The Safety Net: Central Bank Balance Sheets and Financial Crises

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Motivation

• All major central banks have relied on balance sheet expansions for discretionary support to the financial sector during stress episodes in recent years (GFC, Covid, Eurozone programs etc.)

• The debate on the positive effects of such interventions (stabilization) and their negative side effects (moral hazard) is as old as central banking itself

• This paper leveres the history of central bank balance sheets to study the (causal) effects of CB balance sheet expansions during financial crises on macroeconomic outcomes
What we do

1. We build a novel data set for central bank balance sheets and their composition for 17 economies, going back to the first (and proto-) central banks in the 1600s.
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2. We use the new data to study the long-run evolution of CB balance sheets, their short-run fluctuations, and their use for liquidity provision to the financial sector in times of financial stress.
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3. We show that throughout history distinct schools of thought on discretionary balance sheet expansions (f.i., Hankey-Bagehot debate, liquidationists, real bills, etc.) have existed and influenced the (ex ante) beliefs of central bank governors wrt the advisability of interventions in crises.
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3. We show that throughout history distinct schools of thought on discretionary balance sheet expansions (f.i., Hankey-Bagehot debate, liquidationists, real bills, etc.) have existed and influenced the (ex ante) beliefs of central bank governors wrt the advisability of interventions in crises.

4. These ex-ante ideological predispositions of governors correlate with the probability of providing support in crises and give us an instrument to causally estimate the effects on macroeconomic outcomes using the near universe of modern era financial crises interventions.
What we find

1. The recent growth of CB balance sheets is unprecedented relative to GDP, but not relative to financial sector assets. Similarly, CB holdings of government debt are at a record relative to GDP, not relative to outstanding public debt.
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2. The drivers of balance sheet expansions have shifted from war finance to financial sector stabilization in crises.

3. Using quasi random assignment of balance sheet operations during crises, we show that they have large positive effects on the economy, reducing crisis severity.
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2. The drivers of balance sheet expansions have shifted from war finance to financial sector stabilization in crises.

3. Using quasi random assignment of balance sheet operations during crises, we show that they have large positive effects on the economy, reducing crisis severity.

4. We present evidence for elevated boom-bust crisis risk after interventions, indicating that moral hazard could be a valid concern.
Literature

- **Central bank balance sheets and effects of LLR:** Bordo et al. (2001); Honohan and Klingebiel (2003); Drechsler et al. (2016); Calomiris, Flandreau and Laeven (2016); Del Negro, Eggertsson, Ferrero and Kiyotaki (2017); Behr and Wang (2020)

- **Financial crises and their effects:** Reinhart and Rogoff (2009); Schularick and Taylor (2012); Jordá, Taylor and Schularick (2013); Baron, Verner and Xiong (2021); Metrick and Schmelzing (2021)

- **Central bank governors, beliefs and economic outcomes:** Kuttner and Posen (2010); Malmendier, Nagel and Yan (2021); van Ommeren and Piccillo (2021); Bordo and Istrefi (2023); Hack, Istrefi and Meier (2023)
Agenda

1. The evolution of central bank balance sheets in the modern era
2. Major balance sheet expansions and their drivers
3. The causal effects of LLR interventions during crises
The evolution of central bank balance sheets in the modern era
Data

- Annual central bank balance sheet data for 17 countries covering size and detailed composition starting from the 1600s
- We include early and proto central banks
- Additional macroeconomic data and crisis chronologies (JST, BVX)
- All data will be available in the JST database: www.macrohistory.net/database
- Historical sources (primary, secondary) to classify the ex ante ideological predisposition of 112 central bank governors prior to financial crises
Central bank total assets relative to GDP, 17 countries

Notes: Central bank total assets relative to GDP; year-specific mean and quantiles across countries.
Central bank holding of government debt relative to GDP

Notes: Central bank holding of government debt, relative to total government debt outstanding; year-specific mean and quantiles across countries.
Central bank holding of government debt, share of outstanding

Notes: Central bank holding of government debt, relative to total government debt outstanding; year-specific mean and quantiles across countries.
Central bank balance sheets relative to assets of financial sector

Notes: Central bank total assets relative to commercial bank lending to the private sector; year-specific mean and quantiles across countries.
Major balance sheet expansions and their drivers
### Expansions by event type

<table>
<thead>
<tr>
<th>Type</th>
<th>Pre-1870 (n=89)</th>
<th>Post-1870 (n=299)</th>
<th>Post-1945 (n=163)</th>
</tr>
</thead>
<tbody>
<tr>
<td>War</td>
<td>48.2%</td>
<td>35.5%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Fin Crisis</td>
<td>11.8%</td>
<td>25.9%</td>
<td>43.5%</td>
</tr>
</tbody>
</table>

**Note:** Figure displays balance sheet expansion events (at least 15% y-o-y asset growth), by expansion type.
Largest annual expansions - wars vs. financial crises

Notes: Cluster of large CB balance sheet expansions 50-150% year-on-year linked to wars (monetary financing) and financial crises.
Central bank sensitivity to crisis events

Notes: 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 and country fixed effects. Whiskers mark the 95% confidence interval. Deposit insurance system from Demirguc-Kunt and Detragiache (2002).
The long run view: balance sheet trends and expansions

• Shifting drivers of balance sheet expansions
  • 1655-1870: CBs mainly finance government debt, underpinning European war efforts (holding avg. 20% of dom. gvt. debt).
  • 1870-1930: Growing importance of LLR function, but typically still meaningful private sector involvement. Government finance in WWI & II
  • Post-1970s: LLR function becomes dominant, CB balance sheet growth lagging behind financial sector asset growth.

• Precedents to recent balance sheet expansions wrt to size
  • Riksbank monetization of Swedish wars / dom. political chaos, 1740s - 1760s.
  • BoE ramp-up during War of the Spanish Succession, South Sea Bubble, 1710-1725.
  • "Synchronized" DM expansions during WWII, public-asset led.
The effects of central bank liquidity support during crises
Liquidity support and financial crisis outcomes

- Liquidity support correlates with worse crisis outcomes (Bordo et al., 2001, Honohan, Klingebiel, 2003)
Liquidity support correlates with worse crisis outcomes (Bordo et al., 2001, Honohan, Klingebiel, 2003)
But worse crises may warrant more support...
Identification strategy

• Need quasi random variation in liquidity support during crises

• Long-standing differences between schools of thought about the pros/cons of discretionary LLR
  • Hankey-Bagehot debate (19th century),
  • Real bills doctrine and liquidationists (late 19th/early 20th),
  • Rules-focused monetarists (20th century).

• Governors that were ex ante influenced or sympathetic to these schools could be less likely to intervene

⇒ Instrumental variable: beliefs of central bank governor regarding the benefits of LLR
Governor Richard Koch (Reichsbank, 1890-1908) stood in intellectual tradition of non-interventionist Liquidationists – "fierce defender of non-intervention" (Börsen-Zeitung, 1903).

In the 1907 crisis, he refused to intervene despite pressure to do so – intent on "cleansing the Reichsbank balance sheet of all non-trade bills".

"We refuse...to let the Reichsbank be a cheap source of liquidity for commerce...with it being imperative to keep the Imperial currency and stability untouched" (speech at the Prussian Upper Chamber, January 22, 1906).
The arch of intellectual history

PRE-WAR, 1870-

HANKEY-ISTS,
The BOE / REAL BILLS SCHOOL

- W. Lidderdale, BoE
- R. Koch, Reichsbank
- C. Lewenhaupt, Riksbank
- N. V. D. Berg, DNB

INTERWAR &gt;
1929

LIQUIDATIONISTS,
MELLON SCHOOL

- E. Meyer, Federal Reserve
- G. Bachmann, SNB
- V. Moll, Riksbank
- C. Moret, Banque de France
- J. Laundsen, Nationalbanken

MONETARISTS,
BRUNNER-MELTZER-
TAYLOR SCHOOL

POST-WAR,
1980s &gt; 2008

- M. King, BoE
- S. Ingves, Riksbank
- M. Lusser, SNB
- G. Bouey, Bank of Canada
Central bank governor beliefs at the start of banking crises: Step 1

- We parse ex ante crisis period systematically for governor primary sources, exploiting database advances, revealing preference ranking.
Central bank governor beliefs at the start of banking crises: Step 2

- Particular attention is put on statements revealing moral hazard concerns.

“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

$t=1$ Governor appointment date: 1890

$t=2$ BVX crisis date: 1907
## Central bank governor beliefs at the start of banking crises

<table>
<thead>
<tr>
<th>Country</th>
<th>Governing Bank</th>
<th>Governor</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>E. H. Palmer</td>
<td>E. Meyer</td>
</tr>
<tr>
<td>UK</td>
<td>H. Kunitz</td>
<td>G. Richardson</td>
</tr>
<tr>
<td>Switzerland</td>
<td>C. Lewenhaupt</td>
<td>J. M. Lopez de Letona</td>
</tr>
<tr>
<td>Sweden</td>
<td>A. Romero Orin</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Spain</td>
<td>A. de Manara</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Portugal</td>
<td>K. G. Bomhoff</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Norway</td>
<td>N. Van den Berg</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Y. Shigetoshi</td>
<td>Y. Miura</td>
</tr>
<tr>
<td>Japan</td>
<td>C. Bombardi</td>
<td>C. A. Giafferi</td>
</tr>
<tr>
<td>Italy</td>
<td>G. Grillo</td>
<td>R. Kussberg</td>
</tr>
<tr>
<td>Germany</td>
<td>R. Koch</td>
<td>E. Hofstetter</td>
</tr>
<tr>
<td>France</td>
<td>P. Magnin</td>
<td>N. Bernstein</td>
</tr>
<tr>
<td>Finland</td>
<td>T. Wegelin</td>
<td>G. Bouey</td>
</tr>
<tr>
<td>Denmark</td>
<td>S. Lintennen</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Canada</td>
<td>T. De Lantcheva</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Belgium</td>
<td>E. Previnaire</td>
<td>J. C. Trichet</td>
</tr>
<tr>
<td>Australia</td>
<td>W. McMillan</td>
<td>J. C. Trichet</td>
</tr>
</tbody>
</table>

### Biographical features

- **Hawk**: Aggressive monetary policy to combat inflation.
- **Dove/Pragmatist**: More accommodative monetary policy to support growth.

<table>
<thead>
<tr>
<th>Period</th>
<th>Hawk</th>
<th>Dove/Pragmatist</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1910</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td></td>
<td></td>
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<tr>
<td>1950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: The table above lists governors and their beliefs at the start of banking crises in various countries.*
Hawks and doves: crisis response

- LLR = credit to banks unable to borrow at viable rates from (distressed) markets
- Central bank LLR operations increase bank reserves ⇒ expand balance sheet

Notes: 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. Data from 89 crises dated by Baron, Verner and Xiong (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 90% confidence intervals.
Empirical setup: LP-IV

Crisis intervention

\[ m_{i,t+1} = \begin{cases} 
1 & \text{annual CB balance sheet growth} \geq 15\% \text{ in } t \text{ or } t + 1 \\
0 & \text{else} 
\end{cases} \]
Empirical setup: LP-IV

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<table>
<thead>
<tr>
<th></th>
<th>Dove</th>
<th>Hawk</th>
</tr>
</thead>
<tbody>
<tr>
<td>crisis w/o intervention</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>crisis w/ intervention</td>
<td>21</td>
<td>9</td>
</tr>
</tbody>
</table>
Empirical setup: LP-IV

**Crisis intervention**

\[
m_{i,t+1} = \begin{cases} 
1 & \text{annual CB balance sheet growth } \geq 15\% \text{ in } t \text{ or } t + 1 \\
0 & \text{else}
\end{cases}
\]

First stage:

\[
m_{it+1} = a_i + bg_{it+1} + cx_{it+1} + e_{it+1}
\]

Second stage:

\[
y_{it+h} - y_{it+1} = \alpha_{i,h} + \beta_{h} \hat{m}_{it+1} + \gamma_{h} x_{it+1} + \epsilon_{it+h}
\]

\((i,t)\) sample of country-years with financial crises.

\(g_{it+1}\) hawkish governor

\(y_{it}, x_{it}\) macro-financial outcome and control variables

\(a_{i,h}, \alpha_{i,h}\) country fixed effects

\(h = 2, 3, 4\) ▶ Timing
Macro-financial outcome and control variables

Outcome variables $y_{it}$
- log real GDP per capita
- log CPI
- log money

Control vector $x_{it}$:
- real GDP per capita growth, contemporaneous and two lags
- inflation and money growth, contemporaneous and two lags
- Three-year growth of real private sector bank lending (credit boom size)
Ex-ante beliefs and balance sheet expansion

First stage:  \[ m_{it+1} = a_i + bg_{it+1} + e_{it+1} \]

<table>
<thead>
<tr>
<th>Hawkish governor ((g_{it+1} = 1))</th>
<th>-0.363***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.083)</td>
</tr>
</tbody>
</table>

Macro controls: Yes

Country FE: Yes

\[ F = 18.91 \]

\[ R^2 = 0.33 \]

Crisis: 78

Notes: Dependent variable is balance sheet expansion. Macroeconomic controls include contemporaneous and two lags of real GDP growth, inflation and three-year growth in real bank lending to the private sector prior to the financial crisis. Country fixed effects absorbed by within-estimator. Standard errors clustered on countries in parentheses. *** \( p < 0.01 \).
The effects of liquidity support

Track path of real GDP, CPI, money over horizons $h = 2, 3, 4$ relative to levels at $h=1$:

Second stage: $y_{it+h} - y_{it+1} = \alpha_{i,h} + \beta_h \hat{m}_{it+1} + \gamma_h \bar{x}_{it+1} + \epsilon_{it+1+h}$

Liquidity support and crisis trajectories

Impact of central bank liquidity injection ($m_{it+1} = 1$), with confidence bands:

$\hat{\alpha}_h + \hat{\gamma}_h \bar{x}_{it+1} + \hat{\beta}_h$

comparing to average trajectory without liquidity injection:

$\hat{\alpha}_h + \hat{\gamma}_h \bar{x}_{it+1}$

($\hat{\alpha}_h$ denotes the average fixed effect)
Large differences in crisis outcomes

Notes: Plots show the trajectory of macroeconomic aggregates after financial crises depending on central bank liquidity policy. Uncertainty about trajectory of liquidity expansions induced by estimation uncertainty in $\beta_h$ is represented by lightly shaded areas marking its 90% confidence interval; ± one standard error is marked in dark. Country fixed effects and macro-financial controls included. Standard errors clustered on the country level.
Investment and stock prices recover faster

Notes: Lightly shaded areas mark 90% confidence intervals due to uncertainty around $\hat{\beta}_h$. In dark, ± one standard error. Country fixed effects and dynamic macro-financial controls augmented by real stock and aggregate investment growth in $t$ and $t + 1$. Standard errors clustered on countries.
LLR or fiscal monetisation?

(a) Central bank balance sheet composition

(b) Public finances

Notes: Lightly shaded areas mark 90% confidence intervals due to uncertainty around $\hat{\beta}_h$. In dark, ± one standard error. Country fixed effects and baseline dynamic macro-financial controls augmented by growth in central bank deposits and government debt holdings at $t - 1$ and $t - 2$ in the left panel and by growth of real public expenditures and real public debt at $t - 1$ and $t - 2$ in the right panel. Standard errors clustered on countries.
Robustness checks

Alternative control setups
- Government expenditure
- Policy rate changes
- Extant deposit insurance
- Bank capital ratios
- Episode dummies
- No controls except country FE

Alternative liquidity measures
- Injection threshold 10%
- Injection threshold 20%
- Continuous injection measure
- Dependent central banks

Alternative samples
- JST crisis sample
- RR crisis sample
- Dropping post-2007
- Without Great Depression
Long-term risks

Notes: Share of country-years experiencing a credit boom episode, binned by the number of years since last financial crisis and respective central bank liquidity support ($m_{it+1} = 1$). 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.
Liquidity injections predict boom-bust episodes

<table>
<thead>
<tr>
<th></th>
<th>(1) OLS</th>
<th>(2) OLS</th>
<th>(3) Logit</th>
<th>(4) 2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquidity injection, last crisis</td>
<td>0.037**</td>
<td>0.078**</td>
<td>0.105***</td>
<td>0.158***</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.034)</td>
<td>(0.024)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>Macro controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.01</td>
<td>0.10</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Pseudo-$R^2$</td>
<td></td>
<td></td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>First-stage $F$</td>
<td></td>
<td></td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td>$N$</td>
<td>1109</td>
<td>737</td>
<td>527</td>
<td>679</td>
</tr>
</tbody>
</table>

Notes: Coefficient estimates from different models for the probability to experience a boom-bust episode within 20 years since the last financial crisis at time $c(t)$ of the form $B_{it} = \alpha_i + \beta m_{i,c(t)+1} + \gamma h x_{it+1} + \epsilon_{it+h}$. 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. The main row shows coefficients of a dummy indicating liquidity support during the previous financial crisis ($m_{i,c(t)+1} = 1$). 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 $g_{i,c(t)+1}$, replicating the IV setting from the previous section. Macroeconomic controls as detailed in the text. OLS and 2SLS estimators absorb country fixed effects absorbed by within-estimator. Robust standard errors in parentheses. ***, **, *p < 0.01, 0.05, 0.10.
Conclusion

• Central banks balance sheets have grown size relative to the real economy, but not relative to financial sector size

• Sharp shift from fiscal (war) finance to financial sector stabilisation post WW2

• Large liquidity injections stabilise the economy and financial markets in financial crises and boost the recovery

• This may come at the price of elevated boom-bust crisis risk in the long run (moral hazard)
Federal Reserve holding of government debt, share of outstanding

Notes: Central bank holding of government debt, relative to total government debt outstanding; year-specific mean and quantiles across countries.
Major central bank balance sheet expansions

Notes: In total, 742 country-year expansion events are displayed, defined as +15% year-on-year total nominal asset growth or more.
Balance sheet sensitivity towards 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.
Balance sheet operations under currency pegs

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 currency-regime-specific coefficients for a financial crisis as well as country fixed effects. Whiskers mark the 95% confidence interval.
# Biographical attributes of CB governors

<table>
<thead>
<tr>
<th></th>
<th>Hawks</th>
<th>Doves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crisis observations</td>
<td>29</td>
<td>47</td>
</tr>
<tr>
<td>Age at crisis</td>
<td>58</td>
<td>61.0</td>
</tr>
<tr>
<td>Treasury experience (share)</td>
<td>27.6%</td>
<td>40.4%</td>
</tr>
<tr>
<td>Political party membership (share)</td>
<td>17.2%</td>
<td>36.2%</td>
</tr>
<tr>
<td>Financial sector experience (share)</td>
<td>51.7%</td>
<td>31.9%</td>
</tr>
<tr>
<td>Pre-appointment crises</td>
<td>2.22</td>
<td>1.57</td>
</tr>
</tbody>
</table>

**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, with the CPI index sourced via the "JST database".
Measuring LLR via central bank balance sheet expansions

• Not all LLR interventions cause aggregate annual expansions:
  1. Sterilisation
  2. Short-lived expansions
  3. Announcement impact (effect without actual expansion, c.f., OMT)
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 (Baron, Verner, Xiong, 2021). 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.
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.
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.
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.
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.
Due to lagged CB reactions and ambiguities in identifying the start of financial crises, we adopt the following timeline:

- $h = 0$ financial crisis start year (Baron, Verner, Xiong, 2021).
- $h \in \{0, 1\}$ measuring CB balance sheet expansion.
- $h \geq 2$ local projections (change relative to $h = 1$).
## Additional institutional controls in first stage

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<td>78</td>
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</table>

**Notes:** Macroeconomic controls include contemporaneous and two lags of real GDP growth, inflation and three-year growth in real bank lending to the private sector prior to the financial crisis. Country fixed effects absorbed by within-estimator. Standard errors clustered on countries in parentheses. \(*** p < 0.01\).
### Additional biographical controls in first stage

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**Notes:** Variables measure the pre-appointment biographies of governors: number of crises experiences, inflation, positions in the financial sector, treasury or the cabinet, party affiliation and his age. Standard errors clustered on countries in parentheses. *** \(p < 0.01\).
Controlling for government expenditures

Notes: Baseline controls extended by real government expenditure growth with the same lag structure.
Controlling policy rate changes

Notes: Baseline controls extended by policy rate changes with the same lag structure.
Controlling for policy rate changes

Notes: Adding a binary control indicating the presence of an explicit mandatory deposit insurance (Demirguc-Kunt and Detragiache, 2002).
Controlling for fiscal policy

Notes: Within estimation nets out country FE effects. Controlling for changes in the fiscal expenditure coinciding with our balance sheet expansion measure. Standard errors clustered on countries. Light shaded areas mark 90% CIs, dark shading marks ± one standard error.
Controlling for bank capitalisation

Notes: Baseline controls extended by measure of bank leverage ratio in year before financial crisis.
Adding episode fixed effects

**Notes:** Baseline controls extended by two time period fixed effects: (i) classical gold standard and (ii) post WW2.
Omitting all controls except country fixed effects

Notes: Baseline controls dropped, except country fixed effects.
Using +10% expansion threshold

**Notes:** Central banks are coded to have injected liquidity in response to a financial crisis when they grew their balance sheet by +10% annually or more during the initial or subsequent year of the crisis.
Using +20% expansion threshold

Notes: Central banks are coded to have injected liquidity in response to a financial crisis when they grew their balance sheet by +20% annually or more during the initial or subsequent year of the crisis.
Measuring expansion by 2-year balance sheet growth

Notes: Central bank expansions are measures by the bi-annual growth of the central bank balance sheet during the first and second year of the crisis.
Notes: 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.
Using JST crisis chronology

Notes: Dating financial crises using narrative chronology of Jorda et al. (2017).
Using RR crisis chronology

Notes: Dating financial crises using narrative chronology of Reinhart and Rogoff (2009).
Dropping Great Financial and subsequent crises

Notes: Omitting all banking crises starting 2007 or later.
Dropping Great Depression

Notes: Omitting all banking crises starting between 1929 and 1933.
Time to next financial crisis

(a) Averages

(b) Full distributions

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.
Can penalty rates limit moral hazard?

**Notes:** Share of country-years experiencing a credit boom episode, binned by the number of years since last financial crisis with central bank liquidity support ($m_{it+1} = 1$) where annual policy rate increase is below (left) or above median (right). 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.