same time, monetary conditions tightened as shown by the development of interest rates (Table A2.1, Chart A2.1), illustrating that under the constraints of the gold standard a country suffering a confidence crisis is unable to use the interest rate instrument geared towards internal stability.[42]

Table A2.1: Inflation, growth and key interest rates, Germany, 1926 - 1933

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[39] The pre 1914 Goldmark was equal in gold value to the post 1924 Reichsmark. The value of the 47000 tons of gold today would be (with a price per ounce of USD 1700) USD 25,815 Billion, i.e. 780% of German GDP today.

[40] The German hyperinflation was unrelated to the kind of shocks and possible liquidity provision by the Reichsbank discussed in the paper but resulted from direct financing of government expenditures supporting the striking workers in the Ruhr area. On a more general level Bordo (1986, with reference to Capie (1986)) claims that any hyperinflation in the 20th century was associated with situations of extreme social unrest or civil war, i.e. not financial crises.
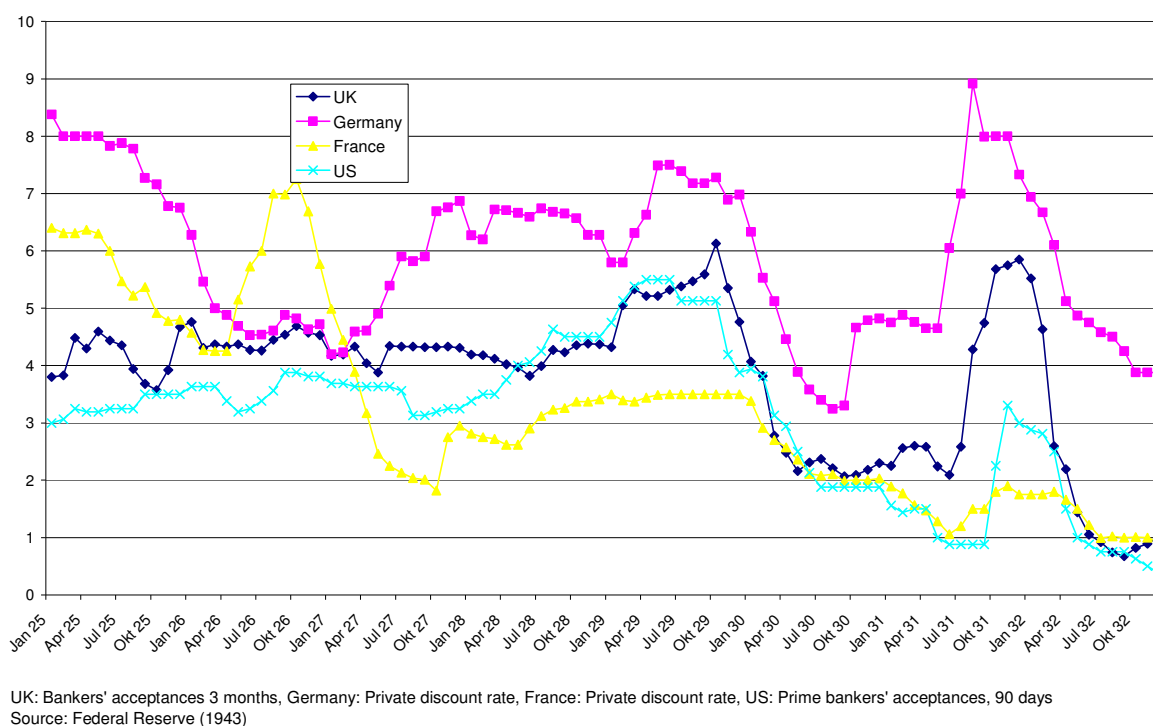
[41] Ritschl (1996, 14) refers to a moral hazard issue: The more Germany would take in as commercial credit, the less reparations would probably have to be paid in the end. Private creditors felt confident to invest in Germany as long as transfer protection prevailed.

[42] Indeed, interest rate tightening by the Reichsbank (being a decoupling from rates set by the other major central banks) had started already in 1927. However, at this stage it was not the reflection of a confidence crisis, but more a standard tightening measure in the context of a still positive economic sentiment (Voth 2003).

	Inflation	Real GNP growth	Discount rate	Lombard rate
1926			6.74%	7.90%
1927	0.9%	9.8%	5.83%	7.24%
1928	2.7%	4.5%	7.00%	8.00%
1929	0.0%	0.0%	7.11%	8.11%
1930	-5.5%	-1.4%	4.93%	5.93%
1931	-9.3%	-7.2%	6.91%	8.58%
1932	-10.4%	-7.8%	5.21%	6.21%
1933	-4.7%	6.8%	4.00%	5.00%

Source: Deutsche Bundesbank (1976)

Chart A2.1: Short-term money rates in the UK, Germany, France and the US, 1925 - 1932

UK: Bankers' acceptances 3 months, Germany: Private discount rate, France: Private discount rate, US: Prime bankers' acceptances, 90 days
Source: Federal Reserve (1943)

The situation in 1930

Germany's total foreign indebtedness in 1930, excluding reparations, was 20-25 billion Reichsmark, or 35-40% of GNP (Toniolo 2005, 100). At a 3% discount rate the net present value of the Young Plan, which foresaw cash flows totaling approximately 110 billion Reichsmark amounted to 54 billion Reichsmark in 1930, i.e. around 80% of GNP. Thus, total foreign debt in 1930 stood around 115-120%. The real debt burden grew substantially in the following three years as nominal GNP shrank by 30% in 1930-32. Therefore, in 1932, the debt/GNP ratio reached an order of magnitude of 150% of GNP. According to Bundesbank (1976), around one half of the 20 billion Reichsmark of private foreign debt was short term, mainly issued by banks. In 1930, however, German banks were in a relatively weak solvency situation, and partially highly dependent on short term foreign loans. Moreover, the Reichsbank's gold reserves were not comfortably exceeding the 40% coverage of banknotes by gold reserves (the threshold imposed by the Dawes and Young Plans).

The **Brüning Government**, which was never able to rely on a solid parliamentary majority, was established in March 1930. It would stay in power until May 1932. An extraordinary Reichstag election on 14 September 1930 sees extremist parties gain, the NSDAP becoming the second largest

party, contributing further to a sense of political destabilization and further capital outflows. In the absence of a parliamentarian majority, the Brüning Cabinet would impose in total 62 emergency decree laws of which four are famous in terms of imposing draconian austerity. Until today, Brüning is commonly accused of having deflated the economy out of misconceived classical business cycle doctrines, or out of the desire to get rid of reparations (e.g. Ferguson and Temin 2001). However doing justice to Brüning requires to recognize that (i) Germany had largely lost capital market access in 1929 (see e.g. Bachmann, 1996), that (ii) at least the unconditional part of the reparation annuities had to be paid, (iii) that monetary financing of Government deficits was excluded by the restrictions imposed by the Dawes and Young Plans, and that (iv) dismissing the gold standard was not an option either, as it would also have been in contradiction with the Young plan and would possibly have created a panic in view of the fresh memories on hyperinflation. Therefore, extreme fiscal austerity and deflationary policies were probably unavoidable, if compliance with the Young plan was to be achieved for as long as possible.

The credit crisis of 1931

In March 1931, the **German – Austrian free trade agreement** was signed, which was seen by some (France in particular) as a political provocation (Ferguson and Temin 2001). It would reduce the willingness of France to agree to the Hoover moratorium and to central bank credits to the Reichsbank. In Mai 1931, problems of the **Österreichische Kreditanstalt** became known (namely an annual loss equal to the banks' total capital, see e.g. Schubert, 2006). Contagion to Germany spread in the form of an interbank run, which was followed by foreign and domestic withdrawals from bank deposits and finally a retail bank run (Schnabel 2004). On 9 Juni 1931, Brüning announced his second emergency decree law, „Notverordnung zur Sicherung von Wirtschaft und Finanzen", which however fails to restore confidence. From 1 to 17 June the Reichsbank lost 1.4 billion RM, more than one half of its gold reserves, and comes close to its minimum 40% coverage ratio prescribed by the Young plan. The decline is in particular driven by banks' need to refund foreign sources of funding. On 13 June, the Reichsbank raises the discount rate from 5% to 7% (in a deflationary context) to stop the capital flight. On 16 June 1931, **Nordwolle**, a large textile company, announces high losses making insolvency likely, leading to a destabilization of Danat bank, which was known to be highly exposed to Nordwolle.

The **Hoover Moratorium of July 1931** was a late attempt to stop the confidence crisis by opening a perspective on restoring debt sustainability, and by relieving the Reichsbank of immediate payments that would have gone further at the expense of its gold reserves. On 20 June 1931, Hoover´s plan was publicly announced. The US would forgo $ 245 million of war debt payable soon by Britain, France, and Italy, provided that the Allies themselves suspend $ 385 million in reparations due from Germany. Markets reacted positive about the news and the German stock market jumped 25% on the following Monday. However, Hoover had not involved Germany's largest creditor, France, and unsurprisingly the French Government reacted negatively. On 5 July 1931, Luther writes in a letter to the BIS that the Reichsbank reserve ratio had fallen below 40% and that Germany could not meet the Young payments due on 15 July. An accord with France on the Hoover Moratorium was reached on 7 July 1931.[43] However, it was too late in the sense that the negative momentum could no longer be reversed. The Danat bank crisis was in full swing. Within one month, the bank had lost 40% of its deposits (Dresdner 11%, Deutsche 8%) (Toniolo, 2005, 101).

In this context, the Reichsbank announced **central bank borrowing limits for banks ("credit restrictions")** with effect on 22 June: **the discount borrowing potential was fixed to the levels of discount borrowing as of 19 June 1931**. In addition the instruction was given that "for any central bank credit provision it is to be ensured that it is not used by the banks to finance the purchase of foreign exchange, who have no real economic foundations. In other words, beyond the strict quantitative restriction, constraints on capital mobility were imposed on banks." (James, 1998, 61).

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[43] According to the Hoover Moratorium, Germany would pay only the unconditional part of the Young Loan which would then be immediately re-loaned to the German Railways.

Imposing general central bank limits froze interbank and capital markets even more, as every bank became extremely concerned about its own funding. Thus, even banks with some liquidity buffer were no longer ready to provide funds out of fears of being the next ones to be illiquid.

On 22 June, Reichsbank President Luther approaches Bank of England Governor Norman for a short term loan of USD 100 million. "The Bank of England, itself walking on thing ice and concerned about possible domino effects of the crisis, gave a positive response. Its only condition was the participation of the Federal Reserve Bank of New York, which in turn required that France be involved." (Toniolo 2005, p. 101) Also the BIS joined the loan consortium, and all four lenders put in an equal share. The credit agreement was signed on 24 June 1931. The difficulties in reaching the agreement are reflected by the fact that it took two days in coordinating the press communiqué to be issued by each participating central bank, eventually published on 26 June 1931 (Toniolo 2005, 102). Moreover, conditionality was imposed on the Reichsbank to take measures to stop capital flight (James 1998). On 8 and 9 July, Luther flies to European capitals to ensure another larger central bank credit. However, "after a number of consultations, the US authorities took the position that '**Germany should first undertake credit restrictions**' and 'present a concrete proposal to the heads of the various central banks assembled in Basel'." (Toniolo, 2005, 105).

This is confirmed by **the most detailed contemporaneous historical account of the episode, Priester (1932)** who describes the dramatic days in mid July 1931. On Saturday, 11 July 1931, the failure to find a solution becomes evident. We recollect these decisive days with some excerpt of Priester (58-62), as it illustrates the various constraints, in particular the collateral and gold constraint, and the unwillingness of foreign central banks to help explored in the main text.

"To understand the future events, it is to be noted that the economic assessment of the ministerial bureaucracy [immediately preceding 11 July 1931] was in principle correct, but that it was unable to make their points towards the Chancelor and the Reichsbank. (p. 56)."

"The senior ministry officials considered the issue as being one of a liquidity crisis. A crisis of which the reasons needed to be removed quickly. This was only possible in their view if the Reichsbnak would give up its restrictive policies and would declare itself again to be ready to accept any trade bill for discounting that the banks would submit…. They were aware that the available stock of eligible discount bills was largely exhausted due to the already much increased recourse to the Reichsbank. So even if the Reichsbank would declare again to discount all eligible bills, the banks would not be able to rely on this since no eligible bills were left in their portfolios. Ergo, so the senior ministry officials, one would have to find ways to create immediately new eligible trade bills. The idea of a guarantee by the Reich came up to achieve this….

Only after the autopsy, one would be able to see what the eventual exposure – the financial risk of the Reichsbank – would be. That is why no special solution for a single bank should be thought, but instead a general guarantee in the above-mentioned form. There was consensus that one could not afford to let any major bank fail.

This plan, which was similar to the eventual solution adopted later on, did not encounter support of the ministers. One was still believing into the breakthrough of the Luther trip [to secure loans from foreign central banks]. Also the Reichsbank strongly opposed the plan. She was not ready to give up its restrictive lending policy under any circumstances. At the contrary, she was committed, with a view of expectations abroad, to become even more restrictive with regard to the provision of discount loans. According to the reports that were available to Luther, the foreign capitals were still regarding the currency flows as German capital flight, which could be stopped immediately by restricting credit (p. 57-58)."

Priester summarizes the events of 11 July 1931 as follows:

"On 11 July 1931, the Government quarter, which is normally very quite on a Saturday evening, had a very unusual appearance. Cars rushed permanently towards the Chancellery. The big conference room was full of people. Not only the leaders of the big banks, not only the members of the Government, but also anyone who had any relation with the Government or the banks felt entitled to participate to this decisive meeting. …

After a short welcome by Chancelor Brüning, state secretary Trendelenburg summarized the situation. There would be two ways to save Danat bank: a merger or supportive solidarity by all other banks. Otherwise, only a closure of Danat bank would remain. A discussion followed. The banks unanimously rejected the idea of solidarity as the situation of Danat bank was completely non-transparent…. Eventually, the banks were ready to help Danat bank with 250 million Reichsmark, but only if the funding would come from the Reichsbank and in any case the Reichsbank would have to give up its restrictive policies.

The President of the Reichsbank Dr. Luther completely rejected this proposal, and announced to the contrary that the restrictive policies would be sharpened even further in the future. Neither him nor Brüning mentioned, that the political negotiations with France [regarding inter-central bank loans] played an important role to explain his position.

Harsh words were exchanged, including by Dr. Luther. He refused to tolerate that all of the burden was dumped on the Reichsbank, who would not be the drudge the banks seemed to perceive in it. She would not be ready to let itself be misused, as the first condition for maintaining the German economy would be that the central bank would remain faultless. If he would provide further discount loans, he would not be able to maintain the 40% gold cover ratio. … The banks should think about the signal an under-fulfillment of the gold cover ratio would imply. Unrest would be created, which could easily be the starting point of a domestic bank run…. Also for political reasons, the Reichsbank would not be in a position to engage in such support measures before the central bank meeting in Basel next Monday….

Luther had spoken himself into a state of strong excitement. He stood there wildly gesticulating, in his hand his bible, the Reichsbank law. The representatives of the banks and the ministries were perplex, as they did not know enough about the political issues who had brought Luther towards such conclusions. … Geheimrat Bücher of the AEG asked Luther ironically, what was the benefit of an faultless Reichsbank if the rest of the economy had broken down. He added that one should not only insist on legal articles, as unusual times also require unusual measures. The Reichsbank would be the institution that was responsible for the functioning of the German credit system. She would had the duty to do whatever was possible, to avoid the collapse of the German credit building. But Dr. Luther constantly insisted that the Reichsbank would not contribute funding in any sense to the rescue of Danat bank. (pages 60-62)"

Hopes that eventually other major central banks, most importantly the gold rich Banque de France (Eichengreen 1986), would provide emergency loans, i.e. act as an international lender of last resort did not materialize. In July 1931 Luther failed to obtain additional central bank loans when *"the run on [German] banks intensified from the first week in July onwards, while capital flight continued. … The Reichsbank currency / reserve ratio dropped below the 40% statutory threshold…. It is against this background that Luther undertook his well-known and well-dramatised tour of the European capitals to rally support from central banks and obtain new credit lines... Norman [the Bank of England Governor] was convinced that only negotiations between the governments could restore market confidence – leaving the impression that, as a central banker, he now felt powerless….. The French were adamant with their guest that only an improvement of the relations between the two countries could open the door to the granting of new credit lines …. US authorities took the position 'that Germany should first undertake credit restrictions' and 'present a concrete proposal to the heads of the various central banks assembled in Basle…. "* (Toniolo 2005, 104-105)

On Saturday 11 July, France had one more time specified its conditions, which *"concentrated on three points: dismantling of the customs union with Austria; renouncing to the construction of the armored cruiser "type B", and economic commitments relating to a tightening of credit restrictions and measures to stop the capital flight out of Germany"* (Priester, 1932, 64). The role of political conditionality is obviously remarkable from today's perspective. However, despite the efforts of the Americans to broker a deal, eventually no new credits were granted.

On Monday 13 July 1931, at a BIS meeting in Basel, "Luther made a poor showing" (Toniolo, 2005, 105), and *"his fellow central bankers were, in any case, in a gloomy mood themselves"*. *"Norman felt that Germany needed 'a credit but that the situation [was] so much political that he [questioned] how*

it [could] be handled'. McGarrah [Fed NY Chairman], for his part, considered that there was nothing to be done at the moment but 'await developments, until we can see what is being done in Berlin'." Still, Luther was able to obtain a prolongation of the three weeks USD 100 million credit from the meeting in Basle.

In the days that followed 13 July, *"the Americans and the French continued to press for tighter credit controls. The Reichsbank discount rate reached as high as 15% at the end of July, while the reserve ratio was allowed to drop below the 40% threshold…. When all was over, the situation had changed, but to no-one's advantage. The Germans failed to get a credit, the French failed to get concessions, the UK Treasury failed to get revisions of the Versaille Treaty, and, one may add, the US lenders failed to get their money back."* (Toniolo, 2005, 105)

As negotiations failed, the Danat bank was unable to open its counters on Monday 13 July. On Sunday 12 July 1931, an emergency decree had announced a guarantee on deposits with Danat bank, and Danat bank was kept closed on 13 July. However, a **run on the other banks developed on 13 July, so that also on all other banks a two days bank holiday was declared**. At the end of July 1931, the discount rate of the Reichsbank stood at 15%; the gold coverage ratio was far below 40%. Full convertibility of the Reichsbank ended and exchange controls, never to be lifted again for decades, were imposed. Moreover, the gold reserves of the Reichsbank would never recover again, and Germany would make no further substantial reparation payments apart from some final payments in 1933 and the repayment of Dawes and Young bonds after World War II. In this sense, July 1931 marks a tragic failure of crisis management the relevance of which can be hardly exaggerated in terms of its economic and political implications.[44]

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[44] On the former James (2010, 239-240) notes that 1931 has been a decisive turning point in 20th century economic history away from market economies and globalisation, demonstrating that there are no means to solve a banking and currency crisis.