THE SAFETY NET: CENTRAL BANK BALANCE SHEETS AND FINANCIAL CRISES*

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Abstract

Across history, central banks have used their balance sheets as lenders of last resort (LLR) to stabilize the financial system during crises. We study the evolution and fluctuation of central bank balance sheets since the 1600s and assess the aggregate effects of liquidity interventions. Using plausibly exogenous variation in the likelihood of crisis interventions induced by ex ante beliefs of central bank governors allows us to show that LLR interventions systematically mitigate financial crises and accelerate macroeconomic recoveries. However, we also present evidence that such interventions raise risks of future boom-bust cycles in the financial system.

JEL codes: G01, G15, G21, N20
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1 Introduction

Central bank balance sheets have played a prominent role in the response to the financial and macroeconomic upheavals of the past decades. In a bid to shield financial markets from the most severe economic strains, both the response to the Global Financial Crisis (GFC) of 2008-9 and the more recent response to the COVID-19 pandemic of 2020-2 featured large-scale asset purchases and the extension of significant amounts of liquidity to the financial sector. In these times of financial stress, major central banks chose to deploy their balance sheet to prevent market freezes and collateral damage to economic activity.

These policies revived a longstanding debate about the effectiveness and side effects of central bank liquidity provision, a controversy tracing back to the 19th century (Thornton, 1802; Bagehot, 1873). A new literature emerged to study recent central bank policies (Gertler and Karadi, 2011; Smets and Potter, 2019; Bernanke, 2020, among others). Yet, a systematic analysis of central bank balance sheet interventions including historical experience is lacking. Our paper is the first to provide historical panel data that reconstructs annual central bank balance sheets for advanced economies over multiple centuries—including the full breakdown of asset and liability components for many episodes. This long-run historical view yields a sample size sufficient to systematically analyze rare financial disasters and estimate the macroeconomic effects of central bank balance sheet operations.[1]

We show that time and again, central banks deployed their power to create liquidity in a bid to insulate economies from disasters.[2] While such deployments first began with geopolitical shocks during the 17th and 18th centuries and occurred with increasing regularity during wars and revolutions, we find that financial crises eventually became the main trigger of central bank balance sheet expansions. This shift was not only driven by the relative frequency of these events, but also by the shifting sensitivity of central banks: After the Great Depression, central bank systematically responded to financial crises with liquidity injections.

We develop a novel empirical strategy to study the causal effects of central bank liquidity support during financial crises. Because only *severe* crises warrant liquidity support in the first place, basic correlations between liquidity support and crisis outcomes are subject to endogeneity bias. Existing literature starting with Bordo et al. (2001) posited that banking crises observed since the late 19th century over a sample of about 80 countries were on average associated with larger GDP *losses* when accompanied by open-ended liquidity support. This finding has been confirmed by

[1] While long-run chronologies for different financial tail events exist in the literature—including for financial crises (Reinhart and Rogoff, 2009; Jorda et al., 2016; Baron et al., 2021), or for wars (Clodfelter, 2017)—the history of central bank interventions has not been studied systematically due to the lack of corresponding intervention data. Ferguson et al. (2014) is concerned with aggregate long-run balance sheet trends, but focused on a more restricted historical sample and did not isolate the causal effects of balance sheet expansions, either.

[2] Conventional wisdom assumes that central banks' utilization of their balance sheets was limited prior to the 1970s. This is partly due to the emphasis on the interest rate as the primary operational tool in the treatises by Walter Bagehot and others in the late 19th century, and partly due to central banks' alleged "passive" mandates (Sayers, 1956; Volcker, 2004; Carlson and Wheelock, 2015; Shafik, 2016).

Honohan and Klingebiel (2003), showing that public liquidity support has been associated with longer crises, larger output losses and slower growth of sectors depending on external finance.[3] However, by comparing crises with and without liquidity support, Bordo et al. (2001) and Honohan and Klingebiel (2003) most likely compare crises of different severity.

We disentangle the effects of crisis severity and liquidity provision by exploiting ex-ante beliefs of central bank governors about the desirability of crisis liquidity support: Governors emphasizing costs over benefits of such operations ex ante will be less likely to intervene—conditional on the nature of the crisis. Recent research has established close links between personal beliefs of political decision-makers, their policy preferences, and aggregate economic outcomes (Gohlmann and Vaubel, 2007; Mishra and Reshef, 2019; Monnet and Puy, 2020; Malmendier and Wachter, 2022; Bordo and Istrefi, 2023; Giuliano and Spilimbergo, 2024; Hack et al., 2024). In this paper, we assess the ideological proximity of central bank governors to schools of thought that advocated against liquidity support to distressed institutions—either based on concerns about moral hazard or loss of institutional credibility due to discretionary policy rules deviations. We define a "hawk" as a governor who disapproves of liquidity support, and classify other governors as "doves/pragmatists".

We characterize a governor's ideological ex ante beliefs prior to the outbreak of the crisis based on a narrative analysis of historical sources. We utilize the extensive historical records to locate each governor in the context of the ideological climate of his time prior to a financial crisis.[4] Our sources include historical newspaper articles, records of speeches and written statements, national biographical dictionaries, academic articles, auto-biographies, and other relevant personal information.[5] We double-check our results against the relevant secondary literature in the history of economic thought, history, and political science—fields in which the many governors left intellectual traces—and also take into account shifts of governors' policy beliefs between crises. A language model-based approach corroborates our manual classification.

We confirm that beliefs of central bank governors correlate strongly with central bank actions during crises: ex ante dovish governors were 34% more likely to expand the central bank's balance sheet in a crisis, indicating that central bank policy reactions corresponded to governor beliefs

[3] Romer and Romer (2018) have recently reached a more benign assessment of the use of monetary policy space during crises on output, they use only a post-1970s event sample, and focus on policy-rate reductions.

[4] In addition to the discussion in section 4.1, see Table A.1 in Appendix A, where we discuss in detail primary and secondary source material commenting on each individual governor in office during a banking crisis over 1870-2019, and also adopt alternative existing approaches to rank policy preferences of decision makers, including a three-way classification scheme. Table A.2 also contains further professional and demographic background on all governors in our sample, with table A.5 testing for their potential role in a first-stage regression setup, and section E containing a random governor classification assignment (Figure A.18).

[5] Appendix 1 documents our classification rationale governor-by-governor in our country sample during financial crisis episodes over the period 1870-2021. We also describe our process for dealing with "borderline" cases, or disagreements across different sources. National biographical dictionaries were particularly relevant in our approach given their nature as extensive peer-reviewed compendia and include, in the case of the Netherlands, for instance, the "Nieuw Nederlands Biografisch Woordenboek"; the Italian equivalent is the "Dizionario Biografico degli Italiani"; in Sweden, we fall back on the "Svenskt biografiskt lexikon" in this category.

formed before the crisis. This provides us with a relevant instrument to identify variation in crisis liquidity support and circumnavigate the inherent endogeneity entangling monetary policy and the macroeconomy. Crucially for our identification, such beliefs will be uncorrelated to triggers and key drivers of crises.[6]

We show that central bank liquidity support systematically cushioned the economic effects of financial crises. Using governor beliefs as a statistical instrument, we estimate that a central bank balance sheet expansion of at least +15% during the first or second year after a financial crisis outbreak increases real GDP by +10 percentage points after three years relative to the counterfactual without liquidity support. Correspondingly, we document the stabilization of asset prices and aggregate investment. On average, this stabilization has been achieved without runaway inflation while hawkish crises management was often associated to stagnant monetary aggregates and protracted deflation. We confirm that liquidity support measured by central bank balance sheet expansions operated in the form of lender of last resort (LLR) operations rather than monetization of fiscal stimulus. Overall, our results are consistent with the hypothesis that risk absorption by the public sector matters for crisis severity.

Finally, we present evidence that these positive short-run effects come with an important medium-term caveat. Hawkish central bank governors often invoke moral hazard prior to, and after the outbreak of a banking crisis. History shows that such concerns have merit. Central bank liquidity support in crises is associated with a rising probability of future episodes of excessive risk-taking by financial intermediaries that end in another financial crisis. If central banks refrained from using their balance sheet to support markets in the previous crisis, episodes of renewed excessive risk taking are much rarer. These insights on the long-term effects of liquidity support on repeated risk-taking in financial markets complement evidence on moral hazard concerns relating to other "safety nets" such as deposit insurance schemes (e.g. Cordella and Yeyati, 2003; Duchin and Sosyura, 2014; Drechsler et al., 2016b).

That is, liquidity support interventions pose a non-trivial trade-off to policy makers, who have to weight the short term benefits of stabilization against the long term risks of future instability. In addition, policy makers may want to consider potential cross-sectional effects of either scenario. Our estimates allow to provide a back-of-the envelope calculation of the effects on the net present value of aggregate output. Across a broad range of plausible assumptions about future growth and discount rates, we find that central bank liquidity interventions raise the net present value of aggregate output.

Previous literature: Our paper adds new evidence to a mature theoretical literature on the lender of last resort. In its classic version envisioned by Thornton (1802) and popularized by Bagehot (1873), LLR policy works through bilateral lending by the central bank to illiquid but solvent private institution against good collateral at high rates.[7] Building on the insights of Diamond and

[6]We discuss possible infringements of the exclusion restriction in detail in Section 4.3. For example, it possible that the anticipation of dovish crisis management could encourage financial risk-taking ex ante. However, this would aggravate crises raise the bar for finding positive macroeconomic effects of dovish central bank liquidity policy.

[7]While it could appear controversial whether open market operations qualify as LLR interventions (Goodhart, 1999;

Dybvig (1983) into creditor runs, modern scholarship has placed liquidity at the heart of theories of financial crises—and their mitigation (Caballero and Krishnamurthy, 2008; Brunnermeier, 2009; Bolton et al., 2011; Gertler and Karadi, 2011; Acharya and Skeie, 2011; Ashcraft et al., 2011; Guerrieri and Shimer, 2014; Benmelech et al., 2016; del Negro et al., 2017). Accordingly, adverse shocks and pessimism about asset returns can spiral into a collective flight to liquid assets—central bank reserves and close substitutes—to whether creditor runs and meet potential shortfalls in cash flows. As markets dry up, even sound institutions risk illiquidity and default, eroding the financial system's intermediation capacity. Unless the monetary authority meets the elevated desire to hold liquidity, wide-spread financial distress threatens a potentially severe real economic downturn. Moral hazard and adverse selection effect, however, can increase banks' risk taking in response (Drechsler et al., 2016a; Behr and Wang, 2020). Further, financial frictions might hamper the distribution of liquidity and foster credit misallocation (e.g. Bleck and Liu, 2018), and the monetary authority risks being trapped by overdosed liquidity (Benmelech and Bergman, 2012; Acharya et al., 2022). We provide evidence on the effect of these interventions both in the short run and over the long term.

Our evidence corroborates and generalizes various case study findings of Richardson and Troost (2009), Giannetti and Simonov (2013), Nakabayashi (2017), and Benmelech et al. (2019)—all of whom evaluated particular liquidity constraints and provisions during financial crises. Since the GFC in particular, a more specialized literature has investigated unconventional monetary policy (Bernanke et al., 2004; Joyce et al., 2011; Gagnon et al., 2011; Engen et al., 2015; Sims and Wu, 2020), with big-picture contributions by Bernanke (2020) and Bailey et al. (2020). Another strand of literature considers the specific risk-mitigating role of large-scale asset purchases (LSAPs) at the macro level (Caballero and Simsek, 2021). The literature has offered positive evaluations of LSAPs as they appear to have succeeded in reducing financial market uncertainty, supported aggregate demand, lowered borrowing costs for households, corporations, and sovereigns, boosted asset prices, and meaningfully raised inflation against the counterfactual scenario.[8] Analyses of the ECB's LTRO and OMT programs, in particular, have motivated assessments of liquidity provisions at the micro (bank) level. Acharya et al. (2019), Jeanne and Korinek (2020), and Crosignani et al. (2020): Drechsler et al. (2016b), however, highlighted the adverse crowding-out effects of these programs.

Our measure of liquidity support based on central bank balance sheet expansions complements the policy chronologies of Calomiris (2011) and Bindseil (2019). Metrick and Schmelzing (2024) provided a recent overview of banking sector interventions across 20 categories over multiple

Tucker, 2014; Praet, 2016; Calomiris et al., 2016), our measure of aggregate liquidity provisions encompasses more narrowly defined LLR operations and as such relates to the works surveyed in Bordo (1990) or Buiter and Sibert (2007).

[8]For summaries of studies and the posited financial and macroeconomic effects, see for instance Borio and Zabai (2018) or Smets and Potter (2019): both also document the wide range of estimates on some variables: the ECB's SMP program, for one, is credited with having less than a 100 basis point impact on Eurosystem government bond yields according to one study, while another credits the program with a 550 basis point impact (Smets and Potter, 2019, 29). Of course, there are selected contributions that negate any overall positive impact of balance sheet expansions, including Greenlaw et al. (2018)—those views, however, are thus far not widely echoed.

centuries, including 540 historical central bank liquidity provisions across 143 economies.

Our classification of governors builds on and develops a wider interdisciplinary literature attempting to formalize policymakers' economic preferences in the context of competing political ideologies (Hibbs, 1977), including monetary policymakers (Rogoff, 1985; Alesina and Sachs, 1988; Havrilesky, 1995; Chang, 2003). This literature equally proposes time-invariant frameworks to distinguish between "hawkish" and "dovish" policy preferences, and to rank their relative importance of employment and growth as well as price and exchange rate stability, and moral hazard concerns. Financial markets also routinely group central bank governors in "hawkish" vs. "dovish/pragmatic" policy categories, based on the assessment of governors' public statements (Kuttner and Posen, 2010). Related to our approach, Hack et al. (2024) exploit the ideological leaning of members in the US Federal Reserve's Open Market Committee in conjunction with the committee's rotation rule to identify shifts in systematic policy of the central bank. They analyze the response of the monetary authority to standard business cycle fluctuations in the US since the 1960s. By contrast, we investigate more exceptional crisis episodes across the advanced world covering modern history. Our definitions of "hawkish" ("dovish") policy ideology differs slightly as we focus on different policy choices.

The structure of the paper is as follows. Section 2 introduces our new data and explores the historical evolution of central bank balance sheets. Section 3 analyzes shifts in how central bank balance sheets responded to multiple types of macroeconomic shocks over the past 400 years. Section 4 focuses on financial crises, and studies the macroeconomic effects of central bank liquidity support. Section 5 concludes.

2 International central bank balance sheet data since 1600

We assemble balance sheet data for central banks in 17 advanced economies.[9] For five countries we are able to trace de facto central banks back to the 1600s.[10] In this section, we explain the construction of the database and present international long-term trends in central bank balance sheets.

2.1 Data

We collected historical data on both de jure national central banks as well as their de facto predecessor institutions. These institutions could be government-sponsored or privately owned (as the Bank of England was prior to 1946) as long as they are recognized as a "bank among banks" with a de facto monopoly on note issuance, or with a preeminent role in government financing. In Appendix B, we detail our definition of such proto central banks and survey various institutions

[9]Our dataset covers: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

[10]Figure 4 visualises the coverage of our data for on a country-year basis.

that fulfill our criteria but were excluded given a lack of satisfactory data.

Our early data cover the Public Banks of Naples (1587-1805, Balletta, 2008), the Bank of Amsterdam (1611-1814, Dillen, 1934), the Sienese Monte (1626-1725, Camaiti, 1956), the Bank of Hamburg (1665-1770, Sieveking, 1934), the Swedish Riksbank (since 1668, Simonsson, 1931; Fregert, 2014), the Bank of England (since 1700, Dimsdale and Thomas, 2017), the Bank of the United States (1792-1848, Baker et al., 2019), the Bank of Finland (since 1813, Asp, 1898), the Danish Nationalbanken (since 1865, Svendsen et al., 1968a), the Bank of Netherlands (since 1815, van der Borght, 1896, and the Dutch *Nationaal Archief*, F1100212/2013), the Royal Bank of Prussia (since 1817, von Niebuhr, 1854; Bankverwaltungsrat, 1851-1872), the Banque de France (since 1800, Courtois, 1881; Baubeau, 2018) and the Banco de San Fernando/Banco d'España (since 1830, de Lorca, 1999; Martín-Aceña, 2017), and for Italy the Banca Nazionale (1856-1892, da Pozzo and Felloni, 1964).[11] From 1870, we add data from the national central banks in Belgium, Finland, Norway and Portugal.[12]

Our post-1870 central bank balance sheet data are sourced from a wide variety of country-level primary and secondary literature detailed in Appendix P. For large parts of this sample, we were also able to study the composition of central bank assets and liabilities in more detail. Our dataset provides full coverage for the 17 advanced economies from 1920 onward.

The institutional organization of central banks varies across advanced economies even in modern times. The Federal Reserve System is technically composed of twelve regional Federal Reserve Banks with their own balance sheets. The European Central Bank has not eliminated the national-level balance sheet accounting in the Eurosystem, currently comprising 19 national central banks. In both cases, the institutions' balance sheet expansion decisions are reached at the centralized level, and balance sheet items are reported on a consolidated basis that aggregates regional Federal Reserves, and Eurosystem central banks, respectively (Stella, 2009; ECB, 2012). As we are interested in the aggregate-level macroeconomic and financial responses of balance sheet dynamics, it is most appropriate to use these consolidated balance sheet definitions as our benchmark series.[13]

[11] There are a select quasi-central banks for the modern period that existing literature treats as such but which we do not cover, mainly because empirical records are either fully lacking or are non-continuous, such as those for the Genoese *Banco di San Giorgio*, or Barcelona's *Taula Di Canvi* (for which few ledgers survived): for the moment, we are also leaving out a few select early series which are not entirely transparent about the full range of balance sheet items covered, such as Tucci (1973)'s data for the Venetian *Banco Giro*, and the Milanese *Banco S. Ambrogio* (Cova, 1972).

[12] All of our twelve early modern central banks have been treated in the literature as de facto predecessors to contemporary central banks.

[13] Notably, Richardson and Troost (2009) argue that the liquidity provision of the Atlanta Fed during 1930—as opposed to the restrictive St. Louis' policy in the neighboring Federal Reserve district during the same period—can be associated with stabilizing outcomes in the former's banking sector. Any changes in the Atlanta Fed's balance sheet in such a case are reflected in the Fed's consolidated balance which we focus on: while our approach is not designed to pick up potential variations in the macroeconomic and financial response on the regional level, it is not "missing" such underlying expansion dynamics, therefore, and if influential enough on the aggregate level, will correspond to measurable impulse response results. Broad policy outlines, even at the Atlanta Fed, were still determined by the FOMC before, during, and after the 1930 episode, including the type of collateral eligible for regional Fed discounting. A corresponding case is a Eurosystem national central bank's provision of emergency liquidity assistance (ELA) lines, which are reflected in consolidated form in the Eurosystem balance sheet, and the broad eligibility of which is set by

Table 1 summarizes our data through the distribution of annual balance sheet fluctuations. In addition to the full sample, we present statistics for three major sub-periods: pre-1870, 1870-1949 and post-1949. The variation in annual growth rates was substantial across all historical episodes, suggesting that balance sheets were in principle able to behave elastically, even under the constraints of metal-based currencies.

Table 1: Central bank balance sheet fluctuations

				Percentiles				
	N	$\hat{\mu}$	$\hat{\sigma}$	5	25	50	75	95
Full Sample	3557	0.09	0.61	-0.15	-0.01	0.05	0.13	0.39
1600 to 1869	1275	0.07	0.90	-0.21	-0.04	0.02	0.09	0.36
1870 to 1949	1099	0.11	0.47	-0.09	-0.01	0.05	0.14	0.47
1950 to 2020	1173	0.10	0.18	-0.10	0.01	0.07	0.15	0.38

Notes: Descriptive statistics—number of country-year observations N, sample average $\hat{\mu}$, sample standard deviation $\hat{\sigma}$ and percentiles—of annual central bank balance sheet growth by sample.

For analysis presented in the main text, we merge the following additional panel datasets. Macroeconomic and aggregate financial data for the period 1870-2020 are sourced from the *Macro-History Database* of Jorda et al. (2017). We date financial crises post 1870 following Baron et al. (2021) and following Metrick and Schmelzing (2024) before 1870. Data on the incidence and severity of wars is sourced from Clodfelter (2017). And we merge series of nominal GDP prior to 1870 for the UK (Broadberry et al., 2015), Sweden (Edvinsson, 2014), Holland (Smits et al., 2000; van Zanden and van Leeuwen, 2012), the Spanish Kingdom (Alvarez-Nogal and de la Escosura, 2013), Kingdom of Naples (Malanima, 2011), Hamburg and Prussia (Pfister, 2022) and France (Ridolfi and Nuvolari, 2021). Government debt series prior to 1870 cover the UK (Dimsdale and Thomas, 2017), Sweden (Edvinsson, 2014), Netherlands (Fritschy, 2017), and France (Vuehrer, 1886). Additional data used in appendix analyses are detailed in the corresponding Appendices.

2.2 Historical evolution of central bank balance sheets

Our data reveals the historical variation in the economic size of central banks across countries and time. In this section, we analyze time series of year-specific cross-sectional data moments. The full set of country-specific series as well as estimates of year fixed effects are shown in Appendix C.

the ECB governing council, rather than the national level (ECB, 2020).

2.2.1 Central bank balance sheets relative to output

Figure 1 shows the cross-sectional mean and quartiles of total central bank assets relative to GDP of the corresponding jurisdiction for each year between 1600 and 2020.[14] We observe that the inception period of central banks in the 17th and 18th centuries saw sharp growth in this measure followed by international dispersion taking hold during the second half of the 18th century. Significant variation in this time period is driven by war finance or geopolitical competition for overseas trade routes.[15, 16]

For much of the 19th century, aggregate central bank assets-to-GDP ratios varied in tight ranges, both across countries and across time. They rarely surpassed 15% of GDP, even during costly macroeconomic and financial shocks such as the Crimean War (1853-56) or the 1857 and 1866 international financial crises. But from the 1880s our series once more records an acceleration of aggregate central bank assets relative to output, partly induced by new ideas about central banking, such as those of Bagehot (1873), which triggered monetary policy reforms, notably in the UK (Calomiris, 2011).

The upheavals of modern history left a major imprint on central bank balance sheets. Despite the clear majority of our country-level constituents being involved in both World War I and World War II, central bank balance sheet patterns differ markedly. Aggregate expansion during the latter were much more pronounced, setting new international and historical records. Such a finding accords with the work of previous scholars who emphasized the private-market financing basis of World War I (Strachan, 2004). Figure 1 shows how assets/GDP reached 20th century lows by the mid-1990s. Since then, central bank balance sheets grew especially in the wake of the Great Financial Crisis, the European Sovereign Debt Crisis and the Pandemic Recession.[17] The exceptional rise in assets from 2008 on this basis represents an "unprecedented" break in multi-century dynamics, with average central bank asset-to-GDP ratios recently reaching almost double their World War II peaks.[18]

Overall, we observe that bullion standard regimes did not necessitate static balance sheets relative to output, but went hand-in-hand with different "balance sheet regimes". Assets/GDP, in other

[14] As denominator. we use the political entity which achieves the highest degree of conceptual consistency over time, and reflects the historical reality of market integration. For details, see Section 2.1.

[15] For example, the Bank of England's balance sheet grew substantially after it assumed government debt previously financed through the semi-public South Sea Company failing 1720. In Sweden, the treasury borrowed heavily from the Riksbank to finance military outlays during the Russo-Swedish war 1741-1743. These debts were rolled over until 1778, when the government forced the Riksbank to write off most of them.

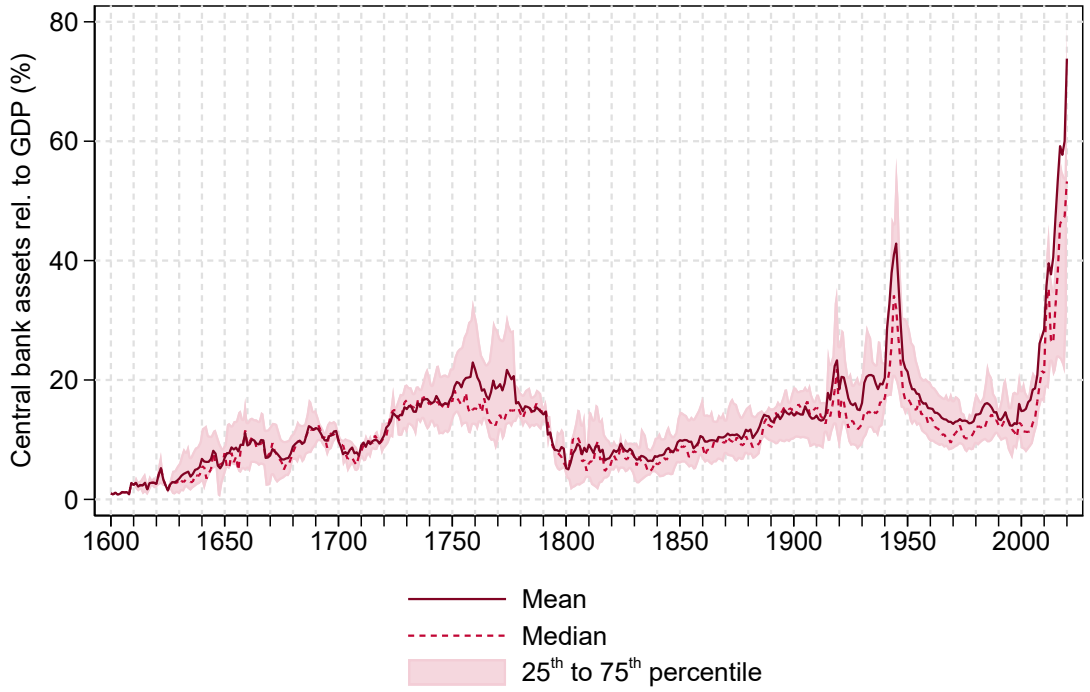
[16] We note that central have have not been created alike and their institutional features and context were instrumental for these dynamics. For example, we find that central bank balance sheets have in principle been greater relative to GDP under monarchies or when the sovereign—be it a monarch or a republican—had major ownership stakes.

[17] Reactions to financial shocks stemming from the burst of the tech bubble 2001 or the 9/11 terrorist attacks did not provoke major central bank balance sheet responses.

[18] None of these pattern highlighted in the text are driven by sample composition effects: Estimates of year fixed effects controlling for country fixed effects in Appendix C trace out a very similar time series.

words, evolved opportunistically, more flexibly than rigid "rules of the game" would imply, and depending on specific demand for a publicly provided safety net. The floating era—when balance sheet sizes were freed from any remaining gold coverage ratios—did not unleash a sustained acceleration of central bank asset growth. However, it certainly contributed to greater elasticity of central bank balance sheets in response to disaster events.

Figure 1: Central bank assets relative to GDP, 1600-2020



Notes: The figure shows the year-specific cross-sectional mean and quartiles of total central bank assets relative to GDP of the corresponding jurisdiction. Sample composition and underlying sources are detailed in Section 2.1.

2.2.2 Central bank balance sheets relative to the size of the financial sector

It is not clear that GDP is the right denominator to benchmark the size of the central bank. Indeed, the picture changes drastically when we normalize aggregate central bank assets by the size of the private financial system. Figure 2 visualizes the annual cross-sectional distribution of central bank balance sheets relative to aggregate private bank lending to the private non-financial sector.[19] While central bank played a major role in pre-WW2 financial systems, private financial intermediation out-grew public central banks thanks to financial deepening, innovation and deregulation. From average levels below 50% in 1960, the ratio falls almost uninterruptedly to all-time lows by 1998, of just 15.4% on average. From this perspective, the recent growth of central bank balance sheets looks but a normalization in which central bank re-establish the role they used to play. This

[19]Due to data limitations on financial sector loan volumes, we show figures only from 1870.

suggests that larger central bank balance seets may be here to stay.[20]

Another important factor behind the relative decline of central bank size, however, was the widespread adoption of an alternative "safety net" for the banking sector: mandatory deposit insurance.[21] While the United States is an outlier, introducing an explicit deposit insurance scheme as early as 1934, all other countries in our sample (bar Australia, which relied on an implicit scheme) introduce explicit deposit insurance schemes between 1961 (Norway) and 1996 (Sweden). In consequence, central bank balance sheets were no longer the only safety net for the banking sector. And the 1970s and 1980s saw a substantial uptick in the share of deposit insurance responses, and an associated decline in traditional liquidity assistance interventions by monetary authorities (Demirguc-Kunt and Detragiache, 2002; Metrick and Schmelzing, 2024).

These developments changed the nature of financial crises over time. Baron et al. (2021) document that between 1870-1940, for a panel of 46 countries, banking crises almost exclusively featured actual "panics", defined as depositor runs. However, the share of banking crises "without panics" rose gradually from the 1960s when shadow banking began to grow in importance (Adrian and Shin, 2009; Antill et al., 2014). By 2010 the overwhelming share of banking crises feature no panics. While deposit insurance prevented classical depositor runs, a larger shadow banking system created new financial stability risks.[22]

2.2.3 Central bank holdings of public debt

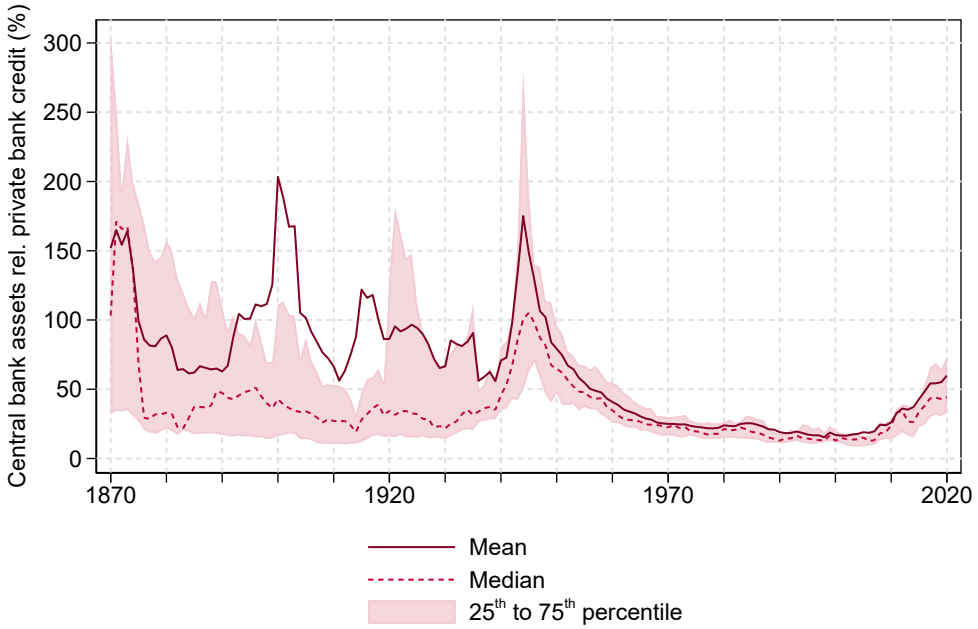
Figure 3 shows a subset of total central bank assets -– namely government debt assets — as a share of total government debt outstanding, and as a share of total central bank assets. As a share of total government debt outstanding, central bank balance sheet holdings of government debt have increased somewhat in recent years, but still fall notably short of the peaks observed during the Seven Years' War and the Napoleonic Wars. The data make it clear that asset purchase operations since 2008 have sharply reversed the post-1945 trend of a "withdrawal" of central banks vis-a-vis growing public financial asset volumes. However, at 17.5% they remain a far cry from classical "debt monetization" episodes, when individual central banks held close to 80% of all

[20]None of these pattern highlighted in the text are driven by sample composition effects: Estimates of year fixed effects controlling for country fixed effects in Appendix C trace out a very similar time series.

[21]See Demirguc-Kunt and Huizinga (1999) and Calomiris (2011) for relevant "safety net" discussions. Identifying recourse to emergency liquidity as a form of financial sector "safety net" repeatedly occurs in previous literature: Calomiris (1997), Calomiris (1999), Mishkin (2000), or Gorton and Metrick (2013) refer to the Fed's LLR facility as a "safety net" for the financial sector, the more prominent one in existing literature being deposit insurance / the FDIC.

[22]In the US, deposit-taking institutions were outstripped by financial institutions without deposit insurance coverage in the 1990s—requiring a shift towards a new role that might be characterized as the "market maker of last resort" function. After initially attempting to re-run a traditional LLR response to the crisis, the 2008 central bank balance sheet expansions overwhelmingly targeted assets held by the *shadow banking sector*, which were unable to fall back on the deposit insurance safety net (Buiter and Sibert, 2007; Gertler and Karadi, 2011).

Figure 2: Central bank assets as a share of total bank lending to the non-financial private sector



Notes: The figure shows the year-specific cross-sectional mean and quartiles of total central bank assets relative to the stock of bank debt owed by private nonfinancial businesses and households. Sample composition and underlying sources are detailed in Section 2.1.

outstanding public debt.[23] We also observe that international financial regimes—whether featuring fixed, floating, or intermediate exchange rate arrangements—do not appear to necessitate a specific asset/debt range. Once again, sharp breaks appear to be event-specific and typically associated with major macroeconomic shocks.[24]

In Figure 3b, we display central bank government debt assets as a share of aggregate central bank assets, in other words, the central banks' concentration of government assets in their portfolios over time across countries. Echoing the previous measure, present fears over "fiscal dominance" appear not to be borne out. Current levels indicating close to half of aggregate central bank assets in the form of public debt are not out of line with historical experience. In this sense, private sector recourse to the central bank "safety net" appears to have been dominant during the classical gold standard (an era lacking deposit insurance schemes, but featuring high capital mobility).

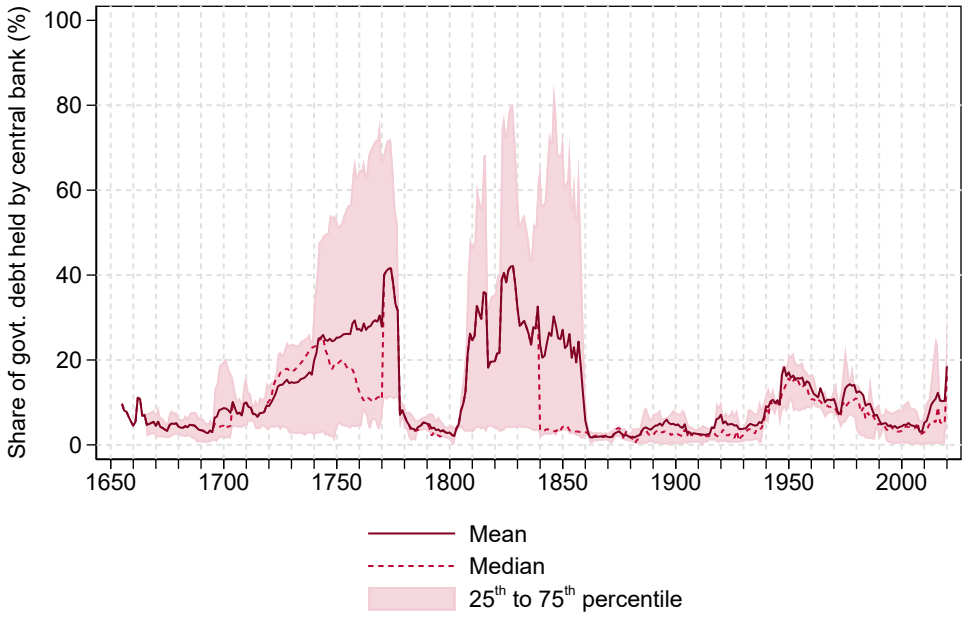
Overall, therefore, aggregate balance sheet trends across advanced economies do not monotonically track trends in transactions or financial asset volumes. Regardless of influential "real bills" policy frameworks and the rules of fixed or floating exchange rate regimes, central bank balance sheets did not consistently fluctuate with output variables. A more plausible interpretation relates

[23]None of these pattern highlighted in the text are driven by sample composition effects: Estimates of year fixed effects controlling for country fixed effects in Appendix C trace out a very similar time series.

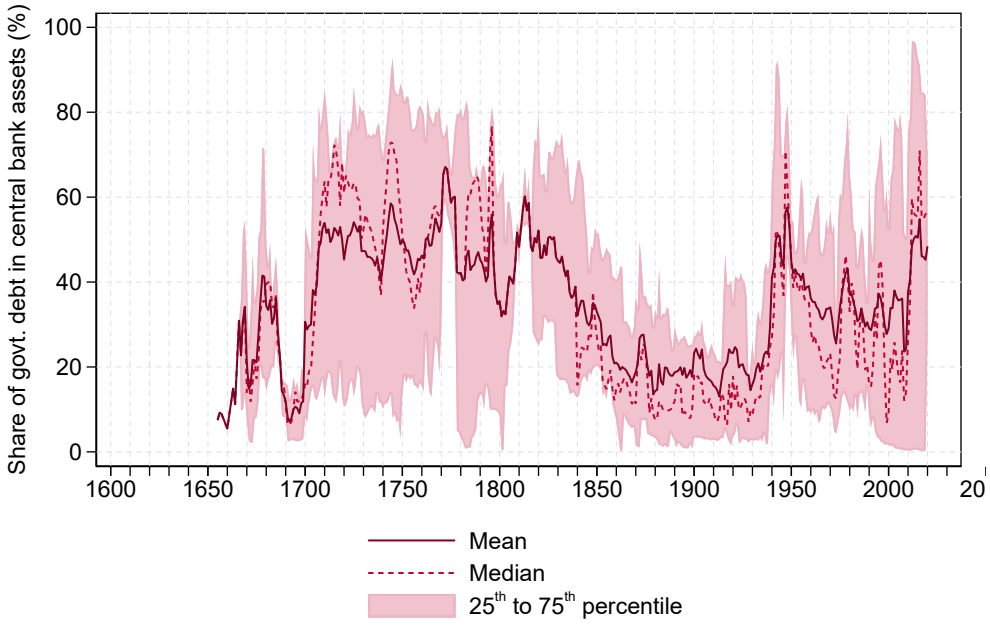
[24]In 1711, amid financial volatility and fears of a more systemic event, the government provided the Bank of England with GBP 45,000 to buy Exchequer Bills in the open market and reduce the prevailing discount rate. The operation was deemed a success on account of the successful reduction of short-term market rates. See Hill (1971).

Figure 3: Government debt held by central banks, 1652-2020

(a) As a share of national government debt outstanding



(b) As a share of total central bank assets



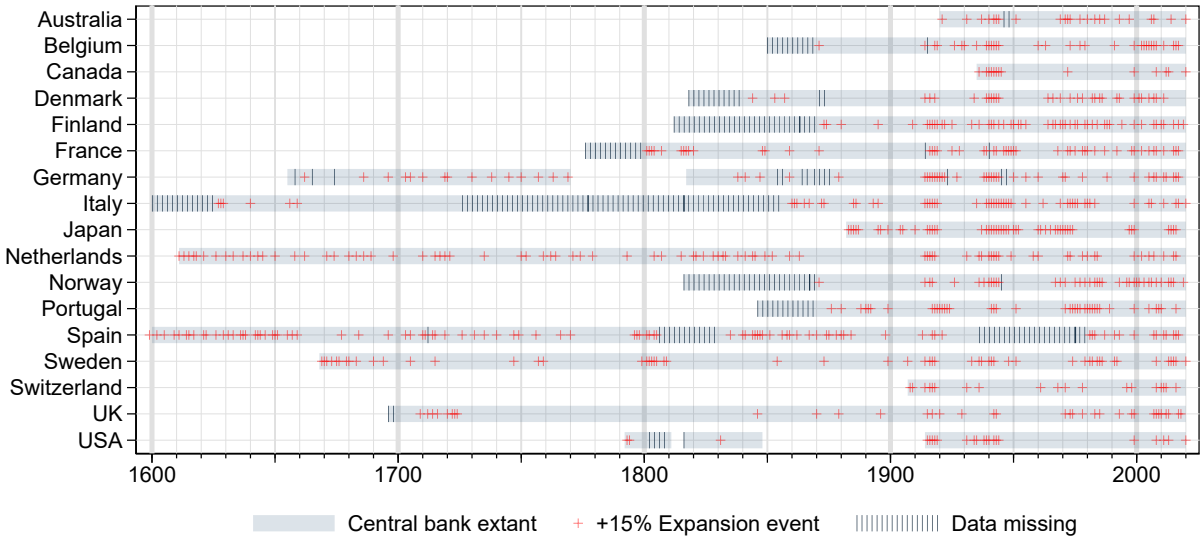
Notes: The figure shows the year-specific cross-sectional mean and quartiles of total central bank holding of government debt relative total government debt outstanding in Panel (a) and relative to total central bank assets in Panel (b). Sample composition and underlying sources are detailed in Section 2.1.

central bank balance sheet trends to the utilization of their safety net function, which ebbed temporarily with the emergence of alternative insurance mechanisms and overall demand for a publicly provided safety net. The rise of the shadow banking sector from the mid-1990s appears to have once more revived financial sector demand for a traditional safety net provision.[25]

3 The central bank balance sheet as a safety net

What drove central bank balance sheet expansions? While the previous section surveyed broad international patterns, we turn to a more rigorous quantitative analysis here. We determine the policy motivation and event context for each central bank balance sheet expansion, defining a "major balance sheet expansion" as an individual country-year during which total nominal central bank asset grew by at least 15% year-on-year. However, all our key conclusions in this section are robust to other cut-offs. Over the period 1600-2020, 742 country-years fulfill our 15% criterion (out of 7,157 total country-year observations).[26] All such expansion dates are visualized for each country in Figure 4. For around 16.3% of country-years pre-1870 (23.7% post-1870), annual balance sheet growth exceeded +15%.

Figure 4: Data coverage and expansion events, 1600-2020



Notes: This figure shows the coverage of the central bank data on a country-year basis. In addition, red crosses mark expansion events defined by +15% year-on-year total nominal asset growth or more.

[25]None of these pattern highlighted in the text are driven by sample composition effects: Estimates of year fixed effects controlling for country fixed effects in Appendix C trace out a very similar time series.

[26]We recognize that a liquidity provision event can be neutral with regards to the overall central bank balance sheet size if the intention is merely to swap "risky" assets held by the private sector for "safe" assets held by the public sector—or if lending is sterilized. Note further that in general, our identifications are robust in nominal and real terms.

3.1 Triggers of central bank balance sheet expansions

Previous literature has offered some guidance on how to distinguish between different central bank balance sheet drivers, classifying types from the operational side. According to Bindseil (2004), central bank balance sheet expansions can be a function of (a) currency issuance; (b) an FX operation; (c) an investment of own funds; (d) liquidity assistance; or (e) a monetary policy operation.

We seek to assess the relative importance of different motives to expand central bank balance sheets and the types of macro shocks that prompted a major balance sheet expansion. We distinguish four main underlying macro shock categories which have led to major balance sheet expansions (as defined above), all of which have historically been associated with the operational responses in Bindseil (2004).[27] The first three represent instances where either public or private sector stress prompted an active deployment to the central bank balance sheet with the intention of reducing short-term liquidity or re-financing risks. Hence, these categories were instances of recourse to a publicly provided "safety net" function of the central bank balance sheet. The fourth category, in contrast, represents a residual "passive" expansion category: events in this group were not designed actively to reduce short-term risk premia or re-financing stress, but exclusively reflected transactional fluctuations, operational idiosyncratic events (such as the TARGET system introduction across central banks in 1999), or other internal needs of the bank itself.[28]

- **"Financial crisis"**: We use this category to denote country-years that were primarily associated with financial market volatility, to which the central bank actively responded. Existing chronologies provide a robust picture of several types of volatility in this context, including stock market crashes, bank runs, systemic liquidity shortages, or other threats to the systemic health of the private financial sector. Our classification concentrates on standard banking crisis chronologies (Reinhart and Rogoff (2009); Schularick and Taylor (2012); Baron et al. (2021), rather than exclusive sovereign or currency crises, to capture more narrowly tradi-

[27]While we focus on summary statistics here, in the appendix, section 2.1, we provide full background historical evidence for the "top 25" largest historical expansion events, and respective sources, to illustrate our classification rationale.

[28]This fourth category of events, hence, does not relate to any of the above "tail events". We aggregate these country-years into a residual category—"Revaluation/Residual/Commercial driver"—to denote country-years where the expansion of the central bank balance sheet is primarily of a passive or commercial nature: these expansions are never designed to alleviate private financial or political pressure, or reduce risk premia, and often relate to the balance sheet categories (a)—(c) in Bindseil (2004), currency issuance, FX operations, and investments of own funds. In total, just over a third (36%) of all expansions fall into this residual category—given such proportions, it is clear that this category did not primarily determine either long-run central bank balance sheet trajectories, or short-term asset spikes. Since there are typically no "active" policy decisions at the central bank level related to these expansions, we disregard this expansion category for many of our subsequent exercises. We count 140 country-years in this category, and the average year-on-year nominal expansion in this category across country-years stands at 55.9%.In this group, the German hyperinflation year of 1922 represents a significant outlier. Reichsbank nominal total assets in 1922 were expanding at 1186% year-on-year, mainly driven by sharply rising commercial bill discounting activity. (Webb, 1985, 480-3) argues the Reichsbank behaved passively through this phase, effectively letting the market decide its balance sheet size.

tional LLR events. We count 83 country-year events in this category—mainly representing private sector-driven recourse to the safety net -, of which 47 were in the post-2007 period. The average country-year in this category saw a 44.6% annual balance sheet expansion.[29] For a discussion of measuring LLR operations using annual aggregate balance sheet movements, see Appendix H.

- **"War or revolution"**: We use this category to denote country-years that were primarily related to major geopolitical events, during which either rising military spending led to explicit or implicit requests by fiscal authorities to monetize ensuing deficits, or domestic political uncertainty motivated monetary policymakers to monetize fiscal outlays, or provide private sector liquidity.[30] War and revolutionary events are identified on the basis of long-run military history reference chronologies (Clodfelter, 2017).[31] Over the long-run, this category constitutes by far the most important one: we count 142 country-year events in this category since 1588, of which 39 occurred during World War I and 47 are during World War II. The average country-year in this category saw a 50.8% balance sheet expansion.

- **"Pandemics or natural disasters"**: This is a category with limited pre-2020 significance because in no previous pandemic was there anything resembling the fiscal and monetary response to that seen in 2021-2.[32] Our sample for this category is therefore comparatively small (n=19), and—with the exception of the 1656-8 pandemic in Naples, in response to which the viceroyalty launched a grain purchase program (Fusco, 2007)—restricted to the most recent central bank policy actions over 2020-21. Country-years in this category have on average so far experienced a 48% balance sheet expansion.

How has the relative importance of these expansion types changed over time? Figure 5 addresses this question, by classifying the context in which a particular type of "tail event" required a decision for a balance sheet expansion—irrespective of the specific policy aim for which this expansion was then deployed (whether an asset market stabilization, or a debt monetization).

[29]For all exercises involving the pre-1870 period, we use banking crisis definitions in Metrick and Schmelzing (2024). Twin crises—as long as they include a banking crisis event as classified by these chronologies—are part of our 'financial crisis' sample.

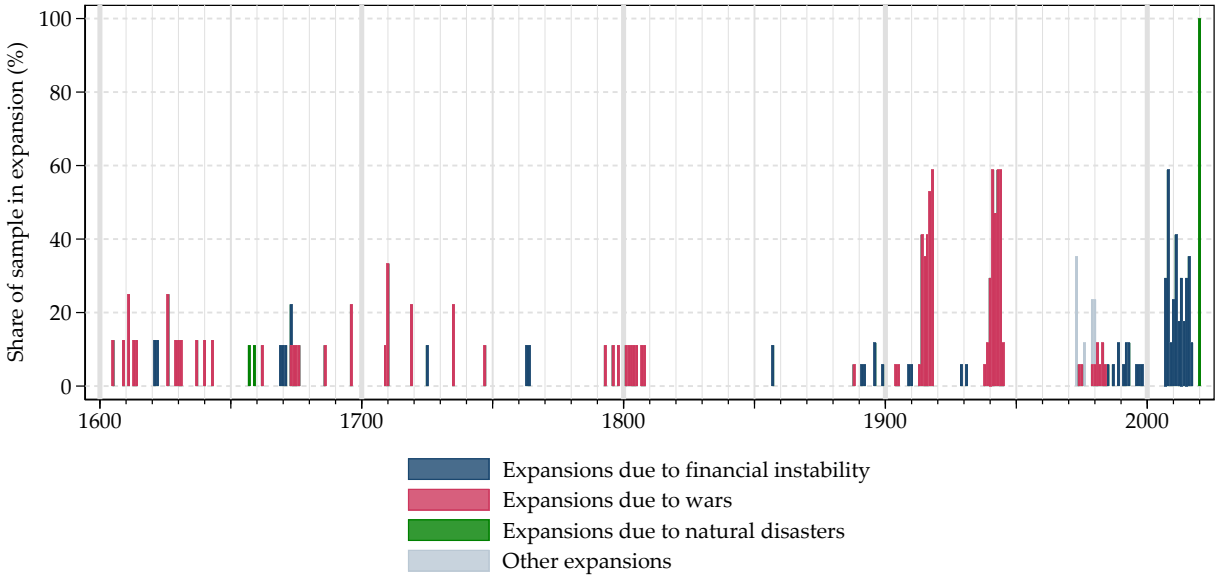
[30]In practice, public asset purchases clearly dominate historically during these episodes. In Appendix 2.2, we break down expansion events by public/private asset types and analyze general trends. We note that "war or revolution" events are repeatedly associated with a "sovereign default" classification in financial crisis chronologies: for instance, Germany 1943, which Reinhart and Rogoff (2009) classify as a sovereign default event; unless also accompanied by a quantitatively dominant banking crisis, these events remain in the "war or revolution" category despite these overlaps.

[31]Our observations are based on the timeline via Clodfelter (2017) remain robust when other approaches are employed, for instance the well-known data in Levy (1983) or Brecke (1999).

[32]We note that even major previous natural or health-related disasters, such as the 1918-19 Spanish influenza, the 1957-58 "Asian flu", or the 1906 San Francisco Earthquake, did not typically engender a measurable monetary policy response. Anderson et al. (2020) argue that the Federal Reserve met extra liquidity demand from member banks affected by the 1918 influenza. However, such assistance was sporadic and did not feature prominently in the annual reports, either by the Federal Reserve Board or the New York Fed, as opposed to the prominent role of the War. We would also consider events such as the 9/11 balance sheet expansion in the U.S. under this category, but the y-o-y growth for 2001 does not pass our 15% threshold: see (Martin, 2009, 400).

On the basis of this evidence, it can be confirmed that the drivers of central bank balance sheet expansions have undergone fundamental shifts over the long-run. Over time, geopolitical and financial crises events account for six out of ten of all balance sheet expansions: but the relative importance of the two main drivers has undergone a substantial shift, partly a consequence of shifting event *frequencies*.[33] While almost half of all balance sheet expansions in the pre-1870 era (48.5%) can be linked to wars, revolutions, or other geopolitical events, such motivations have become rare in the post-1945 world. In turn, more than 40% of all central bank balance sheet expansions after World War II were linked to financial crises, whereas the share was less than 15% in the years prior to 1870 and remained of secondary importance even during the interwar period.[34]

Figure 5: Major balance sheet expansion events, by type, 1600-2020



Notes: Balance sheets expansions expansion events defined as +15% year-on-year total nominal asset growth.

[33]For the long-run evolution in "bank stress", see (Metrick and Schmelzing, 2024, 31), who on the basis of advanced economy GDP-weighted data identify a doubling of bank stress frequency between the 18th and the mid-19th century, a further doubling between the mid-19th century and the interwar period, and a continued increase in the post-Bretton Woods period. For wars, conflict deaths per million population for our 17-country sample stands at 122.5 per country-year between 1650-1945, dropping to 2.12 for 1946-2020; 90.5% of country-years since 1946 are fully conflict-free, all on the Clodfelter (2017) basis.

[34]We generally focus attention on banking crises, as opposed to other types of financial crises for which chronologies exist. We note that the association between currency crises and major balance sheet expansions is less firm. Bordo et al. (2001), for one, classically record a sharp rise in the latter category for DM economies in the period 1945-71, a period with low DM balance sheet expansion frequency. Subsequent chronologies distinguishing between currency and banking crises confirm the general patterns, including Reinhart and Rogoff (2009).

3.2 Sensitivity of central bank balance sheets to wars and crises

The previous section documents a shift from war-related expansions to financial crisis-related expansions. Is this merely driven by a shift in the relative incidence of these events? Arguably, wars have been more frequent in the past, while financial crises only occurred later after financial systems became larger. Have policymakers become more inclined to respond to a particular type of tail event per se?

To test, we estimate a probit model for a binary variable $m_{i,t}$ indicating an annual expansion of the central bank balance sheet of at least +15% during the current or the next year:[35]

$$P(m_{i,t} = 1|\cdot) = \Phi\Big(\gamma_{e,i} + \alpha_e \text{war}_{i,t} + \beta_e \text{crisis}_{i,t}\Big) \tag{1}$$

where Φ is the standard normal distribution function, t indexes the year, i indexes the country and $\text{war}_{i,t}$ and $\text{crisis}_{i,t}$ represent binary variables indicating a war or a financial crisis. The chronology of wars comes from Clodfelter (2017) and we restrict attention to war-years with at least 50 casualties per million of population. Financial crises are dated following Metrick and Schmelzing (2024) for the period until 1870 and Baron et al. (2021) for the period 1870-2020. Moreover, e indexes five distinct historical episodes: pre-industrialization (prior to 1750), industrialization (1750-1869), first globalization (1870-1913), world wars (1914-1945) and post-WW2 (after 1945). That is, $\gamma_{i,e}$ controls era-specific country fixed effects while α_e and β_e measure the era-specific sensitivity of central banks towards wars and financial crises.

Figure 6 plots the average marginal effects of wars and crises on central bank balance sheet expansions, together with their 95% confidence intervals and separately for each episode. Hence, it visualizes the sensitivity with which central banks in our sample react with a major balance sheet expansion to geopolitical or financial tail events. First, we can observe that up until World War II, central banks have been notably more sensitive towards wars than towards financial crises. The probability of a major expansion increased by up to 40% upon a war, outstripping the sensitivity to financial crises of at most 8%. The statistical insignificance of the *average* reaction probability in the case of financial crises does not rule out that central bank did occasionally react, or even systematically so in a few countries and episodes, e.g., the Bank of England in the late 19$^{\text{th}}$ century (cf. Humphrey, 1989; Capie et al., 1995; Calomiris, 2011). However, after the World War II, central bank became systematically more sensitive to financial crises, raising average expansion probabilities by about 30% while the sensitivity to wars collapsed to about 10%.[36]

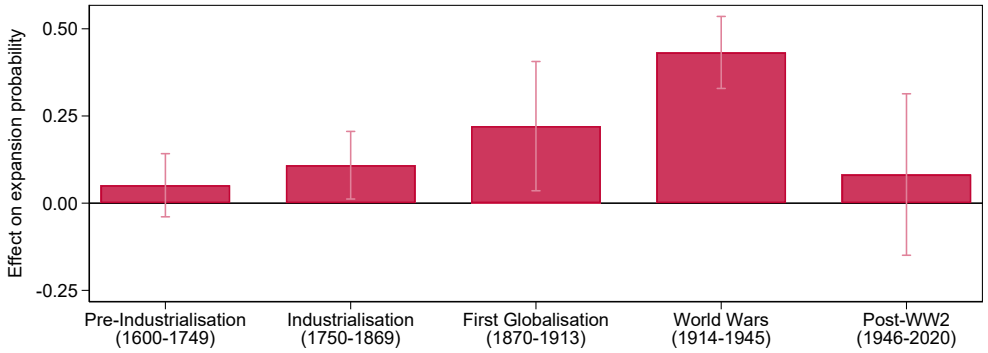
In Appendix E we test sensitivity toward conventional recessions and confirm, that the time pattern is financial crisis sensitivity is not driven by shifts in ordinary monetary policy aimed at business

[35] Estimates are virtually identical when using a linear probability model.

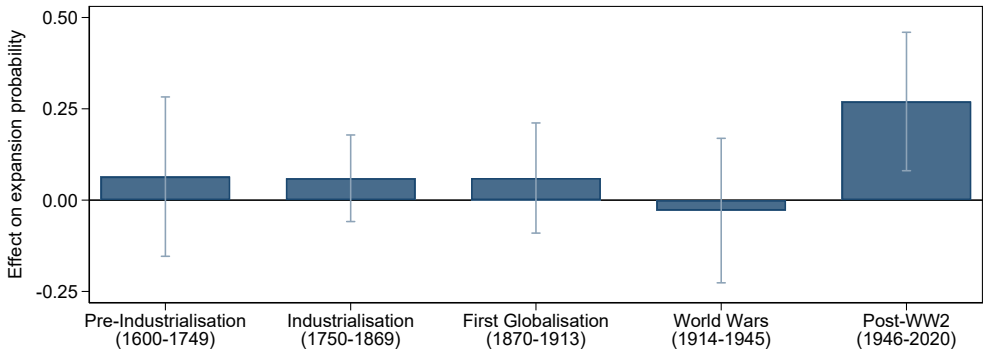
[36] In additional tests, we confirm that the central bank's sensitivity to crises is especially high in country-years without deposit insurance, following the classification of Demirguc-Kunt and Detragiache (2002). In other words, this speaks to the partial substitutability of safety net functions provided by the central bank one the one hand, and deposit insurance on the other. However, given the widespread adoption of deposit insurances post World War II, these estimates are only based on five crisis observations.

Figure 6: Central bank balance sheet sensitivity to disasters, by historical episode

(a) Wars



(b) Financial crises



Notes: The figure plots the average marginal effects on the probability of a central bank balance sheet expansion of +15% or more during the current or the next year. The units are percentage points divided by 100. Estimates based on the probit model of Equation (1). The chronology of wars is sourced from Clodfelter (2017) and we restrict attention to war-years with at least 50 casualties per million population. Financial crises are dated following Metrick and Schmelzing (2024) for the period until 1870 and Baron et al. (2021) for the period 1870-2020.

cycle stabilisation. Likewise, our analysis rejects the hypothesis that pre and post-World War II differences can be explained by constraints of the Gold Standard or currency pegs more generally.

4 The macroeconomic effects of liquidity support during crises

Time and again, central banks sought to mitigate systemic financial distress through providing liquidity. In fact, stabilizing the financial sector became more valuable as financial deepening magnified the economic collateral damage of financial crises. However, warnings about moral hazard and future instability have made these interventions controversial from the start and consensus about overall benefits remains elusive to this date.

Systematic and reliable empirical quantification of stabilization effects has to overcome an inherent identification problem: The central bank's propensity to intervene grows with the severity of the crisis. Bordo et al. (2001) and Honohan and Klingebiel (2003) documented that across countries and history, central bank liquidity support predicts *worse* crises outcomes. In fact, we find the same in our data: Figure 7 visualises the average real GDP trajectories around financial crises dated by Baron et al. (2021), split by whether the central bank responded with large-scale liquidity support $m_{i,t}$ defined as

$$m_{i,t} = \mathbb{1}\Big(\text{annual central bank balance sheet growth} \geq 15\% \text{ in } t \text{ or } t-1\Big) \tag{2}$$

i.e., indicating whether the central bank expanded its balance sheet by +15% or more during the first two years of the crisis.[37] Economic activity shrinks notably for treated crises while it barely slows down for untreated ones. Even four years after crisis start, real GDP is two percentage points lower when the central bank intervened compared to the no-intervention case. However, only severe crises warrant liquidity support in the first place, so comparing crises with and without liquidity support is prone to suffer from reverse causality bias.

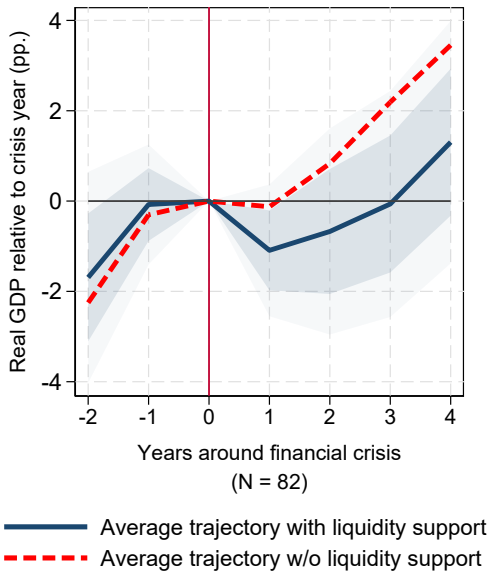
To properly identify the macroeconomic effects of central bank liquidity injections during crises, we use exogenous variation induced by the *central bank governor's beliefs about the benefits and costs of liquidity support to distressed financial institutions* held prior to the crisis. We argue that governors emphasizing costs over benefits will be reluctant use the central bank balance sheet to backstop struggling financial intermediaries. Accordingly, we define a "hawk" as a governor who disapproves of liquidity support, and classify other governors as "doves/pragmatists".

We assess the ideological proximity of central bank governors to schools of thought that advocated against liquidity support to distressed institutions—either based on concerns about moral hazard or the loss of institutional credibility through discretionary policy rules deviations. Corresponding beliefs have evolved over decades of life experience, but they are developed prior to and independent of an acute crisis situation, though of course previous crises have contributed to that experience.

We analyze these beliefs following a narrative approach detailed in the next section and use the resulting binary classification of governors as a statistical instrument to identify the macroeconomic effects of central bank liquidity injections.

[37] By focusing on central bank balance sheet expansions, we capture any operation that monetizes parts of the economy's aggregate asset portfolio at the source, that is any absorption of financial assets by the central bank in exchange for base money.

Figure 7: Central bank liquidity support predicts worse crisis outcomes



Notes: The figure shows the average change of log real GDP relative to financial crisis start, split by large scale central bank liquidity injection (balance sheet expansion of +15% or more during the current or the next year). Estimates are based on a series of regressions indexed by horizon $h \in [-2, ..., 4]$ on the sample of financial crises dated by Baron et al. (2021): $\Delta_h \log(\text{real GDP}_{i,t+h}) = \alpha_h + \beta_h m_{i,t+1} + e_{i,t+h}$ where i indexes the country and t indexes the year. We plot coefficients $\hat{\alpha}_h$ and $\hat{\alpha} + \hat{\beta}_h$. Lightly shaded areas mark 90% confidence interval based on robust standard errors of β_h; $\pm$ one standard error is marked in dark.

4.1 Classification of central bank governor beliefs

It is increasingly understood how past occupational, educational, and other biographical experiences of individuals shape long-lasting economic preferences—for instance, individuals that experience a recession during the ages of 18 to 25 have distinct lifelong political and economic beliefs (Giuliano and Spilimbergo, 2014). A relatively new body of literature has explored the impact of personal attitudes and individual preferences of economic policymakers, their formation through particular experiences or formative life episodes (e.g. the "impressionable years" hypothesis), and their subsequent impact on decision-making and macroeconomic variables—with a consensus forming that such attributes are relevant for institutional policy (e.g. Gohlmann and Vaubel, 2007; Bordo and Istrefi, 2023; Mishra and Reshef, 2019; Monnet and Puy, 2020; Malmendier and Wachter, 2022).

We build on insights from this literature, using evidence of stated personal policy preferences to classify central bank governors as either hawks or doves/pragmatists as defined earlier. We develop a classification algorithm that incorporates information available to the public as closely as possible prior to the outbreak of a banking crisis, and allow for the fact that governors may have undergone ideological shifts during their careers (i.e., governors who preside during multiple banking crises). We focus on advanced economy central banks during financial tail-event years across the 17 countries since 1870, using the comprehensive crisis coding by (Baron, Verner, and

Xiong, 2021, BVX hereafter). BVX define a country-year to experience a crisis as a cumulative bank equity index decline of at least 30% from the previous peak.[38] Our algorithm to classify governors builds on existing methodologies and incorporates both qualitative and quantitative information, across six main economic variables: *moral hazard*, *full employment*, *economic growth*, *price stability*, *exchange rate stability*, and *income inequality*. A full description of the coding exercise and the material used can be found in the designated appendix.

In essence, we study a wide range of primary and secondary historical material—"National Biographic Dictionaries" represented a particularly useful source—to trace governor attitudes across these categories and to establish a ranking of economic preferences for each, designed as follows:Whenever central bank governors publicly worried about "asset bubbles", "speculative excess", "loose lending standards" or use other catchphrases indicating at least an implicit preference to curb such exuberance over the promotion of growth and/or employment variables, we take that as a hawkish signal: Together with price stability concerns, the evidence of worry about moral hazard receives the highest relative weight in the determination of hawkishness. A hawkish signal is also noted if a governor repeatedly positions himself "conservatively" in matters of budget deficits, wage growth, exchange rate arrangements, or excessive financial sector risk-taking: attaching more importance to their inflationary and/or financially "exuberant" consequences as opposed to their potentially desirable growth and employment effects.

Dovish governors typically either do not comment at all on moral hazard, price stability and excessive risk-taking concerns, or do so in a manner that ranks them as relatively less important than the goals of either fostering employment and/or promoting economic growth, the latter two variables receiving the highest weight in our "doves/pragmatists" classification. A "negative dovish signal" is established when a governor cautions against a rigid interpretation of price stability mandates, or downplays risk-taking concerns—all the while refraining from issuing positive statements on growth or employment variables. One idiosyncrasy of "doves/pragmatists" consists in their occasional reference to income inequality: We attach less weight to this variable than employment and economic expansion statements. In practice, of course, "pure" delineations do not always exist. Cases exist where governors exhibited unconventional preference rankings, or shifted their attitudes and we detail further below how we treat such (by and large rare) cases. We reach a final classification verdict once the following criteria are met:

- We have obtained at least three independent sources consistent with one of the two ideological types, at least two of which are not autobiographical.
- These three sources can contain either "positive" or "negative" signals, but must include at least one signal from one of the four "key categories" (price stability, moral hazard, full

[38]We choose the BVX crisis chronology as opposed to other chronologies because it allows the distinction of crisis events based on severity, and because of the fact that the inception of a "bank equity crash" in practice constitutes a better proxy of the timing when a governor is first faced with considerations of a potential policy action: in practice, a central bank governor does not wait until the onset of a "systemic" event before facing a potential policy choice. We also test the chronologies in Reinhart and Rogoff (2009) and Schularick and Taylor (2012) for robustness purposes (appendix figures A.29b and A.29a).

employment, economic growth).

- At least one signal (positive or negative) falls within a five-year horizon prior to the BVX crisis outbreak date.
- We have searched for empirical market evidence to accompany the qualitative material. Wherever available, we then supplement such narrative evidence with quantitative evaluations in the secondary literature(e.g., Kuttner and Posen, 2010).

In total, we obtained 231 individual governor source documents: out of this sample, 50 (22%) documents are *ex ante* sources, in which observers or the governor himself assessed financial and macroeconomic priorities prior to the outbreak of the crisis (as measured by the bank equity crash), and the remainder (181) are *ex post* sources, in which observers or the governor himself reflected on variables and preferences after the financial crisis inception.[39]

Details. Naturally, our identification approach raises a variety of practical and theoretical questions. One of them is whether such a two-way classification scheme of governors—though widely used today—is really plausible for earlier monetary periods. In line with previous studies we argue that, while the explicit labels have undergone constant change, a stable set of relative economic preferences among policymakers has indeed existed over time. This preference ranking has attracted influential research in neighboring disciplines—for instance political science.[40]

Chang (2003) proposed a model of central bank governor beliefs that operates with a binary classification of "easy" as opposed to "tight" monetary policymakers based on five macroeconomic variables. Her insight is that although there are "status quo" central bankers—"neutrals" or "pragmatists"—actual voting is typically expressed in a biased direction. The validity of such a bi-partite ("hawk" vs. "dove") or tri-partite ("hawk" vs. "dove" vs. "pragmatist") approach can also be found in the substantial theoretical and empirical literature building on or exploiting such policy orientations, e.g. the "political monetary cycle" (PMC) (Cukierman et al., 1992). From the perspective of financial markets, too, it has been shown that a binary ideological dichotomy applies when assessing monetary executives: Kuttner and Posen (2010) showed that financial markets categorize central bank governors as "hawkish" or "dovish", and incorporate such assessments in macroeconomic and financial prices.

[39] Using ex post sources can introduce hindsight bias: A hawk might be classified as a dove because the severity of a crisis compelled him to intervene despite his ideological reservations. However, such hindsight bias would invoke the exact same endogeneity problem that previous studies were subject to: on average, governors we classify as doves ex post based on their interventions would simply be associated with more severe crises. Again, this reduces the chances of finding any positive effects from dovish central bank policy. That is, hindsight bias might inflate the first-stage link, but lead to conservative estimation of the second stage main effect.

[40] Analyzing macroeconomic outcomes and political preferences in twelve Western nations, Hibbs (1977) argued that a stable set of economic preferences exists among *political parties* in capitalist societies that allows a time-invariant classification of "left-wing" and "right-wing" political economic ideologies: "Left-wing" parties consistently rank full employment and output growth variables above exchange rate and price stability targets; the reverse is true for "right-wing" parties, which consistently tolerate higher unemployment in order to pursue their preference for lower inflation.

Importantly, our approach does not require us to take a position on whether or not political parties themselves, or appointing governments, are influencing monetary policy. As detailed further in the appendix, we reject the idea of simply deducing a governor's leaning from the party affiliation of the nominating government or legislative body.[41] The exceptions are instances where the central bank is not de facto independent. To assess such influences, we not least benchmark our classifications against one of the most recent widely-used "Central Bank Independence" (CBI) indices (Garriga, 2016), and exclude all "weakly independent" central banks during crises, our main results all continue to hold.[42]

How does our classification algorithm work in practice? In conjunction with a detailed treatment of each individual governor case in the appendix (table A.1), the following contours the interdependencies between distinct governor beliefs about liquidity support and moral hazard on the one hand, and the broader context of output, price, and exchange rate preferences on the other:[43]

- During the **pre-1914 period**, central bank governors remained widely indebted to the British divide between "Banking" and "Currency" Schools. Amid a worldwide deflationary environment that emphasized monetary cooperation according to the "rules of the game", governors engaged in the controversies surrounding the merits of "bimetallism". Looming over all other policy delineations was the "real bills" controversy, which revolved around the contention that only trade-based financial paper should be eligible for discounting purposes—and which "hawks" generally interpreted as ruling out open-ended bank liquidity support (Green, 1988; Dimand, 2020). Governors were also shaped by the major British banking crises occurring over the second half of the 19th century, which triggered foundational debates over the merits of banking crises interventions. Hawkish governors subsequently internalized the dictum advanced in 1866 by the Bank of England that "long-term benefits derived from refusing to rescue insolvent institutions may outweigh the temporary fruits of cooperation" (Schneider, 2021). German Reichsbank governor Richard Koch—dubbed by contemporary commentators a "fierce supporter of *gold*, loathed by bimetallists", hailed by conservative

[41] Our rationale relies on existing literature, including Simmons (1996), who showed that during the interwar period, for instance, central banks systematically tried to steer against government policies. Havrilesky (1995) formalized similar observations in his concept of the "representational governor". Consistent with such views, the "political leanings" of the nominating government as recently identified by van Ommeren and Piccillo (2021) do not accord consistently with the market reactions analyzed by Kuttner and Posen (2010). The unanticipated announcements of Robin Leigh-Pemberton and Eddie George as new Bank of England governors, for instance, generated a dovish market reaction as recorded by the latter – though falling into the "right wing"/"conservative" political category of the former authors.

[42] In this sense, we stress that we generally focus on the most relevant single decisionmaker in the monetary executive: at times, this person does not have to be the central bank governor—or the finance minister—but rather a different person within the central bank. In a total of nine cases, either the Garriga CBI index (post-1970) stands below the value of 0.2 during a BVX crisis, or historical sources (pre-1970) indicate clear constraints on the central banks' independence. These cases are flagged in Figure 8 and discussed further in the appendix (table A.3), with appendix figure A.32 displaying the LP-IV results. In one case (AUS-1931), strong evidence exists that a different person *within* the central bank wielded de facto authority, a case that is equally included in this flagged sample.

[43] We stress that we distinguish these relevant *policy* debates clearly from the *history of economic thought*, with which we are not primarily concerned.

contemporaries for his "cleansing of the [Reichsbank] balance sheet of non-trade bills", and recognized for his "refusal to let the Reichsbank be a cheap source of liquidity" prior to and during the 1907 crisis—combined strong beliefs on price stability, gold standard convictions, and a "liquidationist" attitude to banking crises.[44] His moralistic undertones were echoed by hawkish French counterparts, but opposed by doves such as Banca d'Italia's Giuseppe Grillo, who advocated for silver and objected to the idea of "self-correcting" economic forces.[45]

- Central bank governors during the **1920-1970 period** were occupied by policy debates on the re-establishment of the pre-war gold standard arrangements. Advocates of a transition to free or managed float currency regimes—unambiguous "dove/pragmatists" in our classification—typically downplayed the adverse effects that such a policy decision would engender with regard to price and currency stability. Bonaldo Stringher, the Banca d'Italia governor personified such believes during his three decades in office (1900-30), concurrently supporting a flexible currency arrangement (spearheading the 60% lira devaluation over 1919-20), stubbornly opposing to the deflationary demands of the government during the 1920s (Segreto, 2019), and swiftly though selectively accommodating the 1927-28 banking crisis via LLR (Bonelli, 1982; Molteni and Pellegrino, 2022). Meanwhile, governors favoring a return to traditional fixed exchange rates highlighted the potentially destabilizing capital flow and price effects resulting from floating rates (Mehrling, 1997) and were classic "hawks", who regarded emergency assistance to the financial sector not just as morally wrong ("purging the rottenness"), but also as a complementary threat to both price and exchange rate stability (Meyer, 1954). Junnosuke Inoue, Bank of Japan governor during the 1920s, is one of these representative "hawks". His public warnings about a build-up of speculative asset bubbles (including a key speech in January 1920), motivated his refusal to extend more than symbolic bank support (Shizume, 2018).

- During **the 1970s and early 1980s**, central bank governors across all 17 advanced economies grappled with inflation dynamics and engaged in intense debates about the most efficient remedies Timberlake (1993). In this context, even "dovish/pragmatist" governors could be receptive to certain elements of monetarism without wholly accepting it. An example in this category is the Australian Reserve Bank governor Rob Johnston (1983-89), who experimented with monetary targets in the early phase of his tenure, but then decided to phase out such targets, and moved the bank to inflation targeting. Prior to the Australian crisis of 1989, Johnston adopted a similarly middle-ground attitude, mimicking the poet Arthur Hugh Clough: "Thou may not kill, but need not strive to officiously keep alive." We here see in exemplary fashion how a moderate stance on price stability also coincides with pragmatic

[44] For more on Koch see appendix table A.3, and in particular und Tageblatt (1908).

[45] The economic debate during the Third Republic were deeply influenced by moral hazard concerns, with the Banque de France under governors Pierre Magnin and Georges Pallain subscribing to Clement Juglar's dictum that "a crisis for a nation is the operation made necessary to re-establish an equilibrium broken by speculation" (Bordo and James, 2007, 81).

attitudes on bank support.[46] Hawks, on the other hand, were early and uncompromising converts to Milton Friedman's ideas and favored tight control over inflation, via rule-based money supply (Meltzer, 1997; White, 2012), a stance that led them to reject emergency lending to banks during crises if it violated money growth targets. Characteristically for this group, Rolf Kullberg of the Bank of Finland (1983-92), as a staunch enemy of any Markka devaluation and as disciple of monetarism at the board prior to his executive tenure, repeatedly voiced dire warnings about the moral hazard implications of lax financial conditions prior to the Finnish banking crisis of the 1990s—during which he justified a long hesitation to provide support to banks by the need to wait until institutions "capitulate and submit [themselves] to the bank" on punitive terms (Kuusterae and Tarkka, 2011; Sulkunen, 2015). Kullberg here illustrates the coexistence of an explicit commitment to price and currency stability, with a strong aversion to emergency liquidity provision.

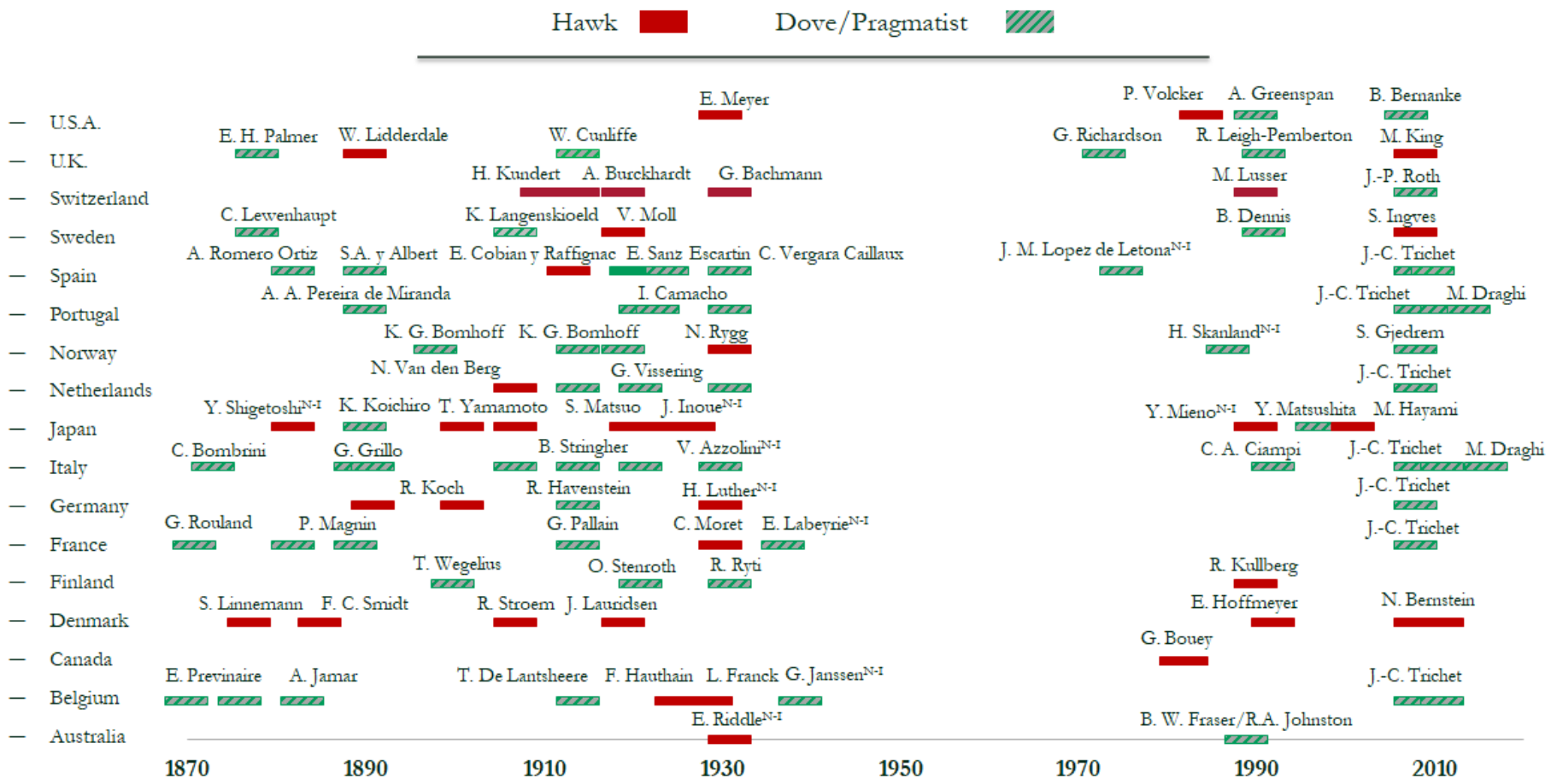
- Finally, **from the 1990s**, governors focused on the designs of new inflation targeting regimes (Goodfriend, 2005), the onset of "great moderation" dynamics, and—in Europe—on the effects of the emerging common currency. These debates again exemplify the coincidence of price and currency stability beliefs on the one hand, and emergency crisis attitudes on the other. In Japan, the Governor Yasushi Mieno sounded dire moral hazard warnings about inflated land values on the eve of a financial crisis, motivating his deployment of the hawkish "Mieno Shock" program (Times, 1990). Similarly, Governor Mervyn King (2003-13)—having spent years building a personal "arch-inflation hawk mythology" (Herald, 2003)—also long resisted the deployment of emergency liquidity to British banks over 2007-8, when peer institutions including the European Central Bank had long approved them, highlighting the moral hazard implications: "The provision of large liquidity facilities penalises those financial institutions that sat out the dance, encourages herd behaviour and increases the intensity of future crises" (King, 2007). Jean-Claude Trichet (ECB, 2003-13), on the other hand, was representative of "dove/pragmatist" beliefs. Though he had been hawkishly inclined earlier in his career, by 2003 markets were identifying him with a "pragmatic and flexible policy stance" (Times, 2003). Prior to the GFC, Trichet explicitly rejected a formalistic leaning against asset price bubbles, advocating a pragmatic stance on moral hazard dynamics and in principle approving of official financial sector support (Trichet, 2003a,b).

Figure 8 displays the resulting panorama of governors in charge during banking panics in the BVX sample across our 17 advanced economies since 1870, according to our assessment of policy orientation at the onset of the respective bank equity crashes. Out of 106 banking panic episodes during which a central bank intervened, we classify 37 as being associated with "hawks", and 69 with "doves/pragmatists". Marked with a superscript "N-I" are cases where either historical sources, or the central bank independence scores by Garriga (2016) indicate constraints on the central bank's autonomy. In these cases, we have identified the policy convictions of the de facto decision-maker during the banking crisis.

[46] Johnston's quote in Johnston (1985). See also Grenville (1997, 129ff.) and Appendix Table A.3.

We corroborate our manual classification using language models. Appendix Section M details a retrieval augmented generation (RAG) algorithm which mimics our manual classification and evaluates its performance.

Figure 8: Central bank governor classification and banking crises



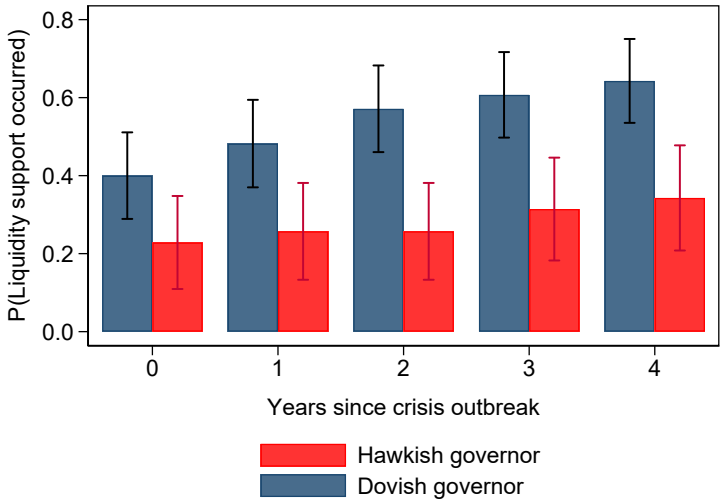
Notes: Central bank governor policy beliefs at the start of banking crises. Color codes refer to our ideological classification of the respective de jure central bank governor during an identified banking crisis, using the crisis definition in Baron et al. (2021). In superscript "N-I"$^{(N-I)}$, we denote cases where the central bank is constrained in its independence, as evidenced by either historical sources, or by a value in the Garriga "Central Bank Independence Index" of below 0.2 (Garriga, 2016). In these cases, we test the policy orientation of de facto decisionmakers in the appendix. See the appendix, table A.3, for all individual governor classification sources and further discussion.

4.2 Governor beliefs and central bank liquidity support during crises

Did governors' beliefs affect central bank policies during financial crises? Or would they be de facto irrelevant in really consequential choices such as large-scale liquidity interventions? Or could central bank committees counter-balance and dilute any ideological predisposition of the governor? Can we even reliably identify doves, given that any central bank governor may try to diffuse excessive risk taking by talking tough ex ante? All these questions concern the relevance of our instrument.

Figure 9 depicts the reaction of central bank balance sheets to financial crises depending on governor beliefs. It visualizes the probability that, by a given horizon, a given governor type grows the balance sheet beyond +15% during some year since crisis outbreak.[47] Accordingly, only in one in four hawks responded with large scale liquidity support before the second anniversary of the crisis' outbreak. By contrast, every second dove staged such an intervention at this point.[48] So while hawks did react to financial crises, they did so significantly less vigorously than their more dovish colleagues.

Figure 9: Liquidity support in financial crises by governor classification



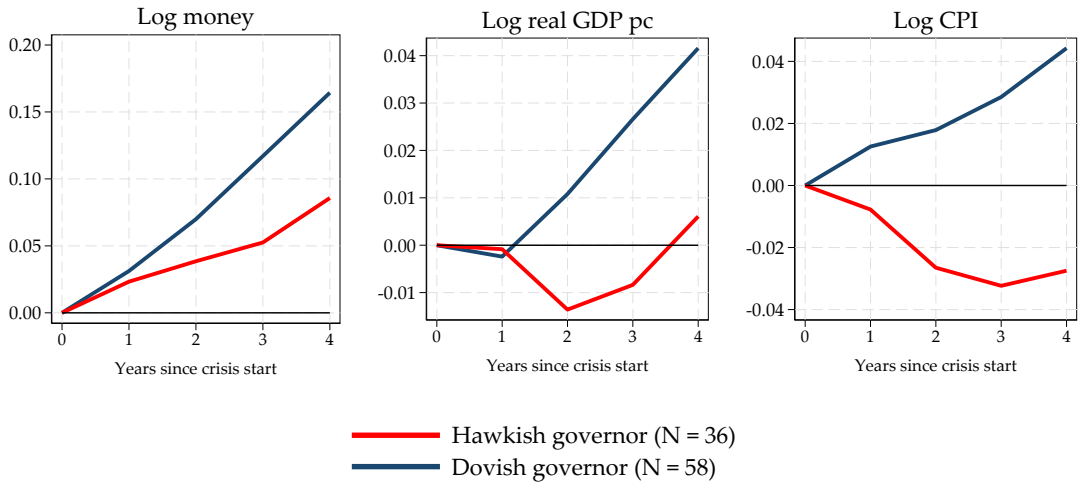
Notes: The figure shows the share of observations with one or more balance sheet expansions exceeding 15% annually since the start year of a financial crisis, by horizons and governor classification. Whiskers mark 90% confidence intervals. Data from 89 crises dated by Baron et al. (2021) occurring between 1870 and 2020 in our sample of 17 advanced economies with an operating central bank, excluding 1914-1918, 1939-1945, the German hyperinflation and the Spanish Civil War. Whiskers mark the 90% confidence interval. Differences are statistically significant at the 5% level starting from horizon one.

[47] The pattern is robust for other reasonable choices of expansion thresholds, e.g., +10% or +20%.

[48] Central banks may expand their balance sheets by different means and governor types may differ not only in their tendency to intervene but also in the manner of how to do it. For example, they may cut interest rates on short term loans, decrease discount rates in repurchase transactions, increase the base of eligible collateral assets or buy assets outright in the open market. Implementation should be targeted to the characteristics of the crisis situation, and some approaches may be superior irrespective of context. In this paper we are largely agnostic about implementation features and focus on measuring average effects, i.e., under average implementation quality. We investigate this further and provide additional evidence in Section 4.4.2.

In principle, effects shown in Figure 9 could be driven by hindsight bias in the historical sources that underlie our classification. However, such hindsight bias would invoke the exact same endogeneity problem that previous studies were subject to: on average, governors we classify as doves ex post based on their interventions would simply be associated with more severe crises. Again, this reduces the chances of finding any positive effects from dovish central bank policy. That is, hindsight bias might inflate the first-stage link, but lead to conservative estimation of the second stage main effect.

Figure 10: Macroeconomic dynamics after financial crises by governor classification



Notes: The figure shows post-crisis average trajectories for money aggregates (M3), real GDP per capita and consumer prices by governor type estimated by the following local projections: $\Delta_h y_{i,t+h} = \alpha_{i,h} + \beta_h g_{i,t} + \epsilon_{i,t+h}$ for $h = 2, 3, 4$ where $g_{i,t}$ is a binary indicating an hawkish governor and $y_{i,t}$ stands for each of the three different outcome variables. Sample of 89 financial crises that occurred since 1870 in 17 advanced economies with an operating central bank and available macroeconomic data, excluding 1914-1918, 1939-1945, the German hyperinflation and the Spanish Civil War. Averages purged of country fixed effects.

The differential effects of governors' preconceived beliefs on central bank policy also appear to alter macroeconomic outcomes. Figure 10 shows average trajectories for the money aggregate (M2), real GDP per capita and consumer prices since the start of a crisis split by ex-ante governor beliefs, controlling for country fixed effects.[49] In the raw data, more dovish policy stances are associated with vigorous money growth, quicker economic recoveries and less deflation. To test these patterns rigorously, we estimate local projections in Section 4.4 in which we instrument balance sheet expansions by pre-existing central bank governors beliefs. But first, we elaborate on the argument behind the exclusion restriction of the instrument in the next section.

[49]To the degree that historical sources characterize central bank governor not only based on ex-ante statements but also by ex-post crisis policy, we run the risk of introducing the same endogenous crisis-related factors into our governor coding that drive liquidity injections themselves. Such a bias would skew our estimates towards effects reported by the existing literature (Bordo et al., 2001; Honohan and Klingebiel, 2003) which suffer from the endogeneity of liquidity injections. This would make it harder for us to detect positive effects of liquidity injections and hence render our estimates conservative.

4.3 Exclusion restriction of the governor beliefs instrument

For our instrument to be valid, governors' beliefs must not affect crisis trajectories through channels other than liquidity support. It is plausible that governors' beliefs are uncorrelated to other factors determining a given crisis outbreak. However, governors are not chosen randomly and their beliefs may interact with the economy in other ways. In the following, we discuss why potential violations of the exclusion restriction will, if anything, render our estimates conservative.

First, financial market participants will learn about the incumbent governor and form expectations about the response to a potential crisis. Anticipation of dovish crisis management could encourage financial risk-taking ex ante. Higher crisis incidence under dovish governors and will not create any bias. However, more severe crises would load the dice against finding positive macroeconomic effects under dovish crisis management because doves face systematically worse situations. Accordingly, estimates of macroeconomic stabilization effects of liquidity support instrumented by dovish governor beliefs would thus be conservative. Furthermore, appendix G.1 presents estimates of general pre-trends in macroeconomic and macrofinancial variables for crises managed by either hawkish or dovish governors. We find that average pre-crisis dynamics across all six variables are quantitatively and statistically very similar.

Second, distressed financial markets may be calmed by pure *announcements* of liquidity interventions by the central bank. Dovish governors should be more likely to make such announcements (credibly), opening another channel through which doves could speed up the recovery besides actual interventions. However, such announcements have been very rare in the past. Metrick and Schmelzing (2024) surveyed interventions across crises, including "major communications", and found that they occurred in only about 1% of financial crises in their sample—compared to 67% of crises met with liquidity support. We conclude that the quantitative relevance of such a mechanism will be negligible in our setting.

Finally, the presence of certain governor types may correlate with specific fiscal policies or regulatory contexts. For example, the government may nominate a central bank governor that promises to support political goals.[50] Moreover, the political economy producing strict capital requirements for banks may be more conducive to nominate a hawkish governor. Such mechanisms could give rise to systematic differences across governor types in pre-crisis macroeconomic developments or fiscal interventions during the crisis. Since we can measure pre-crisis dynamics, regulatory requirements and fiscal policy, we can test these hypotheses explicitly. We find that fiscal interventions are more likely under *hawkish* governors, which, again, hints at a potential downwards bias that render our estimates conservative and Section 4.4.2 discusses related evidence in more detail. We also measure the correlation between governor beliefs and the stringency of

[50] Vuletin and Zhu (2011) report that governments of both developing and advanced economies have frequently replaced disobedient central bank governors with political allies to pursue political objectives in conflict with price stability. We tested the predictability of governor turnover using dynamic economic and financial variables. The predictive capacity of these covariates, however, is swamped by a simple variable counting the years of tenure of the previous governor.

banking regulation in Appendix G.2. We find no statistically significant difference in the level nor changes of capital and reserve requirements across governor types.

4.4 Estimating the causal macroeconomic effects of liquidity support

4.4.1 Stabilization during financial crises

We use local projections with an instrumental variable (LP-IV) to estimate the macroeconomic effects of large-scale liquidity support during financial crises. As in Equation 2, we define large-scale liquidity support as annual central bank asset growth of at least 15% during the current or the past year and encode it in the binary variable by $m_{i,t}$.[51,52,53] We instrument $m_{i,t}$ with the binary variable $h_{i,t}$ which indicates a "hawkish" central bank governor who is overall sceptical about such interventions:

$$h_{i,t} = \mathbb{1}\Big(\text{incumbent central bank governor tends to disapprove of liquidity support}\Big) \tag{3}$$

This identification strategy presumes that hawkish governors are less likely to engage in balance sheet expansions than their dovish colleagues facing a similar crisis. This will induce variation in $m_{i,t}$ that is exogenous to the crisis situation itself. Thereby, $h_{i,t}$ can disentangle variation in $m_{i,t}$ from unobserved factors shaping crisis severity. See Section 4.3 for a detailed discussion of the exclusion restriction of this instrument.

We restrict the sample to country-years with financial crises—of which we count 115 since 1870 in our sample. We discard country-years affected by World War I and II, the German hyperinflation or the Spanish Civil War.[54] This leaves us 102 country-years of which we have to drop those without a national central bank and where data on GDP, consumer prices, money aggregates and total bank lending to the non-financial sector are missing. We index the final 79 observations by (i,t) and will refer to country-year observations that have experienced the onset of a financial crisis τ years earlier by $(i, t+\tau)$.

Our local projections estimate expected changes of macroeconomic and financial variables relative

[51] Using a two-year window accounts for the fact that the probability for exceptional balance sheet expansions is elevated not only in the crisis start year as documented in Figure 9.

[52] We settle for a binary variable in our baseline for two reasons: First, financial crisis outcomes will react non-linearly to volume of liquidity support. Too little will fail to calm markets and hence show no measurable impacts. In turn, once financial markets are put at rest, additional liquidity will again show little effects. Second, a binary measure helps to limit outlier distortions, especially given the volatile nature of economic variables during crises combined with a relatively small sample. In Appendix L, we run our estimation with a continuous measure of central bank expansion and reach the same conclusions with less statistical precision.

[53] There are caveats to measuring liquidity support operations using annual aggregate balance sheet movements. See Appendix H for a detailed discussion.

[54] Since we will estimate trajectories after financial crises stretching up to four years into the future, we not only discard financial crises coinciding with these event but also those that take place up to four years before to prevent those event from meddling with the estimated trajectories.

to levels in $t+1$. LP-IVs are run for horizons $h = 2, 3, 4$, counting the years since start of the crisis. That is, we will estimate how liquidity support during the early phases of the crisis—measured by $m_{i,t+1}$ and instrumented by $h_{i,t+1}$—changes the crisis aftermath and recovery:

$$\text{First stage:} \qquad m_{i,t+1} = a_i + bh_{i,t+1} + \boldsymbol{c}\boldsymbol{x}_{i,t+1} + e_{i,t+1} \tag{4}$$

$$\text{Second stage:} \qquad y_{i,t+h} - y_{i,t+1} = \alpha_{i,h} + \beta_h \hat{m}_{i,t+1} + \boldsymbol{\gamma}_h \boldsymbol{x}_{i,t+1} + \epsilon_{i,t+h} \tag{5}$$

where $y_{i,t}$ denotes a macroeconomic aggregate to be evaluated—M2, real GDP per capita or the index of consumer prices—in natural logarithm to interpret differences as approximate growth rates. We include country fixed effects $\alpha_{i,h}$ to absorb time-invariant but horizon-specific heterogeneity across countries and controls that capture macro-financial dynamics $\boldsymbol{\gamma}_h \boldsymbol{x}_{i,t+1}$. Dynamic controls include the contemporaneous value (in $t+1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis to capture the size of the preceding credit boom. Country fixed effects will be absorbed using within transformations. Appendix L shows results for various alternative control vectors.

The first stage relationship of equation 4 shown in Table 2 is statistically and quantitatively significant. Interpreting it as a linear probability model, hawkish governors have been roughly 34% less likely to conduct a balance sheet expansion either during a crisis year or one year thereafter. The first stage F-statistic for a test of instrument exclusion is 15.4. The empirical pattern behind the first stage is robust to the inclusion of governor-biographical and macro-institutional controls, see Appendix I.[55]

The second stage allows us to gauge the causal effect of liquidity support by contrasting the path with controls at their respective country-specific averages without liquidity support ($m_{i,t+1} = 0$)

$$\hat{\alpha}_h + \hat{\boldsymbol{\gamma}}_h \bar{\boldsymbol{x}}_{i,t+1}, \quad h = 2, 3, 4 \tag{6}$$

with the trajectory affected by liquidity support ($m_{i,t+1} = 1$):

$$\hat{\alpha}_h + \hat{\boldsymbol{\gamma}}_h \bar{\boldsymbol{x}}_{i,t+1} + \hat{\beta}_h \tag{7}$$

where $\hat{\alpha}_h$ denotes the average fixed effect, estimated by the model intercept.[56]

We estimate the LP-IV described by Equations (4) and (5) separately for three macroeconomic aggregates: the monetary aggregate M2, real GDP per capita or the index of consumer prices, all in natural logarithm to interpret differences as approximate growth rates. Based on estimates, we compute and plot the two trajectories of Equations (6) and (7) alongside confidence intervals for the treatment trajectory based on estimated standard errors for $\hat{\beta}_h$.

[55] Appendix I shows that governor beliefs predict liquidity support above and beyond a range of pre-crisis biographical details. Also controlling for the presence of deposit insurance or central bank independence does not blur the link between governor beliefs and liquidity support, while indicating that governor beliefs matters more where central banks are independent or deposit insurance is not in place.

[56] The OLS and 2SLS intercept estimates the average fixed effect absorbed by the within transformation if grand sample averages are added to all model variables after the within transformation removed country-specific averages.

Table 2: First stage relationship

	(1)
	m_{it+1}
Governor holds hawkish beliefs	-0.343***
	(0.087)
Macro controls	Yes
Country FE	Yes
F	15.42
R^2	0.32
Crises	79

Notes: This table presents coefficient estimates and statistics of the first stage regression of Equation (4) where the dependent variable is an indicator for liquidity support during the first two years of the crisis. Macroeconomic controls include the contemporaneous value (in $t+1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. We include country fixed effects $\alpha_{i,h}$ to absorb time-invariant but horizon-specific heterogeneity across countries. Robust standard errors are clustered on countries and shown in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

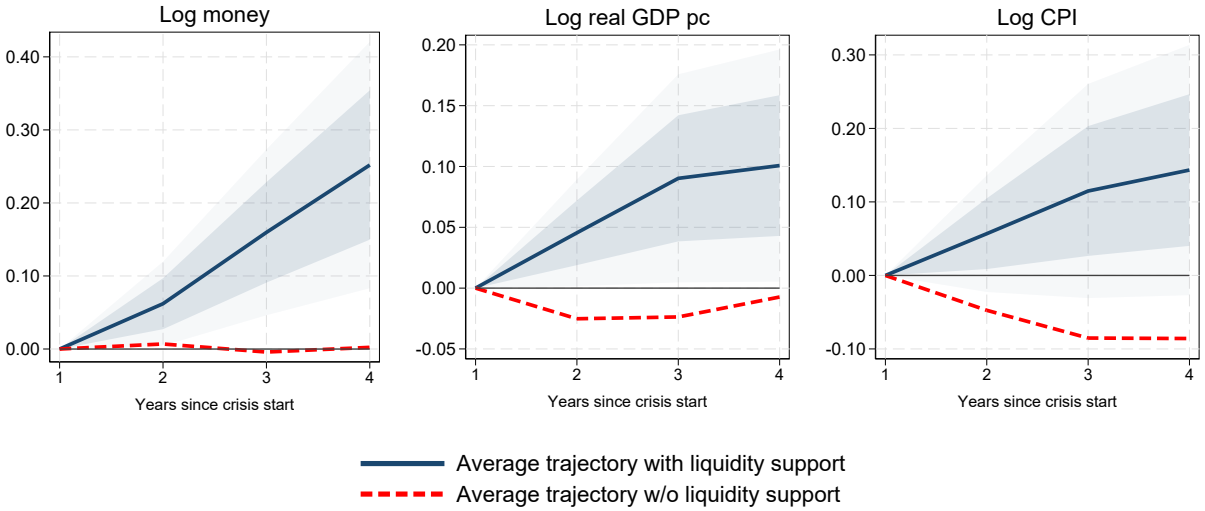
Figure 11 visualizes how the macroeconomic aftermath of financial crises is influenced by large-scale liquidity support. The IV strategy detects sizable *positive* effects, indicating that balance sheet expansions stabilize broad money growth, speed up the recovery of real economic activity, and avert deflation spirals. Tables with underlying coefficient estimates are presented in Appendix K. Our evidence corroborates the literature that has posited positive real effects from liquidity support, such as Richardson and Troost (2009). And it attests to a sizeable negative reverse causality bias in traditional OLS results visualized in Figure 7.

Specifically, we estimate that liquidity support during financial crises substantially cushioned negative effects on output. With liquidity support, real GDP per capita starts to grow again already during the second year after crisis outbreak ($t+2$) and exceeded counterfactual levels of macroeconomic activity by more than +10% four years after crisis outbreak.[57] Correspondingly, our estimates imply large gains in terms of *cumulative* real aggregate income, amounting to +28% over our projection horizon. Moreover, balance sheet expansions led to *persistent* growth of broad money aggregates and typically prevented protracted deflation. Without central bank interventions, we estimate that financial crises without liquidity support were followed on average by three years of falling prices. By contrast, deflation was typically avoided altogether when the central bank absorbed significant volumes of assets to provide liquidity in exchange. These operations typically did *not* cause runaway inflation, however. On average, prices increase by +14% over three years, implying annual inflation of about 2.4%.

These estimates are qualitatively robust towards a range of alternative control setups, sample restrictions and measurement choices. In Appendix L, we visualize estimates obtained when

[57] Our

Figure 11: Financial crises, liquidity support and macroeconomic stabilization (LP-IV)

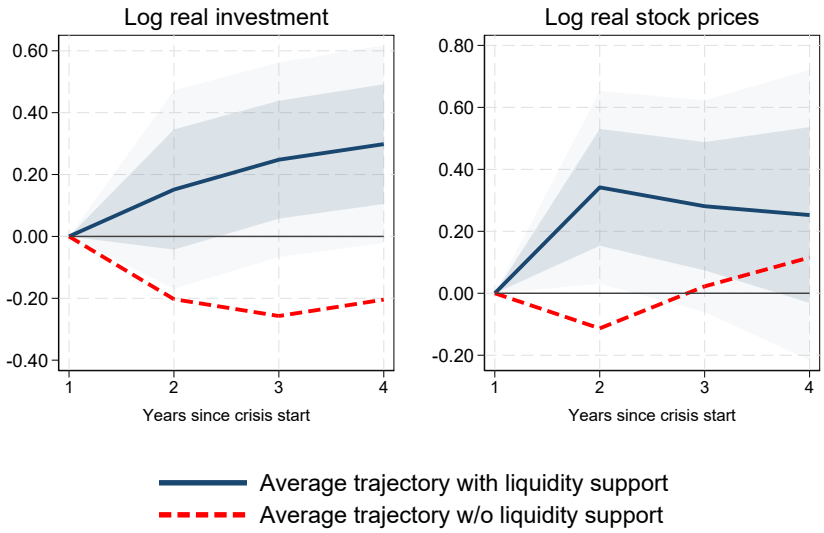


Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval (± one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

adding controls indicating the presence of national deposit insurance or horizon-specific episode fixed effects (Figure A.22), dynamic controls policy rate changes or fiscal expenditures (Figure A.23), dynamic controls for banking sector capitalization (Figure A.24), and results obtained when removing all macro-financial controls (Figure A.25). We also test alternative measures of liquidity support, including one based on a 20% expansion threshold, one based on a 10% expansion threshold or using a continuous measure (Figure A.26), results obtained when measuring liquidity support via central bank deposits rather than aggregate size (Figure A.27), and when using real instead of nominal balance sheets (Figure A.28). And we alter the sample of crises, focusing on those coded by Jorda et al. (2017) or those coded by Reinhart and Rogoff (2009) (Figure A.29), dropping the Great Financial and later crises to rule out that our effects are driven by quantitative easing or when dropping the Great Depression (Figure A.30), and results obtained focusing on the subsample of crises that occur during later phases of international clusters to see if our effects hold for crises likely to be international spillovers and hence less related to domestic economic conditions (Figure A.31).

Figure 12 presents LP-IV estimates of Equations (4) and (5) for real stock market valuation and aggregate real investment. Analogous to the baseline, controls include the contemporaneous value (in $t + 1$) and two lags of real GDP growth, real investment growth and real stock price growth as well as the three-year growth in real bank lending to the private sector prior to the financial crisis Both variables mirror the macroeconomic stabilization seen already in Figure 11. Liquidity

Figure 12: Financial crises, liquidity support and business health (LP-IV)



Notes: The figure shows changes in log real investment and log real stock prices after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval (± one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth, real investment growth and real stock price growth as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

support stabilizes the aggregate investment activity while a hawkish approach is estimated to lead to a substantial contraction in real aggregate investment of about -20% below levels observed in $t = 1$. Compared to GDP and investment, real stock market valuations react more swiftly to liquidity support, presumably for two reasons. On the one hand, forward-looking investors will anticipate improved future business opportunities. On the other hand, ample liquidity provided by the monetary authority might stop detrimental fire-sale spirals hurting financially distressed banks and funds.[58]

4.4.2 Nature and transmission of liquidity support

Central banks can expand their balance sheets in various ways. For example, they may cut interest rates on short term loans, decrease discount rates in repurchase transactions, increase the base of eligible collateral assets or buy assets outright in the open market. Implementation should be targeted to the characteristics of the crisis situation, and some approaches may be superior

[58] Our data does not show significant differences in the real growth of the aggregate debt stocks (unfortunately, we do not have credit issuance data). As those stocks grow clearly faster upon intervention in nominal terms, we infer that debt deflation is an important general equilibrium force under hawkish central bank policy. It will increase the real burden of outstanding stocks, thereby limit the balance sheet scope of borrowers, depressing expenditures and the aggregate economy in turn.

irrespective of context. So far, we have been agnostic about how central banks engineer the balance sheet expansions estimated average effect across past crises, i.e., effects under average implementation quality.[59] However, it is important to understand whether our estimates are driven by lender of last report operation that directly bolstered the liquidity position of the banking sector, or whether it operated through the monetization fiscal stimuli. Both interventions involve expansions of central bank balance sheets, but differ in transmission channel as well as policy implications of our results.[60]

Under LLR, the central bank increases the deposits of chartered banks, i.e., reserves, in exchange for eligible assets. Under fiscal monetization, the central bank absorbs government debt and increases the treasury's account at the central bank and to facilitate additional fiscal spending.[61] To understand which type of balance sheet expansion has been more prevalent in our sample, we asses changes in the central bank balance sheet composition as well as concurrent fiscal policy.

We re-estimate LP-IV Equations (4) and (5) with three modifications to the baseline setup. First, we use alternative dependent variables: bank reserves at the central bank, government debt holdings by the central bank, real public expenditures and real public debt; all in natural logarithm to interpret differences approximately as percentage changes. Second, we include horizons 1 and 0 into the estimations, taking differences with respect to $t-1$. These estimates can be interpreted meaningfully under the assumption that liquidity injections affect central bank balance sheet sub-items as well as fiscal variables but not vice versa. Third, we augment the original control vector by three lagged growth rates of the new dependent variable (at $t-1$, $t-2$ and $t-3$).

Figure 13a shows the estimated effects of liquidity support on the trajectory of central bank deposits and holdings of government debt. While deposits increase by up to 200% over the counterfactual without liquidity support, we find much smaller and no statistically significant difference in the volume of government debt held by the central bank. That is, the variation in liquidity support that drive results estimates shown in Figures 11 and 12 are not linked to systematic purchases of government debt. Responses in fiscal complement these view. Figure 13b plots the path of real fiscal expenditures and real public debt under either liquidity regime. We find no statistically significant difference in the response of either variable to central bank liquidity support that would suggest that the stabilization effects presented previously are actually driven

[59] Balance sheet operations may involve sterilization transactions, which would conceal them from our measurement approach. This problem might be particularly important under currency pegs constraining central bank in their liquidity supply policies. Our granular data on central bank balance sheet subitems allow us to investigate these concerns in a slightly smaller sample, see Appendix Figures A.19 and A.14. We find no differential use of sterilization across governor types, indicating that associated mismeasurement would not undermine our LP-IV estimates. Moreover, we find no evidence currency pegs would have imposed a major constraint. This is consistent with historical accounts of crisis interventions by the Bank of England during the Classical Gold Standard. For a broader discussion of measuring LLR operations using annual aggregate balance sheet movements, see Appendix H.

[60] The answer to this question also bears on the debate of whether there are measurable differences in macroeconomic outcomes depending on whether central bank balance sheet expansions involve mainly public assets, or private assets.

[61] As the Treasury pays for stimulus programs, central bank liabilities shift from the Treasury's account to banking sector deposits over time. In any case, the central bank ultimately holds an increased amount of government debt.

by fiscal stimuli. If anything, public debt growth is more likely to emerge under *hawkish* central bank policy, suggesting fiscal stimulus through a reduction in tax burdens. This corroborates the notion that fiscal and monetary policy substitute—rather than complement—each other in mitigating financial crises.

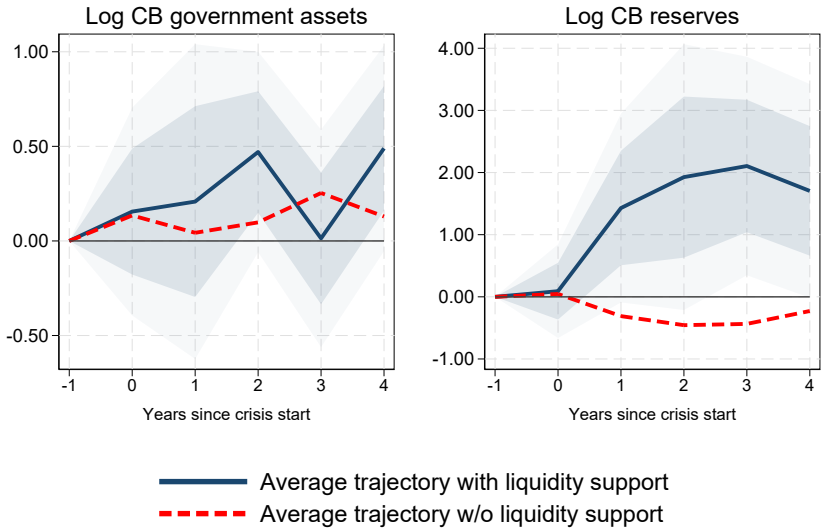
In addition, we find that our baseline results Figure 11 are largely driven expansions in central bank reserves, see Appendix Figure A.27. By contrast, expansions driven by other liability items are characterized by a very weak statistical link to future macroeconomic dynamics. Similarly, baseline results remain robust when restricting the sample to liquidity support dominated by the purchase of assets *other* than government debt, see Appendix Figure A.16.[62] Finally, Appendix J presents evidence on the reaction of commercial bank balance sheets. Consistent with the view the central bank liquidity support operates via the banking sector, we find document a strong and significantly positive effect on aggregate commercial bank capital and evidence of successful deleveraging.

[62]It has been speculated that the asset-specific expansion mix—that is, the breakdown of particular assets being used to extend liquidity support—matters for macroeconomic effects. If investors prefer securities with specific payout dates, the central bank can shape the yield curve by targeting assets of certain maturities (the *preferred habitat* hypothesis, e.g., Vayanos and Vila, 2021). Alternatively, private agents reaction to central bank balance sheet expansions may depend on the overall volume of risk taken off private accounts and absorbed by the public sector (Caballero and Simsek, 2021). Arguably, fixing the aggregate volume of liquidity support and absorbing more risky assets might stimulate private economic activity by more in times of widespread financial distress.

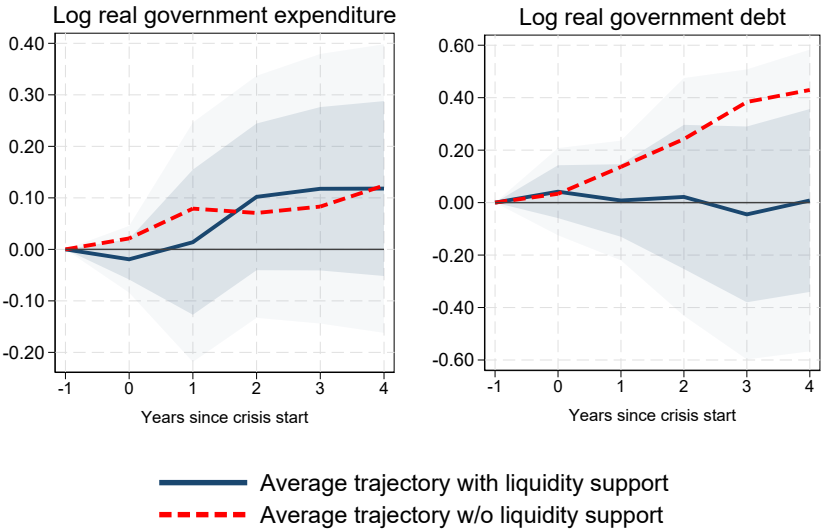
Looking separately at 51 liquidity support events during BVX banking crises which were characterized by relatively small or no government debt purchases, however, we do not find fundamentally different causal effects for money growth, real per capita GDP, and inflation dynamics. The effects continue to stay statistically significant, in the same direction, and at levels closely comparable to our baseline results. This is consistent with the view that the absorption of risky assets matters for macroeconomic stimulation.See further discussion and full results in Appendix Figure A.16.

Figure 13: Nature and transmission of liquidity support (LP-IV)

(a) Changes in central bank balance sheet composition during financial crises



(b) Changes in the fiscal policy stance during financial crises



Notes: Panel (a) shows changes in log central bank holdings of government debt and log central bank reserves during a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Panel (b) shows change in log real government expenditure and log real government debt during a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth, real investment growth and real stock price growth as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries. In addition, estimation underlying Panel (a) controls for growth in central bank deposits and government debt holdings at $t-1$, $t-2$ and $t-3$ while estimation underlying Panel (b) controls for growth of real public expenditures and real public debt at $t-1$, $t-2$ and $t-3$.

4.4.3 Long-run risks to financial stability

Many policy makers share concerns that public liquidity provisioning to distressed financial institutions may encourage excessive risk taking ex ante.[63] In fact, it is one of the defining characteristics of hawkish central bank governors investigated in this paper.[64] On the other hand, anticipation about central banks liquidity support might actually foster financial stability as it can suppress fear-driving creditor runs analyzed by Diamond and Dybvig (1983). Empirical quantification of such long-term effects is tricky in standard datasets. Our panel, however, provides a very suitable empirical basis as its long time dimension covers a sequence of financial crises for each country.

Moral hazard implies that investors take excessive financial risks expecting that the central bank bears liquidity risk or even bails out insolvent institutions ex post. This depresses risk premia, eases credit conditions and fuels credit booms that may end in crises (cf. Richter et al., 2020; Kirti, 2020; Greenwood et al., 2022). Conversely, preempting creditor runs through the expectation of liquidity support can shore up financial stability, especially at the height of a credit boom, and hence have the opposite effect.[65]

To gauge the net effect, we analyze the statistical relationship between central bank liquidity support and future credit boom-bust episodes. Heightened future financial fragility would suggest an important role for moral hazard. Conversely, credit booms going bust less frequently would rather highlight the importance of preventing creditor runs. We operationalize a *credit boom episode* as a three year increase the credit-to-GDP ratio beyond +0.10. We define a *boom-bust episode* as a credit boom episode with a financial crisis ensuing during any of the three subsequent years. Around 23% of all country-years belong to a credit boom episode according to the +10% credit-to-GDP threshold. Roughly quarter of those country-years qualify as a boom-bust episode.

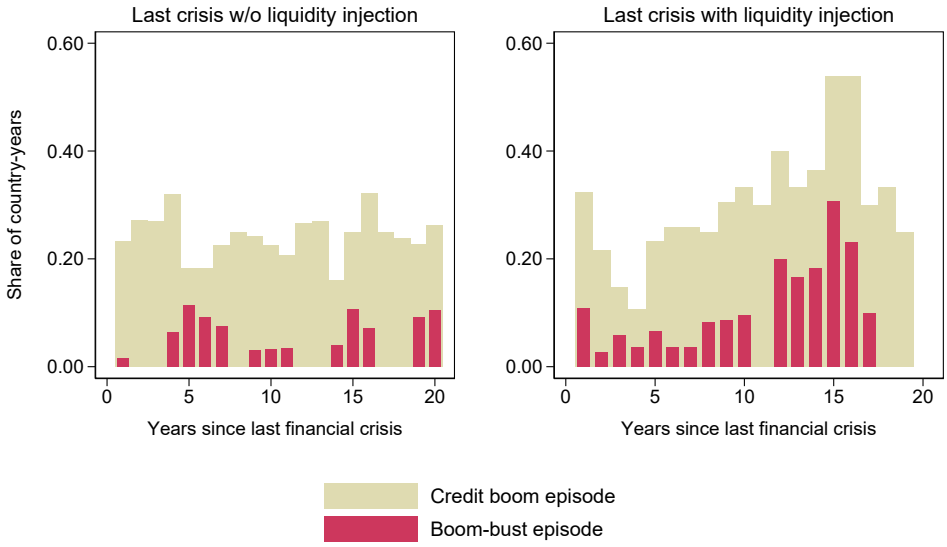
Figure 14 shows the raw data. It plots the relative frequency of credit boom episodes as well as boom-bust episodes, binned by horizon since the last crisis and by whether it saw liquidity support, i.e., $m_{i,0} = 1$. The pattern is clear: After financial crises *without* liquidity support, credit booms occurred with a moderate and stable probability. Around 25% of country-years belong to credit boom episode, a fraction only marginally higher than observed across our entire post-1870 sample. By contrast, the probability of credit booms rose after a crisis *with* liquidity support,

[63] There are several empirical cross-country studies on the moral hazard effects stemming from deposit insurance (e.g., Cordella and Yeyati, 2003; Duchin and Sosyura, 2014; Anginer and Demirguc-Kunt, 2018). Martin (2006) analyses moral hazard effects from LLR provisions from a theoretical perspective.

[64] U.S. Treasury Secretary Andrew Mellon's famous recommendation to use financial crises to "purge the rottenness out of the system"—and therefore not to engage in meaningful public support for struggling banks during the Great Depression (Eichengreen, 1992, 251)—is quoted time and again in the deliberations of central bank governors during crisis episodes. Similar comments from central bank governors on this topic abound and are listed in Appendix N—though we do not equate them outright with an "Austrian" or "liquidationist" theory of the business cycle (White, 2008).

[65] For example, one of the main arguments in the political debate leading up to the foundation of the Federal Reserve has been the need to deal with the frequent liquidity crises shaking the young US financial system back then.

Figure 14: Liquidity support, credit booms and crises



Notes: The figure plots the relative frequency of credit boom episodes as well as boom-bust episodes, binned by horizon since the last crisis and by whether it saw liquidity support, i.e., $m_{i,0} == 1$ We define a country-year to belong to a *credit boom episode* if the credit-to-GDP ratio increased beyond +0.10 over the past three years. We label a country-year to be part of a *boom-bust* episode if in addition a financial crisis ensues during any of the three subsequent years.

peaking 15 years after the crisis with more than 50% of country-years experiencing a credit boom episode.

Importantly, the discrepancy in credit boom probability is almost entirely driven by credit booms going bust. Figure 14 marks the fraction of boom-bust observations in red. They do occur occasionally after crises without liquidity support: 4.3% of observations over a 20-year window belong to a boom-bust episode, slightly below the full-sample prevalence rate of 4.7%. After crises with liquidity support, however, the probability of bad booms sharply accelerates, peaking at 30% at the 15-year horizon. Averaged over a 20-year window, the probability almost doubles to 8.4% relative to the no-injection scenario.

Are these differences statistically significant or can they be explained simply by macroeconomic dynamics confounding past liquidity support? Crises that warrant liquidity support may be fundamentally different from those that do not, and it may be these fundamental factors that shape post-crisis credit booms. We estimate the probability of a boom-bust episode depending on past liquidity support using different statistical models. Table 3 presents the estimates of the coefficient associated to $_{i,t}$ across four different specifications. All the models restrict the sample to observations with a financial crisis within the preceding 20 years and control for country fixed effects. Column (1) shows the plain OLS estimate without additional features. Column (2) adds a third-order polynomial of the distance to the last financial crisis alongside macroeconomic controls characterizing both recent macroeconomic dynamics as well as macro dynamics in the run-up

to the previous financial crisis.[66, 67] Column (3) presents the average marginal effect estimates using a logit model with the same extended vector of controls.[68] And finally, column (4) exploits exogenous variation in liquidity support using our coding of central bank governor beliefs.[69] Across all models, the effect of a liquidity injection during the previous financial crisis significantly increases the probability of experiencing credit boom-bust episode at some point within the two subsequent decades by +3.7 to +15.8%.

Overall, therefore, our data do not allow us to reject concerns about moral hazard. Instead, worries about long-run moral hazard voiced by "hawkish" governors in our sample seem justified. This implies that governors in financial crises face a trade-off short-run between financial stability gains and long-run financial stability risks. Our findings tie into recent literature that has studied specific LLR operations and resultant bank behavior, which highlighted elevated risk appetite and neglect of liquidity hazards (Drechsler et al., 2016b; Anginer and Demirguc-Kunt, 2018; Acharya et al., 2022).

[66]The control vector for recent macro dynamics includes contemporaneous and two lags of real GDP growth, inflation, real stock price index growth and changes in the investment-to-GDP ratio. The control vector for macro dynamics in the run-up to the previous financial crisis includes the exact same variables used in the previous analysis: contemporaneous ($t+1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis.

[67]Controlling for the use of "penalty rates"—a binary variable indicating above-median changes in policy rates during the last crisis intervention—suggests that they can reduce the probability of fragile credit booms substantially by 3 to 5 percentage points.

[68]The drop in observations results from the fact that some fixed effects perfectly predict the dependent; i.e., for some countries, there never is any boom-bust episode within 20 years since the last financial crisis.

[69]Except for contemporaneous macro controls and annual frequency of the data (as opposed to crisis frequency), the first stage is identical to the first stage shown previously.

Table 3: Liquidity support and boom-bust episodes

	(1) OLS	(2) OLS	(3) Logit	(4) 2SLS
Liquidity support, last crisis	0.037**	0.078**	0.105***	0.158***
	(0.020)	(0.034)	(0.024)	(0.067)
Macro controls		Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
R^2	0.01	0.10		0.06
Pseudo-R^2			0.56	
First-stage F				26.6
N	1109	737	527	679

Notes: The table lists estimates from four different models of the probability to experience a boom-bust episode within 20 years since the last financial crisis at time t of the form $P(B_{i,t+20} = 1 \cup B_{i,t+19} = 1 \cup ... \cup B_{i,t+1} = 1) = f(\alpha_i + \beta m_{i,t+1} + \gamma_h \boldsymbol{x}_{i,t+1})$, where $B_{i,t}$ is a binary variable indicating a boom-bust episode; $m_{i,t+1}$ denotes an annual central bank asset growth of at least 15% during t or $t+1$; α_i denotes country fixed effects and $x_{i,t+1}$ captures dynamic macroeconomic and financial controls. Controls include the contemporaneous value (in t + 1) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. We define a country-year to be in a *boom-bust* episode if the credit-to-GDP ratio increased beyond +0.10 over the past three years and a financial crisis ensues during any of the three subsequent years. Column 3 shows the logit estimate of the average marginal effect on the probability of a fragile credit boom episode. Two-stage-least-squares regression uses the usual instrument of governor attitude $h_{i,t+1}$. Robust standard errors in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

4.4.4 Gauging the net benefit of liquidity support

Our results suggest that central bank liquidity support poses a trade-off to policy makers: Intervention prevents financial fallout and bolsters growth in the short run, but at the same time sows risks of financial instability and threatens growth in the long run. Our results also facilitate a back-of-the-envelope calculation of the net benefits of liquidity support.

Using estimates underlying Figure 11 and Table 3, we assess the trajectory of output following a financial crisis with and without liquidity intervention as well as the expected duration to the next financial crisis in either scenario. Combining those with assumptions about real growth of the economy between crises, the social discount rate and the policy stance in future crises we can then compute the net present value of output under each policy. The difference between both values provides an estimate of the net present value of liquidity support if a crisis was to occur today. Appendix O details all calculation steps and assumptions used.

Since the trade-off is intertemporal in nature, assumptions about the discount rate as well as trend growth are critical. To assess the sensitivity of conclusions to those assumption, we compute changes in net present value of output for three different values: 1%, 3% and 5%. Similarly,

we consider three different trend growth rates: 1%, 3% and 5%. Table 4 presents the matrix of estimates as a function of trend growth and discount rate assumptions.[70] Strikingly, the aggregate short-term benefits of liquidity support outweigh the long-run costs across almost all assumption combinations under consideration. The net present value of liquidity support is even exceeds 10% of current GDP in many plausible settings. Only where output grows fast during normal times and discount rates are sufficiently low will future crises be costly enough to swamp the benefits of near-term interventions.[71]

Overall, central bank liquidity injections appear to raise the net present value of output especially in a low-growth environment. Irrespective of assumptions' accuracy, however, these figures carry no information about the distributional impact: Current gains of stabilization may accrue to different population segments, e.g., cohorts, than the long-term cost.

Table 4: Net present value of central bank liquidity support during a crisis

		Discount rate		
		5%	3%	1%
Trend growth	5%	0.088	0.048	-0.023
	3%	0.152	0.145	0.130
	1%	0.182	0.189	0.195

Notes: The table shows the net present value of liquidity support in response to a financial crisis, expressed as a share of pre-crisis GDP, under different assumptions for social discount rates and real trend growth. Calculations account both for short-run stabilization gains as well as long-run financial instability costs and are based on the assumption that the central bank would intervene again during potential future crises. All details on underlying computations are described in Appendix O.

5 Conclusion

Despite a recognition of the centrality of central bank balance sheets in the macroeconomy in academic literature, their long-run empirical evolution, their actual size, and the precise economic effects of their deployment have so far not been studied systematically. Our paper closes this gap. We show that balance sheets have not simply traced transaction volumes in economies. Our long-run evidence suggests that while advanced economy central bank balance sheets have indeed assumed unprecedented proportions relative to output in recent years, in the decades prior to 2008, they severely lagged both total private asset, and total public debt asset growth.

[70] Computations are based on the assumption that the central bank would intervene again during potential future crises. However, conclusions are quantitatively very similar when we assume that the central bank never intervenes again, see Appendix O.

[71] Intuitively, the net present value falls in the trend growth rate as steeper growth mechanically increases the cost of future crises. By contrast, higher discount rates attenuate the (perceived) cost of future crises. Note that for very low growth rates, the cost of future crises becomes so small that higher discount rates primarily delay the benefits of the short run recovery, inverting the effect of discount rates on the net present value.

We also show that liquidity support via central bank balance sheets during financial tail events has a deep history, with two-thirds of such deployments being associated with geopolitical or financial shocks. A willingness to expand balance sheets in times of geopolitical stress existed as early as the 17th century. We demonstrate how the expansion of central bank balance sheets did not yet constitute a *systematic* response during financial crises during Walter Bagehot's lifetime (1827-1877). Rather, this role evolved gradually. Not until the end of World War Two had central bank balance sheet expansions developed into such a tool. Investors in the post-1945 era could increasingly expect meaningful central bank liquidity support in the event of financial distress.

How much support and with what consequences? Using the policy orientation of the key decision-makers responsible for deploying central bank balance sheets in crisis times—typically central bank governors, but sometimes other officials at the central bank or Treasury—we show how one can address these questions empirically. We show that the deployment of liquidity support during financial crises contributes in a statistically significant and economically relevant way to a faster return to trend inflation, trend real GDP growth, higher stock prices, and stronger real investment. It does not appear to make a difference whether such liquidity support focuses on a particular asset type. Such results stand in contrast with more pessimistic results, notably Bordo et al. (2001) or Honohan and Klingebiel (2003).

We also find an important qualification to such seemingly benign effects, however. For a long time, many economists and central bankers suspected that balance sheet expansions during financial crises could give rise to moral hazard—a concern that demonstrably motivated hawkish governors in the past to reject balance sheet expansions. We find evidence that such a trade-off exists. The time until the next systemic financial crisis is significantly shorter after major balance sheet expansions. According to our calculations, however, such long-run risks to economic activity appear moderate compared to potential short-term stabilization gains.

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APPENDIX

A Governor classification

In this section, we detail our sources and methodology to determine the "policy bias" of all governors in charge of central banks during a banking panic, across our 17 advanced economies for the period of 1870-2020. Seminal articles, including Hibbs (1977), have previously associated political-ideological leanings of (legislative) policymakers with relative macroeconomic preference rankings. Generally, such work has associated a higher preference for full employment and for economic expansion – as opposed to price, balance of payments and FX stability - to left and center-left leaning policymakers, and a higher preference for price and FX stability to center-right policymakers. Distinct in our framework is the assessment of "moral hazard" concerns, a specific preference among monetary policymakers. To our knowledge, no previous work has specifically assessed preference rankings for central bank governors – who are distinct from elected political executives by not having to face "popular votes", and not being directly involved in legislative processes. Recent work by Bordo and Istrefi (2023) for the U.S. during 1960-2018, and more recently van Ommeren and Piccillo (2021), does not provide such generalized attitude "rankings", with the latter inferring governor leanings directly from the ideology of the nominating government. Deducing a governors' leaning directly from the nominating government may be appropriate for particular historical instances – such as the appointment of fully dependent central bank executives in the autocratic contexts of Nazi Germany, Imperial Japan, or Fascist Italy. Generally, however, this approach seems to rely on the ambitious assumption that the de facto independent policy room for the governor – once appointed – is highly limited on a *general* level, cannot intellectually evolve, and simply follows political executive directives. It is also inappropriate in practice, as recognized in reference literature: the governor of the Federal Reserve Board in the U.S., of course, has to be confirmed by a Senate majority - which often differs ideologically from the representing party in the White House: hence, Presidential appointment proposals have fallen through repeatedly, and have to take into account "opposition" preferences.[72] All this supports the notion of investigating each governor case individually, and to present evidence supporting such constraints, which we confirm in various cases, and reject in others.

Meanwhile, focusing on a governor's educational and academic backdrop to characterize leaning, for instance by falling back onto labels such as "freshwater" or "saltwater" ideologues as suggested by Bordo and Istrefi (2023) could be adopted to some degree to other countries – but the approach gets more difficult for earlier historical periods — not least because a majority of central bank governors did not hold advanced economics degrees then (the most common profession represented, in fact, is the legal one). Instead, a large number of pre-1945 central bank officials have records of long political careers as members of an ideologically-positioned party and often cabinet positions: while not ignoring the possibility that these individuals could be deviating from majority positions, or from stances by the prime minister in charge, we tend to view such evidence as often being a clear first hint of de facto convictions and leanings of a policymaker.[73]

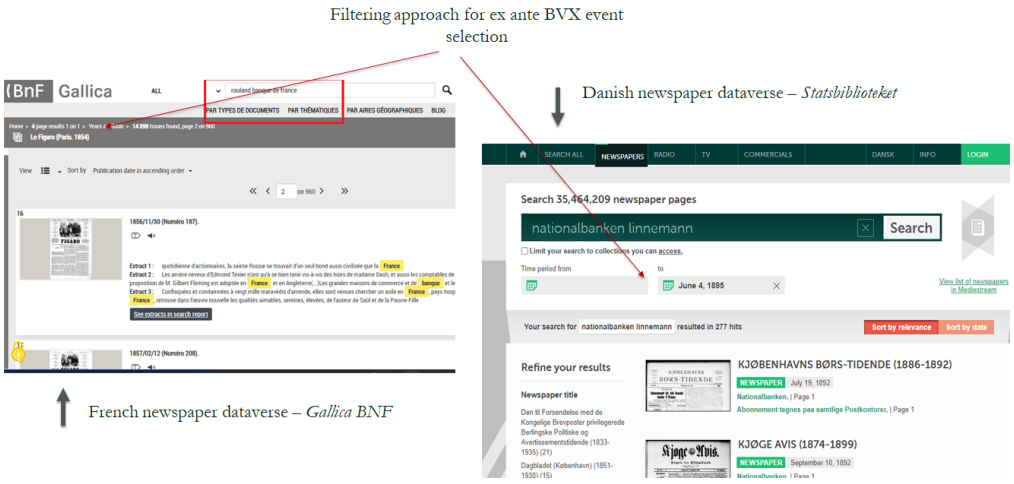
[72] Most recently, recall the rejection of President Obama's nominee Larry Diamond by the oppositional Republican Party in the U.S. Senate in 2010, or in fact President Donald Trump's failure to rally his own party behind multiple Board appointment proposals. Further historical evidence abounds from virtually all countries: over time, legislative chambers retain a veto power over an executive branch central bank governor nominee in [14] of the 17 advanced economies we cover, according to our evidence.

[73] Again, we recognize that ideologies within the political spectrum have shifted over time: at the same time, we do see plenty of evidence that justifies a distinction into socialist party or cabinet membership being indicative of dovish

We count 143 "panic" instances as defined by the Baron et al. (2021) chronology, in addition to 48 annual "crises without panics". For 20 crisis country-years, no central bank had been established yet, or central bank asset data is missing, or a central bank operated without a governor (e.g. "PT-1956"), and hence we operate with a sample of 171 crisis country-years for which information on the respective governors in charge exist.

Figure A.1 now illustrates the first practical step we undertake to source ex ante governor statements prior to a financial crisis. In particular, we extensively rely on digitized newspaper archives – which provide linguistic and chronological filters – which are available for *all* of our 17 advanced economies. The Figure displays the respective databases for France (*Gallica BNF*, hosted via the Bibliotheque Nationale), and for Denmark (*Statsbiblioteken*, hosted via the Danish State Library).

Figure A.1: STEP 1: selected newspaper archives, chronological filtering approach for ex ante governor results, Danish (*Statsbiblioteket*) and French (*Gallica BNF*) cases.



As detailed above, we classify a governor as a *"hawk"*, or *"dove/pragmatist"* if at least three news or research items – of which at least one must be an ex ante source – indicate a particular policy leaning in any direction prior to the BVX crisis start date. The national biographical encyclopedias (ex post sources) –– existing for virtually all advanced economies in question – constitute a key resource type for the ex post material, commenting on a policy maker's fundamental stance, intellectual development and key convictions. Typically, unambiguous and repeated pro-austerity, anti-inflationary leanings and comments are common indications for us to classify a governor as a *hawk*. Importantly, hawks frequently voice moral hazard concerns or warn about the build-up of asset price bubble – a rationale they then invoke to refuse liquidity support on a scale acceptable to doves/pragmatists during crises. In addition, in the earlier half of the sample, expressions of support for the real bills doctrine are common; on the other hand, governors who are ready to grant liquidity requests relatively liberally, prioritize exchange rate flexibility and devaluations over price stability and fixed exchange rates and revaluations, are regular indications that lead us to classify a policymaker as *"dove/pragmatist"*.

Figure A.2 illustrates the second step: systematically parsing the statements outputted by our database search, filtering for statements (in the respective languages) related to keywords and parses now summarized

leanings, and conservative/center-right party or cabinet membership being indicative of hawkish leanings. We flag cases where such a distinction is too simplistic (i.e. in the case of a "Catholic socialist" such as Bank of Spain governor Eduardo Sanz y Escartin).

Figure A.2: STEP 2: Identifying policy stances based on pre-crisis public statements and assessments: example for Richard Koch, October 31, 1903.

Abend- № 512. Ausgabe.

Berlin, Sonnabend, den 31. October 1903.

Berliner

Börsen-Zeitung.

Bestellungen werden angenommen bei allen Postanstalten, Zeitungs-Spediteuren und unserer Expedition.

Expedition der Berliner Börsen-Zeitung: Berlin W. 8., Kronenstrasse No. 37.

Reichsbank-Präsident Dr. Koch.

"President Koch is the fierce defender of the gold standard…loathed by the bimetallists…"

"who cleanses the Reichsbank balance sheet of items unrelated to trade…"

October 31, 1903 (BVX date: 1907)

Notes: Ex ante primary source commenting on policy stances of Reichsbank President Richard Koch, via *Berliner Boersen-Zeitung*, October 31, 1903.

via A.1.

Table A.1: Policy preferences of central bank governor types

	Dove	Pragmatist	Hawk
Decreasing order	Full employment		Price stability
	Economic expansion	Price stability	Moral hazard
	Income equality	Economic expansion	FX stability
		Full employment	
	Price stability	FX stability	Economic expansion
	FX stability	Income equality	Full employment

Notes: Ranking of central bank governor policy preferences regarding key macroeconomic goals. Adopted from Hibbs (1977, 1471).

Besides obituaries, academic sources and contemporary media commentary, wherever possible we also take into account the market reaction upon the appointment of the particular governor to assess the leaning of the policymaker, partly falling back on work by Kuttner and Posen (2010) who assessed market reactions for 15 advanced economies since 1980. If the latter report an exchange rate depreciation and/or a bond yield appreciation, we take this as an indication that market participants assessed the new governor to have dovish, expansionary leanings; in the case of an exchange rate appreciation and/or bond yield contraction, we see such a reaction as an indication of a hawkish assessment of future policy by market participants.

Table A.2: Further Governor attributes, by ideology

	Hawks	Doves/Pragmatists
Crisis observations	29	47
Age at crisis	58	61.0
Treasury experience (share)	27.6%	40.4%
Political party membership (share)	17.2%	36.2%
Financial sector experience (share)	51.7%	31.9%
Pre-appointment crises	2.22	1.57

Notes: Additional central bank governor attributes prior to appointment or banking crisis. "Party Political Experience" counts either official political offices held prior to appointment (e.g. Senator), or position within a national political party (e.g. press secretary) - but not passive party memberships. "No. of lifetime systemic crises" counts panics on the BVX basis between the birth year and the appointment year for the respective governor. "Average inflation experience" measures the average of the annual change in the CPI index from the respective governor's birth year to the final year prior to the banking crisis outbreak.

Figure A.3 displays a typical newspaper sources we utilize, the first representing a detailed profile of Reichsbank governor Richard Koch, written on the occasion of his 50th anniversary as head of the (de facto) central bank, in October 1903 – thus four years prior to our observation of the 1907 German banking crisis in "BVX". The paper, the *Berliner Börsen-Zeitung* was a widely-circulating medium for financial industry professionals, businessmen, and economic policymakers, comparable to the British *Financial Times*. The opinion of the paper thus provides key context of the prevailing attitude among these groups towards the Reichsbank at that date, and the assessment of its governor. The praise lavished onto the governor as a "fierce defender the gold standard..loathed by the bimetallists" can be contextualized well in the literature on the bimetallic debates prominent in the final years of the gold standard era – with conservative "deflationary" policymakers typically being outspoken against the proponents advancing the case for silver (Green, 1988). The assessment by the paper is echoed in other sources, for instance the rival *Berliner Handels- und Tageblatt*, which equally praises Governor Koch for "cleansing" the Reichsbank balance sheet of "bills unrelated to trade" - a clear confirmation of Koch's real bills convictions – well associated with the overarching aim of preventing "inflationary overissue" (Humphrey, 1982).

Not separately displayed is an interview with then-Banque de France governor Jean-Claude Trichet with the leading French daily *Le Monde*, in June 1997. In the interview, Trichet expresses highly critical views of the public debt management situation, repeatedly criticizing the efforts of the Chirac government. In sharp terms, the governor thus expresses a preference of price stability goals over economic growth and employment goals, the respective preferences of the Chirac government. The interview was conducted well before the identified "BVX" crisis in 2008, when Trichet had risen to the position of ECB governor, and thus confirms other contemporary evidence that identified Tichet with "hawkish" preferences: already upon his appointment in 1993, financial markets reacted to the news with a "hawkish pattern" as analyzed in Kuttner and Posen (2010) - with a clear appreciation of the French Franc, and a sharp decline in French bond yields. In subsequent years, however, Trichet's attitudes markedly softened, and the Frenchman was positioned by a block of Southern, more deficit-prone Eurozone countries to succeed the "German-style hardliner" on currency and inflation issues, Wim Duisenberg, half-way through his regular tenure (e.g.Telegraph (1998, 14)); by mid-2003, shortly before his official ECB appointment, markets had shifted their expectations in favor of a "pragmatic and flexible policy stance" from the governor, contrasting with his predecessor

(Times, 2003, 1). This backdrop serves to illustrate our dynamic classification approach, which takes into account shifts in the governor's policy attitude over time, and seeks to capture as precisely the expectations associated with him as closely as possible at the time of the banking crisis outbreak: in this case, it is more relevant what Mr. Trichet's public policy beliefs were in 2003, rather than during the 1990s: and in contrast to classification schemes such as Bordo and Istrefi (2023), we sharply discount information on the governor's earlier biographic attributes (for instance his educational background) if such attitudes have evidently shifted.

Figure A.3: Editorial on Banque de France governor Trichet, *Le Monde*, June 25, 1998.

Jean-Claude Trichet juge « impensable » la non-réduction des déficits

Dans un entretien accordé au « Monde », le gouverneur de la Banque de France, insiste, dans le but de lutter contre le chômage, sur la nécessaire modération des salaires, sur la poursuite de la réduction des déficits publics et sur le besoin de réforme de l'économie

« Quelles sont les grandes recommandations que fait le Conseil de la politique monétaire au président de la République et au Parlement ?

– Lorsqu'il transmet son sentiment dans le rapport annuel, le Conseil de la politique monétaire n'entend naturellement pas se substituer au gouvernement, au Parlement, aux syndicats, au patronat, etc. Il soumet simplement son diagnostic et ses réflexions à la discussion démocratique, comme le lui demande la loi. Les cinq principales recommandations de cette année correspondent à notre position constante. Elles sont, comme les années précédentes, inspirées par le souci de préserver la stabilité, la confiance dans la monnaie et de consolider l'une des conditions nécessaires de la croissance et de la lutte contre le chômage.

» En premier lieu, la modération dans les évolutions des revenus nous paraît essentielle non seulement pour maintenir un bas niveau des prix mais encore pour lutter contre le chômage. En second lieu, réduire les déficits publics, conformément aux orientations du traité de Maastricht, est nécessaire pour consolider la confiance et pour

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monde entier que le franc d'aujourd'hui est essentiel. Il y a dans nos taux à dix ans, au moment où je parle, huit ans et demi d'euro ! Que deviendraient nos taux d'intérêt à long terme – et donc notre croissance – si l'Euro était peu solide et inspirait peu confiance ?

– A quoi attribuez-vous la baisse des taux en 1996 ? – La baisse des taux de marché, qui nous a conduit au troisième plus bas niveau du monde, a été le fruit d'un accroissement considérable de la confiance. C'est le fruit d'une stratégie continue poursuivie depuis de longues années.

» De notre point de vue, la décision prise par le gouvernement et le Parlement de donner l'indépendance à la Banque de France en

publics en 1997 comme celui en 1998 et au-delà. C'est indispensable pour l'Europe. Mais, et c'est ceci qui enracine encore plus ma propre confiance, c'est indispensable pour la croissance et la création d'emplois en France. Car s'il apparaissait que nous ne pouvons pas ou ne voulons pas respecter le critère, nous perdrions en termes de création d'emplois beaucoup plus du fait de la perte de confiance nationale et internationale et de la hausse de nos taux d'intérêt de marché que ce que nous penserions gagner grâce au déficit supplémentaire. Si nous avons aujourd'hui les troisièmes plus bas taux d'intérêt du monde, cela signifie que les épargnants français et étrangers ont déjà complètement intégré le fait que le gouvernement français était et est prêt à prendre les mesures nécessaires.

» Quant au niveau européen, nous savons, depuis Amsterdam, que nous aurons un bon pacte de stabilité et de croissance, ce qui est essentiel pour la crédibilité de l'euro. C'est indispensable mais ce n'est pas suffisant. En outre, nous avons un renforcement de la coordination des politiques économiques dans le strict respect na-

doxe français. Vu de l'étranger, nous inspirons confiance puisque nous avons les troisièmes plus bas taux d'intérêt du monde. Aussi parce que nous avons le niveau de vie le plus élevé d'Europe avec l'Allemagne. *The Economist* vient, dans sa dernière édition, de nous classer comme numéro deux mondial pour la qualité de vie. Et, dans le même temps, nous avons un très mauvais moral à cause du chômage, en particulier du chômage des jeunes, dont nous sommes malheureusement nous-mêmes, dans une très large mesure, les auteurs puisque l'OCDE dit que notre

« Le gouvernement a maintenu l'engagement européen de la France et je suis donc convaincu qu'il fera ce qui est nécessaire. Je le répète : en infléchissant cette stratégie, la lutte contre le chômage serait moins efficace »

chômage est structurel à 80 %. Et ce mauvais moral lui-même crée

bonne politique budgétaire sont des conditions nécessaires mais pas suffisantes à elles seules. Au-delà, il faut, croyons-nous, des réformes structurelles pour enrichir notre croissance en emplois. C'est ce que disent les communiqués d'Amsterdam et de Denver.

– Le gouvernement Jospin veut accélérer la croissance en engageant un tournant keynésien de la politique économique par une relance de la consommation et par une consolidation du rôle de l'Etat. Qu'en pensez-vous ?

– C'est votre interprétation. La

consommation privée ne présente pas d'anomalie marquée, ce qui est

3 % ou moins de déficit cette année. Il en reste quatre. La Grèce est dans une situation spéciale. Et, à part la Grèce, trois pays, l'Italie, l'Allemagne et la France feraient spontanément un peu plus de 3 %. Naturellement, ces trois pays vont prendre des mesures correctrices. Ne pas prendre des mesures correctrices est impensable. Et, s'agissant de nous, qui peut croire que c'est en étant le pays le plus déficitaire d'Europe que l'on peut le mieux combattre le chômage ?

– Si, néanmoins, le déficit français atteint 3,5 % du PIB %, alors que le traité de Maastricht fixe une limite à 3 %, pourra-t-on faire l'euro ?

– Ce chiffre donnerait probablement à la France la plus mauvaise performance de l'Union européenne, la Grèce mise à part ! Ce n'est ni notre tradition, ni notre vocation, ni notre intérêt pour combattre le chômage. Je le répète, j'ai confiance dans la volonté de notre gouvernement de respecter le traité.

– Un report est-il envisageable ?

– Reporter la monnaie unique, cela veut dire amender le traité puisque la date du 1er janvier 1999

To illustrate our approach further, we proceed with several examples within our governor sample, spanning several relevant cases from both categories. Also added in these analyses, in brackets, we report the result of the machine learning classification exercise (more details in section M below): for all governors the bracketed information in column 3 in Table A.3 denotes the result of the ChatGPT 4.0 RAG classification ("H" for "Hawk", "D" for "Dove"). As we elaborate in the associated discussions, the LLM model does not fully overlap with our human classifications, but the degree of agreement is substantial. This is also true for the four example governors below, for all of whom ChatGPT 4.0 yields agreement with our human classification.

- **Bonaldo Stringher, Banca d'Italia (1900 to 1930) – Dove [GPT: D]**. Bonaldo Stringher – the longest-serving governor in our entire sample – took helm at the Italian central bank at the turn of the 19th century as a 45 year-old public servant, gaining previous experience at the Italian Statistical Office, the Italian Treasury, and as a finance lecturer at the University of Rome. His biographical details are comparatively well-documented, in both Italian and English sources, including entries in the Italian biographical dictionary ("Dizionario Biografico degli Italiani", via Segreto (2019)). From these sources, we learn the following details about Stringher's pre-appointment convictions: Stringher supported the establishment of popular banks, and described himself as a "devoted disciple" of his mentor Luigi Luzzatti, the progressive 20th Prime Minister of Italy and dedicated advocate for worker's rights during the last quarter of the 19th century (ibid.). Luzzatti himself remains clearly associated with the unionist, co-operative economic ideas spearheaded by the German Hermann Schulze-Delitzsch that sought, not least, to establish a widespread national network of "people's banks" promoting low interest rates and high levels of permanent liquidity (Pecorari and Ballini, 2006). In the immediate years prior to the outbreak of the 1907 crisis, Stringher, generally favoring classical gold standard arrangements for Italy, is recorded to pursue "cordial" relationships with the Treasury, helping in various advantageous public debt conversion operations and etatist industrial and infrastructure projects – a level of collaboration not necessarily standard across other DM central banks at the time, and thus further indication to us of a clear personal prioritization of growth and unemployment goals above those of FX and price stability. With no evidence that Stringher's fundamental stances changed decisively in between our four banking crisis dates ("IT-1907", "IT-1914", "IT-1921", and "IT-1930"), our classification for the governor remains uniform across these events.
- **E.C. Y Roffignac, Banco d'Espana (1911 to 1913) – Dove [GPT: H]**. Eduardo Roffignac served a brief term at the Spanish central bank, having obtained a law degree and previous experience in multiple parliamentary deputy and senatorial roles. Roffignac is representative of many of his pre-1945 peers in his legal and technocratic professional background, and only peripheral acquaintance with academic economics. Our source basis, particularly for governors serving short-term appointments, or not discussed in detail in English, is typical: we consulted the Spanish national dictionary ("Diccionario Biográfico electrónico") [74] established by the Spanish Historical Academy, where learn that Roffignac "from his first parliamentary interventions...focused his economic ideology on achieving budgetary balance, in accordance with the prevailing thinking among economists and politicians of the time" del Arroyo (2018). In other words, our governor displayed clear preferences for FX and inflation stability, over growth and unemployment goals – however, consensus sentiment in Spain after the exceptionally costly Spanish-American War was leaning towards fiscal austerity across partisan lines: such a fact discounts an otherwise clear data point suggesting a "hawkish" leaning. Together with the fact that he appears to have abandoned his political conservatism after the death of his "mentor" Fernandez Villaverde in 1905 del Arroyo (2018), we designate Roffignac as a "dove/pragmatist".

[74] Available via dbe.rah.es.

- **Victor Moll, Sverige's Riksbank (1912 to 1928) – Hawk [GPT: H]**. Victor Moll's economic and political beliefs underwent several transformations over the course of his professional career. Historians are in agreement that Moll began his career as a progressive in the circle of the politician Karl Staaff, helping him to draft unionist, anti-monarchical speeches and financial policy proposals. A member of the Swedish Parliament for the Liberal Party prior to his tenure at the central bank, Moll initiated legislative proposals to restrict stock market speculation. Gradually, however, Moll shifted his ideological convictions towards more traditional foundations, becoming a committed defender of the pre-war gold standard arrangements, opposing more flexible currency arrangements - and turning to "combative opposition" to some progressive and liberal Swedish economists, including Knut Wicksell (Grafvert, 1985, 662). In 1917, Moll penned a detailed refutation of Gustav Cassel's proposals for a more flexible re-arrangement of pre-war gold standard arrangements that took account of international PPP dynamics (Moll (1917)). Moll's case is typical of a number of governors that underwent ideological shifts over their lifetimes: the relevant datapoint for our purposes is the identification of the governor stance as closely as possible prior to the banking crisis year in the BVX chronology we are utilizing: in this case "SWE-1919". As Moll's outspoken opposition to stock market speculation and (comparatively) flexible FX arrangements precede the year 1919, but evidently occurs subsequent to the accounts of his early center-left leanings in his dealings with Staaff, we read the evidence as confirming that Moll's intellectual shift towards more traditional monetary thinking – as well as moral hazard concerns regarding financial market trends - clearly preceded the banking crisis. On this basis, we reach the verdict to classify Governor Moll as a "hawk".
- **Ben Bernanke, Federal Reserve (2006 to 2013) - Dove [GPT: D]**. Ben Bernanke hailed from an academic professional background when appointed chairman at the Federal Reserve in 2006, having previously served on the Board. Kuttner and Posen (2010, 358) document an exchange rate depreciation of the US Dollar, and a (slight) rise in U.S. bond yields upon the announcement of Bernanke as new Fed chair in 2006 – a reaction in line with more dovish market expectations. While a lifelong registered Republican, Bernanke is exemplary of our approach not to prioritize such formal party affiliations, or the political leaning of the nominating government. Just prior to his appointment confirmation, in-depth profiles of Bernanke in U.S. news outlets were universally stressing the governor's "unclear" political stance – with some academic colleagues commenting on his de facto "Democratic" stance (McGinn and Wolffe, 2005; Uchitelle and Porter, 2005, C1). In such instances, we would prioritize evidence of "de facto" pre-existing policy leanings, and emphasize as well the documented market reactions: in result, Ben Bernanke is classified as a "dove/pragmatist" in our framework.

Table A.3: Central Bank Governor Classification

Governor	Term	Classification	Sources
		Australia	

E. Riddle	1927 to 1937	**Hawk** [GPT: D]	*Two ex-ante, two ex-post source:* Promotes low interest rate policy early in Great Depression, supports work schemes, the expansionist "Premier's Plan" of 1931, and public deficits, see Financial Times (1935, 12f. – E.A.); Giblin (1951, 35ff. – E.P.): Riddle "not much interested in central banking", "the whole responsibility for the formulation of central bank policy [fell] on the Chairman ... Sir Robert Gibson". Gibson, in turn, strongly hawkish on inflation and supportive of the anti-expansionary policies by Scullion/Theodore ministries of 1920s ("principal bulwark of orthodoxy [in economic policy]"), via Tabletalk (September 11, 1930, 13 – E.A.) and Hart (1969, 38ff. – E.P.).
R.A. Johnston	1983 to 1989	**Dove** [GPT: D]	*Three ex-ante, one ex-post sources:* Johnston mainly "worried" about inflation in public eye, but no radical counter-measures, see Australia (1989, 3 – E.A.), and AFR (2017, 17 – E.P.) announcement; regarding interventions, pragmatic attitude and publicly embraces "light and flexible" commitment to liquidity and solvency support from RBA during banking crises pre-1989 crisis, though there is no "guarantee" ex ante (Johnston, 1983, 1985, E.A.); "non-radical adherence to monetarism" under early years in term, then phasing out of monetary targets (Grenville, 1997, 129ff. – E.P.);
		Belgium	
E. Previnaire	1870 to 1877	**Dove** [GPT: H]	*Three ex-post sources:* Long-term liberal party member and senator, on the one hand influenced by Frere-Orban policies – which are interventionist, mildly socialist/progressive, see in particular Parliamentary debates (Hymans, 1880, 7f., 12f. – E.P.); "Follower of the principles of Smith and Malthus", free market beliefs, (Kauch, 1954b, 9 – E.P.); Politically free-market liberal and pro-business, but highly restrictive policies during Franco-German War of 1870-1, see also generally (Buyst and Maes, 2008, E.P.);

A. Jamar	1882 to 1888	**Dove** [GPT: D]	*Three ex-post sources:* Heading a "bureaucratic, inward-looking institution with little interest in new responsibilities" or intervening in wider economy, see Buyst and Maes (2008, 170f. – E.P.); interventionist and pro-employment and growth attitudes as minister of public works in Frere-Orban government: passing pro-labour legislation, advocating nationalization of key railway operators in mid-1870; opposes rail tariffs for adverse impact on workers, supports Caisse d'Epargne given favorable impact on workers, see Kauch (1954a, 9ff. – E.P.), van Hentenryck (1984, E.P.);
T. De Lantsheere	1905 to 1918	**Dove** [GPT: H]	*Four ex-post sources:* Career bureaucrat and Catholic pragmatist, with long political career preceding bank role - squarely located in moderate wing of party, but flexible ("Zijn persoonlijke opvattingen lieten zich niet opsluiten in een keurslijf van partijtucht", Janssens (1997, 66 – E.P.)) – especially in context of death penalty, universal suffrage debates (Monballyu, 2014, 187ff. – E.P.); from 1912, Lantsheere firmly supports gold standard, as opposed to bimetallic Latin Currency Union standard, citing price and financial stability reasons - but at the same time builds "secret" low-denomination cash fund of five-franc notes in 1912 for emergency use (Janssens, 1997, 68f., 71 – E.P.); Kauch (1957, 3ff. – E.P.);
L. Franck	1926 to 1937	**Hawk** [GPT: H]	*Four ex-post sources:* Bank with deflationary bias going into Great Depression, gradually becoming more interventionist and pro-inflationary (van der Wee, 2012, 142f. – E.P.); Shennan (1992); Buyst (2012, 4f. – E.P.) – generally, clear rejection of Keynesianism prevails, majority of executives committed to stabilization anti-inflation policies; Franck, who holds "idees conservatrices et liberales" in regular conflict with Socialist government, including Finance Minister Henri de Man over interventionism (Buyst et al., 2005, 137 – E.P.);

G. Janssen	1938 to 1941	**Dove** [GPT: H]	*Three ex-post sources:* Lawyer by training, generally "followed the instructions of cabinet members, especially the minister of finance" (Taber, 2014, 229 – E.P.), "interventionist conceptions ... follower of the ideas of [Etatist/Socialist] Henri de Man" as head of Banking Commission, conflicts with more conservative predecessor Louis Franck (Buyst et al., 2005, 137, 139 – E.P.); later highly concerned about inflationary impact of RKKS issuance during German occupation (Klemann and Kudryashov, 2012, 195 – E.P.);
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	*Four ex-ante, two ex-post sources:* Clear hawkish reaction upon announcement as BdF governor in 1993, see Kuttner and Posen (2010, E.P.); repeated clashes with Jacques Chirac over budget deficits, which T. criticizes publicly as too high (Monde, 1997, 18 – E.A.); consistently dismissive or skeptical about LLR function of CBs pre-2008, e.g. "apart from their operational tasks -– such as the management of money market liquidity and the monitoring of large value payment systems – central banks must endeavour unremittingly to create the conditions for the international economy to minimize misalignments in asset prices, excessive volatility, purely speculative phenomena and dangerous herding behaviour. This is the underlying message in central banks' repeated calls for prudence and caution", (Trichet, 2003c, E.A.); subscribes to primacy of price stability mandate...but rejects bailouts given moral hazard threats, as "not all boom or bubble episodes are threatening financial stability. Policy makers should not fall into the fallacy of attempting to eliminate all risk from the financial system. Either they would be unsuccessful (moral hazard) or they are likely to hamper the appropriate functioning of a market economy where risk taking is of the essence." (Trichet, 2005, E.A.); but moderation of policy positions in years leading up to 2008, with market consensus expecting "pragmatic and flexible policy stance" by April 2003, (Times, 2003, 1 – E.A.); more ambiguity by 2004, "The overall assessment will determine whether remedial action is needed", (Trichet, 2004, E.A.); Tobback et al. (2017, E.P.).

M. Draghi	2012 to 2019	**Dove** [GPT: D]	*Two ex-ante, one ex-post source:* Generally seen as Keynesian: Times (2011, E.A.) – early studies under Keynesian Federico Caffè; Fiorella Kostoris: "would describe him as a Keynesian 'in the MIT sense'"; in agreement also: Tamburello (2011, E.A.); Tobback et al. (2017, E.P.).
		Canada	
G. Bouey	1973 to 1986	**Hawk** [GPT: H]	*Three ex-ante, two ex-post sources:* Bouey as convinced monetarist, praised by Milton Friedman; follows U.S. in staunch anti-inflation policies during 1980s, "dramatically Friedmanesque" public agenda by 1975, see: WSJ (1980, 6 – E.A.); Drainville (1995, E.P.); by 1977, publicly seen as Bouey's Bank of Canada, starting with "watershed" speech in 1975, "embraced the monetary doctrine known as monetarism", seen as decisive in implementation of wage and price controls; under Bouey, "The Bank of Canada's insist[s] on fighting inflation as the first priority in the face of mounting unemployment", via (Chodos, 1977, 41ff. – E.A.); ex post fully in agreement in Crow (2009, E.P.).
		Denmark	
M. Levy	1861 to 1891	**Dove** [GPT: D]	*Three ex-post sources:* Levy models bank policy on Bank of England – for the first time moving to liberal general discount policy, but "not a man with great visions ... had long employed caution, which provides means to help business in 1885 crisis", see Gejl and Vestberg (1981, 24f. – E.P.); main aim from 1861 is to increase discount policy flexibility, introducing rate rage among other steps, as lesson of overly hawkish 1857 crisis response, see Svendsen et al. (1968a, 296-298 – E.P.); Positive assessments from both Social-Democratic and Conservative analysts, Levy frequently participates in public debate, pushing Scandinavian monetary union, gold currency basis, and presents himself as patriotic "banker of the people", see Soerensen (2015, 331ff. – E.P.);
S. Linnemann	1891 to 1896	**Dove** [GPT: D]	*One ex-post source:* Trained lawyer with pragmatic and unideological bureaucratic career, generally see Vestberg (1981, 82 – E.P.).

J.P. Winther	1907 to 1924	**Hawk** [GPT: D]	*Two ex-post sources:* Hansen (1991, 38ff.); Hansen (1996, 312) – Winther states that he does "not hold principle" that central banks should not generally be ready to help banks with liquidity; other sources emphasize outsized roles of director Marcus Rubin as well as Carl Th. Ussing – both as vocal supporters of full employment policies –, see Svendsen et al. (1968a, 358ff., E.P.).
J. Kr. Lindberg	1924 to 1932	**Dove** [GPT: D]	*Three ex-post sources:* Long activism in labor/social democratic grassroot organizations, campaigning for worker rights and publishing on social problems. Implements austerity measures during early Great Depression, but reallocates expenditures to lower incomes. Resists Krone devaluation and key Leftist FX policy demands in 1933, vowing to preserve currency stability. See Dybdahl (1979, 445ff. – E.P.); in agreement: Thomsen (2019, E.P.). As early as summer 1931, isolated across Social Democratic and center-left circles with advocacy of deflationary macro policies Svendsen et al. (1968b, 162ff. – E.P.).
E. Hoffmeyer	1965 to 1994	**Hawk** [GPT: H]	*One ex-ante, two ex-post source:* "Hoffmeyer is known for his ... conservative monetary philosophy" (Europe 1991); "Hoffmeyer preaches an old-time religion: ... austerity" (WSJ 1992, A10 – E.A.); H. decisive for spread of monetarist ideas in Denmark, see Marcussen and Zoelner, 106f. – E.P.; Soerensen (2015, 341ff. – E.P.); Jyllands Posten (2016 – E.P.);
B. N. Andersen	1995 to 2005	**Hawk** [GPT: D]	*One ex-ante, one ex-post source:* Initially seen as "continuity candidate" – "there has been no change in the bank's policies. Continuity is the watchword" (FT March 29, 1995 – E.A.); supports adoption of Maastricht criteria, opposes inflation target, steers against more FX flexibility; van Ommeren and Piccillo (2021, 30 – E.P.) tag as centrist/center-left;
N. Bernstein	2005 to 2013	**Hawk** [GPT: D]	*Two ex-ante, two ex-post source:* Engrained fiscally hawkish views – public criticism of right-wing government for not being austere enough in 2007, see (FT, 2007, 2 – E.A.); EIU (2008 – E.A.); van Ommeren and Piccillo (2021, E.P.); however, subsequently justifies rescue of Roskilde for systemic reasons – "tailored solutions" are appropriate as long as rescue costs borne by private sector (Bernstein, 2010, 2 – E.P.).
Finland			

T. Wegelius	1898 to 1906	**Dove** [GPT: D]	*Three ex-post sources:* Pragmatic attitude to FX policies when on executive board 1880s, i.e. flexible adjustments to threats of rising unemployment, see Pipping (1969, 157 – E.P.); further: (Schybergson, 1913, 318 – E.P.); (Kuusterae and Tarkka, 2011, I, 366 – E.P.).
O. Stenroth	1918 to 1923	**Dove** [GPT: H]	*Three ex-post sources:* Member of Young Finnish nationalist party, pro-business and background in banking; during 1920s supportive of abolishing FX controls, but favors balanced budgets, later pro-Allied forces during WWII and supporting flexible exchange rates, see also Kuussterae (1997, 294 – E.P.), (Kuusterae and Tarkka, 2011, I, 454ff. – E.P.); more generally, Tudeer (1940, E.P.);
R. Ryti	1924 to 1940	**Dove** [GPT: D]	*One ex-ante, two ex-post sources:* Early etatist and pro-labor convictions, with Ryti later rejecting deflationary policies for adverse social consequences. But even by 1936, supportive of gold standard version with flexible bands: "first duty [of the central bank] is that it should maintain internal purchasing power of the currency" Ryti (1936, E.A.); Tudeer (1940, E.P.); Kivimaeki (1943, E.P.).
R. Ryti	1944 to 1945	**Dove** [GPT: D]	See above.
R. Kullberg	1983 to 1992	**Hawk** [GPT: H]	*Two ex-ante, two ex-post sources:* Anti-inflation and austerity attitude from early 1970s: "especially under Mr. Kullberg, the bank has become increasingly monetarist in its approach" (FT, 1984, 33 – E.A.); Kullberg (1984 – E.A.): "monetary policy should never be easy. It should always be hard in order to keep the banks in your hands all the time ... we have found that it is best always to fight inflation. Employment policy is up to the government"; strongly held fixed FX conviction (ECU peg), tenders resignation upon FIM float in 1991, see further Jonung et al. (2009, E.P.) and Kuusterae and Tarkka (2011, II, 466ff. – E.P.);
France			

G. Rouland	1865 to 1878	**Dove** [GPT: H]	*Three ex-post sources:* Career politician with no background in financial matters: "Rouland's position in the bank seems to have been to defend loyally but not strenuously the government's point of view in the Conseil General, accepting the decisions of the latter, independently of whether they were in favor or against the government's will" (Einaudi, 2001, 137 – E.P.); see also Bouvier (1988, E.P.). Plessis (1985, 328ff. – E.P.) is more nuanced: Rouland a "neophyte who develops no original ideas on money or banking" ("Mais ce neophyte n'exprime point d'idee originale sur la monnaie et la banque"), but from at least 1867 leans more and more towards the Regents rather than the government: de facto opposes Minister Rouher over Credit Mobilier emergency aid in September 1867;
P. Magnin	1882 to 1897	**Dove** [GPT: D]	*One ex-ante, two ex-post sources:* pre-BdF voting record in French Senate is center-left, including support for Adolphe Thiers, against monarchists, but moderate fiscal policies in Ministry of Finance, accused of "favoritism" towards capitalists in context of rentes issuance, see Robert et al. (1891, 222 – E.A.); Close connections to leftist Union Republicaine, later entry into C. de Freycinet cabinet, see further Ortiz-Serrano (2018, 349 – E.P.); Biographical volume in Delabrousse (1916, esp. 54ff. – E.P.), confirms his strong conceptual support for Bank's stabilizing role as early as 1865 in Senate proceedings, advocating great capital increase ("qu'en 1865, Magnin avait prononcé sur la Banque de France un des discourles plus documentés qui figuraient dans les annales parlementaires, ajoutant que c'était à lui qu'était réservé l'honneur de réaliser la mesure qu'il réclamait dès 1865, en faveur de l'industrie et du commerce français").
G. Pallain	1898 to 1920	**Dove** [GPT: D]	*One ex-ante, three ex-post sources:* Asserts before U.S. Congress in 1908 that he would "help" Credit Lyonnais and other banks in times of crisis, supports role of BdF as de facto "bank of banks", (Aldrich, 1908, 3, 10, 25 – E.A.); further: Blancheton (2014).

E. Moreau	1930 to 1934	**Hawk** [GPT: H]	*Three ex-post sources:* Widely acknowledged "conservative" views on policy, but supports Franc devaluation, see Moure (1992, 141 – E.P.) and Flandreau and Zumer (2016, E.P.); Moret draws sharp criticism from commercial banks for pushing competitive policy during crisis, but defends independent bank outlook in private responses – ("far from a bank of banks"), see Gonjo (1996, 312f. – E.P.);
E. Labeyrie	1936 to 1937	**Dove** [GPT: D]	*One ex-ante, three ex-post sources:* Labeyrie appointment as part of "leftist" Leon Blum nationalization of Banque, and ousting of old elites, see CSM (1936 – E.A.); Margairaz (1991, 285ff. – E.P.); Labeyrie "attuned to Popular Front desires for low interest rates ... was clearly following Popular Front cheap money", "pliant" and less devaluationist choice over Pierre Quesnay, (Moure, 1988, 499 – E.P.); Le Journal (March 13, 1937 – E.P.);
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	See above.
M. Draghi	2012 to 2019	**Dove** [GPT: D]	See above.
		Germany	
R. Koch	1890 to 1907	**Hawk** [GPT: H]	*Two ex-ante, three ex-post sources:* Divergent views: "fierce defender of the gold standard...often loathed by the bimetallists...refuses to let the Reichsbank be a cheap source of long-term liquidity" (Börsen-Zeitung, 1903, 1f. – E.A.); in agreement: Arendt (1895, E.A.); implements de facto real bill policies "cleansing [Reichsbank] portfolio of bills unrelated to trade" (und Tageblatt, 1908, 11 – E.A.); ex post sharply criticized for too liberal credit policies in 1890s, see Plenge (1913, 22ff. – E.P.), also Bopp (1954, 180 – E.P.); vis-a-vis liberal credit growth internationally pre-1907, still on balance hawkish, criticized for hands-off approach during 1907 crisis, see Eschweiler (1993, 50f. – E.P.);

R. Havenstein	1908 to 1923	**Dove** [GPT: H]	*One ex-ante, three ex-post sources:* Upon appointment in 1908, observers sense continuation of Koch's hawkish leanings and praise his alignment with de facto real bills doctrine: "by and large following Koch's policies, namely regarding discount policies...and the cleansing of bill portfolios [of the Reichsbank] of bills unrelated to trade" (und Tageblatt, 1908, 11 – E.A.); Humphrey (1982, 12 – E.P.) also notes underlying real bills convictions leading to money expansion. Post-war dovish shift, by 1920 "fully rejects FX stabilizations ... his fiscal policy amounted to nothing but a tolerance of the inflation machinery" (Berliner Tageblatt 1923); Havenstein fully "abandons opposition to the Reich's inflationary fiscal policy", "partial adoption of balance of payments theories", "shifts towards quantity theory", (Holtfrerich (1986, 166ff. – E.P.), Holtfrerich (1988, E.P.)).
H. Luther	1930 to 1932	**Hawk** [GPT: H]	*Two ex-ante, two ex-post sources:* Generally known for austerity bias during tenure as Finance minister – "reigning in finances and harshly raising taxes among other unpopular measures" (Handels-Wirtschaftszeitung, 1930, 1 – E.A.); Close confidante of Bruening – supports deflation policy and Mark stabilization, but pragmatic attitude during banking crisis; Luther supports comparatively hawkish policies during hyperinflation as Cabinet minister, but during 1926 recession turns into advocate of deficit spending (Clingan, 2010, 41ff., 77ff. – E.P.); on economic and monetary matters, intellectually influenced by Gustav Schmoller and Hans Preuss, pushes hawkish credit policies and deflationary fiscal consolidation as finance minister together with Schacht from October 1923, and is strong advocate of Bruening's deflation policies from 1929, see Born (1987, 545ff. – E.P.).
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	See above.
		Italy	

C. Bombrini	1870-1882	**Dove** [GPT: D]	*One ex-ante, one ex-post source:* Between 1861-1882 director of Banca Nazionale: supports controversial state financing via fiat money during first war of independence, against many opponents, and despite inflationary dangers Calzaverini (1969, E.P.). Sponsors bill for abolition of "forced currency exchange" to better aid liquidity and bank groups ("Consorzio") as early as 1881, see Bombrini (1881, E.A.).
G. Grillo	1882 to 1894	**Dove** [GPT: D]	*Three ex-post sources:* Between 1882-1893 director of Banca Nazionale (de facto CB), Bocci (2002, E.P.) – at first supportive of highly expansionary fiscal policies of Agostino Magliani, and general acceleration of public note issuance – concerned about unification of Italian note supply; later opposes Crispi government and Treasury in their attempt to enact monetary easing and threaten independence of BdI, see Barone (1997, 70 – E.P.); contemporaries criticize too liberal lending bias at Banca Nazionale, supporting struggling banks (inc. Banca Romana) as early as October 1885, see Colajanni (1893, 359ff. – E.P.).
B. Stringher	1900 to 1930	**Dove** [GPT: D]	*Three ex-post sources:* Supports progressive social legislation during 1880s, including rights to strike, influenced strongly by "mentor" Luigi Luzzatti who abolishes bank clearing system and founds popular (credit expansionary) banks, see Segreto (2019, E.P.); later repeatedly opposes demands from Treasury for more deflationary action, supports Lira devaluation and freely meeting private credit demand – however, supports more banking regulation and hestitant on BdI interventions during 1907, see Bonelli (1982, E.P.); Stringher (1993, E.P.);

C.A. Ciampi	1980 to 1992	**Dove** [GPT: D]	*Three ex-post sources:* Considered politically center-left, generally pro-expansionary attitudes, though he leads bank "divorce" from Treasury and previous purchase obligations; amid global inflation of 1980s, focus on price/monetary stability, but less aggressive than committed monetarists (Signorini, 2018, 7f. – E.P.); Savona (2016, E.P.) argues that Ciampi departs from Keynesianism initially, espousing more monetarist views, only to later oppose deflationary impulses; Kuttner and Posen (2010, 357 – E.P.) measure dovish market reaction (FX depreciates upon announcement, bond yields tighten upon departure).
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	See above.
M. Draghi	2012 to 2019	**Dove** [GPT: D]	See above.
		Japan	
Y. Shigetoshi	1882 to 1887	**Hawk** [GPT: H]	*Three ex-post sources:* De facto policy is made by Treasury under Matsukata – who pursues deflationary policy, with Shigetoshi intellectually in agreement – hands-off LLR approach in initial BoJ period, but focus on general market liquidity provision, see Sims (2001, 57ff. – E.P.); Shizume (2017, 9ff. – E.P.) Ericson (2020, 88 – E.P.).
K. Koichiro	1890 to 1896	**Dove** [GPT: D]	*Three ex-post sources:* Long career in Mitsubishi conglomerate - "the personification of feudal morality" prior to BoJ appointment, but favorable treatment of business concerns and zaibatsu cooperation throughout tenure, initiates cross-stock holdings from BoJ and personally, see Wray (1984, 26, 240, 487 – E.P.), Shizume (2017, 9ff. – E.P.), Ericson (2019, 100 – E.P.).
T. Yamamoto	1899 to 1903	**Hawk** [GPT: D]	*One ex-ante, one ex-post source:* Prolonged resistance of BoJ against higher fiscal deficits, until Yamamoto removed – Yamamoto speaks out repeatedly against government debt policies, opposing raising of foreign loans, and supporting fiscal consolidation (i.e. speech on November 18, 1902, via Yamamoto (1902, 417f. – E.A.); background in Mitsubishi bank conglomerate; Sims (2001, 101 – E.P.): "much too orthodox for Seiyukai party ... determined to take even tougher measures to restore financial soundness than the previous cabinet".

S. Matsuo	1904 to 1910	**Hawk** [GPT: D]	*One ex-ante, two ex-post sources:* Matsuo as traditional Imperialist, supporting Emperor during Restoration struggles. Refuses to stimulate markets during 1903-4 recession, "reserved" and "cautious" attitude in view of observers, "[BoJ] could not but conform to situation...general tendency was in the direction of decrease [of advances to money market]" (Chronicle, 1904, 222 – E.A.). Energetic (fiscally restrictive) reforms in Treasury, incl. debt consolidation, establishments of reserve funds, balanced budgets, see Matsuo (1911, 2of. – E.P.); Magazine (1911, 642ff. – E.P.).
J. Inoue	1919 to 1923	**Hawk** [GPT: H]	*Five ex-post sources:* NYHT (1932 – E.P.); Member of liberal Minseito party, member of liberal-moderate Hamaguchi cabinet; warnings from early 1920s about moral hazard and need for banking restraint in the face of emerging asset price bubble, see speech of January 27, 1920, via Shizume (2018, 134 – E.P.); clear advocate for high interest rates to fight inflation during 1920s, and advocate for classical gold standard return, repeatedly opposing expansionary Treasury, see Hanawa and Ogawa (1985, 35ff. – E.P.) and (Shizume, 2002, 83 – E.P.); further confirmation via Eichengreen (1992, 308 – E.P.) and End (2019, 250);
J. Inoue	1927 to 1928	**Hawk** [GPT: H]	See above.
Y. Mieno	1989 to 1994	**Hawk** [GPT: H]	*Two ex-ante, two ex-post sources:* Aggressive tightening policy from beginning of term ("Mieno shock", early 1990), public rows with Finance minister over hawkish interest rate turn from February 1990, with public view to deflate asset bubbles, defend currency, limit inflation, see Times (1990, D3 – E.A.), FT (1990, 8 – E.A.); But initially FX depreciation upon announcement in Kuttner and Posen (2010, E.P.); van Ommeren and Piccillo (2021, E.P.).
Y. Matsushita	1995 to 1998	**Dove** [GPT: H]	*Two ex-post sources:* Werner (2003, 143ff. – E.P.) claims that Matsushita was not de facto in charge – left in the dark about credit creation policies by BoJ staff – though he consents to features of easy money strategies. Repeatedly full public prioritization of "price stability" over growth or employment goals, but against context of deflationary tendencies, see also Friedman (2002, 10 – E.P.).

M. Hayami	1998 to 2002	**Hawk** [GPT: D]	*One ex-ante, two ex-post sources:* Markets at first react dovishly to announcement, see Kuttner and Posen (2010, 357 – E.P.); but increasingly defensive policy in light of deflation, publicly doubtful on QE, see Heckel (2014, 272ff. – E.P.); by late 1999, repeated public warnings about "moral hazard" resulting from BoJ liquidity provisions (WSJ, 1999, 6 – E.A.);
		Netherlands	
N. van den Berg	1891 to 1912	**Hawk** [GPT: H]	*Two ex-post sources:* Berg as skeptic of silver standard arrangements, devotes extensive publications to Dutch colonial finance, and as head of Java Bank at times he argues for low interest rates as preferable to high dividends. Steady rise in gold dominance in Netherlands economy during his tenure, following German model. See Jong (1967, 427ff. – E.P.) and Imhulsen (1989, E.P.);
G. Vissering	1913 to 1931	**Dove** [GPT: D]	*One ex-ante, three ex-post sources:* As head of "Zuiderzee Society" and "Vissering Commission" pushes Etatist/interventionist reclamation projects, despite formal liberal political affiliations; heads interest group during 1920s to call for "deflation of the world's balance sheet", fiscal restraint, see Vissering (1915, E.A.); in 1925, warnings against threat of deflation and "inopportune" return to gold standard arrangements (which he implements), see de Vries (1989, E.P.); Feldman (1997, 315f. – E.P.); van de Grift (2013, 613f. – E.P.);
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	See above.
		Norway	
K.G. Bomhoff	1893 to 1920	**Dove** [GPT: D]	*Three ex-post sources:* Member of economically progressive Liberal Party in 1880s: chosen over Evald Rygh because Bomhoff closer to progressive Venstre party ideology, see Lie (2020, 97f. – E.P.); though resists political influence over Norges Bank in early years gradually more lax, inflationary policies pushed by Knudsen government – Norges Bank as willing executor, see Gjedrem (2010, E.P.); further: Gram (2020, E.P.).

N. Rygg	1921 to 1946	**Hawk** [GPT: H]	*Four ex-post sources:* Background in statistical offices, convinced of deflationary policies to return to pre-War FX parities, later criticized for "too deflationary" policies, see (Jahn, 1954, 51 – E.P.); pushes votes of no confidence against socialist politicians; "main executor of deflation policies", see Kutsen (1991, 57 – E.P.); further: Sjersted (1973, E.P.); Notermans (2000, 68 – E.P.);
H. Skanland	1986 to 1993	**Dove** [GPT: D]	*Two ex-post sources:* Pragmatic anti-inflationist, supports fixed exchange rate framework (Gjedrem, 2010, 8f. – E.P.); however, Skanland during 1970s leads Keynesian commission advocating wage fine-tuning, widespread interventionism, (Qvigstad, 2010, 2f. – E.P.);
S. Gjedrem	1999 to 2010	**Dove** [GPT: H]	*Three ex-post sources:* Expresses repeated doubts on fixed exchange rate regimes to combat financial crises – favors tighter regulation on banks and short-term capital flows, plus tight macro-pru policies regarding fin. sector, see Gjedrem (1999, E.P.); market reactions in Kuttner and Posen (2010, 358 – E.P.); van Ommeren and Piccillo (2021, E.P.).
		Portugal	
A. A. Pereira de Miranda	1887 to 1891	**Dove** [GPT: D]	*Three ex-post sources:* Repeatedly initiates pro-business legislation as member of the liberal-progressive party in Parliament, moderate-liberal views, see da Silva (2010, E.P.). However, banking community still accuses him of "selfish" protection of Banco de Portugal interests (de Lisboa, 1893, 2 – E.P.). Voices concerns about income inequality and consistently close to progressive causes: Diplomatique (1905, 1 – E.P.).
I. Camacho	1911 to 1936	**Dove** [GPT: D]	*One ex-post source:* Clear socialist, anti-monarchist (Republican) leanings, together with wider family, position in Republican Party directory; later shift to social conservatism, liberal-conservatism, see (de Meneses and Sharp, 2011, 29ff. – E.P.);
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	See above.
M. Draghi	2012 to 2019	**Dove** [GPT: D]	See above.
		Spain	

A. R. Ortiz	1881 to 1883	**Dove** [GPT: D]	*One ex-post source:* Liberal journalistic and literary background and engaged in anti-monarchical, anti-clerical, progressive politics and economic policies pre-1868 (incl. universal suffrage), various concurrent bureaucratic appointments pre-BdE tenure, del Campo (2018, E.P.).
S. A. y Albert	1885 to 1890	**Dove** [GPT: H]	*Two ex-post sources:* "Old moderate", loyal to Monarchy during 1868 Revolution, but progressive social policies in Cuba (incl. support to abolish slavery). Economically "free trader" spearheading liberal trade agreement with France, against much criticism from fellow conservative party members, close collaborator of liberal economic agenda developed under MinFin Camacho prior to BdE tenure. See Anon. (1890, 3 – E.P.), de Montaud (2018, E.P.).
E. C. y Roffignac	1911 to 1913	**Hawk** [GPT: H]	*Two ex-post sources:* Strongly influenced by classical economic liberalism of Smith, Say, Sismondi, Mill, and especially Leroy-Beaulieu, including non-interventionism see Pan-Montojo (2000, 174 – E.P.); supports "sanctity of balanced budgets" ["santo temor al deficit"], see del Arroyo (2018, E.P.).
L. Pascual	1913 to 1916	**Hawk** [GPT: H]	*Two ex-post sources:* PLC Conservative Party member, agrarian background, "cautious and serene" minister worried as MinFin about BoP deficits - which he tries to adjust via sharp import contractions and widespread tax hikes, irrespective of growth and unemployment effects, Toribio (2005, E.P.) and Toribio (2018, E.P.).
E.S. Escartin	1920 to 1920	**Dove** [GPT: D]	*Two ex-post sources:* Intellectually indebted to "eclectic" fusion of organicism and evolutionism, as well as Italian Catholic socialists: includes supports for some state interventionism and the need for the organization of workers; on the economic side, influenced by Piernas Y Hurtado, Le Play, and Krausismo, see Sanchez (2011, E.P.); Gallego and Trincado (2020, 28 – E.P.).
C.V. Cailleaux	1924 to 1929	**Dove** [GPT: D]	*One ex-post source:* Career bureaucrat in Finance ministry under Primo de Rivera, engaged in unsuccessful attempts to stabilize Peseta: no strong intellectual convictions, or economic ideology recorded by any biographers. General reluctance at BdE to assume LLR or other financial stability mandates, see Pastor (018a, E.P.).

L.C. de Palma	1971 to 1976	**Dove** [GPT: D]	*Four ex-post sources:* Mainly recognized prior to appointment as "new generation technocrat" pushing pro-business, pro-growth liberalization agenda in Spain as part of the "neoliberal clique" around Enrique Fuentes Quintana and Fabian Estape; key supporter of 1959- Stabilization Plan(s) together with Mariano Navarro Rubio, which seek to push growth but rein in on inflation, abolish budget deficits; see de Lorca (1982, 69ff. – E.P.); Sanz (2006, E.P.); Atares (2008, E.P.); Pastor (018b, E.P.).
L. De Letona	1976 to 1978	**Dove** [GPT: D]	*Three ex-post sources:* Franco regime appointment, pro-business stance, with corporate/industrial background; hailing from same intellectual circles as predecessor Palma, supports 1959 Stabilization Plan, pushes growth program and productive efficiency improvement - repeated clear prioritization of economic expansion agenda above other variables; see (de Lorca, 1982, 69ff. – E.P.); Sanz (2006, E.P.); Calzas (2018, E.P.).
J.-C. Trichet	2004 to 2011	**Dove** [GPT: D]	See above.
		Sweden	
C. Lewenhaupt	1872 to 1889	**Hawk** [GPT: H]	*One ex-post source:* Tolerant of some emergency aid, but generally strict stance against banking community, including Wallenberg/Ensklida, see (Brisman, 1931, 155ff. – E.P.).
K. Langenskioeld	1901 to 1911	**Dove** [GPT: D]	*Two ex-post sources:* Models general bank organization and policy on Bank of England, Riksbank as "bank's bank"; though on the right within Riksdag, "dogmatically liberal" on various issues, deviating from party line, see Franzén (1977, E.P.); Some (mildly) interventionist banking sector convictions during 1890s, including tighter regulation of deposit rates, see Pipping (1969, 158f. – E.P.);
V. Moll	1912 to 1928	**Hawk** [GPT: H]	*Three ex-post sources:* Early in career close to left-wing liberals around Karl Staaff, for which he drafts (progressive, unionist, anti-monarchical) financial policy; later good relations with Wicksell, and D. Davidson – but "combative" opposition to conservative economists around Gustav Cassel, see (Grafvert, 1985, 662 – E.P.); Riksbank pursues particularly deflationary and credit-restrictive policies, Riksbank intent to restore gold parities despite costs; see Peteri (1984, E.P.); Rongved (2017, E.P.).

I. Rooth	1929 to 1948	**Hawk** [GPT: H]	*Three ex-post sources:* Hires some Keynesians during term for policy views, including Dag Hammarskjöld, but resists both Riksbank LLR demands (Krueger affair – only bows after severe gvt. Pressure) – and later repeated conflicts with Social Democratic government over debt financing/low interest rate policies, see (Grafvert and Elgemyr, 1998, 300 – E.P.); further: Straumann and Woitek (2009, E.P.); Riksbank (2010, 283ff. – E.P.).
B. Dennis	1982 to 1993	**Dove** [GPT: H]	*One ex-ante, three ex-post sources:* Pragmatic attitude during banking crisis: lets Krona float, but introduces inflation targeting mandate; slightly dovish market reaction upon appointment, see (Kuttner and Posen, 2010, 358 – E.P.); see WSJ (1988 – E.A.); Canova (1994, E.P.); van Ommeren and Piccillo (2021, E.P.).
S. Ingves	since 2006	**Hawk** [GPT: D]	*One ex-ante, two ex-post sources:* Hawkish market reaction upon appointment via (Kuttner and Posen, 2010, 358 – E.P.); Eijffinger et al. (2013, E.P.); however, during 1990s, Ingves gives strong public support to large-scale government assistance for banking sector, including controversial aid for Nordbanken and Gota, (FT, 1994, 32 – E.A.).
		Switzerland	
H. Kundert	1907 to 1915	**Hawk** [GPT: H]	*Three ex-post sources:* Long service in Cantonal banks pre-appointment; supports Real Bills doctrine, clear focus on price stability: inaugural speech in 1907 scorns build-up of "non-trade-related discount portfolio" at public banks, promises "relentless cleansing" to focus on trade bills only, via Bachmann et al. (1932, 74f. – E.P.); Baltensperger and Kugler (2017, 48 – E.P.); NZZ (1924, 1 – E.P.);
A. Burckhardt	1916 to 1924	**Hawk** [GPT: H]	*Two ex-post sources:* Burckhardt, as protégé of Kundert, closely shares convictions, including Real Bills Doctrine, see (Bachmann et al., 1932, 449f. – E.P.); "pursues hard anti-inflationist course", Gerber (1934, E.P.);
G. Bachmann	1926 to 1938	**Hawk** [GPT: D]	*Two ex-ante, two ex-post sources:* Intellectually influenced in 1910s and 1920s by Conrad Cramer-Frey, liberal but etatist economist and politician, see NZZ (1947, 5 – E.P.); Consistently opposed to CHF devaluation after British gold standard exit, with FX stability as primary mandate; repeated public interventions opposing Franc devaluation see Bachmann (1934, E.A.); Katona (1934, 6 – E.A.); Bordo et al. (2006, 14 – E.P.).

M. Lusser	1988 to 1995	**Hawk** [GPT: H]	*One ex-ante, three ex-post sources:* Widely considered a monetarist – closely advised by monetarist Karl Brunner, see Furstenberg and Ulan (1998, 135ff. – E.P.); Rich (2007, E.P.); in 1988, Lusser prevails against Switzerland joining EMS for fears of losing FX autonomy, threats to price stability primacy, embodying consensus on conservative and tight money principles (FT, 1988, 14 – E.A.); Kuttner and Posen (2010, 358 – E.P.) measure slightly dovish market reaction, incl. FX depreciation;
J.-P. Roth	2001 to 2009	**Dove** [GPT: H]	*Two ex-ante, two ex-post sources:* In early 2000s, Roth's policy actions largely can be rationalized in standard macro reaction functions given business cycle, see Ohyama and Tanigawa (2006, E.P.); in January 2007, at Davos meeting, Roth warns of "speculative bubbles" in financial markets, will steer against exuberance (NZZ, 2007, 35 – E.A.); Aggressive policy easing in response to crisis, some (undue) concern about inflation 2009ff.; FT (2004 – E.A.); mixed market reaction upon inauguration documented in Kuttner and Posen (2010, 358 – E.P.).
		United Kingdom	
E. H. Palmer	1878 to 1879	**Dove** [GPT: D]	*Two ex-post sources:* Very scarce evidence on Palmer himself in Clapham (1958, E.P.) or Kynaston (2017, 201ff. – E.P.), but BoE de facto engaging in supportive policies during 1878 crisis ("Bagehot would have approved", see Kynaston (2017, 211f. – E.P.);
W. Lidderdale	1889 to 1892	**Hawk** [GPT: D]	*One ex-ante, two ex-post sources:* Praised across the bench for pragmatic stance during Barings crisis (Clapham, 1958, 328ff. – E.P.); FT (January 1, 1891 – E.A.): "a more retiring man never held the governorship" and "a public speech is his abomination"; career background in commerce and merchant banking (Rathbone Bros & Co.); but intellectually opposes Bagehot, see (Kynaston, 2017, 207 – E.P.);

W. Cunliffe	1913 to 1918	**Dove** [GPT: D]	*One ex-ante, two ex-post sources:* Close co-operation with Treasury from early states of war, assists in freezing "enemy banks", backs supporting businesses in "temporary insolvency" Bankers-Magazine (1917, E.A.); . Often in agreement with Keynes, but generally in 1914 "he had neither the sort of experience nor the intellectual power which would have helped him to judge what really was happening...all measures were marked by practical sense" (Economic-Journal, 1920, 130 – E.P.). Increasingly submits to Treasury under Bonar Law as War progresses, see Sayers (1976, I, 79ff. – E.P.).
G. Richardson	1973 to 1982	**Dove** [GPT: D]	*Two ex-ante, one ex-post sources:* 'Pragmatic' monetarist, who supports adaptable targets, flexibility, see Richardson (1978, E.A.) and Bareau (1978, 46f. – E.A.), but not "undiluted, pure, monetarism"; mildly pro-inflationary; Independent (2010): "flirting with monetarism", but ultimately rejecting policies as "too tight", "pragmatist"; see further Loehnis (2010 – E.P.).
R. Leigh-Pemberton	1983 to 1993	**Dove** [GPT: H]	*One ex-ante, three ex-post sources:* Strongly dovish market reaction upon appointment, see Kuttner and Posen (2010, 358 – E.P.); Generally approves of central bank liquidity interventions during crises, explicitly in 1989, "It has been recognized since at least the nineteenth century that the macroeconomic goals of price and exchange rate stability can be undermined if the financial system is unstable. For this reason, all central banks have developed ways of channelling liquidity to the banking system in periods of pressure and the arrangements for the prudential supervision of individual firms have been progressively strengthened. I imagine most of us could agree, at least in broad terms, on these goals", via Leigh-Pemberton (1989, E.A.); Conservative party member, but pragmatist supporting EMU accession for Britain, see: Guardian (2013 – E.P.), further van Ommeren and Piccillo (2021, E.P.).

M. King	2003 to 2013	**Hawk** [GPT: D]	*Two ex-ante, three ex-post sources:* Tends to be seen as pro-Conservative; The Standard (2010 – E.P.) – "hawkish pre-crisis, dovish since the crisis"; in early 2000s, King acknowledges role for liquidity support during financial crises in cases where crisis in liquidity, but not fundamentals-driven (King, 2001, 9 – E.A.)..."[LLR] would normally be short-lived, and should be made available at an above-market interest rate such that this sort of finance is seen as last not first resort"; hawkish market reaction upon appointment, see Kuttner and Posen (2010, 358 – E.P.); equally, van Ommeren and Piccillo (2021, E.P.). Generally approves of government interventions during crises, including Asian LLR responses during 1990s crises, "From time to time, there may well be financial crises when it would be appropriate for the international community to provide temporary financial assistance to mitigate the costs of sharp adjustment in trade flows and output. But such a role should not be the principal focus of international monetary co-operation", King (2006, E.A.).
United States			
E. Meyer	1930 to 1933	**Hawk** [GPT: D]	*Three ex-post sources:* Nuanced context in Meltzer (2005, E.P.) – Meyer subscribes to Riefler-Burgess doctrine and real bills framework – sides with hawkish real bills majority within committee including McDougal, Norris, Young: Ben Strong and over-expansionary policies in late 1920s – "the New York bank had built up its power entirely out of proportion with the intent of the [Federal Reserve] Act" (ibid., 409); (Eichengreen, 1992, 297f. – E.P.) confirms hawkish leaning; however, Butkiewicz (2013, E.P.) suggests intellectual influence of Adolph Wagner and German state interventionism;
P. Volcker	1979 to 1987	**Hawk** [GPT: H]	*Two ex-post sources:* Kuttner and Posen (2010, 358 – E.P.) record clear hawkish market reaction upon announcement; by early 1979 (pre-appointment), Volcker fundamentally at odds with Miller Fed, pushing for more aggressive action on inflation, rejects notions that policy is "tight" already, see (Goodfriend, 2005, 994f. – E.P.).

A. Greenspan	1988 to 2005	**Dove** [GPT: D]	*Three ex-ante, two ex-post sources:* Pro-business/deregulation, but usually associated with dovish or neutral leanings, see Bordo and Istrefi (2023, E.P.); Clear USD depreciation upon announcement, coupled with sizable yield widening (27bps), see Kuttner and Posen (2010, 358 – E.P.); however, various hawkish statements with regards to LLR and bailout policies, including Greenspan (1999, E.A.) and Greenspan (2002, E.A.) – "Alan Greenspan, chairman of the Federal Reserve, warned nervous markets that they shouldn't count on a Fed bailout if recent financial turbulence intensifies. "We must be careful not to foster an expectation that policy makers will ultimately solve all serious potential problems and disruptions," Mr. Greenspan said in a speech at a Chicago banking conference" (WSJ, May 5, 2000).
B. Bernanke	2006 to 2013	**Dove** [GPT: D]	*Two ex-ante, two ex-post sources:* In early 2000s, as board governor, Bernanke rejects "lean against the wind" strategy vis-a-vis asset bubbles, but in principle recommends LLR upon crisis inception, "if necessary, the Fed should provide ample liquidity until the immediate crisis has passed. The Fed's response to the 1987 stock market break is a good example of what I have in mind" (Bernanke, 2002, 2 – E.A.); Kaletsky (2014, via Reuters – E.P.) – "Bernanke, despite his radicalism during the financial crisis, was philosophically an orthodox monetarist, who followed his mentor Milton Friedman in believing that the main job of a central bank is to stabilize inflation"; Anna Schwartz, via Sorman (2009, E.A.), disputes that Bernanke policy is "monetarist"; 2004 "Bernanke doctrine" warns of deflation; though not consistent pre-2008, on balance seen as dovish, see (Bordo and Istrefi, 2023); slightly dovish market reaction via (Kuttner and Posen, 2010, 358 – E.P.);

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B Early central banks – a filtering approach

Table A.4: Early central banks: excluded banking institutions, and details

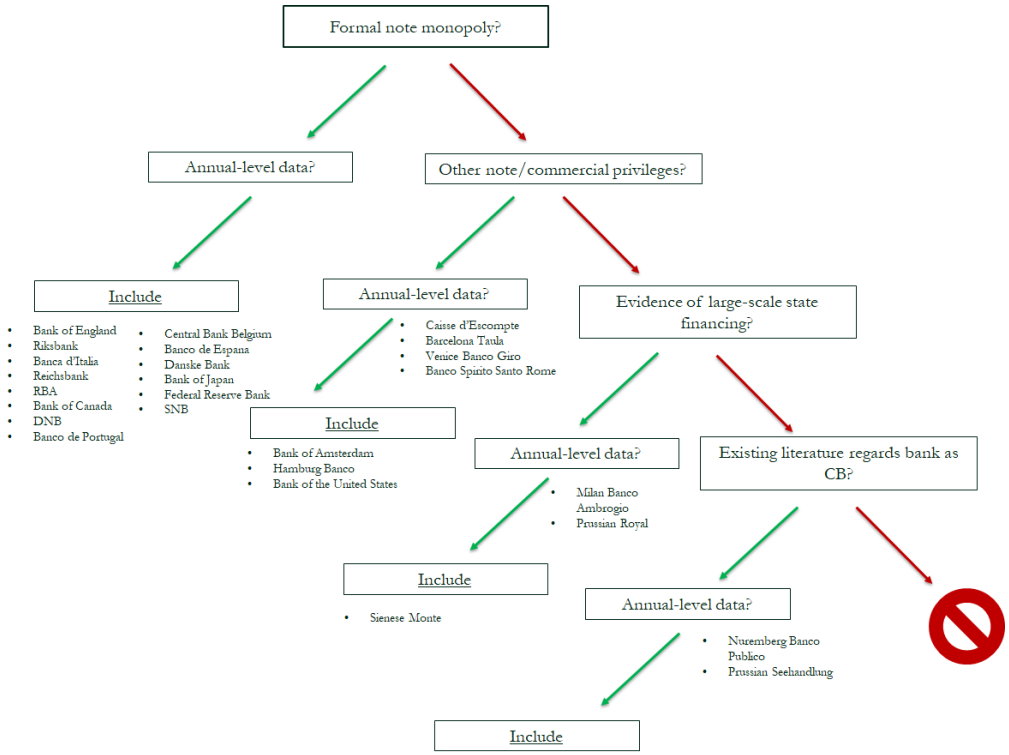
	Country, est. date	Max. known assets (year)	Comments	Literature
Barcelona Taula di Canvi	Spain, 1403	358,053 ll (1433)	Usher (1943) reports various aggregate balance sheet data points (including for January 1433) – however, the data is far too sparse to construct an annual series.	Usher (1943).
Milan Banco Ambrogio	Italy, 1593	L 43.81M (1658)	The Banco acts as a de facto central bank, but while Cova (1972, 178ff.) provides a total of 19 annual balance sheets for the Bank over the period 1624-1800, it is not possible to built a continuous series on this basis.	Cova (1972).
Roman Banco di Santo Spirito	Italy, 1605	Scudi 2.8M (1858)	Ponti (1951) reports bank activities over 1605-1870, but precise balance sheet data is only given sporadically. The Bank acts as a direct agent for the Papacy, with a de facto monopoly in the state.	Ponti (1951).
Venice Banco Giro	Italy, 1619	Ducati correnti 6.083M (1762)	The Banco acts as a de facto central bank, but while individual asset items are covered on an annual basis (deposit volumes, the "metallic fund"), Tucci (1973) does not provide total asset volume data – these figures therefore remain unknown.	Tucci (1973).

cont.: Table A.4: Early central banks: excluded banking institutions, and details

Nuremberg Banco Publico	Germany, 1621	Rfl 219,482 (1706)	The Banco acts as a de facto central bank, but while Denzel (2012) provides deposit volumes and turnover figures for the Bank on a continuous annual basis, total asset volumes are unknown.	Denzel (2012).
Caisse d'Escompte	France, 1777	LT 503.3M (1789)	While the Caisse can be regarded as a de facto central bank, Courtois (1881, Annexe E) only provides turnover and escompte volumes over 1777-93, but not total asset volumes.	Courtois (1881).
Royal Prussian Banco Franconia	Germany, 1780	Rfl 5.5M (1800)	While the Royal Prussian Banco can be regarded as a de facto central bank, both von Poschinger (1876) and Steffan and Diehm (1955) only provide intermittent aggregate balance sheet data, insufficient for a continuous series.	von Poschinger (1876), Steffan and Diehm (1955).

Note: The table reports existing de facto and de jure central bank institutions, as surveyed by existing literature – and our rationale for including or excluding the institution in our data set. The "max. known assets (year) column reports the volume and year for which the maximum total asset volume can be identified, on the basis of the existing sources – this volume is not necessarily the actual peak volume of assets, nor does it necessarily include all actual bank assets.

Figure A.4: Filtering approach to early modern central banks (CBs) – a decision tree.



Notes: Modern and early modern bank inclusion decision tree. For sources and further definitions see Table A.3 and discussion in Section 2.1.

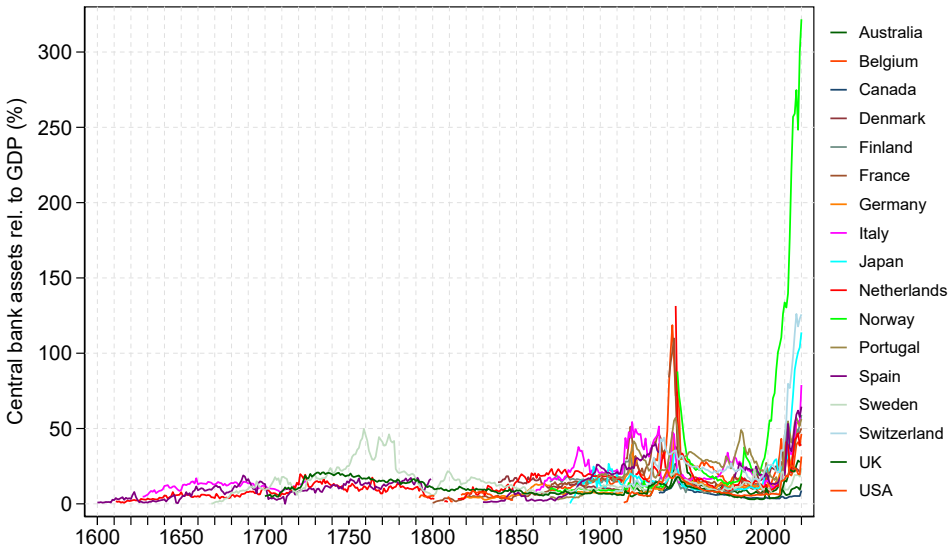
C Additional evidence on the historical evolution of central bank balance sheets

This section presents country-specific long-run series as well as estimates of year fixed effects controlling for country fixed effects. This allows to test for potential sample composition effects in th aggregate patterns shown and discussed in Section 2.2.

C.1 Country-specific series

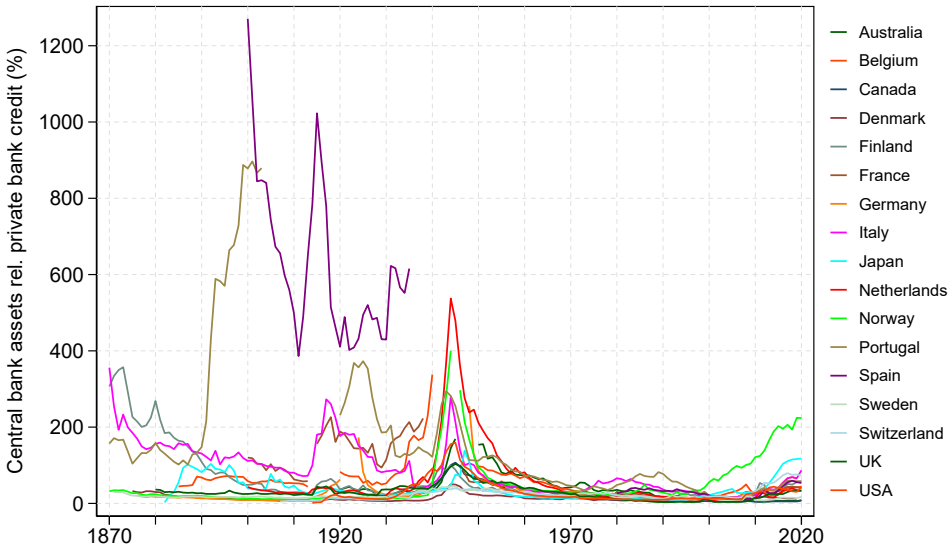
Country-specific series for central bank assets relative to GDP are shown in Figure A.5, central bank assets relative to private lending in Figure A.6, central bank holding of government debt relative to total government debt outstanding in Figure A.7 and central bank government debt as a share of total central bank assets in Figure A.8.

Figure A.5: Central bank assets relative to GDP, by country



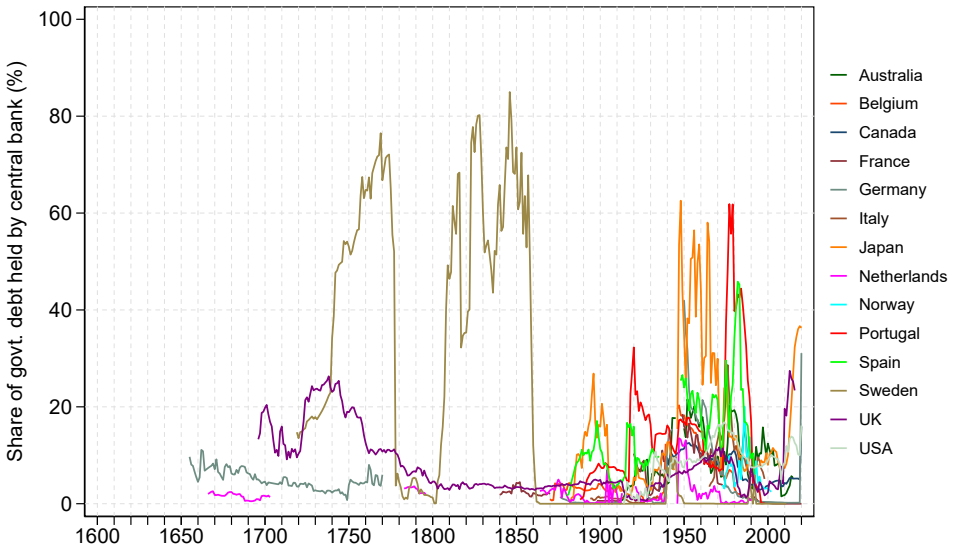
Notes: The figure shows country-specific series of central bank assets relative to GDP.

Figure A.6: Central bank assets relative to private lending, by country



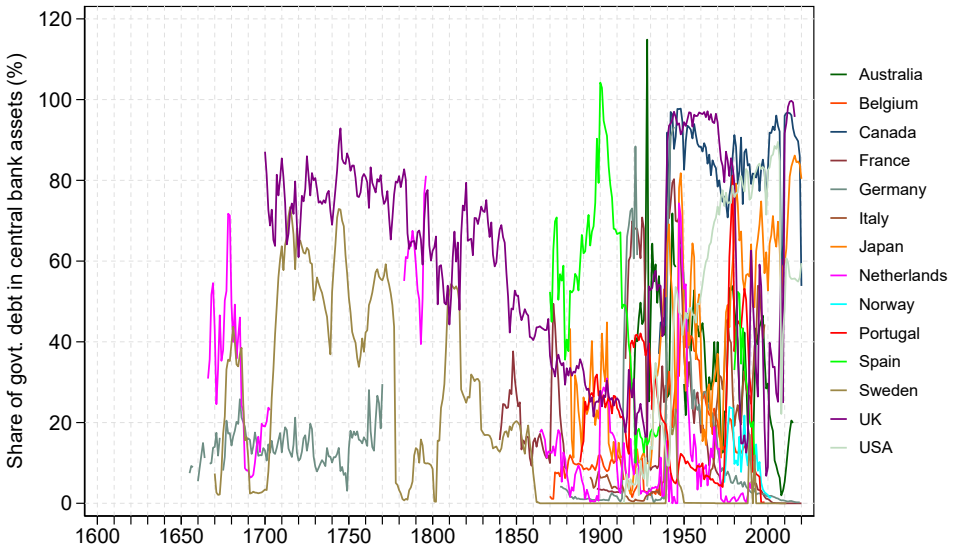
Notes: The figure shows country-specific series of central bank assets relative to bank loans to the nonfinancial sector.

Figure A.7: Share of outstanding public debt held by central bank, by country



Notes: The figure shows country-specific series of share of outstanding public debt held by central bank.

Figure A.8: Share of government debt in central bank assets, by country

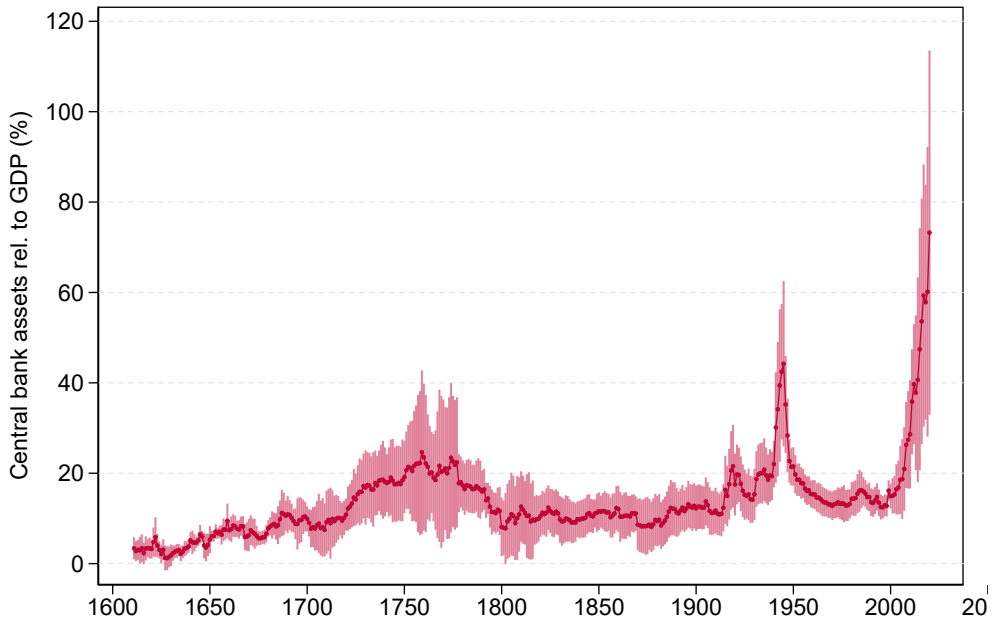


Notes: The figure shows country-specific series of the share of government debt in central bank assets.

C.2 Estimated time effects

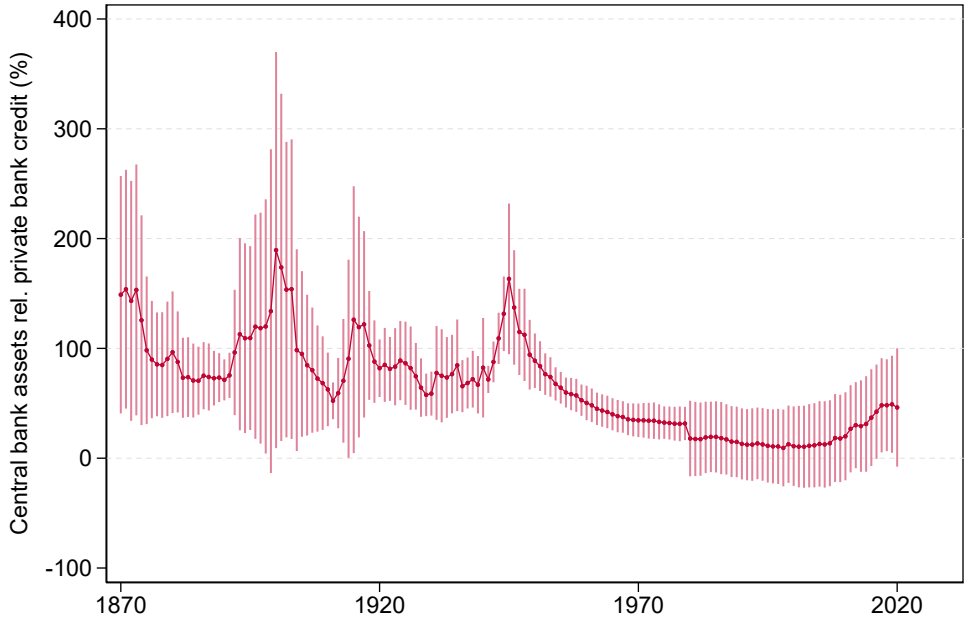
This section tests whether main features discussed in Section 2.2 are driven by sample composition. Specifically, we estimate year fixed effects controlling for country fixed effects for each variable to filter the time effect net of sample composition. Figure A.9 plots the year effect with 95% confidence intervals for central bank assets relative to GDP. Figure A.10 shows estimates for central bank asset relative to private lending, Figure A.11 examines central bank government debt relative to total government debt outstanding and Figure A.12 shows the estimates for central bank government debt as a share of total central bank assets. In each case, aggregate patterns are very similar to the raw data moments presented in the main text.

Figure A.9: Estimated time effects in central bank assets relative to GDP



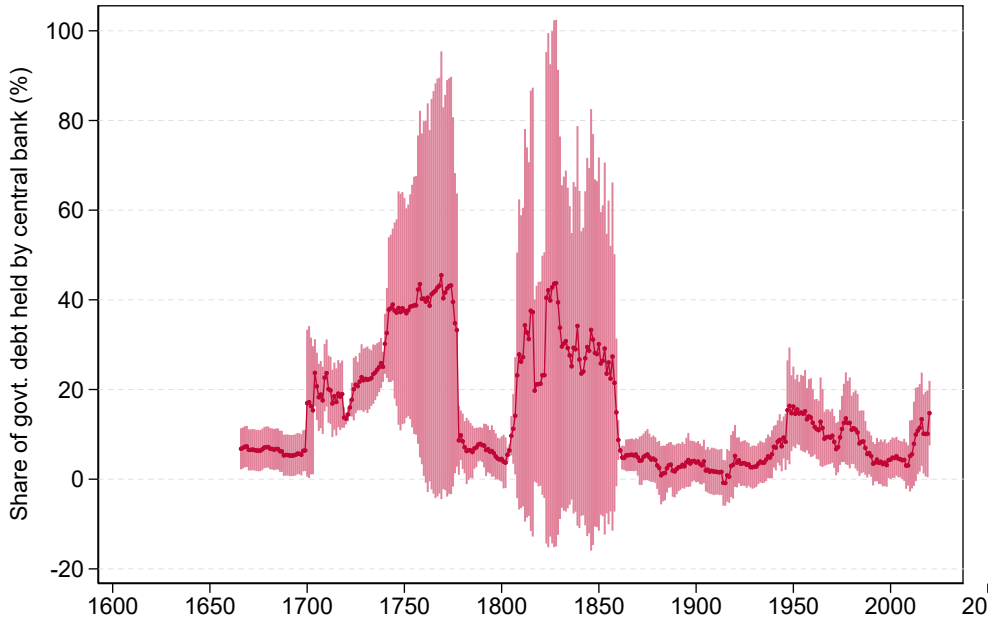
Notes: The figure shows estimates of year fixed effects from a panel regression of central bank assets relative to GDP, controlling for country fixed effects. Whiskers mark the 95% confidence intervals.

Figure A.10: Estimated time effect in central bank assets relative to private lending



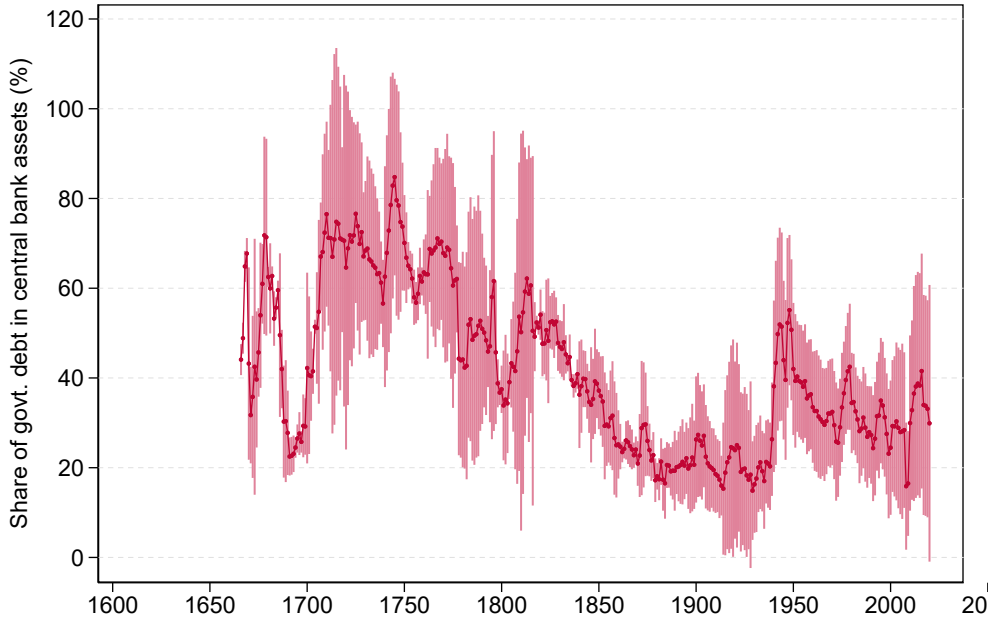
Notes: The figure shows estimates of year fixed effects from a panel regression of central bank assets relative to bank loans to the private nonfinancial sector, controlling for country fixed effects. Whiskers mark the 95% confidence intervals.

Figure A.11: Estimated time effects in share of public debt held by central bank



Notes: The figure shows estimates of year fixed effects from a panel regression of central bank government debt assets relative to total government debt outstanding, controlling for country fixed effects. Whiskers mark the 95% confidence intervals.

Figure A.12: Estimated time effects in central bank assets share of public debt



Notes: The figure shows estimates of year fixed effects from a panel regression of the share of government debt in total central bank assets, controlling for country fixed effects. Whiskers mark the 95% confidence intervals.

D Details on individual major expansion events

In this appendix section, we present details of around the "top 25" nominal year-on-year central bank balance sheet expansion events, in chronological order, to illuminate the particular types of expansion drivers, and rationalize our classifications. Expansion figures always refer to year-on-year nominal year-average growth, unless otherwise noted.

Neapolitan public banks, 1609 +197% expansion: Stefano (1940) or Balletta et al. (2018) do not record a specific tail event during 1609; the backdrop is in this case a sharp increase in banking activity and the swift establishment of multiple new banking houses in the Kingdom of Naples since 1580 –– a boom that ends in the severe banking crisis of 1622, when aggregate balance sheets contract substantially.

Bank of Amsterdam, 1618 +235% expansion: the Bank of Amsterdam, as the de facto central bank of the (emerging) Dutch Republic grew rapidly after its foundation in 1609; from its inception, financial markets in Amsterdam were under the influence of the major geopolitical events of the time, including the ongoing Eighty-Years War, during which the Dutch states fought for independence from Spain, and the religious tensions in the Holy Roman Empire. In 1618, matters saw a sharp escalation with the "defenestration" in Prague –– the event that is commonly associated with the beginning of the Thirty Years War. Despite important domestic factors, we interpret the

expansion event as a function of an exogenous, pan-European capital flight, into the early modern "safe havens" (Van Dillen 1934, 84ff.). We would therefore characterize the expansion as 'war or revolution" driven in our typology, but one demonstrably driven by gold and foreign asset growth.

Bank of Hamburg, 1675 +68% expansion: the history of Hamburg — with its famed merchant and financial communities -– during the last quarter of the 17th century is closely tied to the geopolitical events brought about by France's belligerent regent, Louis XIV. The largest nominal aggregate asset expansion at the Bank of Hamburg takes place just after the French declaration of war against the Dutch Republic, and the invasion of French forces into the German Rhineland in 1674. We view the underlying drivers of the Hamburg expansion as clearly motivated by capital flight from the Dutch and German financial hubs, and would classify the 1675 balance sheet expansion as a typical "war or revolution" event, though it did not involve modern-type war financing activities on behalf of the Hamburg municipal authorities themselves -– there was no bank-led emergency lending to public authorities. As Israel (1989, 293) notes, the Dutch commercial hubs immediately felt the pain after the French declaration of war in April 1672: "there was a massive run on the banks. Millions of guilders were transferred abroad". Apart from Hamburg, Italian cities were a key beneficiary for funds hastily withdrawn (Barbour, 1963, 57ff.).

Riksbank, 1726 +66% expansion: in the aftermath of the South Sea Bubble, Sweden saw significant capital inflows and one of the largest pre-1870 annual expansions of the central bank's balance sheet; in the absence of clear geopolitical drivers, we designate the event a financial crisis expansion, despite no evidence of domestic volatility in Stockholm's financial community at the time (Fregert, 2014).

Japan, 1883 +728.1% expansion: this country-year records the second-highest y-o-y growth on record across our sample; we have classified the event in the "revaluation" category at present. The Bank of Japan is founded in 1882, and begins operations in October of that year. The sharp rise in 1883 on a year-on-year basis is thus explained by technical factors, and the increase in operation from a very low asset base in the inception year. There are no exceptional crisis or exogenous events in 1883 otherwise, though a still-elevated inflation level persisted as a legacy from the Seinan Civil War of 1877 (Shizume, 2020).

Japan, 1905 +113.6% expansion: Japan is most prominently represented in our "top 25" expansion sample (with four listings on the aggregate asset expansion basis); 1905 marks the Russo-Japanese War, which Tokyo successfully completed by September 1905. Japanese war expenditures were met partly by raising substantial foreign loans in London and New York, but also aided by significant BoJ accommodation including direct purchases of Treasury bills; public debt/GNP more than doubles within a span of less than five years over 1902-1907 (BoJ, 1906, 4).

USA, 1917 +161.3% expansion: this country-year records the sixth-highest y-o-y growth on record across our sample, and is currently classified as a "war or revolution" expansion. While war finance — specifically the issuance of Liberty Loans during 1917-1919 — exercised the strongest influence over Federal Reserve balance sheet dynamics in the early years of the Fed's inception, some of the increase in the central bank's total assets are related to the technical consolidation of the member bank system enacted in 1917: legislation enacted in June of the year, for instance, required member banks to deposit a much higher share of required reserve at Federal Reserve banks — a move increasing total excess reserves in the Fed system by US$ 300m (Meltzer, 2005, 79ff.).

Belgium, 1918 +151.2% expansion: this country-year marks the ninth-highest growth on record, and is classified in the "revaluation" category. Following the occupation of Belgium during World War One, and the subsequent armistice, the National Bank of Belgium (NBB) was instructed by the political authorities to swap the substantial amount of outstanding German mark money volumes — made legal tender by the Germans during 1916-1918 – into newly-issued Belgian currency. Such operations, in addition to the financing of post-war reconstruction efforts, significantly expanded the NBB's balance sheet (van der Wee, 2012, 130f.).

Germany, 1922 +1186% year-on-year total asset expansion: the German hyperinflation years mark the largest central bank balance sheet events across our entire sample over 150 years. Against the wider macroeconomic backdrop, and the complete collapse of one of the leading advanced economies of the time, this status is perhaps unsurprising. The expansion itself during 1922 is mainly driven by sharply rising commercial bill discounting activity. Webb (1985) argues the Reichsbank behaves passively through this phase, de facto letting the market decide its balance sheet size. We have designated the event in the "revaluation" category, since market actors' borrowing activity is overwhelmingly motivated by attempts to counter the rapid price surge and match revalued liabilities (ibid.).

Switzerland, 1931 +91.1% expansion: this country-year records the 19th-highest y-o-y growth on record across our sample, and represents the largest balance sheet expansion in the "FX attack or accumulation" group. The German emergency laws of July 1931 –- amid the collapse of Danat Bank and heavy capital outflows –- froze substantial volumes of Swiss creditor funds. In the aftermath, and the escalation of European-wide uncertainty, Switzerland experienced substantial capital inflows, despite reductions in discount rates –- not least representing inflows facilitated by foreign central banks. The momentum substantially accelerated after the British departure from gold in September, with the SNB increasingly resorting to direct substantial gold purchases to stem the currency appreciation: gold assets on the SNB balance sheet rose from CHF 953M in May 1931, to CHF 2.4BN by the end of December (Bachmann et al., 1932, 302ff.).

Belgium, 1942 +38.7% expansion. The expansion is related to sharp growth in NBB assets related to the establishment of the Banque d'Emission de Bruxelles; the exact breakdown of underlying assets is not reported in printed accounts to our knowledge -– but it is likely that a mix of international, and domestic public and private assets are ultimately involved (van der Wee and Verbreyt, 2009, 109ff.). We treat the event as a "mixed" domestic asset expansion event.

Germany, 1939-1945 Expansions driven by "Reichskreditkassenscheine" ("RKKS") during Nazi Germany's occupation. Reichskreditkassenscheine ("RKKS") were created by Nazi occupation authorities to replace the domestic money supply in various countries after 1939, to enable a direct underwriting of armament and occupation costs — leaving significant traces on central bank balance sheets at the time, though the overall recourse varied across occupied territories; Klemann and Kudryashov (2012, 194-201) provide a general discussion about the phenomenon and technical details. RKKSs enabled both individual soldiers to transact on an everyday basis in occupied territories, as well as the Wehrmacht armaments offices and other associated public agencies to purchase equipment and related needs; in this sense RKKS transactions reflect a combination of public and private economic activity and we designate central bank balance sheet expansions as a "mixed" domestic asset expansion in country-years where these items assume a dominant influence. The following expansions are demonstrably dominated by RKKS liability growth:

Norway, 1940-1944 The country's +147.4% expansion in 1940 features in the "top ten" all-time expansion events, and is closely related to Nazi Germany's invasion of the country in the first half of the year. Though it managed to transfer its entire gold reserves to the U.K. in an emergency operation in April 1940, from later this month the Norges Bank was de facto required to accept German RKKS as official legal tender. The Norges Bank accepted to swap domestic currency for RKKS, and in practice financed both the ongoing Wehrmacht campaigns against British forces, as well as the regular occupation costs, via domestic money expansion. Later, all RKKS transactions were booked via a special "occupation account" on Norges Bank balance sheet, with amounts until 1945 in this account recaching NOK 11.3BN (Espeli, 2014). We have accordingly designated the country-year as a "war or revolution" type. Also see figure breakdowns in Hvidsten (2013).

Netherlands, 1940-1945 As in France, the German occupants took control over the monetary institutional architecture and decisively upset balance sheet dynamics at the Dutch National Bank — but one that did not trigger domestic asset expansion events under our benchmark definitions; for details on the Dutch situation, see Barendregt (1993).

Belgium, 1942-1944 See in particular van der Wee and Verbreyt (2009) for the Belgian experience with RKSS issuance driving the NBB balance sheet dynamics during the German occupation.

France, 1941-1942 See Baubeau (2018), with French RKKSs in the balance sheet of the Banque de France peaking in December 1941, at FRF 64.6M, or 18% of total liabilities. RKKSs account for just

over 43% of the total Banque de France balance sheet growth over the course of 1941-42. Note that these years still fall short of our domestic asset expansion threshold.

Denmark, 1941, 1943, 1944 See Abildgren (2017), with RKKSs being recorded under "deposits and other net liabilities", which grow from 10.3% of Danish GDP in 1940, to no less than 45.1% by 1945.

Italy, 1941 +123.6% expansion: this country-year marks the eleventh-highest growth on record, as we have classified it in the "war or revolution" category. Fratianni and Spinelli (1997, 162ff.) associate the initial war years with failed attempts to finance the spiraling government deficits via a "capital circuit" strategy -– de facto forced private sector purchases of government securities. With the growing realization that this chancel was unable to sufficiently address financing needs, currency creation was increasingly resorted to.

Japan, 1945 +217.1% expansion: the final World War Two year in Japan ranks among the "top 5" all-time central bank balance sheet expansion years. Despite the obvious association with "war finance" dynamics as the country struggles to prevail against the odds in the Pacific War theatre, the balance sheet expansion has multiple origins. As Nakamura (2003, 75ff.) and others document, Japanese M2 surges year-on-year by almost JPY 80BN, but the increase is fueled not least by capital flight from formerly occupied territories, and rampant inflation from August 1945 (ibid., 90), which leads to a surge in the value of the BoJ's outstanding "notes" components. The fiscal deficit rises relatively "modestly" in 1945, by JPY 12BN y-o-y, and newly-issued Japanese government bond volumes actually fall y-o-y. A sharp rise is instead recorded in public subsidies to the industrial sector. Given the underlying price and capital flow dynamics, a reasonable case could be made to treat this country-year as a "revaluation" event. On the margin, we still opted to see it as a "war or revolution" event, however, given the overwhelming influence of these factors on the general economy.

Japan, 1947 +121.5% expansion: this country-year features in the "top 20" all-time central bank balance sheet expansion events, and is closely associated with the immediate post-war political and financial efforts to reconstruct Japan's economy. Key for the Bank of Japan's balance sheet expansion is the authorities' establishment of the Reconstruction Finance Bank ("Fukko Kinyu Koko") during the year, which saw its bond issuance fully subscribed to by the Bank of Japan (Nakamura 2003, 91f.).

Italy, 1976 +151.5% expansion: this country-year records the seventh-highest y-o-y growth on record across our sample; we have classified this event in the "revaluation" category at present. Italy during the 1970s experienced deep-seated structural problems related to lacklustre productivity growth, high inflation, and rising fiscal deficits. (Lubitz, 1978, 14f.) notes that "the rapid expansion

of the monetary aggregates is in turn due to the increase in the monetary base and the major source of monetary base creation has been the central bank's financing of the Treasury deficit. The Bank of Italy has itself maintained that it has been required to finance the Treasury deficit and has therefore lost control of the monetary base and money supply".

U.K., 1999 +212% expansion: this country-year marks the fifth-largest expansion on record over the past 150 years across advanced economy central banks. In its 1999 annual report, the Bank of England comments on its balance sheet increase as follows: "The Bank is providing EUR 3 billion as a float of liquidity for the UK financial sector's use of TARGET. This float comprises securities and deposits denominated in euro and is included on the Bank's balance sheet. together with the corresponding funding. The Bank started to acquire the assets for the float in December 1998 purchasing securities and placing deposits, initially in currencies that would on I January 1999 convert to the euro. These assets were then redenominated into the euro. This portfolio was financed by swaps and an increase in the deposits for the Issue Department. The TARGET system involves the creation of bilateral positions between central banks in the member countries. These balances reflect the net flows between the individual countries through the central banks. Although the net position is what matters for most operational purposes, the individual balances are with different legal entities and must therefore be shown gross under UK accounting rules. The existence of these balances has resulted in a significant increase of around EUR 12BN (GBP 8BN) in the Bank's balance sheet footings at the balance sheet date" (BoE, 1999, 51). Hence, this country-year is part of the general increase in Eurosystem TARGET claims that generate key "expansion" events for most Eurosystem central banks in 1999 (see our separate note on 1999 as a European technical expansion event below). The Bank of England aggregate balances in 2000 -– as is the case in most other affected Eurosystem member banks — record a substantial decrease in total assets almost exactly canceling out the previous expansion. We have designated the country-year as a "revaluation" event, reflecting the purely technical background to this "major expansion".

Norway, 2000, 2001, 2005 The Norges Bank asset expansion over the two years of 2000, 2001 and for 2005 are notable in size, but are overwhelmingly driven by changes in assets related to the "Government Petroleum Fund", which for accounting purposes appears in the central bank balance sheet. The Norges Bank ((NorgesBank, 2001, 59), (NorgesBank, 2006, 26)) does provide details about the asset allocation of the Petroleum Fund for these years, which reveals that its assets are overwhelmingly invested in foreign equity and foreign fixed income assets for all three years -– the two categories responsible for the overwhelming share of the y-o-y growth. While such asset growth is not technically consolidated under the headline "international reserves" category, we treat the three country-years as "foreign asset"-driven, and as such they do not appear in our domestic expansion event sample.[75]

[75]For instance, the 2005 year-on-year change in Government Petroleum Fund assets are given as + NOK 387BN, of which + NOK 169 are related to "foreign equities" changes, and + NOK 50.7BN to "foreign fixed income" changes -–

Sweden, 2008 +230.4% expansion: this country-year records the third-highest y-o-y growth on record across our sample, and is classified in the "financial crisis" category. The increase in the Riksbank balance sheet was primarily related to a substantial provision of liquidity assistance to the banking sector during the second half of the year, with total loans reaching more than SEK 450BN over that timeframe (Elmer et al., 2012, 2ff.).

USA, 2008 +151.3% expansion: the U.S. response – together with the Swedish case – marks the most aggressive financial crisis monetary policy interventions on record over the past 150 years; initially, the Fed's actions in 2008 concentrated upon liquidity provision to the banking sector and money markets, with programs such as TAF, MMIFF, and CPFF being mainly responsible for the balance sheet expansion in the early phase of the crisis – only later did Treasury purchases assume a more decisive role (Calomiris and Kahn, 2015).

Portugal, 2010 +82.5% expansion: this country-year is recorded in the context of the early stages of the European debt crisis, with sharply rising Portuguese bond spreads over 2H-10 and the ECB announcing its SMP program and new LTROs in May 2010; the Banco de Portugal de facto replaced international financing of the Portuguese economy, via recourse to unconventional policy instruments, and supplied substantial liquidity to the banking sector: the average balance of open market operations and net liquidity provision increased by +EUR 24.5BN y-o-y, concentrated on MROs and LTROs, in addition to EUR 3.5BN in monetary security purchases (BdP, 2011, 303ff., 362). We designate the country-year as a "financial crisis" type given the overall context of events.

Finland, 2011 +113.1% expansion: this country-year features among the top 25 long-run expansions. The unfolding European sovereign debt crisis – with a particular focus on Greece, Portugal, and Ireland – dominated financial market and Euro Area monetary policy action during the second half of 2011. During the year, an expansion of the SMP program was decided by the ECB, as well as substantial liquidity support measures for the common currency area's banking sector (including a 36-month LTRO program in December 2011). More important for the overall expansion of the balance sheet, however, was the surge in net TARGET 2 claims: the Bank of Finland records an increase of EUR 46.32BN of TARGET 2 claims for the year 2011, while by year-end, the increase in LTRO assets only reached EUR 2.5BN (BoF, 2012, 92). Almost the entire balance sheet expansion of EUR 42.15BN can thus be related to TARGET 2: we therefore decided to regard this country-year as a "residual" type, rather than a "financial crisis" type, even though we acknowledge the fact that such TARGET claims may well to some extent reflect underlying intra-European capital flight dynamics.

Netherlands, 2011 +97.7% expansion: this country-year records the 17th-highest y-o-y nominal expansion across modern developed economies. Similar to the reasoning in the Finnish case (s.a.),

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the aggregate Norges Bank asset change for the year is reported as + NOK 457BN (NorgesBank, 2006, 18,26).

we have designated this event as a "residual" type. According to (DNB, 2012, 122) figures, net 'other' claims within the Eurosystem rose between 2010-2011 from EUR 40.2BN, to no less than 152.8BN. This latter figure constituted no less than 57% of total 2011 DNB balance sheet assets, and the underlying reporting reveals that TARGET 2 claims are responsible for the asset dynamics.

The Bank of Amsterdam, together with the Bank of England, is the first institution in our sample whose balance sheet expansions can be characterized as having an "active" nature. Even though legally it was prohibited – like other institutions – from creating explicit overdraft accounts, it did lend increasingly large sums to the Dutch VOC, the municipal government and channeled lending via the Leeningen Office to the merchant community, for instance in 1763 (Van Dillen ibid., 96ff.). After the Bank of Naples, the Bank of Amsterdam had the highest frequency of "major expansion events", 33 in total. Most of these events reflected asset fluctuations of a technical or business cycle nature, but there are various notable exceptions: the year 1617-8, for instance, would qualify as a major expansion event according to our definitions, being driven by gold inflows into the Dutch states – the two years saw growth in assets of 235%, amid the surge in geopolitical volatility in Bohemia (typically associated with the outbreak of the Thirty Years' War). We note additional episodes of particularly sharp asset growth in 1626, in 1645, during and after the South Sea Bubble in 1719-1723, and again during 1763-4, perhaps the first instance of a clear emergency lending operation.[76]

During the Napoleonic occupation of Amsterdam (and its subsequent confiscation of wealth, followed by liquidation), the banks' assets sharply declined. We also display the Bank's total asset/GDP ratio, with current Holland GDP data (interpolated decadal averages, in guilders) based on van Zanden and van Leeuwen (2012). On this basis, the long-run asset/GDP ratio until the Bank's demise stands at 7.8%, a figure well within the ranges of modern, post-1945 advanced economy central bank balance sheets.

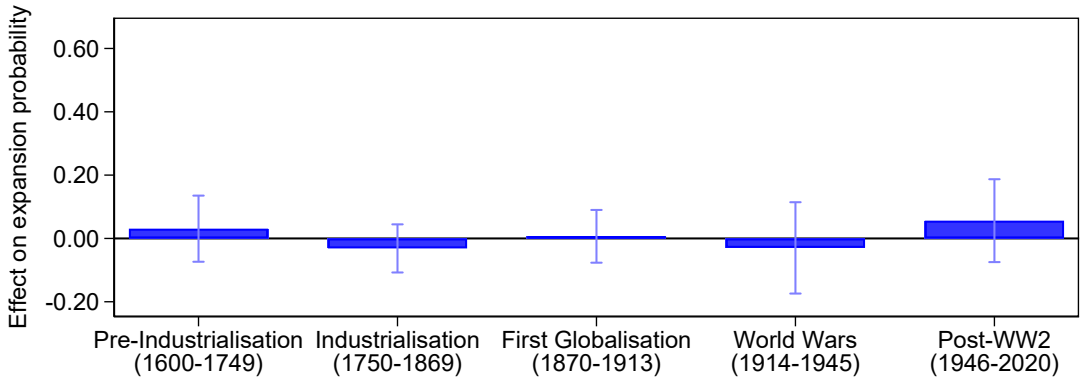
E Additional evidence on central bank balance sheet sensitivity

The secular increase in the sensitivity of central bank balance sheets to financial crises post WWII documented in the main text Figure 6 does actually not extend to recession events, see Figure A.13. It suggests that balance sheet expansions are inherently related to financial stabilisation operations, rather than conventional monetary policy intended to stabilise the business cycle.

To what extend do currency pegs constraint central bank rescue operations? Might the discrepancy in balance sheet sensitivity to financial crises found between pre and post-World War II be actually be due to Gold Standard constraints? The left panel of Figure A.14 repeats the analysis for the years 1870-2020, differentiating by the presence of a Gold Standard or other currency peg. In fact, we find no statistical different, pointing to the flexibility of central bank convertability pledges afforded by ad-hoc coordination or institutionalised arrangements (Metrick and Schmelzing, 2024).

[76] For details, see Ugolini (2017, 130).

Figure A.13: Central bank balance sheet sensitivity to recessions



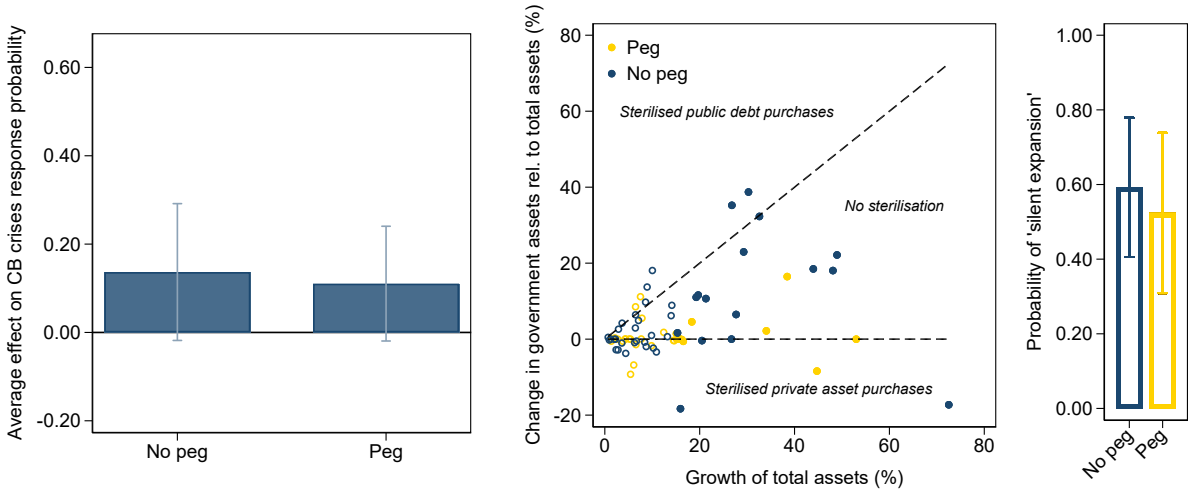
Notes: Average effects on the probability of a central bank balance sheet expansion of +15% or more during the current or the next year. Estimates from probit model with episode-specific coefficients for a war, a financial crisis or recession as well as country fixed effects. Whiskers mark the 95% confidence interval.

In addition, the right panel in Figure A.14 investigates whether the currency pegs compelled central banks to sterilise their balance sheet interventions to not risk convertibility. It plots the change in public debt assets held by the central bank against the aggregate asset increase, both normalised by total assets, for all country-years in the first or the second year of a financial crisis (Baron et al., 2021). While sterilisation may of course occur also within the sub-aggregates of public and private assets, contrasting these broader categories is a natural and interesting first cut and recognises our data constraints. For all observations inside the cone demarcated by the dashed lines, the increase in public debt assets is smaller than that of total assets. By contrast, observations above the cone are characterised by increases in public debt assets *in excess* of the expansion of total assets. Mechanically, this implies sale of private assets, i.e., sterilised public asset purchases. Similarly, observations below the cone exhibit sales of public assets while aggregate assets increase, i.e., sterilised private asset purchases. Importantly, central banks did not differ significantly in their propensity to sterilise interventions across currency regimes, again corroborating the arguments in Metrick and Schmelzing (2024).

F Major expansions by asset type

We zoom into the dominant drivers of expansion in Figure A.15, distinguishing expansions primarily driven by public versus other asset types. "Government debt-led expansions" (red bars) are defined as balance sheet expansion events that are driven by at least 80% of the assets consisting of public assets (domestic government bills, notes, and bonds): all other assets, including gold and foreign exchange assets are classified as "other" assets. Historically, we observe that most expansions are facilitated by a mix of public and other asset purchases. Public asset expansions have constituted around one-fifth of all balance sheet expansions over the period 1870-2020. In particular, World War Two stands out as a tail event that experienced mostly government debt-led

Figure A.14: Central bank balance sheet sensitivity to financial crises, by currency peg

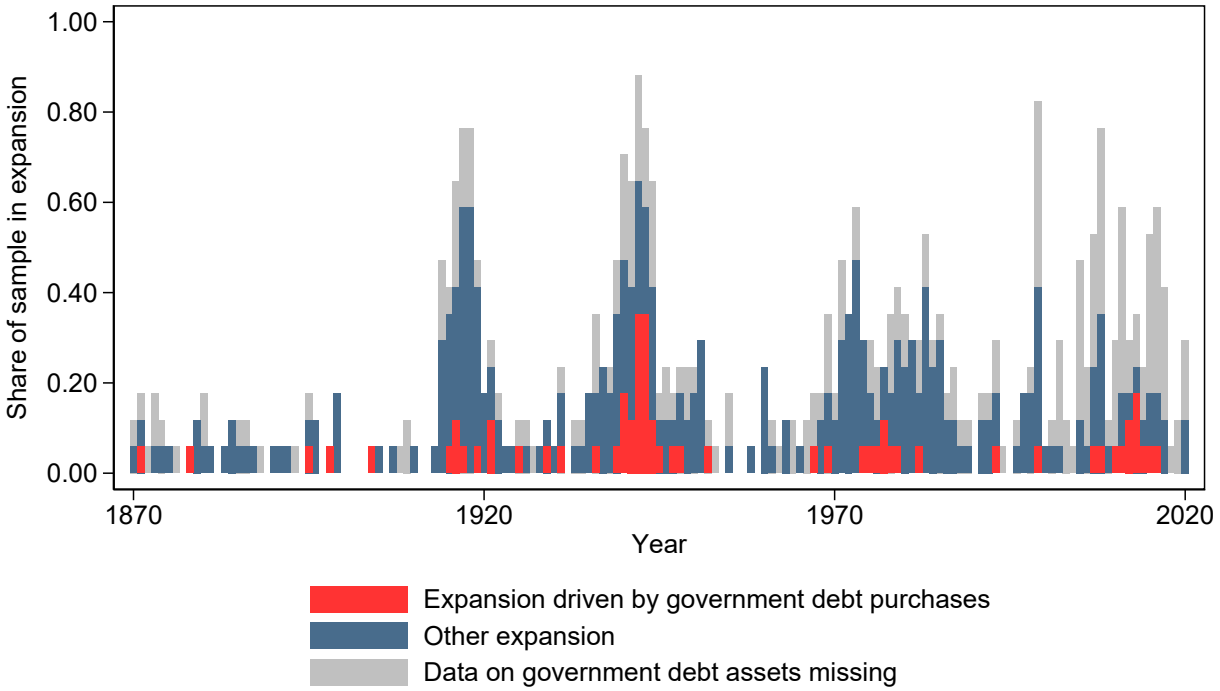


Notes: Left: Average effects on the probability of a central bank balance sheet expansion of +15% or more during the current or the next year. Estimates from probit model with currency-regime-specific coefficients for a financial crisis as well as country fixed effects. Whiskers mark the 95% confidence interval. Middle: Country-year observations of central bank balance sheet operations during first and second year of financial crises (Baron, Verner, Xiong, 2022). Hollow circles mark observations with aggregate balance sheet expansion below +15%. Observations outside cone imply increases in either private of public asset sub-aggregate in excess of the overall balance sheet expansion (sterilisation). Right: Share of operations below +15% aggregate expansion involving sterilisation, by currency regime.

expansions – an observation that holds for both Allied and Axis economies over the period. It is not clear-cut, however, to associate a particular tail event type generally with a specific asset bias: we note that other geopolitical tail events (World War One) experienced mainly mixed or other asset type expansions. Meanwhile, financial crises events, such as the Great Depression years or 2008 following, experienced a dominance of government debt-led expansions in certain phases, but not in any statistically significant way.

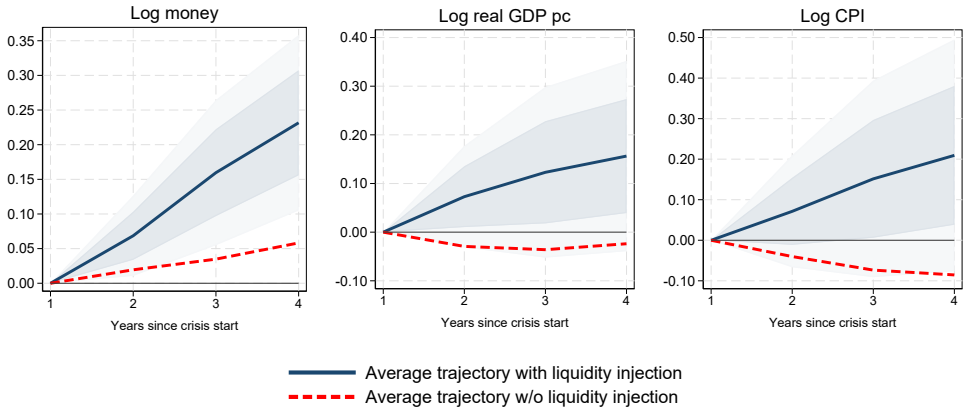
Figure A.16 displays the LP-IV effects for the subset of 51 balance sheet expansions that are classified as "other", non-government debt-led expansions in Figure A.15: we observe that there does not seem to be any obvious distinction with regards to the effects on money supply, real GDP growth, or CPI when such expansions are driven by "other assets". The three variables continue to display a robust effect over non-expansion events over the four-year horizon, in the same broad size compared to the full sample. Overall, therefore, the specific asset type-mix comprising a liquidity support intervention during banking crises appears not to have dramatically altered the macroeconomic response of such operations over time, at least when analyzed in such a broad public-private asset distinction.

Figure A.15: Central bank balance sheet expansions, by dominant asset type.



Notes: Central bank balance sheet expansion of at least +15% annually. Expansions marked in red are underpinned by domestic government debt purchases of 80% or more of the annual total (net) asset change.

Figure A.16: Expansions not driven by government debt assets



Notes: Omitting banking crises with expansions fuelled through the purchase of government debt. We define an expansion to be fuelled by government debt if the increase in central bank domestic government debt holdings amounts to at least 80% of the overall net balance sheet expansion in the respective expansion year. Lightly shaded areas mark 90% confidence intervals; ± one standard error in dark. Country fixed effects included, but excluding macro controls given the reduced number of observations ($N = 51$) standard errors clustered on counties.

G Pre-crisis developments by governor type

G.1 Macroeconomic developments prior to crisis outbreak

We assume that the original shocks triggering crises are similar across governor types. To build confidence in this assumption, we investigate macroeconomic dynamics in the run-up to crises and compare those across governor types. For example, this addresses the concern that dovish governors are more likely to invite excessive credit expansions as financial firms take extra risk expecting leniency in the case of a crisis.

Specifically, we run regressions of the following form

$$y_{i,t-l} - y_{i,t} = \alpha_{l,i} + \beta_l \text{dove}_{i,t} + e_{i,t} \quad \text{for} \quad l \in [1, 2, ..., 5] \tag{8}$$

for all country-years (i, t) with a financial crises as coded by Baron et al. (2021). We run the regression for different dependent variables y including log real GDP, log CPI, the log narrow money aggregate, total bank loans relative to GDP, the log real stock price index and the log real house price index. The estimates are visualized in Figure A.17. For none of the six variables can we detect significant differences in pre-crisis trajectories.

Overall, we do not reveal any striking differences. Macroeconomic pre-trends in real, monetary and financial variables have been generally comparable across crises when central banks were either led by hawkish or dovish governors. If anything, we find somewhat steeper growth for the hawkish set of crisis, where differences are significant at the 10% level at some horizons. However, other variables do not indicate that crisis with hawkish governors would be systematically preceded by stronger economic booms as trends in unemployment, lending, stock valuations and interest rates cannot be distinguished with any statistical assurance.

G.2 Banking sector regulation prior to crisis outbreak

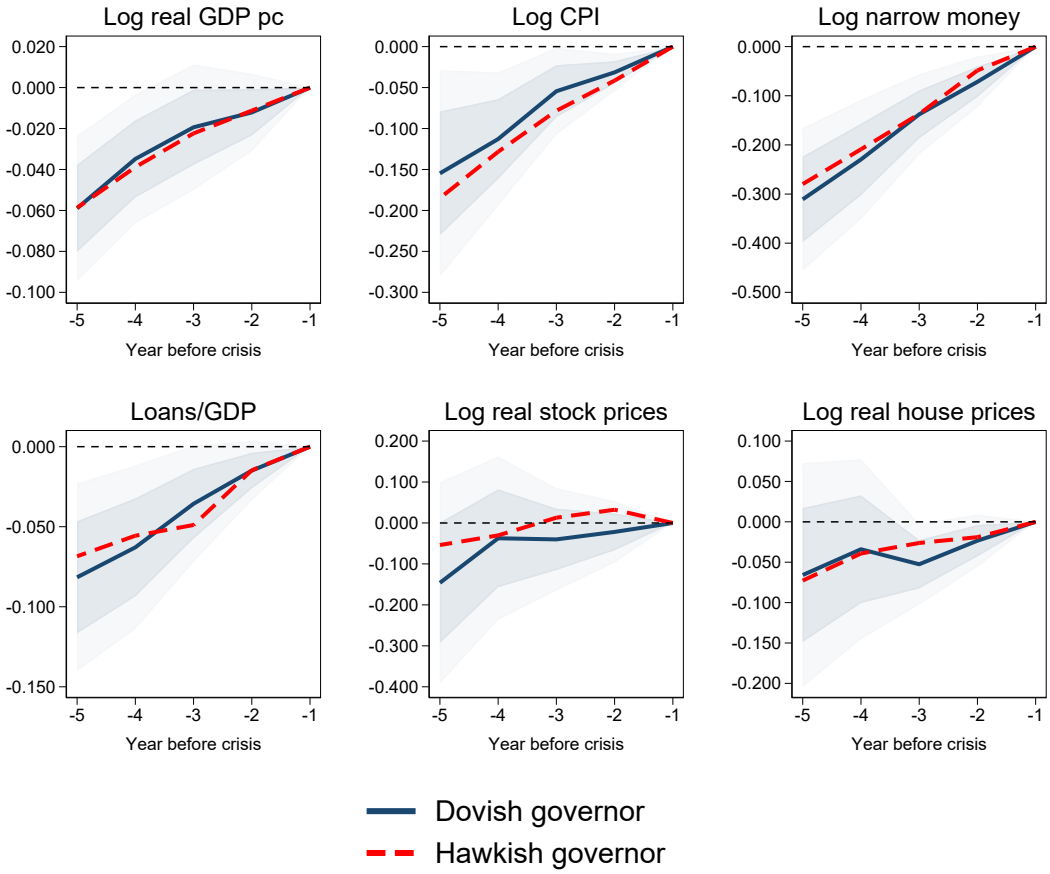
Hawkish governors might push systematically for stricter bank regulation. This would arguably attenuate crisis outcomes and hence render our estimates conservative. Conversely, hawkish governors might get appointed *because* the regulatory framework is lenient to which political forces seek counterbalance. If such political economy factors dominate, our results could indeed be driven by differential banking sector regulation prior to crisis outbreak.

To test, we source data on legal reserve requirements from Federico et al. (2014) and data on banking sector capitalization from Jordà et al. (2020). While actual banking sector capitalization is only an indirect measure of regulation stringency, this data covers our entire sample period starting in the 1870s. Reserve requirement data is available from the 1970s onward.[77]

Figure A.18 compares the two measures during pre-crisis term segments of dovish and hawkish central bank governors. Figure A.18a shows results for reserve requirements, Figure A.18b for

[77] We use fourth quarter values of the average legal reserve requirement measure of Federico et al. (2014).

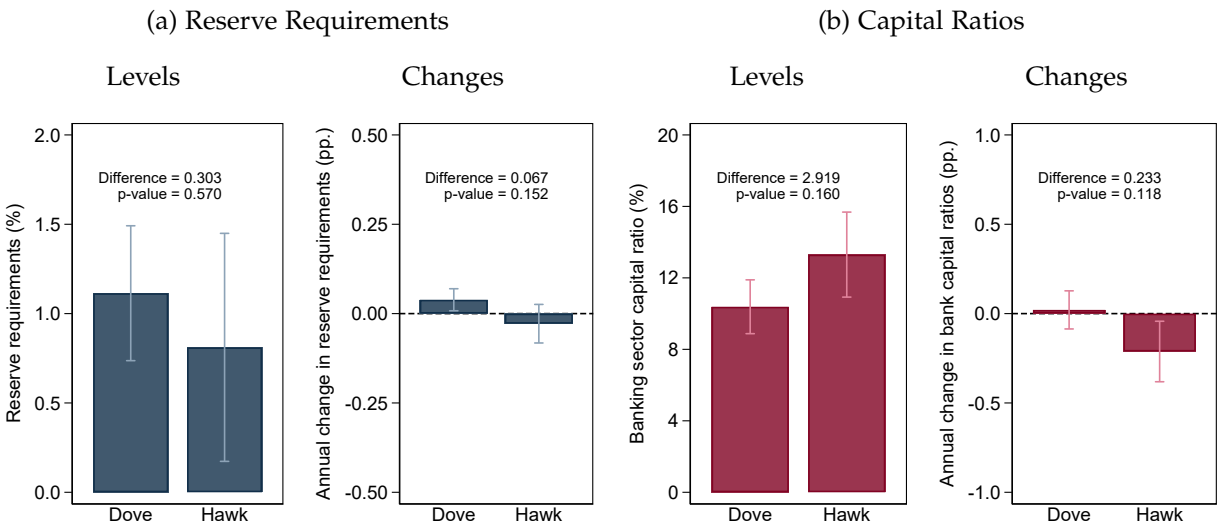
Figure A.17: Macroeconomic trends in real and financial variables prior to crises, by governor type



Notes: The figure shows estimates from a sequence of regressions of the form $y_{i,t-l} - y_{i,t} = \alpha_{l,i} + \beta_l \text{dove}_{i,t} + e_{i,t}$ for $l \in [1, 2, ..., 5]$ and 88 country-years (i, t) with a financial crises coded by Baron et al. (2021). The main regressor $\text{dove}_{i,t}$ is a binary variable indicating a dovish central bank governor during the crisis. For each dependent variable, the corresponding panel plots the average horizon-specific fixed effect $\bar{\hat{\alpha}}_{l,i}$ as the dashed red line and its sum with the horizon-specific coefficient $\hat{\beta}_l$ as solid blue line. Shaded areas mark the 90% confidence interval for coefficients $\hat{\beta}_l$ and ± 1 standard error. Standard errors are clustered at the country level. Due to data coverage, regressions for stock prices and house prices only cover 79 and 69 crises, respectively.

banking sector capitalization. Irrespective of whether we consider average levels or average annual changes, we find no statistically significant difference between governor types in either measure. In terms of point estimates, banking sector capital buffers have been even larger in the run-up to crises when hawkish governors were in charge.

Figure A.18: Pre-crisis banking regulation, by governor type



Notes: The figure plots estimates from the sample of country-years outside domestic wars during which a central bank governors holds office who will face a financial crises later during his term. We estimate regressions $y_{i,t} = \alpha_i + \beta \text{hawk}_{i,t} + e_{i,t}$ for four different dependent variables $y_{i,t}$: Legal reserve requirements, annual changes in legal reserve requirements, banking sector capitalization and annual changes in banking sector capitalization. For each regression, we plot the average value for dovish governors (measured by the average of the country fixed effects) and its sum with the *hawk* coefficient β next to it. Whiskers mark 95% confidence intervals. The printed *difference* is the absolute value of β, with its p-value below.

H Lender of last resort and central bank balance sheet operations

Lender of last resort operations are commonly defined as provision of liquidity to financial institutions that have become illiquid, i.e., unable to obtain liquidity via market transactions under viable conditions, in the wake of widespread financial distress.[78] Enjoying the privilege to issue liabilities carrying legal tender status—the most liquid asset in the economy—the central bank is the natural and the typical institution to act as LLR. Specifically, central bank LLR implies growth in accounts held by targeted banks, which, ceteris paribus, translates into central bank balance sheet expansions. Therefore, our long-term central bank balance sheet data allows us to detect and measure central bank LLR operations around financial crises.

There are three main caveats to measuring the strength of LLR operations with the size of aggregate annual central bank balance sheet expansions:

1. *Sterilisation:* Emergency liquidity injections might take place alongside maturing of other asset blocks or active asset sales. Especially when financial distress is in its roots and still concentrated among few institutions, such sterilisation does not even infringe with the effectiveness of LLR interventions.

2. *Swift interventions*: We work with end-of-year balance sheet data. Any swift in-and-out

[78] Ideally, liquidity is extended only to solvent but illiquid institutions to contain moral hazard effects. Thus the art of such interventions is to separate the solvent illiquid from the insolvent illiquid institutions.

operations within the year thus fly under our radar. For example, the Bank of England back in the day usually discounted commercial bills with low remaining maturity, often two to three months and stuck to it during the crisis of 1763 among others (Bindseil, 2019).

3. *Anticipation effects*: LLR often entails an announcement effect, which may calm financial markets irrespective of the ultimate injection volume. Timing is the important feature here: earlier announcements can be much more effective and may reduce the necessary balance sheet expansion.

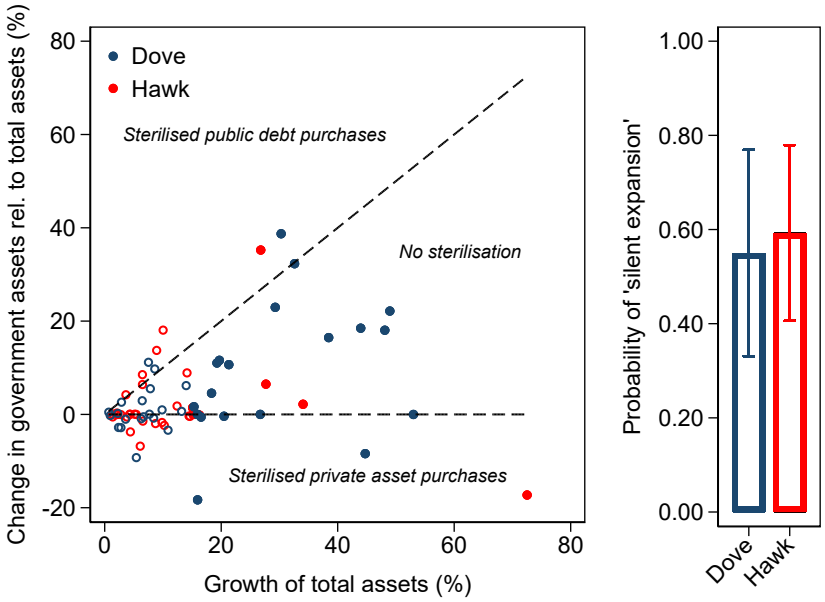
For all these caveats but the third one, we can gauge the precision of our measurement approach. To the extent that we miss (specific) LLR operations, our results are to be interpreted as evidence on LLR operations involving *large and persistent balance sheet expansions*.

First, we compare changes in asset sub-aggregates to aggregate balance sheet movements to detect sterilisied interventions. Figure A.19 plots the change in public debt assets held by the central bank against the aggregate asset increase, both normalised by total assets, for all country-years in the first or the second year of a financial crisis (Baron et al., 2021). While sterilisation may of course occur also within the sub-aggregates of public and private assets, contrasting these broader categories is a natural and interesting first cut and recognises our data constraints. For all observations inside the cone demarcated by the dashed lines, the increase in public debt assets is smaller than that of total assets. By contrast, observations above the cone are characterised by increases in public debt assets *in excess* of the expansion of total assets. Mechanically, this implies sale of private assets, i.e., sterilised public asset purchases. Similarly, observations below the cone exhibit sales of public assets while aggregate assets increase, i.e., sterilised private asset purchases. For some observations, the volume of sterilisation is considerable compared to the aggregate balance sheet expansion, e.g., -10% change in public assets alongside +6% increase in total assets implies a +16% annual increase in private assets. Notably, operations involving sterilisation in this sense are more prevalent when the aggregate expansion is below our threshold of +15%. Crucially for our identification strategy, however, governor types do not differ significantly in their propensity to engage in sterilisied balance sheet operations, as shown in the right panel of Figure A.19.

Second, we can use weekly balance sheet data from the Bank of England to assess how many within-year expansion events go undetected with yearly reference dates for that particular institution. Figure A.20 plots the year-on-year changes of the weekly consolidated aggregate balance sheet. Vertical lines mark dates of our annual data, which the Bank of England traditionally reported in late February. We mark the start of a within-year expansion event as the first time the weekly year-on-year growth exceeds +15% (marked by long-dashed line) after surpassing the long-term average growth rate (marked by short-dashed line). We can then assess how many of these within-year expansions did or did not correspond to a +15% increase for that year in the annual data.

The figure is split in four panels (partly to confine y-axis distortion from very large movements to corresponding sub periods). The first panel shows the data from 1844 up until World War I with

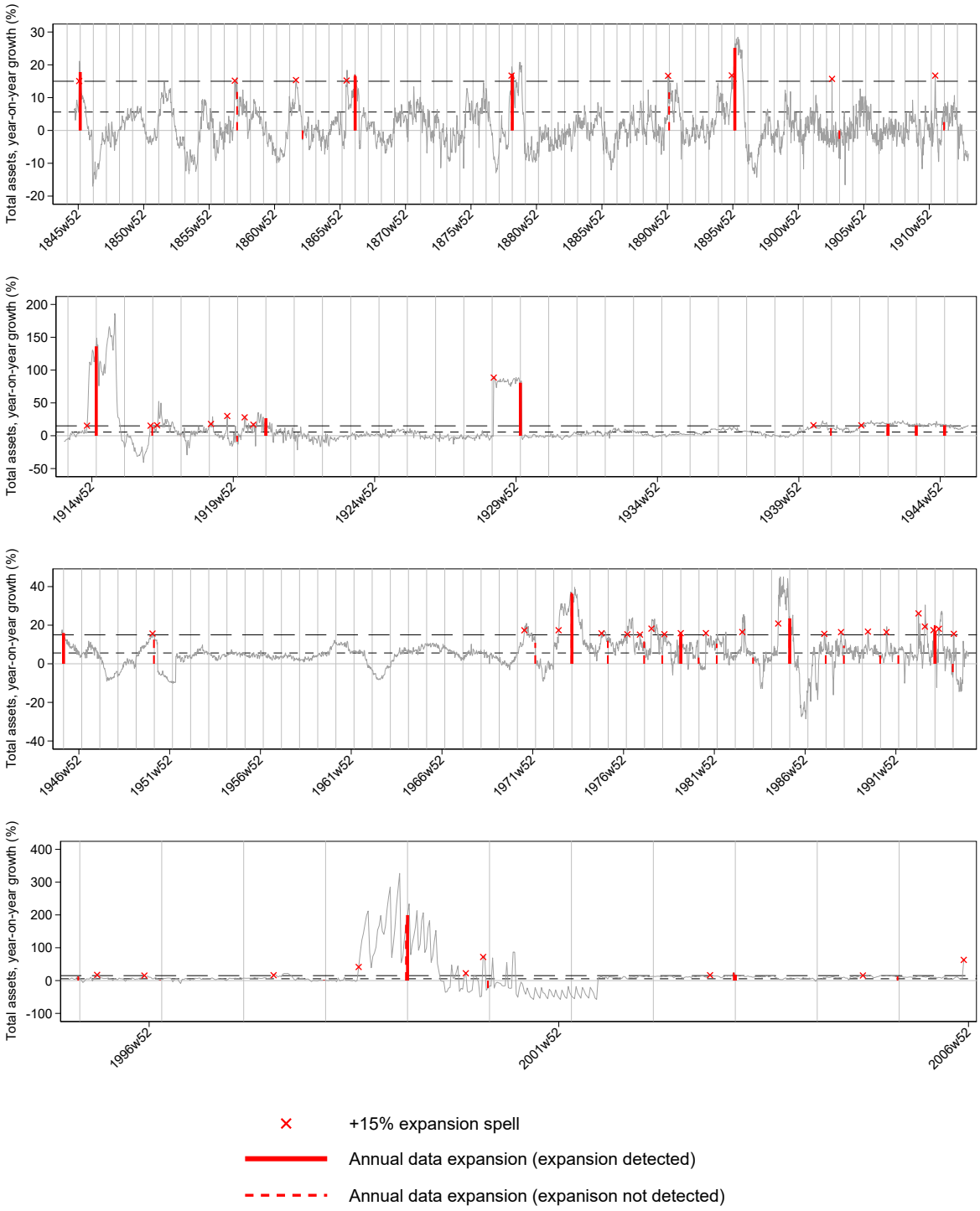
Figure A.19: Sterilisation of central bank asset purchases



Notes: Left: Country-year observations of central bank balance sheet operations during first and second year of financial crises. Hollow circles mark observations with aggregate balance sheet expansion below +15%. Observations outside cone imply increases in either private of public asset sub-aggregate in excess of the overall balance sheet expansion (sterilisation). Right: Share of operations below +15% aggregate expansion involving sterilisation, by governor type.

nine within-year expansions of which the annual data detects four. The second panel depicts 1914 to 1945 including eight years with within-year expansions, six of which are detected by annual data. The third panel shows post-World War II data up until 1995, covering 17 years with within-year expansions, notably after the fall of Bretton Woods. Of those mostly exchange-rate-related balance sheet operations one can detect five in annual data. Finally, the fourth panel shows the weekly data until it stops in 2006, including seven years with within-year expansions of which five to undetected in annual data. According to this analysis, the number of expansions we cannot detect may be considerable, but overall the incidence of annual expansions consistently flags periods with intense balance sheet use.

Figure A.20: Within-year expansion events and annual data



Notes: Bank of England weekly aggregate consolidated balance sheet, year-on-year growth. Within-year expansion events defined as the first time exceeds +15% (marked by long-dashed line) after surpassing the long-term average growth rate (marked by short-dashed line) marked by red crosses. Vertical lines mark dates of annual balance sheet data.

I First stage robustness

The first stage relationship between governor ideology and central bank liquidity injections during financial crises is robust to alternative controls, see Table A.4 and A.5.

Column (1) of Table A.4 replicates the baseline specification presented in the main text for comparison with the remaining columns, which introduce additional controls for macro-institutional features.

Reassuringly, the relevance of governor ideology cannot be explained by the presence of a deposit insurance system (Demirgüç-Kunt and Detragiache, 2002), see column (2) and (3). Point estimates in column (3) suggest that the presence of a national deposit insurance scheme shrinks the probability of large central bank liquidity injections and mutes the relevance of governor ideology, but estimators are imprecise and insignificant.

Analogous conclusions hold when controlling for central bank independence, measured using an indicator assuming a value of 1 when Garriga (2016) assigns an index value below 0.5. The point estimate for the coefficient on governor beliefs increases slightly relative to the our baseline, see column (4) and (5) which introduce a level and interaction control. Column (5) corroborates the intuition that governor ideology should matter for for actual central bank policy outcomes only where the central bank enjoys a sufficient degree of independence: Adding the baseline and interaction effect gives a point estimate of about 0.09, much smaller than the baseline of 0.36. However, the interaction effects is subject to substantial statistical uncertainty.

Table A.5 shows that our measure of governor beliefs is robust to the inclusion of, and statistically superior to, relevant biographical variables including the number of financial crises experienced pre-appointment and previous positions held. Notably, previous government affiliation has a statistically significant and quantitatively important positive effect on the propensity to expand inject central bank liquidity during financial crises.

Table A.4: First stage with institutional controls

	(1)	(2)	(3)	(4)	(5)
Hawk ($g_{it+1} = 1$)	-0.363***	-0.349***	-0.560***	-0.441***	-0.466***
	(0.083)	(0.083)	(0.184)	(0.104)	(0.114)
Deposit insurance		0.069	-0.135		
		(0.139)	(0.252)		
Hawk × deposit insurance			0.472		
			(0.346)		
Central bank not independent				-0.278	-0.424
				(0.196)	(0.267)
Hawk × central bank not independent					0.376
					(0.308)
Macro controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
F	18.91	17.73	9.24	17.86	16.74
R^2	0.33	0.34	0.38	0.36	0.36
Crises	78	78	78	78	78

Notes: Macroeconomic controls as described in the main text. Country fixed effects absorbed by within-estimator. Standard errors clustered on countries in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

Table A.5: First stage with biographical controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hawk ($g_{it+1} = 1$)	-0.363***	-0.339***	-0.321***	-0.333***	-0.320***	-0.340***	-0.331***	-0.329***
	(0.083)	(0.081)	(0.086)	(0.082)	(0.087)	(0.088)	(0.079)	(0.097)
Crises		0.009						-0.011
		(0.020)						(0.019)
Inflation			0.012**					0.013
			(0.005)					(0.009)
Financial sector				-0.022				-0.029
				(0.135)				(0.147)
Treasury/cabinet					0.151**			0.153*
					(0.070)			(0.083)
Party member						-0.024		-0.103
						(0.141)		(0.158)
Age							0.002	-0.005
							(0.008)	(0.011)
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	18.91	17.68	14.07	16.56	13.69	15.00	17.77	11.45
R^2	0.33	0.39	0.41	0.39	0.41	0.39	0.39	0.42
Crises	78	77	77	77	77	77	77	77

Notes: Variables measure the pre-appointment biographies of governors: the number of crises experiences, life-time average annual inflation, whether his career included positions in the financial sector, in the treasury or the cabinet, whether the governor has been affiliated to a political party and his age. Macroeconomic controls as described in the main text. Country fixed effects absorbed by within-estimator. Standard errors clustered on countries in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

J Crises, liquidity injections and the banking sector

How do central bank liquidity injections affect a distressed banking system? To test, we use aggregate data on banking sector balance sheets collected by Jordà et al. (2020) and run local projection on a dummy indicating large-scale liquidity support during the first or second year of a financial crises, instrumented by the ideological belief set of the responsible central bank governor and controlling for two lags of the dependent variable.

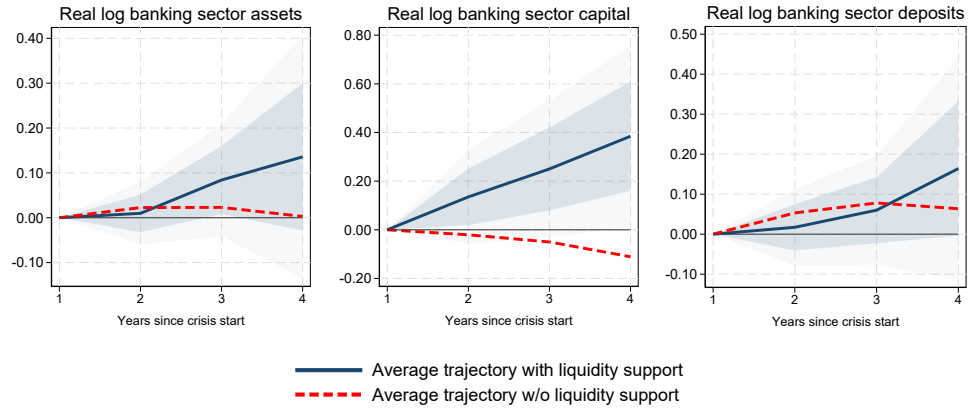
Estimated impulse responses are shown in Figure A.21a for real banking sector assets, capital and deposits and in Figure A.21b for the non-core funding ratio, the capital ratio and the deposit ratio. Overall, estimates are characterized by substantial statistical uncertainty. However, we can assert that central bank interventions lead to a strong and significant recovery in banking sector capitalization. It seems that central bank support enables commercial banks to delever and shore up capital buffers to reassure depositors. Arguably, this reduces the likelihood bank runs and associated inefficient bank failures that destruct bank equity value. Accordingly, a governor belief-driven expansion of the central bank balance sheet beyond +15 percentage points in response to a crisis increases total banking sector capitalization over three years by +30 basis points and raises the capital ratio by +2 percentage points relative to the non-intervention counterfactual.

But are these effects indeed a virtue of liquidity injections—or rather the result of confounding capital injections into the banking sector orchestrated by the fiscal authority? Earlier research has pointed out that central bank liquidity support and fiscally financed bank capital injections often went hand-in-hand in the past (Metrick and Schmelzing, 2024). We investigate this caveat by re-running our LP-IV regressions with controls for capital injection events during the year of the onset of the crisis, the subsequent year and the preceding year—and conclusions remain unchanged.[79]

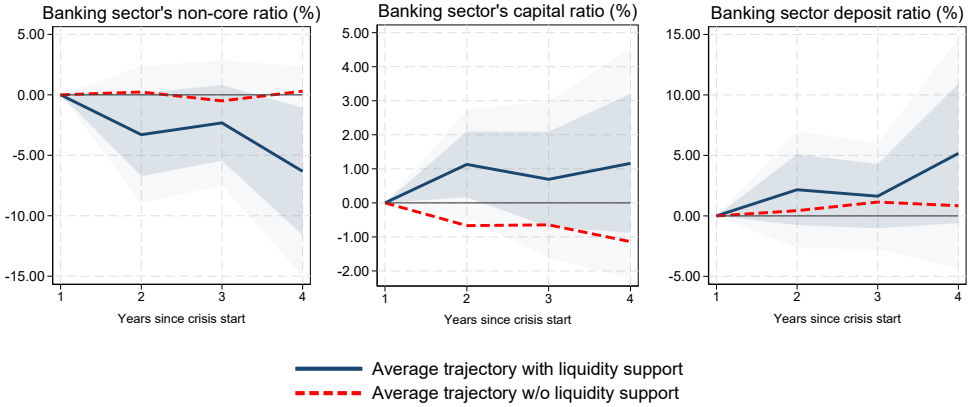
[79] The quantitative effect shrink to +20 basis points.

Figure A.21: Reaction of distressed banking systems to belief-driven central bank interventions

(a) Commercial bank balance sheet aggregates



(b) Commercial bank balance sheet ratios



Notes: Panel (a) of the figure shows changes in log real banking sector assets, log real banking sector capital and log real banking sector deposits after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Panel (b) of the figure shows changes in the banking sector noncore funding ratio, the banking sector capital ratio and the banking sector deposit ratio after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. In addition, Panel (a) controls for the contemporaneous value (at $h = 1$) and two lags of real banking sector asset growth, real banking sector capital growth and real banking sector deposit growth while Panel (b) instead adds controls for the contemporaneous value (at $h = 1$) and two lags of the banking sector capital ratio and deposit ratio (noncore funding ratio controls would be collinear). Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries. Estimates from LP-IV using governor beliefs to instrument central bank balance sheet expansions for various dependent variables. Each panel plots corresponding impulse response estimates $\hat{\beta}_h$ with 90% confidence intervals based on standard errors clustered on countries. Sample covers an imbalanced panel of 17 advanced economies from 1870 to 2015, excluding domestic war episodes.

K Tables with LP-IV estimates

This appendix presents regression statistics for the LP-IV model of Equations (4) and (5) underlying results shown in Figures 11 and 12.

Table A.6: LP-IV estimates underlying Figure 11

(a) Log money aggregate M3

	(1) $h = 2$	(2) $h = 3$	(3) $h = 4$
Liquidity support ($m_{it+1} = 1$), instrumented	0.055	0.164**	0.250**
	(0.035)	(0.069)	(0.102)
Macro controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
F (first stage)	17.10	17.10	17.87
R^2 (within)	0.18	0.09	0.06
Crises	77	77	76

(b) Log real GDP

	(1) $h = 2$	(2) $h = 3$	(3) $h = 4$
Liquidity support ($m_{it+1} = 1$), instrumented	0.071***	0.114**	0.108*
	(0.027)	(0.052)	(0.058)
Macro controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
F (first stage)	15.52	15.52	16.62
R^2 (within)	0.07	0.00	0.01
Crises	78	78	77

(c) Log consumer price index

	(1) $h = 2$	(2) $h = 3$	(3) $h = 4$
Liquidity support ($m_{it+1} = 1$), instrumented	0.104**	0.200**	0.229**
	(0.048)	(0.088)	(0.103)
Macro controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
F (first stage)	15.52	15.52	16.62
R^2 (within)	0.19	0.18	0.18
Crises	78	78	77

Notes: The table shows estimates of Equations (4) and (5) on the sample of financial crises dated by Baron et al. (2021). In Panel (a), the dependent variable is the cumulative change in log money aggregate M3 at different horizons since the first crisis year $h = 1$. In Panel (b), the dependent variable is the cumulative change in the log real GDP per capita at different horizons since the first crisis year $h = 1$. In Panel (b), the dependent variable is the cumulative change in the log CPI at different horizons since the first crisis year $h = 1$. Robust standard errors clustered on the country level are shown in parentheses. Macroeconomic controls include the contemporaneous value (at $h = 1$) and two lags of real GDP growth, inflation, real investment growth and real stock price growth as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Country fixed effects absorb time-invariant but horizon-specific heterogeneity across countries.

Table A.7: LP-IV estimates underlying Figure 12

(a) Log real stock price index

	(1) $h = 2$	(2) $h = 3$	(3) $h = 4$
Liquidity support ($m_{it+1} = 1$), instrumented	0.455**	0.259	0.137
	(0.189)	(0.207)	(0.284)
Macro controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
F (first stage)	10.86	11.57	11.33
R^2 (within)	0.10	0.21	0.11
Crises	63	64	63

(b) Log real investment

	(1) $h = 2$	(2) $h = 3$	(3) $h = 4$
Liquidity support ($m_{it+1} = 1$), instrumented	0.354*	0.505***	0.503***
	(0.194)	(0.191)	(0.193)
Macro controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
F (first stage)	11.57	11.57	11.33
R^2 (within)	0.12	0.07	0.15
Crises	64	64	63

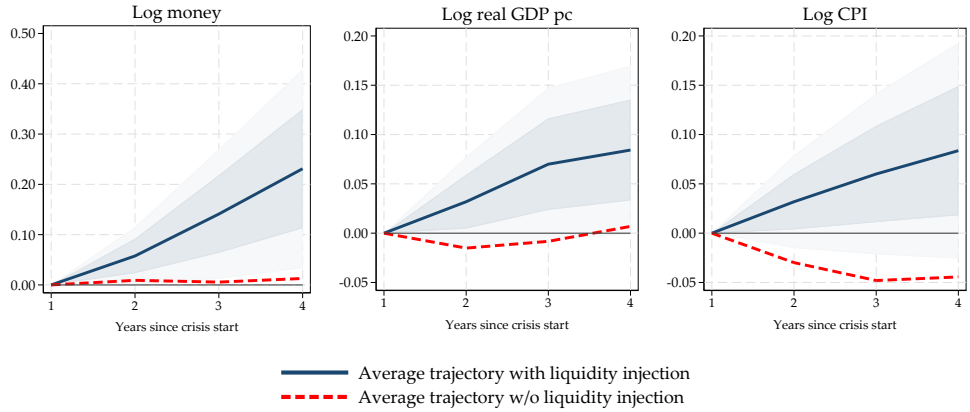
Notes: The table shows estimates of Equations (4) and (5) on the sample of financial crises dated by Baron et al. (2021). In Panel (a), the dependent variable is the cumulative change in log real investment at different horizons since the first crisis year $h = 1$. In Panel (b), the dependent variable is the cumulative change in the log real stock price index at different horizons since the first crisis year $h = 1$. Robust standard errors clustered on the country level are shown in parentheses. Macroeconomic controls include the contemporaneous value (at $h = 1$) and two lags of real GDP growth, inflation, real investment growth and real stock price growth as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Country fixed effects absorb time-invariant but horizon-specific heterogeneity across countries. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

L Robustness of estimates

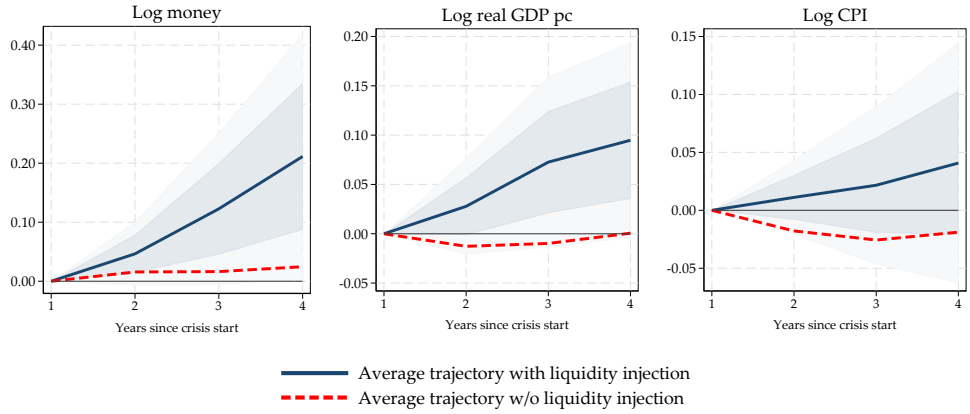
This appendix shows estimates from various alternative setups of LP-IV regressions. We augment controls, restrict the sample, use alternative financial crisis indicators or adopt different measures of liquidity support. Conclusions remain qualitatively insensitive to all those variations.

Figure A.22: Controlling for institutional context

(a) Controlling for the existence of national deposit insurance



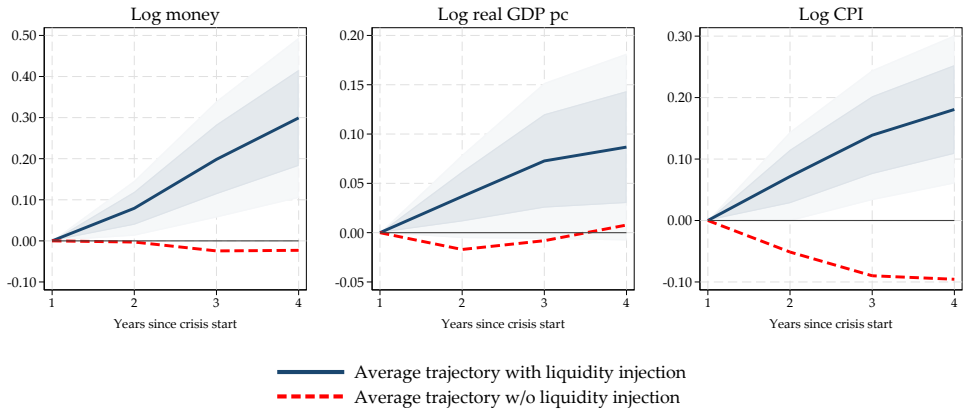
(b) Include episode fixed effects



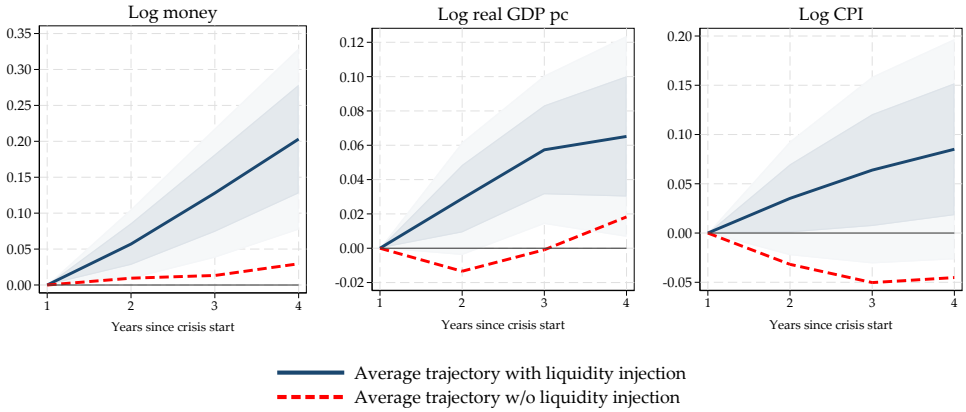
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval (± one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on baseline macroeconomic controls described in the main text on page 32 In addition, Panel (a) controls for a binary variable indicating the presence of an explicit mandatory deposit insurance (Demirguc-Kunt and Detragiache, 2002) while Panel (b) instead adds two horizon-specific time period fixed effects: (i) classical gold standard and (ii) post WW2.

Figure A.23: Adding controls for other policy changes

(a) Policy rate changes

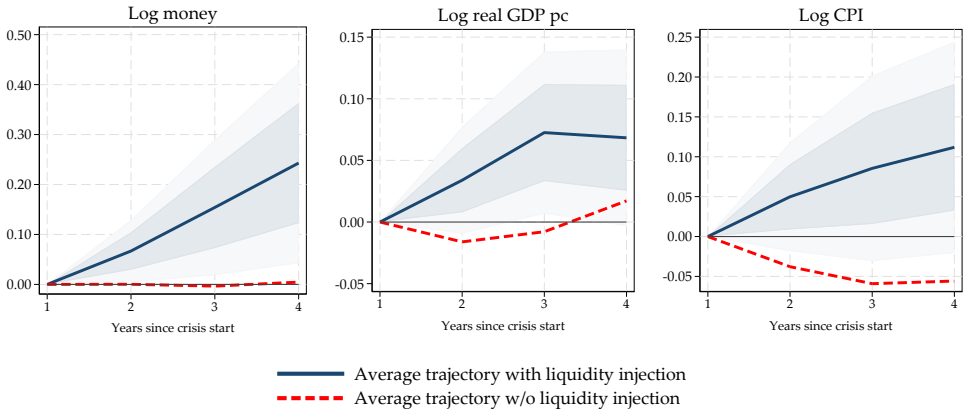


(b) Government expenditures



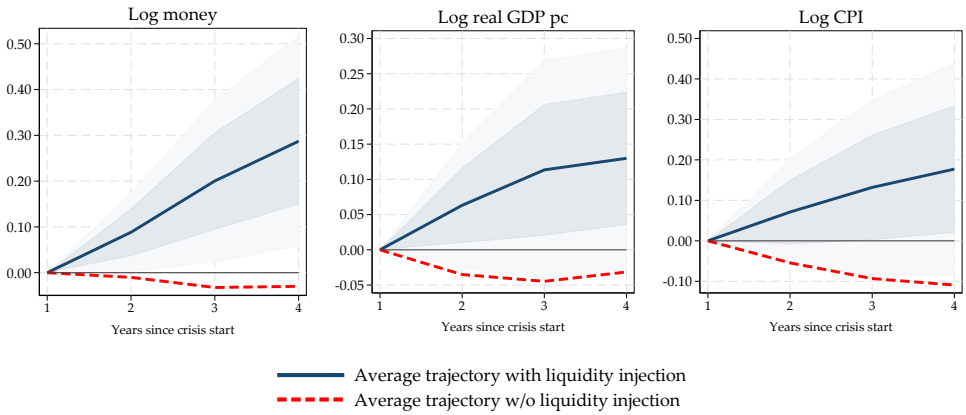
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on baseline macroeconomic controls described in the main text on page 32 In addition, Panel (a) adds controls for policy rate changes while Panel (b) instead adds controls for government expenditure growth, both with the same lag structure as for GDP growth and inflation.

Figure A.24: Adding controls for bank capitalisation



Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval (± one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. In addition, this specification controls for measure of bank leverage ratio in year before financial crisis as collected by Jordà et al. (2020). Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

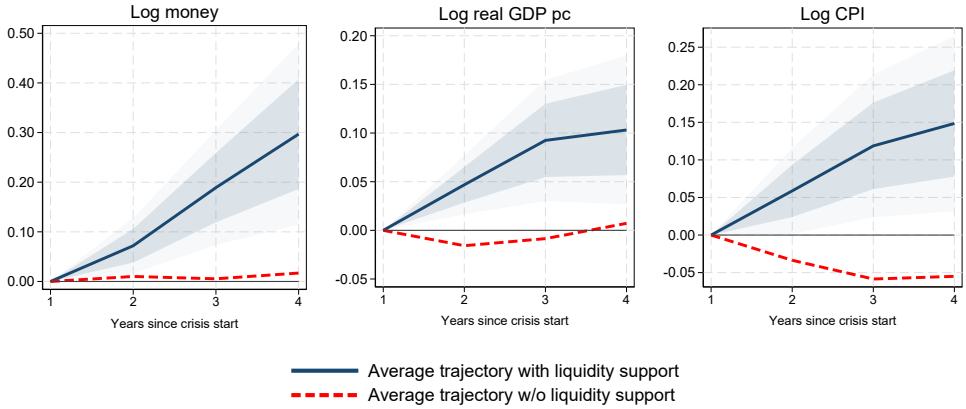
Figure A.25: Without any controls except country fixed effects



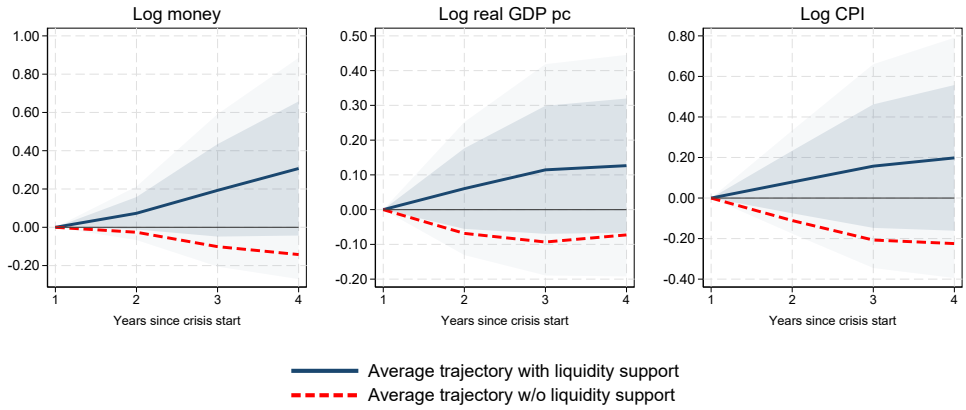
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval (± one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. This specification drops all controls except country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

Figure A.26: Alternative approaches to measure liquidity support

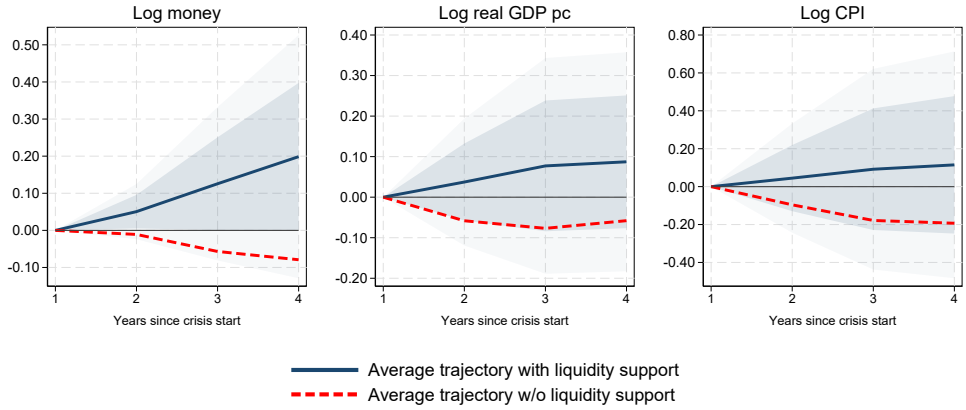
(a) Central bank balance sheet growth beyond 20% threshold



(b) Central bank balance sheet growth beyond 10% threshold



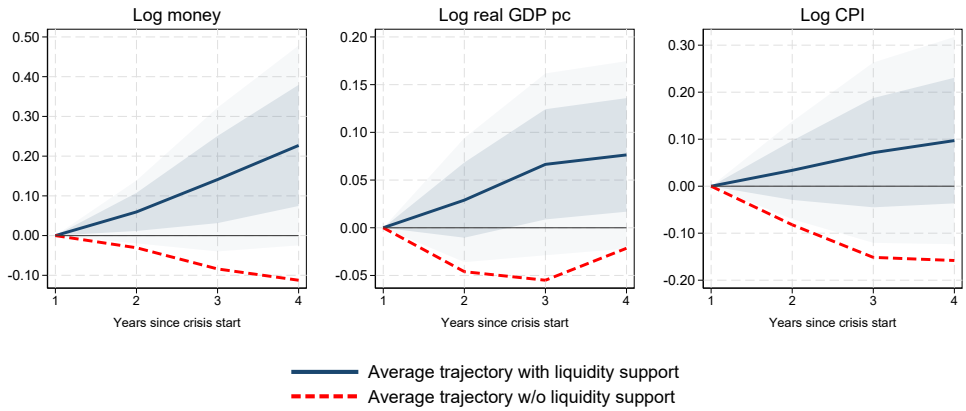
(c) Continuous measure of balance sheet growth



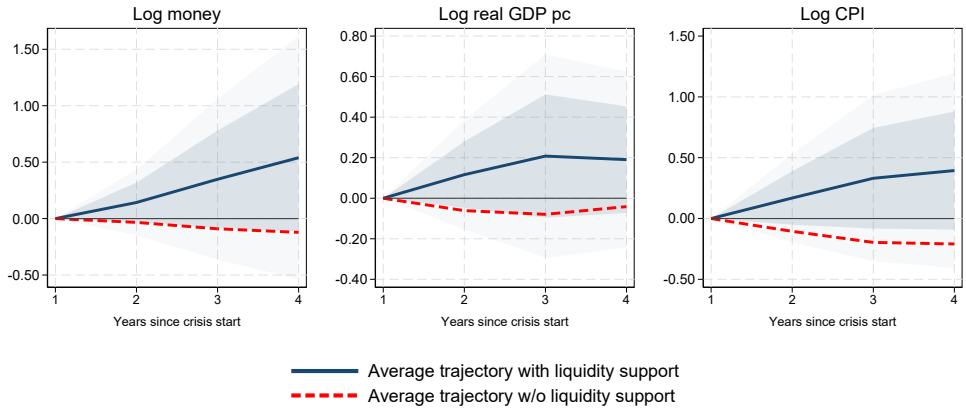
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). In Panel (a), liquidity support is defined as +20% annual central bank balance sheet growth or more during the first or second year of the crisis. In Panel (b), liquidity support is defined as +10% annual central bank balance sheet growth or more during the first or second year of the crisis. In Panel (c) liquidity support is measured by the bi-annual growth of the central bank balance sheet during the first and second year of the crisis and results are shown +30% growth, the average balance sheet growth rate conditional on the baseline +15% threshold. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval (± one standard error) obtained with robust standard errors clustered on the country level. Controls are the same as in the baseline, see main text page 32.

Figure A.27: The role of central bank reserves

(a) Measuring liquidity support via expansions in central bank deposits

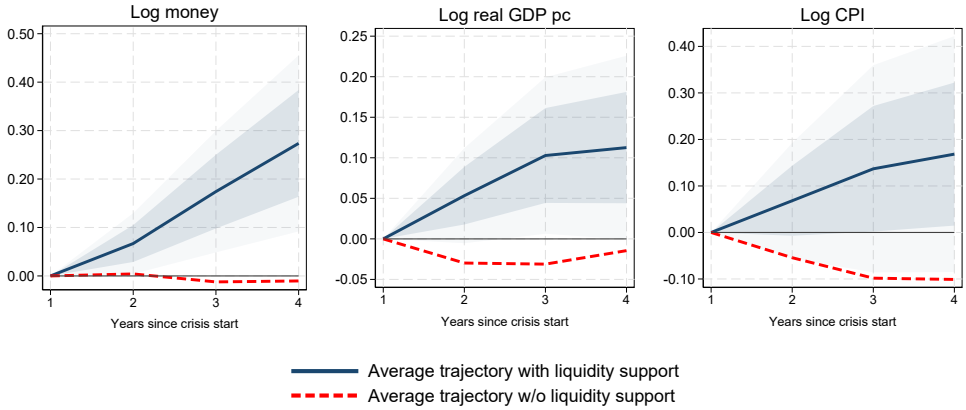


(b) Measuring liquidity support via expansions in central bank liabilities other than deposits



Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). In Panel (a) liquidity support is defined as growth in central bank deposits of at least 15% during the first and second year of the crisis. In Panel (b) liquidity support is defined as growth in central bank liabilities other than deposits of at least 15% during the first and second year of the crisis. Central bank deposits in our data are dominated by banking sector reserves, but can include treasury or other public accounts where source data is to coarse. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

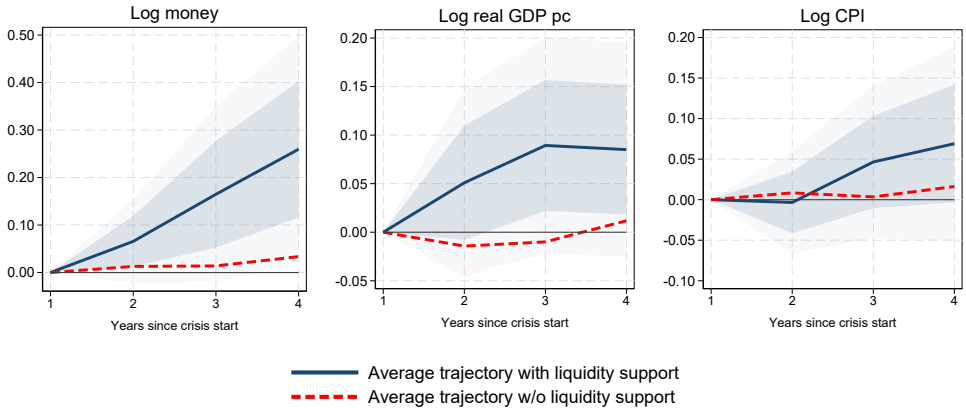
Figure A.28: Measuring expansions in real terms



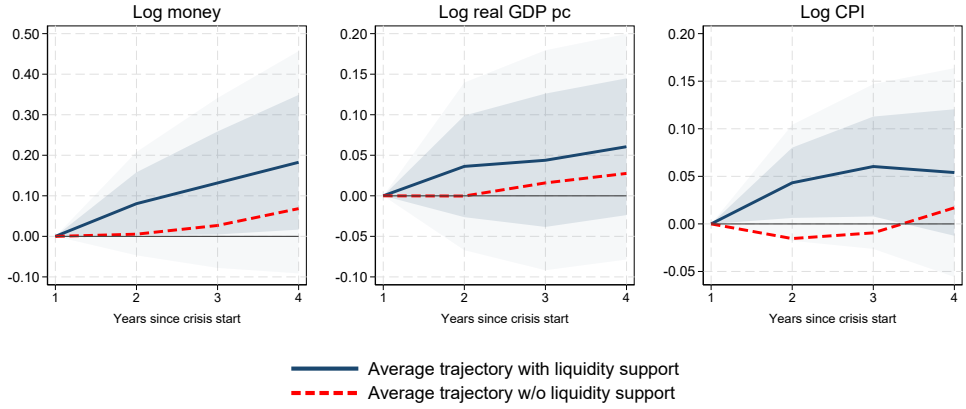
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Liquidity support is defined as +15% real annual central bank balance sheet growth or more during the first or second year of the crisis. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

Figure A.29: Alternative chronologies of financial crises

(a) JST crisis sample



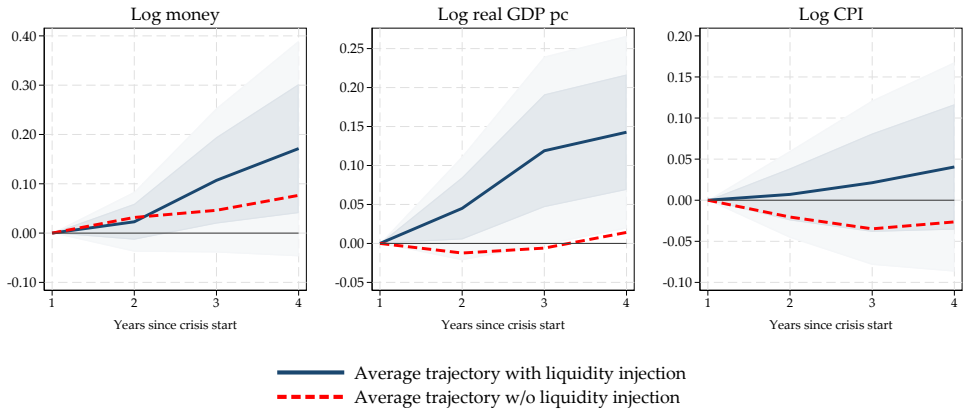
(b) RR crisis sample



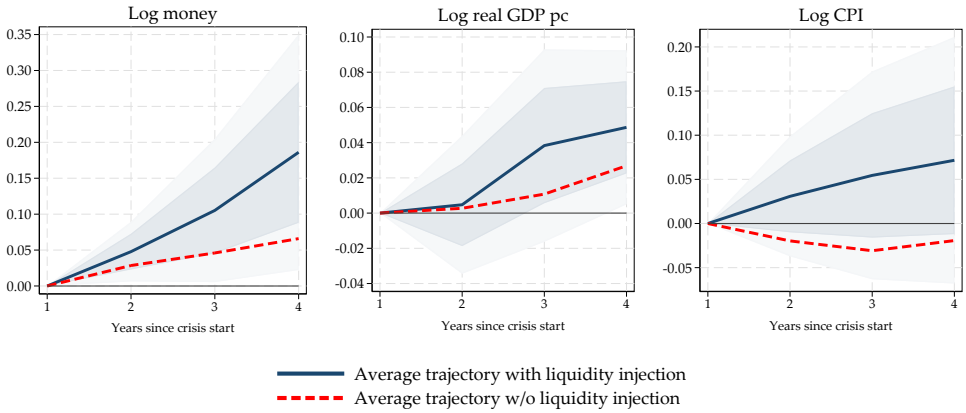
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5) for alternative crisis samples: Panel (a) dates financial crises using narrative chronology of Jorda et al. (2017). Panel (b) dates financial crises using narrative chronology of Reinhart and Rogoff (2009). Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

Figure A.30: Dropping major crisis clusters

(a) Dropping the Great Financial and subsequent crises

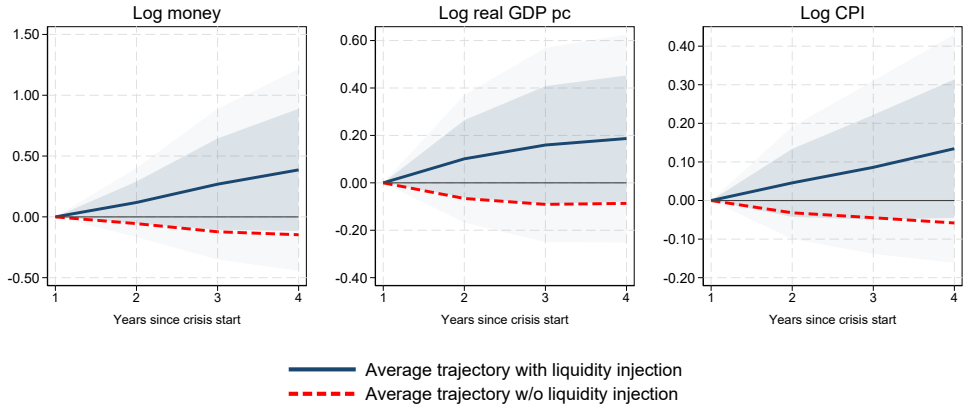


(b) Dropping the Great Depression



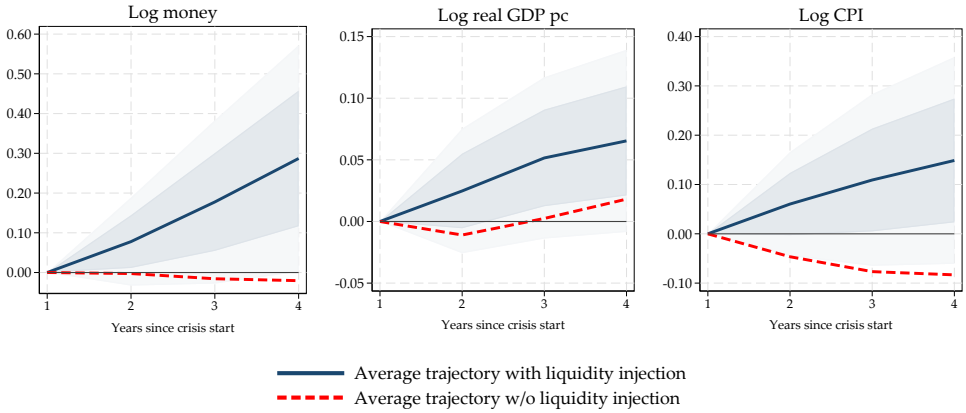
Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5), for alternative crisis samples: Panel (a) shows results obtain after omitting all banking crises starting 2007 or later. Panel (b) shows results obtain after omitting all banking crises starting between 1929 and 1933. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

Figure A.31: Subsample of "imported crises"



Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5), using a subsample of 58 crises occurring during the later stages of an international crisis cluster, i.e., crises more exogenous to domestic economic conditions. We operationalise a crisis cluster as the set of crises with starting years coinciding or directly neighbouring the starting year of another. We then exclude all crises starting in the cluster's first year. For the Great Financial Crises, we include all crises except the US event. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

Figure A.32: Using government ideology where central bank enjoyed little independence



Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Replace the governor coding by a coding of government ideology instead for central banks that rank low on indices of central bank independence as measured by Garriga (2016): we impute the government policy stance for all central bank country-years in which the central bank index is recorded as less than 0.5, for our banking crisis years, we count 19 such instances. In these cases, we impute center-right/conservative-led government = hawk ; centrist/center-left/left-led government = dove/pragmatist. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation as well as the three-year growth in real bank lending to the private sector prior to the financial crisis. Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

M Language model-based classification of governors

Classifying central bankers' policy preferences based on historical documents requires a judgment call. To be transparent as possible, we detail our reasoning underlying each case in Appendix A. This section compares our judgments to those that language models take.

Any difference between our classification and that of the language model implies that either our manual or the model's judgment is erroneous.[80] Their disagreement simultaneously captures errors at either side. Importantly, we can compare disagreement across two language models of different quality to shed light onto relative prevalence of manual vs. model-based errors: If disagreement barely changes when moving from a mediocre language model to a cutting-edge one, a big share of disagreement is likely to be caused by errors on the manual classification side. Conversely, if disagreement changes a lot, model classification errors are likely to play a more important role.

We deploy publicly available and widely-used language models from OpenAI's GPT family to allow readers to gauge quality of the models from own experiences. We query OpenAI's legacy language model `gpt-3.5-turbo-0125` as well as its more powerful successor version `gpt-4o` via its API.

M.1 Obtaining a language model-based classification

As other studies with similar research problems, we use a *retrieval augmented generation* (RAG) algorithm to classify each governor on the basis of digitized documents. For each governor, we proceed as follows:

i) Chunk source documents All source documents associated to a governor are broken into chunks of 1000 characters. For all but the document's first chunk, we allow for an overlap of 200 characters with the preceding text chunk to prevent that unfortunate sentence splits might obscure meaning.

ii) Rate chunks' relevance We rate each chunk based on how related this text chunk is to central bank policy during crises. We evaluate such meaning proximity using embedding models.[81] We query the embedding model `text-embedding-3-large` via the OpenAI API to compute the embedding, a high-dimensional vector, for each text chunk from the source documents as well as for the following content benchmark string: "Financial instability and optimal central bank

[80] We are assuming that a true type exists for each governor. Moreover, agreement between our manual and the model-based classification might result from a joint error.

[81] Embedding models are a key building block of large language models. They are trained to map a string into a high-dimensional vector space in such a way that two strings that express similar meaning will be located closer together in that latent vector space.

reactions". For each text chunk, we then compute the cosine similarity with the content benchmark string: The higher the cosine similarity, the more a text chunk is related to "Financial instability and optimal central bank reactions", and the more relevant it is for our purposes.[82]

iii) Query language models Via the OpenAI API interface, we initiate the chat completion model (once for `gpt-3.5-turbo-0125` and once for `gpt-4o`) with the following system prompt:

> You are an expert on central banking. Use the following two definitions:
>
> 'Strict central bank crisis policy' avoids any discretionary liquidity support for illiquid banks and values commitment to policy rules (such as the Gold Standard). Key objectives are the prevention of moral hazard, asset price bubbles, and the strengthening of central bank credibility.
>
> 'Pragmatic central bank crisis policy' supports illiquid banks and financial markets during times of systemic distress. Key objectives are the prevention of bank runs, asset price collapses and economic recessions.

Moreover, we insert the 50 most relevant text chunks, separated by line breaks, in the following question:

> The following text snippets describe views of a person who was governor of some central bank at some point:
>
> *[50 text chunks separated by line breaks]*
>
> Judging based on those text snippets and provided definitions of 'strict central bank crisis policy' and 'pragmatic central bank crisis policy': Would this governor be more likely to follow 'strict' or 'pragmatic' central bank policy during a financial crisis? First explain your reasoning in three sentences. Then give the classification as a binary code: '1' means 'strict central bank crisis policy'; '0' means 'pragmatic central bank crisis policy'.

That is, the model identifies hawkish governors as those who would have used "strict" policy during a financial crisis.[83]

---

[82] The cosine similarity is a workhorse measure in language modeling to assess the distance between two vectors $\mathbf{A}, \mathbf{B}$:

$$\text{cosine similarity}(\mathbf{A}, \mathbf{B}) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^{n} a_i b_i}{\sqrt{\sum_{i=1}^{n} a_i^2} \cdot \sqrt{\sum_{i=1}^{n} b_i^2}}$$

[83] We avoid the direct use of the words 'hawk' or 'hawkish' in the prompt to avoid associations to inflation control in normal business cycle management.

Table A.8: Performance of language model-based governor classification

	(1) GPT 3.5	(2) GPT 4.0
OLS coefficient	0.02	0.42***
	(0.12)	(0.09)
Hawk share (sensitivity)	0.62	0.62
Dove share (specificity)	0.41	0.79

Notes: The top panel presents the coefficient of a simple bivariate OLS regression of the manual classification dummy on the model-based classification dummy. Standard errors in parentheses are clustered simultaneously at the level of the governor's country and decade, with $^{***}p < 0.01$. The bottom panel shows the share of manually classified hawks (doves) categorized as such by the model corresponding to the column.

M.2 Results

We evaluate disagreement between our manual and each model-based classification through the coefficient of a simple bivariate OLS regression of the manual classification dummy on the model-based classification dummy. Perfect agreement between our manual and the model-based classification would show up as a OLS coefficient of 1. We cluster regression standard errors simultaneously at the level of the governor's country and decade. Moreover, we compute the share of manually classified hawks (doves) categorized as such by the model, i.e., the sensitivity (specificity) of the language model classification. Table A.8 presents all three metrics separately for each language model, i.e., the legacy `gpt-3.5-turbo-0125` in column (1) and its more powerful successor version `gpt-4o` in column (2).

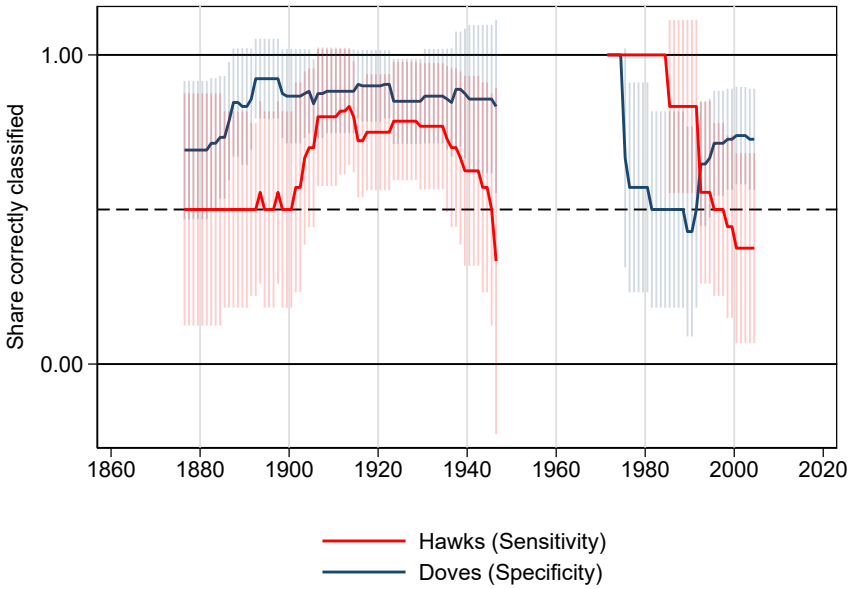
Table A.8 reveals considerably better alignment between our manual and the model-based classification as we move from the legacy GPT 3.5 to the new GPT 4.0 model. The linear relation is essentially flat for the former but positive and statistically highly significant for the latter.[84] The improvement happens to be primarily along the margin of classifying doves, where agreement between our manual and the model-based classification almost doubles. Such a large improvement indicates that disagreement between our manual and the GPT 3.5-based classification was heavily driven by model-side errors. And it raises doubts that GPT 4.0 classifies governors without flaws.

In fact, our governor classification exercise features aspects that might be challenging for language models more generally: Key policy issues as well as the consensus about desirable central bank behavior has shifted over time. This implies that a hawk in the 1920s will say and write things that are different from a hawk in 2000s. For example, advocacy for adherence to policy rules to check money growth—e.g., the Gold Standard—is a classical hawkish position before World War II, while strict inflation targeting became mainstream in the modern period and would not serve the separation between doves and hawks all that much. The language model cannot account for such historical context without feeding it an entire lexicon on the intellectual history of central

[84] The coefficient jumps to 0.42. A perfect correspondence between our manual and

banking—which itself would involve subjective choices and thus amount to hard-wiring our classification into the algorithm. In fact, Figure A.33 shows the performance of the GPT 4.0 RAG algorithm in terms of specificity and sensitivity, indeed showing notable swings in both measures across time episodes.

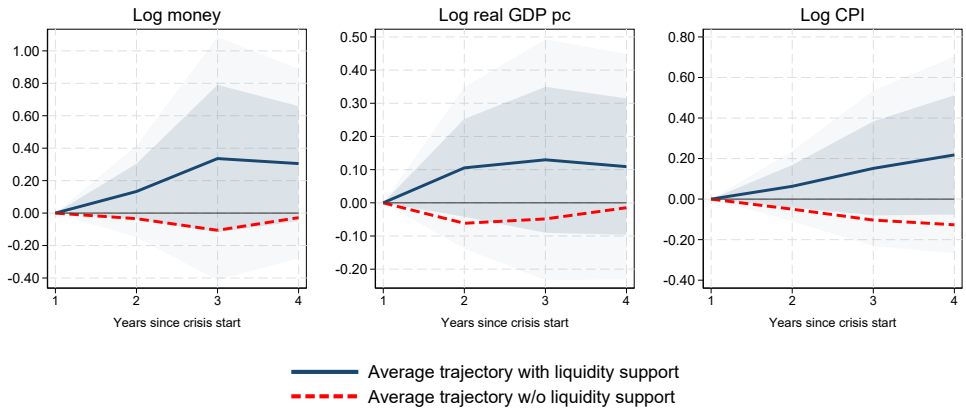
Figure A.33: Performance of the GPT 4.0 RAG algorithm across time



Notes: The figure shows centered 31-year rolling window shares of manually classified hawks (doves) categorized as such by the model. Whiskers mark 90% confidence intervals.

Despite those challenges, the agreement between the GPT 4.0 RAG algorithm and our manual classification is considerable. Thus, we also obtain very similar point estimates when we use this model-based classification in our baseline LP-IV regression, see Figure A.34. Elevated uncertainty around those estimates is consistent with noise in the model-based classification. We include episode-specific fixed effects to control the aforementioned time-varying misclassification in the model algorithm.

Figure A.34: Baseline setup with language model-based governor classification



Notes: The figure shows changes in log money aggregate M3, log real GDP per capita and log CPI after a financial crises if the central bank provides liquidity support (solid blue) or not (dashed red). Results are based on LP-IV estimation of Equations (4) and (5). Liquidity injections are instrumented by governor beliefs classified by a GPT 4.0 RAG algorithm. Uncertainty about the effect of liquidity support is represented by lightly (darkly) shaded area marking its 90% confidence interval ($\pm$ one standard error) obtained with robust standard errors clustered on the country level. Estimates are conditional on macroeconomic controls including the contemporaneous value (at $h = 1$) and two lags of real GDP growth and inflation, the three-year growth in real bank lending to the private sector prior to the financial crisis and episode-specific fixed effects (Classical Gold Standard, Interwar period, Bretton Woods, Post Bretton Woods). Local projections include country fixed effects to absorb time-invariant but horizon-specific heterogeneity across countries.

N Moral hazard

N.1 Examples of central bank policy motivated by concerns about moral hazard

- According to (Bordo and James, 2007, 81), monetary policies of the Banque de France during the first decades of the Third Republic (then under governors Pierre Magnin and Georges Pallain) were heavily influenced by moral hazard concerns - with Clement Juglar in 1884 allegedly expressing widespread non-interventionist policy sentiments by declaring that "A crisis for a nation is the operation made necessary to re-establish an equilibrium broken by speculation" (ibid.).

- Similar biases are documented for the Bank of England's governors: not least, the clear refusal to aid the tumbling house of Overend and Gurney in 1866 was underpinned by the belief that "even systemically important businesses did not labour under a 'too-big-to-fail' guarantee, thus eliminating the moral hazard problem from the policy equation. The path chosen by the Governors in 1866 effectively circumvented the moral hazard problem since the Bank's intervention in the wholesale market through the discount houses ensured both that the payments system was stabilized and that systemic risks from contagion effects were rendered manageable. Figuring prominently in the Bank's calculations was the belief that long-term benefits derived from refusing to rescue insolvent institutions may outweigh the temporary fruits of cooperation" Schneider (2021). Such biases at "the Bank" are widely

documented well into the interwar period Gregory (1929).

- Fed governor Eugene Meyer, by his own account, was deeply influenced by his teacher William Graham Sumner, and his influential model of "laissez faire" economic liberalism - an economic Darwinism that sharply contrasted even with the mildly interventionist RFC institutional policies of 1933 and following, which he reluctantly supported after considerable political pressures (Meyer, 1954).
- Indeed, (Meltzer, 2005, 464ff.) and others (e.g. Calomiris (1997)) demonstrate how the entire pre-Great Depression era was dominated on a more general level by laissez-faire ideology - both on the policy- and on the private market-, banking-, sides, with market meltdowns viewed as "purgative" processes: Marriner Eccles (soon-to-be Fed governor) reports the prevailing consensus of the pre-1933 environment as amounting to the belief that "a depression was a scientific operation of economic laws...a deflation in values, and a scaling down of the debt structure to meet existing price levels, would in time create a self-corrective [sic] force".
- More recent case studies have often focused on the case of the "Greenspan Put" (Miller et al., 2002; Bornstein and Lorenzoni, 2018), associated with the October 1987 stock market crash in the U.S.: while we do not record a "major" expansion event on the balance sheet basis for any advanced economy then, proponents of the existence of such moral hazard features attached to a "Fed put" are positing that the phenomenon has been present ever since, and especially during financial crises - thus rationalizing a test of such assumptions for all events since then. [85]

N.2 Distance to next financial crisis

In our dataset, we can test whether the duration to the next banking crises differs by governor attitude. In fact, estimates in Figure A.35 show that the next banking crash came on average almost 10 years earlier if the current financial crisis was governed by doves ($\hat{\mu} = 16.8$ years) as opposed to hawkish central bank leadership ($\hat{\mu} = 26.3$ years). A two-sample one-sided t-test rejects equality at the 5% significance level.[86] Looking at the full distributions on the left of the same figure reveals that the majority of financial crises under hawks were followed by another within 25 years. By contrast, the probability to wait 30 years of longer for the next crisis to arrive is considerable under hawks.

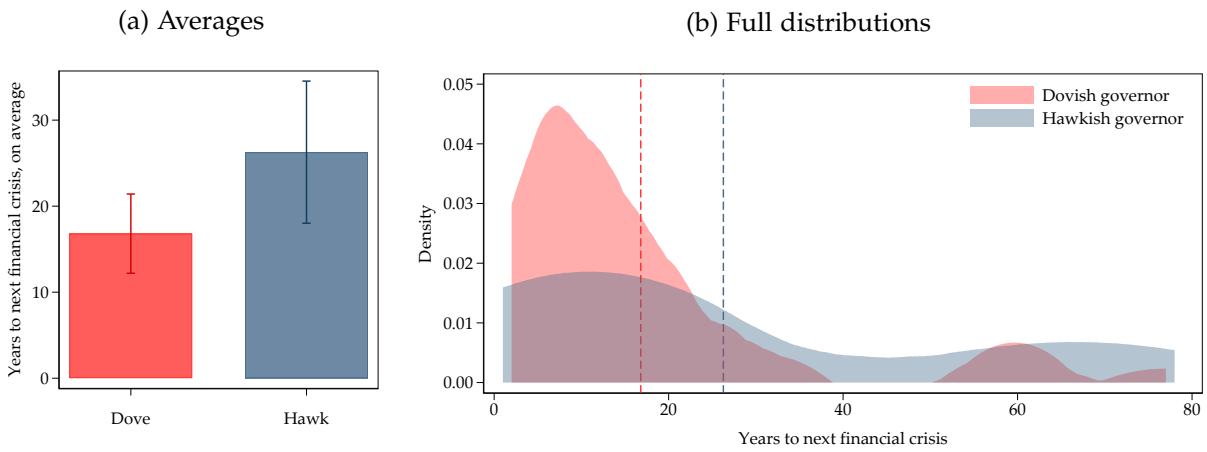
Results presented in Figure A.35 shed no light on quantitative link to expansion size. Moreover, different pre-crisis dynamics or country fixed effects might affect estimates. In that sense, they

[85] For instance Hall (2011) posits that a standard Taylor rule model for the Fed meaningfully improves once asset price dynamics are taken into account over the period 1987-2008. Hall on this basis concludes that "agents' confidence in a stronger response of the US central bank to significant market declines urging to an easing of monetary conditions in their favour was therefore not unfounded".

[86] Differences magnify when including the most recent financial crisis assuming that the next crisis would strike in 2022.

do not yet show to what extent generous liquidity drives these differences. To test the narrower hypothesis, we regress the time to the next financial crisis on liquidity injection ($m_{i,t+1} = 1$), instrumented by governor attitude as before and conditioning on the same set of business cycle controls as in the previous LP-IV analyses. The sample now consists of 59 financial crises, after dropping 17 crises for which the following financial crisis was not observed by 2020. Table A.9 details estimation results. The instrumented second-stage coefficient qualitatively confirms the moral hazard hypothesis. Quantitatively, balance sheet expansions could reduce the time to the next financial crisis by 40 years – yet, statistical uncertainty is large: the 95% confidence interval covers reductions of 6 to 74 years.

Figure A.35: Time to next financial crisis, by governor attitude



Notes: The left panel shows average number of years to the next financial crisis across all 70 financial crises for which the next crisis has been observed yet, by attitude of central bank governor during current crisis. Error bars mark the 90% CI. A two-sample one-sided t-test rejects equality at the 5% significance level. The right panel shows the kernel density estimates for the same sample, by governor attitude. Vertical dashed lines mark corresponding averages.

Table A.9: Balance sheet expansions reduce time to next financial crisis

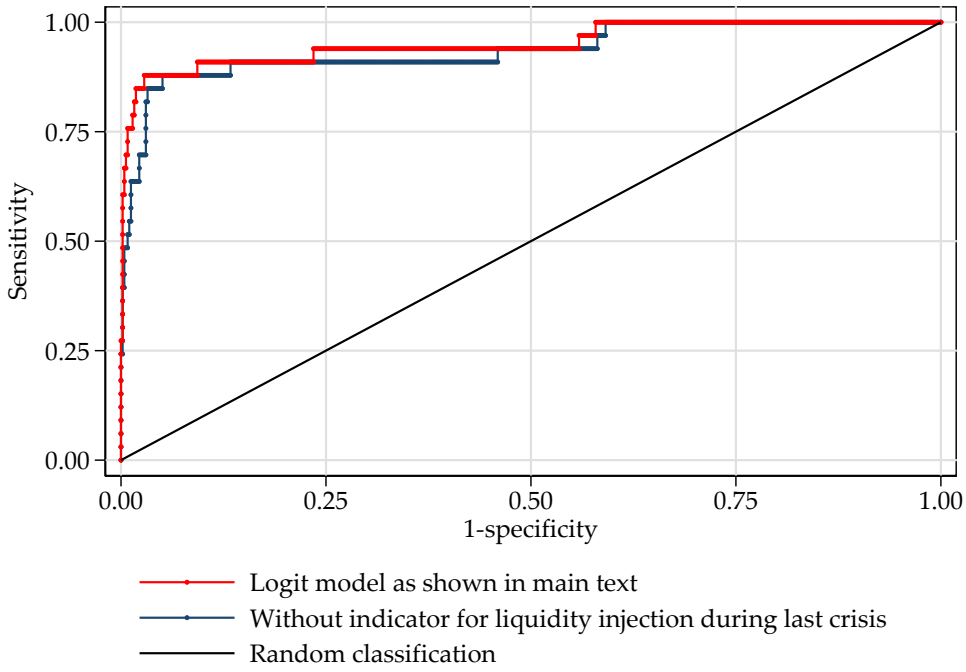
	(1)
	Years to next crisis
Liquidity injection $m_{it(f)+1}$, instrumented	-40.2**
	(17.4)
Macro controls	Yes
Country FE	Yes
First stage F	11.51
R^2	0.08
Crises	59

Notes: Two-stage-least-squares regression uses the instrument of governor attitude g_{it+1}, replicating the IV setting from the previous section. Macroeconomic controls identical to baseline specification. Country fixed effects absorbed by within-estimator. Robust standard errors in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

N.3 Predictive power of liquidity injections for fragile credit booms

Table 3 shows evidence for the predictive power of liquidity injection during last crises for fragile credit booms, i.e., booms that end in financial crises, going forward. Figure A.36 below plots the receiver operating characteristic (ROC) curve for the logit model with and without the injection indicator. As can be seen, controls including a third-order polynominal of time since the last crisis, controls for the current macroeconomic environment that the one leading up to the last crisis and country fixed effects already give strong predictive power for fragile credit booms. The area under the curve (AUC) is 0.9366. Yet, adding the liquidity injection indicator pushes the ROC out further, weakly improving the sensitivity for any level of specificity and yielding an AUC of 0.9517. The χ^2 statistic for a test of equality between the two AUCs is 3.31—despite the large baseline AUC—implying a p-value of 0.0687.

Figure A.36: ROC curves for predicting fragile credit booms



Notes: ROC curves for the logit model presented in Table 3 as well as for the same mode but excluding the injection indicator. AUCs are 0.9517 and 0.9366, respectively, and the test on equality returns a p-value of 0.0687.

O Back of the envelope calculation of net value of liquidity support

Our results suggest that central bank liquidity injections during crises come with a trade-off: They bolster short-term growth by containing financial fallout, but threaten long-term growth by sowing financial stability risks. Based on our estimates, we gauge the conditions under which such interventions raise the net present value of output, when under which they are not.

Since the trade-off is intertemporal in nature, assumptions about the discount rate as well as trend growth are critical. To assess the sensitivity of conclusions to discount rates, we will compute changes in net present value of output for three different values: 1%, 3% and 5%. Similarly, we will consider three different trend growth rates: 1%, 3% and 5%. This yields a matrix of nine assumption combinations. Across all nine combinations, we assume that crisis liquidity injections boost output according to our point estimates:

	No injection $(\hat{\alpha}_h + \hat{\gamma}_h \bar{x}_{it+1})$	Injection $(\hat{\alpha}_h + \hat{\gamma}_h \bar{x}_{it+1} + \hat{\beta}_h)$	Difference $(\hat{\beta}_h)$
$h = 2$	-0.015	0.035	0.050
$h = 3$	-0.005	0.075	0.080
$h = 4$	0.005	0.080	0.075

To be conservative, we assume the differential to close by horizon five .This allows us to compute the short-term gain of liquidity interventions.

To compute interventions' cost of future instability, we assume that an additional crisis occurs after ten years with a probability $p = 15.8\%$.[87] Furthermore, we assume that a financial crisis mutes growth during the first ($h = 0$) and second ($h = 1$) year—irrespective of central bank policy.[88] Finally, we assume economies to back to trend by $h = 5$, i.e., the horizon at which we also assume the gap between intervention an no intervention to be closed, see above. We consider i) the case in which the future governor does not intervene again and i) a central bank that will continue to intervene, risking a indefinite sequence of future crises.

Based on discount rate ρ and trend growth γ, we can compute the net present value of liquidity injections for case i) as follows:

$$\begin{aligned}
&\frac{\hat{\beta}_2 y_0}{1+\rho} + \frac{\hat{\beta}_3 y_0}{(1+\rho)^2} + \frac{\hat{\beta}_4 y_0}{(1+\rho)^3} - p\Big(\frac{y_0(1+\gamma)^{10} - y_0(1+\gamma)^9}{(1+\rho)^{10}} + \frac{y_0(1+\gamma)^{11} - y_0(1+\gamma)^9}{(1+\rho)^{11}} \\
&\qquad + \frac{y_0(1+\gamma)^{12} - y_0(1+\gamma)^9(1+\hat{\alpha}_2 + \hat{\gamma}_2 \bar{x}_{i0})}{(1+\rho)^{12}} \\
&\qquad + \frac{y_0(1+\gamma)^{13} - y_0(1+\gamma)^9(1+\hat{\alpha}_3 + \hat{\gamma}_3 \bar{x}_{i0})}{(1+\rho)^{13}} \\
&\qquad + \frac{y_0(1+\gamma)^{14} - y_0(1+\gamma)^9(1+\hat{\alpha}_4 + \hat{\gamma}_4 \bar{x}_{i0})}{(1+\rho)^{14}} \Big)
\end{aligned}$$

$$\begin{aligned}
= y_0 \Big(&\frac{\hat{\beta}_2}{1+\rho} + \frac{\hat{\beta}_3}{(1+\rho)^2} + \frac{\hat{\beta}_4}{(1+\rho)^3} - p\frac{(1+\gamma)^{10}}{(1+\rho)^{10}} \Big(\frac{1-(1+\gamma)^{-1}}{1} + \frac{(1+\gamma)-(1+\gamma)^{-1}}{1+\rho} \\
&+ \frac{(1+\gamma)^2 - (1+\gamma)^{-1}(1+\hat{\alpha}_2 + \hat{\gamma}_2 \bar{x}_{i0})}{(1+\rho)^2} \\
&+ \frac{(1+\gamma)^3 - (1+\gamma)^{-1}(1+\hat{\alpha}_3 + \hat{\gamma}_3 \bar{x}_{i0})}{(1+\rho)^3} \\
&+ \frac{(1+\gamma)^4 - (1+\gamma)^{-1}(1+\hat{\alpha}_4 + \hat{\gamma}_4 \bar{x}_{i0})}{(1+\rho)^4} \Big) \Big)
\end{aligned}$$

In case ii) the loss from the next crisis is smaller due to interventions, but this in turn risks future

[87] We estimate that liquidity injections elevate crisis risk over the next 20 years by 3.7 to 15.8 percentage points. We use the largest of our estimates to be conservative. Moreover, effects seem mostly driven by horizons 10 to 15, so we settle for a ten years, again to be conservative.

[88] This is motivated by evidence from our sample, where average real GDP growth is zero during those two years, i.e., forgoing average trend growth of about 2.6%.

crises:

$$\begin{aligned}
&\frac{\hat{\beta}_2 y_0}{1+\rho} + \frac{\hat{\beta}_3 y_0}{(1+\rho)^2} + \frac{\hat{\beta}_4 y_0}{(1+\rho)^3} - p\Big(\frac{y_0(1+\gamma)^{10} - y_0(1+\gamma)^9}{(1+\rho)^{10}} + \frac{y_0(1+\gamma)^{11} - y_0(1+\gamma)^9}{(1+\rho)^{11}} \\
&\qquad + \frac{y_0(1+\gamma)^{12} - y_0(1+\gamma)^9(1+\hat{\alpha}_2 + \hat{\gamma}_2 \bar{x}_{i0} + \hat{\beta}_2)}{(1+\rho)^{12}} \\
&\qquad + \frac{y_0(1+\gamma)^{13} - y_0(1+\gamma)^9(1+\hat{\alpha}_3 + \hat{\gamma}_3 \bar{x}_{i0} + \hat{\beta}_3)}{(1+\rho)^{13}} \\
&\qquad + \frac{y_0(1+\gamma)^{14} - y_0(1+\gamma)^9(1+\hat{\alpha}_4 + \hat{\gamma}_4 \bar{x}_{i0} + \hat{\beta}_4)}{(1+\rho)^{14}} \\
&\quad - p^2\Big(\frac{y_0(1+\gamma)^{20} - y_0(1+\gamma)^{19}}{(1+\rho)^{20}} + \frac{y_0(1+\gamma)^{21} - y_0(1+\gamma)^{19}}{(1+\rho)^{21}} \\
&\qquad + \frac{y_0(1+\gamma)^{22} - y_0(1+\gamma)^{19}(1+\hat{\alpha}_2 + \hat{\gamma}_2 \bar{x}_{i0} + \hat{\beta}_2)}{(1+\rho)^{22}} \\
&\qquad + \frac{y_0(1+\gamma)^{23} - y_0(1+\gamma)^{19}(1+\hat{\alpha}_3 + \hat{\gamma}_3 \bar{x}_{i0} + \hat{\beta}_3)}{(1+\rho)^{23}} \\
&\qquad + \frac{y_0(1+\gamma)^{24} - y_0(1+\gamma)^{19}(1+\hat{\alpha}_4 + \hat{\gamma}_4 \bar{x}_{i0} + \hat{\beta}_4)}{(1+\rho)^{24}} \Big) \\
&\quad \ldots \\
&= y_0\Big(\frac{\hat{\beta}_2}{1+\rho} + \frac{\hat{\beta}_3}{(1+\rho)^2} + \frac{\hat{\beta}_4}{(1+\rho)^3} - \sum_{j=1}^{\infty} p^j \frac{(1+\gamma)^{10j}}{(1+\rho)^{10j}} \Big(\frac{1-(1+\gamma)^{-1}}{1} + \frac{(1+\gamma)-(1+\gamma)^{-1}}{1+\rho} \\
&\qquad + \frac{(1+\gamma)^2 - (1+\gamma)^{-1}(1+\hat{\alpha}_2 + \hat{\gamma}_2 \bar{x}_{i0} + \hat{\beta}_2)}{(1+\rho)^2} \\
&\qquad + \frac{(1+\gamma)^3 - (1+\gamma)^{-1}(1+\hat{\alpha}_3 + \hat{\gamma}_3 \bar{x}_{i0} + \hat{\beta}_3)}{(1+\rho)^3} \\
&\qquad + \frac{(1+\gamma)^4 - (1+\gamma)^{-1}(1+\hat{\alpha}_4 + \hat{\gamma}_4 \bar{x}_{i0} + \hat{\beta}_4)}{(1+\rho)^4} \Big) \Big)
\end{aligned}$$

Tables A.11 and A.10 show very similar results for case i) and case ii) respectively. Strikingly, the net present value of interventions is positive across almost all considered assumption combinations and substantially above 10% of current GDP under many plausible assumptions. Only when future output is substantially larger and discount rates are low will future crises be costly enough to swamp the benefits of near-term interventions.

Table A.10: Net present value of output changes, case (i)

		Discount rate		
		5%	3%	1%
Trend growth	5%	0.077	0.041	-0.014
	3%	0.136	0.124	0.104
	1%	0.172	0.175	0.175

Notes: The net present value of liquidity injections in response to a financial crisis expressed as a share of current GDP under different assumptions for social discount rates and real trend growth. These figures account both for short-run stabilization gains as well as long-run financial instability costs and are computed under the assumption that there are no interventions during a potential future crisis.

Table A.11: Net present value of output changes, case (ii)

		Discount rate		
		5%	3%	1%
Trend growth	5%	0.088	0.048	-0.023
	3%	0.152	0.145	0.130
	1%	0.182	0.189	0.195

Notes: The net present value of liquidity injections in response to a financial crisis expressed as a share of current GDP under different assumptions for social discount rates and real trend growth. These figures account both for short-run stabilization gains as well as long-run financial instability costs and are computed under the assumption that the central bank would intervene again during potential future crises.

P Selected long series of central bank total assets

Sweden and Britain: Figure A.37 shows total central bank assets/British NGDP between 1700-2016 on the basis of Dimsdale and Thomas (2017), and current GDP estimates at market prices via Broadberry et al. (2015). Britain has of course served as a key case study to study financial-institutional modernization, and serves as the classic case of an early centralized public financial system. [89] World War Two and the post-2008 expansion stand out here on a historic scale - but we note that pre-GFC all-time records were not in fact set during 1939-1945, but rather during the early years of the Bank of England, following its 1694 inception.

Figure A.37 shows sharp asset expansions beginning around the time of the South Sea Bubble, with total BoE assets relative to GDP reaching a peak of 24% by 1735: representative of the fact that many early central banks were able to provide substantial liquidity volumes even under gold standard regimes, and were initially not bound to target real economic activity.[90]

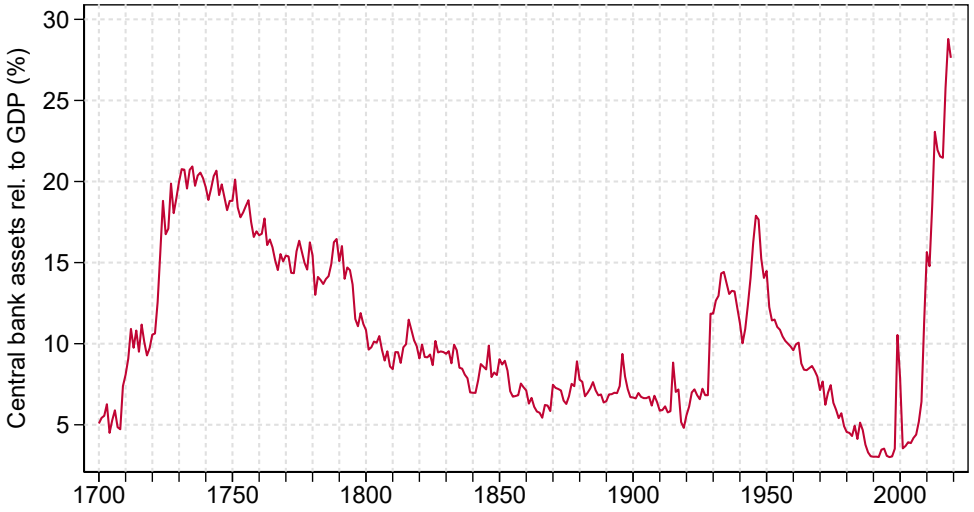
Figure A.38 displays Riksbank total assets as a share of Swedish GDP, 1668-2020, on the basis of recently released data (Fregert, 2014). Sweden - contrasting with the British case - serves as an example of a historical "laggard" in the development of public finance, and from its inception kept its central bank formally under public (Parliamentary) ownership.[91] We observe that a

[89] Following Dincecco (2011)'s classification, who posits a completion of fiscal centralization for England in the year 1066, which is echoed in related literature.

[90] In nominal terms, the key expansion years for total BoE assets at the time are 1720 (+19.5% year-on-year), 1723 (+24.1%), and 1724 (+19.1%). None of these years technically qualifies as a "major" expansion event along our definitions; the 1720 expansion is driven by an expansion in non-public securities (+133% year-on-year), and 1723-4 by a jump in government security assets, see (Dimsdale and Thomas, 2017, sheet A.23).

[91] Dincecco (2011) posits a fiscal centralization for Sweden only by the year 1840, almost eight centuries after the English centralization. The 1668 and 1719 statutes explicitly formalized ownership of the Riksbank by the Riksdag, and contained a pledge by the King to respect the Bank's independence, see (Fregert and Jonung, 1996).

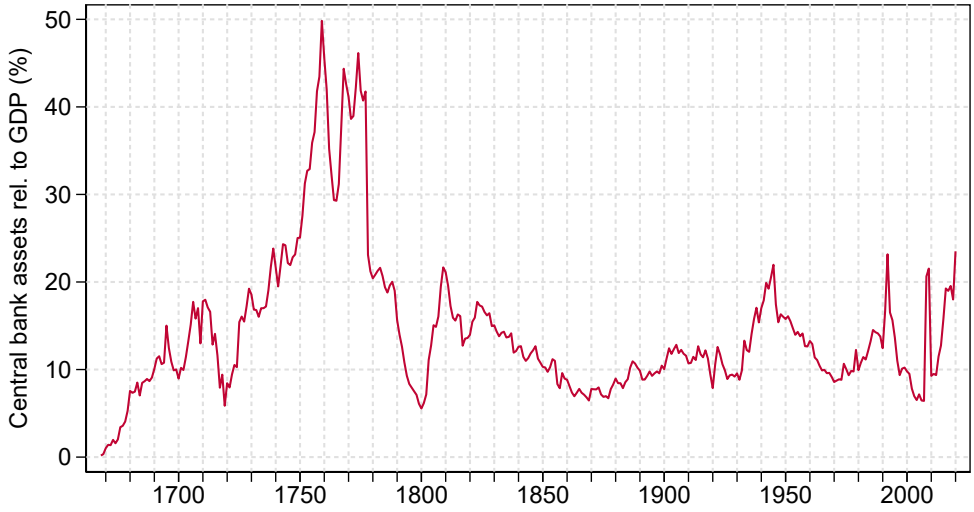
Figure A.37: Bank of England, total assets, 1700-2020



Notes: In percent of current U.K. GDP (contemporary borders).

public-ownership status did not preclude substantial active central bank balance sheet expansions relative to GDP, either, and that they were not exclusive to the floating currency regime era. Once more, large asset expansions can be linked directly to the motivation to reduce liquidity risks in financial markets: in the Swedish case the most dramatic increase in total assets over the very long term is recorded for the 1750-1765 period, when the share surged from below 20% to a record 49.8% in 1759. The backdrop was the Seven Years' War – with the costly Pomeranian Campaign almost exclusively financed by rapid Riksbank note issuance – the erosion of silver prices, and heavy bank runs in Stockholm during the 1740s, eventually triggering a suspension of convertibility by 1745 and a period of floating currency in Sweden (Heckscher, 1954; Fregert and Jonung, 1996).

Figure A.38: Riksbank, total assets, 1668-2020



Notes: In percentage of current Swedish GDP.

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Data Appendix

Sources of Central Bank Balance Sheet Data

Australia

Assets: Total

- 1920 to 1945: from National Library of Australia, "Queanbeyan Age and Queanbeyan Observer ", various issues, accessible online (link)
- 1950 to 1997: from Reserve Bank of Australia, File "3.6 Assets", accessible online (link)
- 1998 to 2014: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online (link), column "Total Assets", June-values.
- 2015 to 2020: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online. (link), column "Total Assets". Weekly data, average of June-values.

Assets: Government debt

- 1920 to 1945: from S. J. Butlin, A. R. Hall and R. C. White, "Australian Banking and Monetary Statistics 1817-1945", Reserve Bank of Australia, Occasional Paper No. 4A, Sydney, 1971, page 136, table 9, series "Govt. And Municipal Securities", converted to AUD.
- 1950 to 1997: from Reserve Bank of Australia, File "3.6 Assets", accessible online (link)
- 1998 to 2015: from Reserve Bank of Australia. Statistics. Statement of Liabilities and Assets. Summary historical data. Excel file A1 - Liabilities and Assets - Summary. (link)

Assets: Gold

- 1920 to 1945: from National Library of Australia, "Queanbeyan Age and Queanbeyan Observer ", various issues, accessible online (link)
- 1950 to 1997: from Reserve Bank of Australia, File "3.6 Assets", accessible online (link)
- 1998 to 2014: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online (link), column "Gold and foreign exchange", June-Entry.
- 2015 to 2020: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online. (link), "Gold and foreign exchange". Weekly data, average of June-values.

Assets: Foreign

- NA

Liabilities: Notes and coin

- 1950 to 1997: from Reserve Bank of Australia, File "3.5 Liabilities", accessible online (link), column "Bills and Notes".
- 1998 to 2014: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online (link), column "Notes on Issue", June-Entry.
- 2015 to 2020: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online. (link), column "Notes on Issue". Weekly data, average of June-values.

Liabilities: Deposits

- 1920 to 1945: from S. J. Butlin, A. R. Hall and R. C. White, "Australian Banking and Monetary Statistics 1817-1945", Reserve Bank of Australia, Occasional Paper No. 4A, Sydney, 1971, page 135, table 9, sum of series "Total deposits" and "Balances due to other banks", converted to AUD.
- 1960 to 1997: from Reserve Bank of Australia, File "3.5 Liabilities", accessible online (link). Sum of columns "Notes on issues", "Non-callable/SRD", "Overseas Institutions", "Commonwealth", "State" and "Other".
- 1998 to 2014: from Reserve Bank of Australia. Statistics. Statement of Liabilities and Assets. Summary historical data. Excel file A1 - Liabilities and Assets - Summary. (link)
- 2015 to 2020: from Reserve Bank of Australia, File "A1.1 Liabilities and Assets", accessible online. (link), Sum of columns "Exchange Settlements Balances" and "Deposits". Weekly data, average of June-values

Liabilities: Foreign

- NA

Belgium

Assets: Total

- 1870 to 1914: from National Bank of Belgium, Annual Report, various issues, "Total Assets" or "Total Actif", accessible online (link)
- 1916 to 1998: from National Bank of Belgium, Annual Report, various issues, "Total Assets" or "Total Actif", accessible online (link)

- 1999 to 2020: from National Bank of Belgium, NBB Stat, Financial Institutions, National Bank of Belgium, "Assets", accessible online (link). M12 value. Converted to BEF

Assets: Government debt

- 1870 to 1914: from National Bank of Belgium, Annual Report, various issues, accessible online (link), Sum of Columns "Prets sur fonds publics" and "Fonds public".
- 1916 to 1938: from National Bank of Belgium, Annual Report, various issues, accessible online (link), Sum of Columns "Prets sur fonds publics" and "Fonds public".
- 1939 to 1990: from National Bank of Belgium, Annual Report, various issues, column "Government debt". Accessible online (link).

Assets: Gold

- 1870 to 1914: from National Bank of Belgium, Annual Report,"Caisse: Espèces et lingots" or "Or a l'etranger" or "Gold", series ends in 1990 when Belgium started to value gold holdings at market prices, various issues, accessible online (link).
- 1916 to 1998: from National Bank of Belgium, Annual Report,"Caisse: Espèces et lingots" or "Or a l'etranger" or "Gold", series ends in 1990 when Belgium started to value gold holdings at market prices, various issues, accessible online (link).
- 1999 to 2020: from National Bank of Belgium, NBB Stat, Financial Institutions, National Bank of Belgium, "Assets", accessible online (link). M12 value. Converted to BEF

Assets: Foreign

- 1944 to 1998: from National Bank of Belgium, Annual Report, various issues, Sum of "Creances en devices etrangeres", "Billets et monnaies etrangers", "Avoirs en devises etrangeres", "Effets en francs belges sur l'etranger", "Accord "Union Europeenne de Paiements": francs belges" and "Creances sur l'etranger dans le cadre d'accords de paiement". Accessible online (link).
- 1999 to 2020: from National Bank of Belgium, NBB Stat, Financial Institutions, National Bank of Belgium, sum of "Claims on non-euro area residents denominated in foreign currency", "Receivables from the IMF", "Claims on non-euro area residents denominated in euro" and "Intra-eurosystem claims" accessible online (link). M12 value. Converted to BEF

Liabilities: Notes and coin

- 1870 to 1914: from National Bank of Belgium, Annual Report, various issues, column "Billets de banque en circulation". Accessible online (link).

- 1916 to 1998: from National Bank of Belgium, Annual Report, various issues, column “Billets de banque en circulation”. Accessible online (link).
- 1999 to 2020: from National Bank of Belgium, NBB Stat, Financial Institutions, National Bank of Belgium, “Banknotes in Circulation”, accessible online (link). M12 value, converted to BEF

Liabilities: Deposits

- 1870 to 1914: from National Bank of Belgium, Annual Report, various issues, column “Comptes courants crediteurs”. Accessible online (link).
- 1916 to 1987: from National Bank of Belgium, Annual Report, various issues, column “Comptes courants crediteurs”. Accessible online (link).
- 1988 to 2020: from International Monetary Fund, International Financial Statistics, Monthly Report, various issues, series "Central bank, reserve deposits of other depository corporations", December values.

Liabilities: Foreign

- 1946 to 1998: from National Bank of Belgium, Annual Report, various issues, accessible online (link).

Canada

Assets: Total

- 1935 to 2020: from Statistics Canada, “Bank of Canada, Assets and Liabilities, at Months-end” (Table 176-0010), accessible online (link), December values.

Assets: Government debt

- 1935 to 2020: from Statistics Canada, “Bank of Canada, Assets and Liabilities, at Months-end” (Table 10-10-0108-01), column “Direct and guaranteed securities”, accessible online (link), December values.

Assets: Gold

- NA

Assets: Foreign

- 1935 to 1980: from Statistics Canada, "Bank of Canada, Assets and Liabilities, at Months-end" (Table 10-10-0108-01), accessible online (link), December values.

Liabilities: Notes and coin

- 1935 to 2020: from Statistics Canada, "Bank of Canada, Assets and Liabilities, at Months-end" (Table 10-10-0108-01), column "Total, Notes in circulation", accessible online (link), December values.

Liabilities: Deposits

- 1935 to 2020: from Statistics Canada, "Bank of Canada, Assets and Liabilities, at Months-end" (Table 10-10-0108-01), sum of columns "Government of Canada", "Government of Canada enterprises", "foreign central banks and official institutions", "members of the Canadian Payments Association" and "other", accessible online (link), December values.

Liabilities: Foreign

- 1945 to 2020: from Statistics Canada, "Bank of Canada, Assets and Liabilities, at Months-end" (Table 10-10-0108-01), accessible online (link), December values.

Denmark

Assets: Total

- 1865 to 1874: via Svendsen et al. (1968a), Dansk Pengehistorie 1700-1960.
- 1875 to 2005: from Nationalbank of Denmark, working paper "Monetary Trends and Business Cycles in Denmark 1875-2005", Table A1, accessible online (link).
- 2006 to 2019: from Nationalbank of Denmark, "Report and Accounts", various issues, accessible online (link).

Assets: Government debt

- 1865 – via Svendsen et al. (1968a).

Assets: Gold

- 1865 to 1874: via Svendsen et al. (1968a).
- 1875 to 2005: from Nationalbank of Denmark, working paper "Monetary Trends and Business Cycles in Denmark 1875-2005", Table A1, accessible online (link).

- 2006 to 2019: from Nationalbank of Denmark, "Report and Accounts", various issues, accessible online (link).

Assets: Foreign

- 2006 to 2019: from Nationalbank of Denmark, "Report and Accounts", various issues, accessible online (link).

Liabilities: Notes and coin

- 1875 to 2005: from Nationalbank of Denmark, working paper "Monetary Trends and Business Cycles in Denmark 1875-2005", Table A1, column "Currency", accessible online (link).
- 2006 to 2019: from Nationalbank of Denmark, "Report and Accounts", various issues, accessible online (link).

Liabilities: Deposits

- 1875 to 2005: from Nationalbank of Denmark, working paper "Monetary Trends and Business Cycles in Denmark 1875-2005", Table A1, accessible online (link).
- 2006 to 2019: from Nationalbank of Denmark, "Report and Accounts", various issues, accessible online (link).

Liabilities: Foreign

- 2006 to 2019: from Nationalbank of Denmark, "Report and Accounts", various issues, accessible online (link).

Finland

Assets: Total

- 1813 to 1865: from Asp (1898), Tables 1-24.
- 1870 to 1992: from Bank of Finland, "Suomen Pankin Keskustelualoitteita", Table "Suomen Pankin Tase 1868-1992", column "Saatavat", accessible online (link)
- 1993 to 1998: from Bank of Finland, Annual Report of 1998 and Statistical Yearbook, Various Issues, accessible online (link).
- 1999 to 2020: from Bank of Finland. Series: Total assets. (link)

Assets: Government debt

- 1813 to 1865: from Asp (1898), Tables 4 and 21 ("Depositionsfond, Staatsdarlehen, und Reservefond, in Rubel Silber").

Assets: Gold

- 1842 to 1865: from Asp (1898), Table 17 ("Bestand der Valuta, in Rubel Silber").
- 1993 to 1998: from Bank of Finland, Annual Report of 1998 and Statistical Yearbook, Various Issues, accessible online (link).
- 1999 to 2020: from Bank of Finland. Series: Gold. (link)

Assets: Foreign

- 1842 to 1865: from Asp (1898), Table 18 ("Auslaendische Correspondenten, Darlehen gegen Hypothek u. diskont. inlaendische Wechsel).
- 1870 to 1992: from Bank of Finland, "Suomen Pankin Keskustelualoitteita", Ikonen Vappu, Suomen Pankin tase vuosina 1868-1992, Table "Suomen Pankin Tase 1868-1992", column "Ulkomaiset saatavat", accessible online (link).
- 1993 to 1998: from Bank of Finland, Annual Report of 1998 and Statistical Yearbook, various issues, Sum of "Special drawing rights", "IMF reserve tranche", "Convertible Currencies", accessible online (link).
- 1999 to 2020: from Bank of Finland. Sum of series "Claims on non-euro area residents denominated in foreign currency", "Claims on euro area residents denominated in foreign currency" and "Claims on non-euro area residents denominated in euro" (link)

Liabilities: Notes and coin

- 1870 to 1992: from Bank of Finland, "Suomen Pankin Keskustelualoitteita", Table "Suomen Pankin Tase 1868-1992", column "Liikkeessä oleva setelistö", accessible online (link).
- 1993 to 1998: from Bank of Finland, series "Banknotes in circulation", accessible online (link)

Liabilities: Deposits

- 1870 to 1992: from Bank of Finland, "Suomen Pankin Keskustelualoitteita", Table "Suomen Pankin Tase 1868-1992", sum of column "Velat julkiselle sektorille" and "Bank Deposits", accessible online (link)

- 1993 to 1998: from Bank of Finland, Annual Report of 1998 and Statistical Yearbook, various issues, Sum of "Liabilities to financial Institutions", "Liabilities to the public sector" and "Liabilities to corporations", accessible online (link).
- 1999 to 2020: from Bank of Finland, sum of series "Liabilities to euro area credit institutions related to monetary policy operations denominated in euro", "Deposits, balances and other liabilities", accessible online (link)

Liabilities: Foreign

- 1878 to 1879: from Bank of Finland, "Suomen Pankin Keskustelualoitteita", Table "Suomen Pankin Tase 1868-1992", column "Ulkomaiset velat", accessible online (link).
- 1889 to 1992: from Bank of Finland, "Suomen Pankin Keskustelualoitteita", Table "Suomen Pankin Tase 1868-1992", column "Ulkomaiset velat", accessible online (link).
- 1993 to 1998: from Bank of Finland, Annual Report of 1998 and Statistical Yearbook, various issues, Sum of "Foreign Currency Liabilities" and "Other Foreign Liabilities", accessible online (link).
- 1999 to 2020: from Bank of Finland., sum of series "Liabilities to non-euro area residents denominated in euro", "Liabilities to euro area residents denominated in foreign currency", "Liabilities to non-euro area residents denominated in foreign currency", "Intra-Eurosystem liabilities" and "Counterpart of special drawing rights allocated by the IMF" (link)

France

NGDP basis:

- We rely on Ridolfi and Nuvolari (2021) over 1800-1850, who report annual per capita Gross Domestic Product in real GK$ 1990 prices, and apply the 1764 current GDP benchmark figure in Riley (1987), and using French population data sourced from Dupaquier (1988).[92] We switch to Mitchell (2013) over 1851-69, and JST afterwards.

Assets: Total

- 1800-1839: Courtois (1881), Annexe P, "Tableau des operations et des chiffres des principaux comptes de la Banque de France, annee par annee, du 20 fevrier 1800 au 31 decembre 1847".
- 1840 to 1998: from P. Baubeau (2018) "The Bank of France's balance sheets database, 1840–1998", Cambridge University Press, Financial History Review, series "Total Actif", last December values, accessible online (link).

[92] We thank Leonardo Ridolfi for comments on this approach.

- 1999 to 2020: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheets; BdF Statement, “Total Assets”, converted to FRF, accessible online (link), December values.

Assets: Government debt

- 1840 to 1998: from P. Baubeau (2018) "The Bank of France’s balance sheets database, 1840–1998", Cambridge University Press, Financial History Review, last December values, accessible online (link).ia Baubeau (2018).
- 1999 to 2020: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheet, BdF Statement, “Assets, Resident general government loans (stock)”, accessible online (link).

Assets: Gold

- 1840 to 1998: from P. Baubeau (2018) "The Bank of France’s balance sheets database, 1840–1998", Cambridge University Press, Financial History Review, series "Or", last December values, accessible online (link)
- 1999 to 2020: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheets; BdF Statement, “Assets Gold (stock)”, converted to FRF, accessible online (link), December values.

Assets: Foreign

- 1915 to 1939: from Bank of France, “Situation hebdomodaire de la Banque de France 1898-1974”, Comptes Courants et Devises, accessible online (link).
- 1941 to 1973: from Bank of France, “Situation hebdomodaire de la Banque de France 1898-1974”, Comptes Courants et Devises, accessible online (link).
- 1995 to 1998: from P. Baubeau (2018) "The Bank of France’s balance sheets database, 1840–1998", Cambridge University Press, Financial History Review, series "Avoirs et placements en devises", December values, accessible online (link).
- 1999 to 2023: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheets, BdF Statement, sum of “Assets - Rest of the World” and “Assets other Euro area Countries”, converted to FRF, accessible online (link), December values.

Liabilities: Notes and coin

- 1840 to 1998: from P. Baubeau (2018) "The Bank of France’s balance sheets database, 1840–1998", Cambridge University Press, Financial History Review, series "Billets en circulation", December values, accessible online (link).

- 1999 to 2023: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheets, BdF Statement, "Liabilities, Banknotes and coins in circulation (stock)", converted to FRF, accessible online (link), December values.

Liabilities: Deposits

- 1840 to 1998: from P. Baubeau (2018) "The Bank of France's balance sheets database, 1840–1998", Cambridge University Press, Financial History Review, series "Comptes courants des établissements astreints à la constitution de réserves", December values, accessible online (link).
- 1999 to 2023: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheets, BdF Statement, Liabilities, "Residents deposits (stock)", converted to FRF, accessible online (link) December values.

Liabilities: Foreign

- 1962 to 1973: from Bank of France, "Situation hebdomodaire de la Banque de France 1898-1974", Comptes des banques institutions et personnes étrangères, accessible online (link).
- 1990 to 2023: from Bank of France, Webstat, Monetary Statistics, MFI Balance Sheets, BdF Statement, sum of "deposits of extra euro area" and "other euro area countries deposits", converted to FRF, accessible online (link), December values.

Germany

NGDP basis:

- We rely on Pfister (2022) over 1817-69, who reports annual per capita Gross National Income in current prices, and multiply this figure with Prussian population estimates sourced from Hohorst (1977).

Assets: Total

- 1817-1850: Royal Bank of Prussia basis, via Niebuhr (1854), Geschichte der Königlichen Bank in Berlin. Von der Gründung derselben (1765) bis zum Ende des Jahres 1845.
- 1851-1872: Royal Bank of Prussia, via annual reports of Bankverwaltungsrat (1851-1872).
- 1876 to 1922: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank", column „Summe der Aktiva bzw. Passiva", accessible online (link).

- 1924 to 1944: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Summe der Aktiva bzw. Passiva“, accessible online (link).
- 1948 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, column „Aktiva gesamt“, accessible online (link).
- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, Various Issues, Table „Ausweise der deutschen Bundsbank“, accessible online (link)
- 2002 to 2023:

Assets: Government debt

- 1876 to 1922: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, sum of columns „Noten anderer Banken“ and „Deckungsfähige Devisen“. Accessible online (link).
- 1928 to 1945: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, sum of columns „Noten anderer Banken“ and „Deckungsfähige Devisen“. Accessible online (link).
- 1948 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, sum of columns „Reserveposition im IWF“, “Devisen und Sorten” and “Auslandswechsel“, accessible online (link).
- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, various issues, table „Ausweise der deutschen Bundsbank“, sum of columns „Reservepositionen im internationalen Währungsfonds“, „Forderungen an den EFWZ“, „Devisen und Sorten insgesamt“ and „Kredite und sonstige Forderungen an das Ausland“, accessible online (link).
- 2002 to 2023: from Deutsche Bundesbank, Geldmengenaggregate, konsolidierter Ausweis des Eurosystems, series „General government debt“, converted to DM, accessible online (link).

Assets: Gold

- 1876 to 1877: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Gold in Barren und Münzen“, accessible online (link).
- 1880 to 1882: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Gold in Barren und Münzen“, accessible online (link).
- 1884 to 1886: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Gold in Barren und Münzen“, accessible online (link).

- 1898: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Gold in Barren und Münzen“, accessible online (link).
- 1891 to 1922: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Gold in Barren und Münzen“, accessible online (link).
- 1924 to 1945: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Gold in Barren und Münzen“, accessible online (link).
- 1951 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, column „Gold“., accessible online (link).
- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, various issues, table „Ausweise der deutschen Bundsbank“, accessible online (link). Note: gold makes a re-evaluation jump from 1998 to 1999.
- 2002 to 2023: from Deutsche Bundesbank, Geldmengenaggregate, konsolidierter Ausweis des Eurosystems, series „Gold“, converted to DM, accessible online (link).

Assets: Foreign

- 1876 to 1922: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, sum of columns „Noten anderer Banken“ and „Deckungsfähige Devisen“, accessible online (link).
- 1924 to 1945: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, sum of columns „Noten anderer Banken“ and „Deckungsfähige Devisen“, accessible online (link).
- 1948 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, sum of columns „Reserveposition im IWF“, “Devisen und Sorten” and “Auslandswechsel”, accessible online (link).
- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, various issues, table „Ausweise der deutschen Bundsbank“, sum of columns „Reservepositionen im internationalen Währungsfonds“, „Forderungen an den EFWZ“, „Devisen und Sorten insgesamt“ and „Kredite und sonstige Forderungen an das Ausland“, accessible online (link).
- 2002 to 2019: from Deutsche Bundesbank, Geldmengenaggregate, konsolidierter Ausweis des Eurosystems, series „Claims on non-eure area residents denominated in foreign currency“ converted to DM, accessible online (link).

Liabilities: Notes and coin

- 1876 to 1922: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Summe der Aktiva bzw. Passiva“, accessible online (link).

- 1924 to 1945: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Summe der Aktiva bzw. Passiva“, accessible online (link).
- 1948 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, column „Banknotenumlauf“, accessible online (link).
- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, various issues, table „Ausweise der deutschen Bundsbank“, accessible online (link).
- 2002 to 2023: from Deutsche Bundesbank, Geldmengenaggregate, konsolidierter Ausweis des Eurosystems, series „Banknotes in circulation“, converted to DM, accessible online (link).

Liabilities: Deposits

- 1876 to 1922: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Einlagen insgesamt“, accessible online (link).
- 1924 to 1945: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CI 1.01 „Ausweis der Reichsbank“, column „Einlagen insgesamt“, accessible online (link).
- 1948 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, sum of columns „Einlagen inländische Kreditinstitute“ and „Einlagen zusammen“, accessible online (link).
- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, various issues, sum of „Einlagen von Kreditinstituten insgesamt“, „Einlagen von öffentlichen Haushalten insgesamt“, „Sondereinlagen des Bundes und der Länder“ and „Einlagen von anderen inländischen Einlegern insgesamt“, accessible online (link).
- 2002 to 2023: from Deutsche Bundesbank, Geldmengenaggregate, konsolidierter Ausweis des Eurosystems, sum of series “Liabilities to euro area credit institutions related to monetary policy operations denominated in euro”, “[...] current account”, “[...] deposit facility”, “[...] fixed term deposits”, “[...] fine-tuning reserse operations”, “[...] deposit related to margin calls”, “[...] general government”, “other liabilities to euro-area credit institutions denominated in euro” and “liabilities to other euro area residents denominated in euro”, converted to DM, accessible online (link)

Liabilities: Foreign

- 1949 to 1974: from Deutsches Geld- und Bankwesen in Zahlen 1876-1975, table CIII 1.01 „Aktiva und Passiva des Zentralbanksystems“, column „Ausländische Einleger“, accessible online (link).

- 1975 to 2001: from Deutsche Bundesbank, Geschäftsberichte, various issues, table „Ausweise der deutschen Bundsbank“, accessible online (link).
- 2002 to 2023: from Deutsche Bundesbank, Geldmengenaggregate, konsolidierter Ausweis des Eurosystems, series: “Claims on non-euro area residents denominated in foreign currency and in euro”, accessible online (link). Converted to DEM.

Italy

NGDP basis:

- We rely on current per capita income figures for Northern Italy in Malanima (2011), appendix table 2, column 7 ("Per capita GDP in Florentine lire, current prices"). These per capita figures are then multiplied by population estimates for The Republic of Siena in Baroch, Batou, and Chavre (1988).

Assets: Total

- 1626 to 1725: Sienese Monte, via Camaiti (1956), L’attivita bancaria a Siena nel seicento attraverso la ricostruzione e l’analisi statistica di cento bilanci del Monte dei Paschi di Siena.
- 1845 to 1861: Conte (1990) Banca di Genova-Banca Nazionale, 283ff.
- 1862 to 1893: Da Pozzo and Felloni (1964), La Borsa Valori Di Genova nel secolo XIX, “Principali voci contabili della Banca Nazionale”.
- 1894 to 1936: from De Mattia, R. (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d’Italia.
- 1937 to 1998: from Banca d’Italia, Serie storica bilanci Banca d’Italia (IBIS), series “Attivo: Totale dei conti patrimoniali”, December values, accessible online (https://ibis.bancaditalia.it/ibis).
- 1999 to 2023: from Banca d’Italia. Statistical Database. Topics, International Monetary Fund’s Special Data Dissemination Standard Plus (SDDS Plus) statistics, Bank of Italy balance sheet aggregates. Series: Total assets, converted to ITL, accessible online (link), December values.

Assets: Government debt

- 1845 to 1861: Conte (1990) Banca di Genova-Banca Nazionale, 283ff.
- 1894 to 1936: from De Mattia, R. (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d’Italia.
- 1965 to 1998: from Banca d’Italia, Serie storica bilanci Banca d’Italia (IBIS), December values, accessible online (link).

Assets: Gold

- 1894 to 1936: from De Mattia, R. (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d'Italia.
- 1937 to 1998: from Banca d'Italia, Serie storica bilanci Banca d'Italia (IBIS), series "Attivo: Oro a riserva", December values, accessible online (link).
- 1999 to 2023: from Banca d'Italia, Statistical Database, series "Gold and gold receivables".

Assets: Foreign

- 1890 to 1926: from Mattia (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d'Italia.
- 1936 to 1965: from Banca d'Italia, Serie storica bilanci Banca d'Italia (IBIS), December values, accessible online (link).
- 1999 to 2023: from Banca d'Italia, Statistical Database, series "Claims on non-Euro-area residents, in euro and foreign currency", converted to ITL.

Liabilities: Notes and coin

- 1894 to 1936: from Mattia (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d'Italia.
- 1937 to 1998: from Banca d'Italia, Serie storica bilanci Banca d'Italia (IBIS), series "Passivo: Circolazione di biglietti", December values, accessible online (link).
- 1999 to 2023: from Banca d'Italia, statistical Database, series, "Banknotes in circulation".

Liabilities: Deposits

- 1626 to 1725: Sienese Monte, via Camaiti (1956), *L'attivita bancaria a Siena nel seicento attraverso la ricostruzione e l'analisi statistica di cento bilanci del Monte dei Paschi di Siena.*
- 1894 to 1936: from Mattia (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d'Italia.
- 1963 to 2023: from International Monetary Fund, International Financial Statistics, Monthly Report, various issues, series "Central bank, reserve deposits of other depository corporations", December values.

Liabilities: Foreign

- 1936 to 1936: from Mattia (1967). I bilanci degli istituti di emissione italiani dal 1845 al 1936. Roma: Banca d'Italia.
- 1937 to 1991: from Banca d'Italia, Serie storica bilanci Banca d'Italia (IBIS), December values, accessible online (link).
- 1999 to 2023: from Banca d'Italia, Statistical Database, series "Liabilities on non-Euro-area residents, in euro and foreign currency".

Japan

Assets: Total

- 1882 to 1965: from 100-year statistics of the Japanese economy, table 63 "Accounts of the Bank of Japan", column "Total Assets or Liabilities".
- 1966 to 1984: from Statistics Japan, Chapter 14 Finance and Insurance, Table 14 "Assets and Liabilities of Trust Fund Bureau, Ministry of Finance, accessible online (link).
- 1985 to 1997: from Statistics Japan. Chapter 14 Finance and Insurance. 14- 2 Accounts of Bank of Japan (1949--2005), accessible online (link)
- 1998 to 2023: from Bank of Japan. Series: BJ'MABJMTA Total Assets. Dec value, levels, accessible online (link)

Assets: Government debt

- 1882 to 1965: from 100-year statistics of the Japanese economy, table 63 "Accounts of the Bank of Japan", Sum of columns "Loans to Gov't" and "Gov't securities".
- 1966 to 1984: from Statistics Japan, Chapter 14 Finance and Insurance, Table 14 "Assets and Liabilities of Trust Fund Bureau, Ministry of Finance, accessible online (link).
- 1985 to 1997: from 1985-1997 from Statistics Japan. Chapter 14 Finance and Insurance. 14- 2 Accounts of Bank of Japan (1949--2005), accessible online (link)
- 1998 to 2023: from Bank of Japan. Series: BJ'MABJMA5
- Bank of Japan Accounts/Assets/Japanese Government Securities(f), Dec values, levels, accessible online (link)

Assets: Gold

- 1882 to 1965: from 100-year statistics of the Japanese economy, table 63 "Accounts of the Bank of Japan", column "Cash and Gold Bullion".

- 1966 to 1984: from Statistics Japan, Chapter 14 Finance and Insurance, Table 14 “Assets and Liabilities of Trust Fund Bureau, Ministry of Finance, accessible online (link).
- 1985 to 1997: from 1985-1997 from Statistics Japan. Chapter 14 Finance and Insurance. 14- 2 Accounts of Bank of Japan (1949--2005), accessible online (link)
- 1998 to 2023: from Bank of Japan. Series: BJ’MABJMA1 Bank of Japan Accounts/Assets/Gold(a), Dec values, levels, accessible online (link)

Assets: Foreign

- 1955 to 1997: from Statistics Japan, Chapter 14 Finance and Insurance, Table 14 “Assets and Liabilities of Trust Fund Bureau, Ministry of Finance, accessible online (link).
- 1998 to 2023: from Bank of Japan. Series: BJ’MABJMA12 Bank of Japan Accounts/Assets/Foreign Currency Assets, Dec values, levels, accessible online (link)

Liabilities: Notes and coin

- 1885 to 1965: from 100-year statistics of the Japanese economy, table 63 “Accounts of the Bank of Japan”, column “Bank Notes Issued”.
- 1966 to 1984: from Statistics Japan, Chapter 14 Finance and Insurance, Table 14 “Assets and Liabilities of Trust Fund Bureau, Ministry of Finance, accessible online (link).
- 1985 to 1997: from Statistics Japan. Chapter 14 Finance and Insurance. 14- 2 Accounts of Bank of Japan (1949--2005), accessible online (link)
- 1998 to 2023: from Bank of Japan, series BJ’MABJML1 Bank of Japan Accounts/Liabilities and Net Assets/Banknotes, Dec values, levels, accessible online (link)

Liabilities: Deposits

- 1882 to 1945: from 100-year statistics of the Japanese economy, table 63 “Accounts of the Bank of Japan”, column “Deposits”.
- 1963 to 2023: from International Monetary Fund, International Financial Statistics, Monthly Report, various issues, series "Central bank, reserve deposits of other depository corporations", December values.

Liabilities: Foreign

- NA

Netherlands

NGDP basis:

- We rely on Smits et al. (2000) from 1807, who report annual Gross National Income in current prices (table F.1, in guilders); and between 1611-1806, we use van Zanden and van Leeuwen (2012) for NGDP, using interpolated decadal figures (appendix table 2, in guilders).

Assets: Total

- 1611 to 1814: Bank of Amsterdam, via Dillen (1934).
- 1815 to 1864: De Nederlandsche Bank, via Van der Borght (1896).
- 1865 to 1919: Dutch Nationaal Archief, *De Nederlandsche Bank N.V.: Jaarverslagen*, F1100212/2013, 457652-457793.
- 1920 to 1990: from De Nederlandsche Bank 2000C, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3. Series: Balans totaal.
- 1991 to 2023: from table T5:1 Balance Sheet of the Nederlandsche Bank (monetary presentation), "Total Assets", converted to NLG, accessible online (link).

Assets: Government debt

- 1865 to 1919: Dutch Nationaal Archief, *De Nederlandsche Bank N.V.: Jaarverslagen*, F1100212/2013, 457652-457793.
- 1920 to 1990: from De Nederlandsche Bank, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3., "Vorderingen op het binnenland – Schatkistpapier", "Weekstaatpost Neederlandse Munten", "Schotkistpapier dor DNB gekocht", "Schuldbrieven door DNB gekocht".

Assets: Gold

- 1865 to 1919: Dutch Nationaal Archief, *De Nederlandsche Bank N.V.: Jaarverslagen*, F1100212/2013, 457652-457793.
- 1920 to 1990: from De Nederlandsche Bank, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3., sum of "Goud"," imf"," bijzondere trekkingsrechten" and "Ecu's".

Assets: Foreign

- 1900 to 1990: from De Nederlandsche Bank, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3., Sum of "Goud"," imf"," bijzondere trekkingsrechten" and "Ecu's".

Liabilities: Notes and coin

- 1900 to 1990: from De Nederlandsche Bank, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3., "Bankbiljetten in omloop".
- 1991 to 2023: from table T5:1 Balance Sheet of the Nederlandsche Bank (monetary presentation), "Currency in Circulation", converted to NLG, accessible online (link).

Liabilities: Deposits

- 1900 to 1990: from De Nederlandsche Bank, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3., sum of "Passiva: tegoeden van Rijk" and "Passiva: tegoeden van Banken en anderen".
- 1991 to 2023: from table T5:1 Balance Sheet of the Nederlandsche Bank (monetary presentation), "Total Deposits of Euro Area Residents", converted to NLG, accessible online (link).

Liabilities: Foreign

- 1947 to 1990: from De Nederlandsche Bank, Nederlandse financiele instellingen in de twintigste eeuw: balansreeksen en naamlijst van handelsbanken DNB Statistische Cahiers Nr. 3., "Passiva: Nietingezetenen".

Norway

Assets: Total

- 1870 to 1944: from Norges Bank, Balance Sheets from 1817 onwards. Series: Total Asset, levels, acessible online (link), December values.
- 1946 to 2023: from Norges Bank, Balance Sheets from 1817 onwards. Series: Total Asset, levels, acessible online (link), December values.

Assets: Government debt

- 1973 to 2002: from Norges Bank, Balance Sheets from 1817 onwards, accessible online (link).

Assets: Gold

- 1946 to 2011: from Norges Bank, Balance Sheets from 1817 onwards, accessible online (link). Note: missing data for 1945 and 1992 to 2003.

Assets: Foreign

- 1887 to 1944: from Norges Bank, Balance Sheets from 1817 onwards, sum of “Reserveposition in the IMF”, “Loans to IMF”, “SDRs”, “Foreign exchange reserves”, “Equivalent value of IMF”, “Other Foreign assets”, “Bank deposits abroad”, “Foreign treasury bills”, “Foreign bearer bonds” and “Other foreign assets”, accessible online (link).
- 1946 to 2011: from Norges Bank, Balance Sheets from 1817 onwards, sum of “Reserveposition in the IMF”, “Loans to IMF”, “SDRs”, “Foreign exchange reserves”, “Equivalent value of IMF”, “Other Foreign assets”, “Bank deposits abroad”, “Foreign treasury bills”, “Foreign bearer bonds” and “Other foreign assets”, accessible online (link).

Liabilities: Notes and coin

- 1870 to 1944: from Norges Bank, Balance Sheets from 1817 onwards, series “Notes and Coins in circulation”, December values, accessible online (link).
- 1946 to 2023: from Norges Bank, Balance Sheets from 1817 onwards, series “Notes and Coins in circulation”, December values, accessible online (link).

Liabilities: Deposits

- 1870 to 1944: from Norges Bank, Balance Sheets from 1817 onwards, sum of "Sight deposits: Domestic Banks" and "State accounts", December values, accessible online (link).
- 1960 to 2023: from International Monetary Fund, International Financial Statistics, Monthly Report, various issues, series "Central bank, reserve deposits of other depository corporations", December values.

Liabilities: Foreign

- 1950 to 2011: from Norges Bank, Balance Sheets from 1817 onwards, accessible online (link).

Portugal

Assets: Total

- 1870 to 1946: from Nuno Valério (2001). Estatísticas Históricas Portuguesas. Cuadro 7.6.B – series "Assets".
- 1947 to 1995: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal, accessible online (link).
- 1996 to 1998: Banco de Portugal, Annual Reports, various issues, accessible online (link).
- 1999 to 2023: from Banco de Portugal. BPstat Estatísticas Online, Estatísticas monetarias e financeiras, Institucoes financeiras monetarias, Balanco de Banco de Portugal, series "Total assets", December values, converted to PTE, accessible online (link).

Assets: Government debt

- 1888 to 1946: from Nuno Valério (2001). Estatísticas Históricas Portuguesas, Table 7.
- 1947 to 1995: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal, accessible online (link).
- 1996 to 1998: Banco de Portugal, Annual Reports, Various Issues. Sum of "Current accounts of the Autonomous Regions" and "Portuguese metal coin held in reserve", accessible online (link).

Assets: Gold

- 1947 to 1995: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal, accessible online (link).
- 1996 to 1998: Banco de Portugal, Annual Reports, various issues, accessible online (link).
- 1999 to 2023: from Banco de Portugal. BPstat Estatísticas Online, Estatísticas monetarias e financeiras, Institucoes financeiras monetarias, Balanco de Banco de Portugal, series "Monetary gold", December values, converted to PTE, accessible online (link).

Assets: Foreign

- 1947 to 1964: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal. Accessible online (link). Note: year 1965 appears to be an error in the source; data point set to missing.

- 1966 to 1995: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal. Accessible online (link).
- 1996 to 1998: Banco de Portugal, Annual Reports, Various Issues. Sum of "Deposits and other Investments", "Foreign Securities", "International Monetary Fund", "European Monetary Institute" and "Other international organisations". Accessible online (link).
- 1999 to 2023: from Banco de Portugal. BPstat Estatísticas Online. Estatísticas monetarias e financeiras, Institucoes financeiras monetarias, Balanco de Banco de Portugal, sum of assets vis-a-vis nonresidents: "SDR", "IMF", "Credits", "Securities other than shares" and "Shares and other equity", December values, converted to PTE, accessible online (link).

Liabilities: Notes and coin

- 1870 to 1946: from Nuno Valério (2001). Estatísticas Históricas Portuguesas, Table 7.6.
- 1947 to 1995: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal, accessible online (link).
- 1996 to 1998: Banco de Portugal, Annual Reports, Various Issues. Accessible online (link).
- 1999 to 2023: from Banco de Portugal. BPstat Estatísticas Online. Estatísticas monetarias e financeiras, Institucoes financeiras monetarias, Balanco de Banco de Portugal, series, "Notes and coins", December values, converted to PTE, accessible online (link).

Liabilities: Deposits

- 1947 to 1996: from Banco de Portugal, Séries longas para a economia portugesa pós II Guerra Mundial, Parte I – Estatísticas monetárias e financeiras, Balanco do Banco de Portugal, accessible online (link).
- 1976 to 2020: from International Monetary Fund, International Financial Statistics, Monthly Report, various issues, series "Central bank, reserve deposits of other depository corporations", December values.

Liabilities: Foreign

- 1996 to 1998: Banco de Portugal, Annual Reports, various issues, sum of "Non-resident credit institutions", "International Monetary Fund", "European Monetary Institute", "Other international institutions" and "Other non-residents", accessible online (link).

Spain

NGDP basis:

- We use Alvarez-Nogal and de la Escosura (2013)'s series.

Assets: Total

- 1587 to 1805: Public Banks of Naples, via Balletta (2018). Note: since the Kingdom of Naples constituted a Spanish possession until the Napoleonic era, governed by a Spanish viceroy, we treat the Public Banks of Naples as Spanish institutions, in line with related literature.
- 1830-1870: Banco de San Fernando/Banco d'Espana, via de Lorca (1999) and Martin-Acena (2017).
- 1870 to 1935: from Banco de Espana, BIEST - Sistema de búsqueda de información estadística, Publicaciones, Boletín Estadístico, 7. Banco de Espana, December values, converted to ESP, accessible online (link).
- 1980 to 2023: from Banco de Espana, BIEST - Sistema de búsqueda de información estadística, Publicaciones, Boletín Estadístico, 7. Banco de Espana, December values, converted to ESP, accessible online (link).

Assets: Government debt

- 1870 to 1935: Carreras, Albert and Tafunell, Xavier, "Estadísticas historicas de Espana, Siglos, XIX-XX, Volumen 1", Capitulo 9, Sistema moneatrio y financiero, Cuadro 9.9.
- 1948 to 1992: Carreras, Albert and Tafunell, Xavier, "Estadísticas historicas de Espana, Siglos, XIX-XX, Volumen 1", Capitulo 9, Sistema moneatrio y financiero, Cuadro 9.9.

Assets: Gold

- NA

Assets: Foreign

- 1980 to 2023: from Banco de Espana, BIEST - Sistema de búsqueda de información estadística, Publicaciones, Boletín Estadístico, Banco de Espana, December values, converted to ESP, accessible online (link).

Liabilities: Notes and coin

- 1870 to 1935: from Carreras, Albert and Tafunell, Xavier, "Estadísticas historicas de Espana, Siglos, XIX-XX, Volumen 1", Capitulo 9, Sistema moneatrio y financiero, Cuadro 9.9.
- 1941 to 1979: from Carreras, Albert and Tafunell, Xavier, "Estadísticas historicas de Espana, Siglos, XIX-XX, Volumen 1", Capitulo 9, Sistema moneatrio y financiero, Cuadro 9.9.
- 1980 to 2023: from Banco de Espana, BIEST - Sistema de búsqueda de información estadística, Publicaciones, Boletín Estadístico, 7, Banco de Espana, December values, converted to ESP, accessible online (link).

Liabilities: Deposits

- 1870 to 1935: from Carreras, Albert and Tafunell, Xavier, "Estadísticas historicas de Espana, Siglos, XIX-XX, Volumen 1", Capitulo 9, Sistema moneatrio y financiero, Cuadro 9.9.
- 1941 to 1972: from Carreras, Albert and Tafunell, Xavier, "Estadísticas historicas de Espana, Siglos, XIX-XX, Volumen 1", Capitulo 9, Sistema moneatrio y financiero, Cuadro 9.9.
- 1980 to 2023: from Banco de Espana, BIEST - Sistema de búsqueda de información estadística, Publicaciones, Boletín Estadístico, 7, Banco de Espana, December values, converted to ESP, accessible online (link).

Liabilities: Foreign

- NA

Sweden

NGDP basis:

- Prior to 1870, we rely on NGDP figures in Edvinsson (2014), table II.A4.1, "GDP by activity in current prices".

Assets: Total

- 1668 to 2011: Fregert (2014).
- 2012 to 2023: from Sveriges Riksbank, "The Riksbank's assets and liabilities, the Weekly Report", Issues of last December-week, "Gold", 31th of December values, levels, accessible online (link).

Assets: Government debt

- 1668 to 2011: Fregert (2014). From 1858, Fregert (2014) consolidates Swedish government bonds together with other domestic assets into "domestic assets" – the decomposition is available via Simonsson (1931), which we use.

Assets: Gold

- 1668 to 2011: Fregert (2014).
- 2012 to 2023: from Sveriges Riksbank, "The Riksbank's assets and liabilities, the Weekly Report", Issues of last December-week, "Gold", 31th of December values, levels, accessible online (link).

Assets: Foreign

- 1668 to 2011: Fregert (2014).
- 2012 to 2023: from Sveriges Riksbank, "The Riksbank's assets and liabilities, the Weekly Report", Issues of last December-week. "Claims on residents outside Sweden denom-
- inated in foreign currency". 31th of December values, levels, accessible online (link).

Liabilities: Notes and coin

- 1668 to 2011: Fregert (2014).
- 2012 to 2023: from Sveriges Riksbank, "The Riksbank's assets and liabilities, the Weekly Report", Issues of last December-week, "Bank Notes and Coins in Circulation", 31th of December values, levels, accessible online (link).

Liabilities: Deposits

- 1668 to 2011: Fregert (2014).
- 2012 to 2023: from Sveriges Riksbank, "The Riksbank's assets and liabilities, the Weekly Report", Issues of last December-week, "Liabilities to Swedish credit institutions related to monetary policy operations denominated in Swedish Kronor", 31th of December values, levels, accessible online (link).

Liabilities: Foreign

- NA

Switzerland

Assets: Total

- 1907 to 1995: from Swiss National Bank, Balance Sheets and Income Statements table 1.1, accessible online (link).
- 1996 to 2023: from Swiss National Bank, "Bilanzpositionen der SNB", December values, accessible online (link).

Assets: Government debt

- NA

Assets: Gold

- 1907 to 1995: from Swiss National Bank, Balance Sheets and Income Statements table 1.1, accessible online (link).
- 1996 to 2020: from Swiss National Bank, "Bilanzpositionen der SNB", December values, accessible online (link).

Assets: Foreign

- 1907 to 1995: from Swiss National Bank, Balance Sheets and Income Statements, table 1.1, sum of column "International Payment Instruments", "Reserve Position in the IMF" and "Foreign Currency Investments", accessible online (link).
- 1996 to 2023: from Swiss National Bank, "Bilanzpositionen der SNB", sum of "Devisenanlagen", "Reservepositionen beim IWF" and "Internationale Zahlungsmittel", December values, accessible online (link).

Liabilities: Notes and coin

- 1907 to 1995: from Swiss National Bank, Balance Sheets and Income Statements table 2.1, accessible online (link).
- 1996 to 2023: from Swiss National Bank, "Bilanzpositionen der SNB", December values, accessible online (link).

Liabilities: Deposits

- 1907 to 1995: from Swiss National Bank, Balance Sheets and Income Statements table 2.1, accessible online (link).

- 1996 to 2023: from Swiss National Bank, "Bilanzpositionen der SNB", sum of "Girokonten inländischer Banken", "Girokonten ausländischer Banken" and "Übrige Sichtverbindlichkeiten", December values, accessible online (link).

Liabilities: Foreign

- 1961 to 1995: from Swiss National Bank, Balance Sheets and Income Statements table 2.1, accessible online (link).
- 1996 to 2020: from Swiss National Bank, "Bilanzpositionen der SNB", December values, accessible online (link).

United Kingdom

Assets: Total

- 1700 to 2016: via Dimsdale and Thomas (2017), "The Bank of England's historical balance sheet", accessible online (link).
- 2017-2023: via Bank of England (2024).

Assets: Government debt

- 1700 to 2016: via Dimsdale and Thomas (2017), "The Bank of England's historical balance sheet", accessible online (link).
- 2017-2023: via Bank of England (2024).

Assets: Gold

- 1700 to 2016: via Dimsdale and Thomas (2017), "The Bank of England's historical balance sheet", accessible online (link).
- 2017-2023: via Bank of England (2024).

Assets: Foreign

- NA

Liabilities: Notes and coin

- 1700 to 2020: via Dimsdale and Thomas (2017), "The Bank of England's historical balance sheet", accessible online (link).

- 2017-2023: via Bank of England (2024).

Liabilities: Deposits

- 1700 to 1986: via Dimsdale and Thomas (2017), "The Bank of England's historical balance sheet", accessible online (link).
- 1987 to 2023: from International Monetary Fund, International Financial Statistics, Monthly Report, various issues, series "Central bank, reserve deposits of other depository corporations", December values.

Liabilities: Foreign

- NA

United States

NGDP basis:

- Between 1870-2002, we rely on NGDP in Sutch (2006), resident population multiplied by nominal p.c. GDP.
- From 2003-2023, via Bureau of Economic Analysis [creator], via FRED [distributor], series "GDP".

Assets: Total

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".
- 1914 to 2002: from Federal Reserve System Archives (FRASER), Annual Reports of the Board of Governors, accessible online (link), digitised by C. Bao, J. Chen, N. Fries, A. Gibson, E. Paine, and K. Schuler (2018) "The Federal Reserve System's Weekly Balance Sheet since 1914", Johns Hopkins University, series "Total assets", December values, accessible online (link).
- 2003 to 2020: from Federal Reserve Bank of St. Louis, Economics Data, Sources, Board of Governors of the Federal Reserve System (US), H.4.1 Factors Affecting Reserve Balances, Series "All Federal Reserve Banks: Total Assets", annual data end of year values, levels, accessible online (link).

Assets: Government debt

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".
- 1914 to 2018: from Federal Reserve System Archives (FRASER), Annual Reports of the Board of Governors, digitised by C. Bao, J. Chen, N. Fries, A. Gibson, E. Paine, and K. Schuler (2018) "The Federal Reserve System's Weekly Balance Sheet since 1914", Johns Hopkins University, series "Total U.S. Treasury securities ", December values, via FRED [distributor], series "RAGSTUSTS".
- 2019 to 2023: from Board of Governors [creator], via FRED [distributor], series H.4.1 Factors Affecting Reserve Balances, series "Assets: Securities Held Outright: Federal Agency Debt Securities" and "Assets: Securities Held Outright: U.S. Treasury Securities", annual data end of year values, levels, via FRED [distributor].

Assets: Gold

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".
- 1914 to 2017: from Federal Reserve System Archives (FRASER), Annual Reports of the Board of Governors, accessible online (link), digitised and extended by C. Bao, J. Chen, N. Fries, A. Gibson, E. Paine, and K. Schuler (2018) "The Federal Reserve System's Weekly Balance Sheet since 1914", Johns Hopkins University, series "Gold and gold certificate reserves", December values, accessible online (link).

Assets: Foreign

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".

Liabilities: Notes and coin

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".
- 1914 to 1983: from Federal Reserve System Archives (FRASER), Annual Reports of the Board of Governors, accessible online (link), digitised by C. Bao, J. Chen, N. Fries, A. Gibson, E. Paine, and K. Schuler (2018) "The Federal Reserve System's Weekly Balance Sheet since 1914", Johns Hopkins University, series "Federal Reserve notes in actual circulation", December values, accessible online (link).
- 1984 to 2020: from Federal Reserve Bank of St. Louis, Economics Data, Sources, Board of Governors of the Federal Reserve System (US), H.4.1 Factors Affecting Reserve Balances, series "Currency in Circulation", annual data end of year values, levels, accessible online (link).

Liabilities: Deposits

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".
- 1914 to 2017: from Federal Reserve System Archives (FRASER), Annual Reports of the Board of Governors, accessible online (link), digitised by C. Bao, J. Chen, N. Fries, A. Gibson, E. Paine, and K. Schuler (2018) "The Federal Reserve System's Weekly Balance Sheet since 1914", Johns Hopkins University, series "Total deposits", December values, accessible online (link).

Liabilities: Foreign

- 1792 to 1848: Bank of the United States, via Baker et al. (2019), "The Balance Sheets of the Bank of the United States".
- 1914 to 2018: FRED [distributor], series "LDFBFOA".