An analytical framework to calibrate macroprudential policy

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Outline

1 Macroprudential analysis: the objectives;

2 The analytical tools;

3 The analytical framework at Banque de France;

4 The hybrid approach;

5 The structural approach;

6 Conclusion.

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Intro to the Macroprudential analysis

Implementation of MaP is among the key post-crisis global (G20) policy goals.

Macroprudential policy (MaP) aims at preventing the risk of widespread disruption to the provision of financial services that impacts the real economy.

Intro to the Macroprudential analysis

- How do we measure the risks?
- What if these risks materialize?
- When should we activate our instruments?
- By how much? What is the "right" size of the activation?
- What is the impact of our measures?

The recent design of these policies and the limited policy makers' experience over this domain leave us with many questions and very few answers (so far).

Analytical models help us to answer these questions.

The different phases of the Map analysis

The Macroprudential analysis can be unfolded in four phases:

1. Risk assessment: evaluating the build-up of imbalances. Different dimension: cyclical versus structural risks; global versus sectoral risk (i.e. housing); internal versus external risk;
2. Scenario design: mapping the identified risks into possible scenarios;
3. Calibration: finding the optimal level of our instruments. Different dimension: size of the activation; timing, phasing-in period, lenght, duration, communication, reciprocity.
4. Evaluation of the impact: identifying the effects related to the activation of the instruments. Different dimension: short versus long run; costs versus benefits; domestic effects versus spillovers.

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Risk assessment

- Risk can be assessed by a series of time-varying indicators.
- Early warning indicators: they capture financial overheating and signal potential banking distress over medium-term horizons (Coudert et Idier, 2017).
- EWI are calibrated with reference to the signal-to-noise ratio, defined roughly as the ratio of correctly predicted historical episodes to false alarms.

Early Warning Indicators: some examples

- Credit/GDP, Credit growth, Housing prices growth;
- Debt to Service Ratio:

$$DSR_t = \frac{D_t}{Y_t} \frac{i_t}{1-(1+i_t)^{-m}} \tag{1}$$

- Basel gap: the gap between the credit-to-GDP ratio and its long-term trend;
- Other measures of the financial cycles are the *composite* indicators: weighted averages of simple indicators.

Debt to Service Ratio

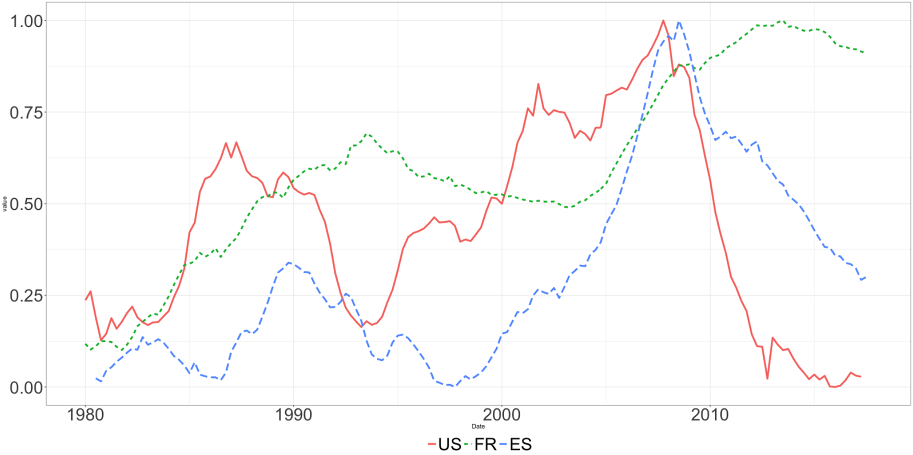

Figure : Households Debt to Service Ratio, rescaled between 0 and 1

Credit to GDP gap

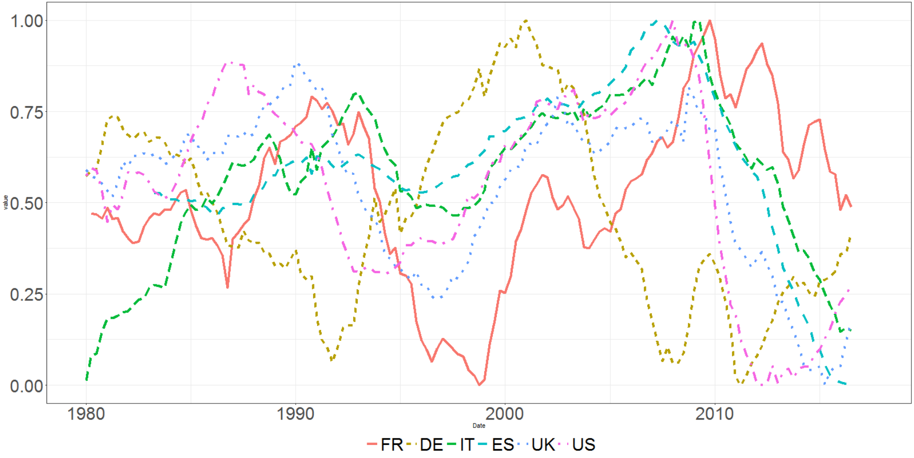

Figure : Households Debt to Service Ratio, rescaled between 0 and 1

From risk to scenarios

The risks identified need to be translated into the macroeconomic scenarios.

For example: An overheating in the housing sector can increase the risks of housing burst. This risk can be mapped into a strong negative housing shock on the main macroeconomic and financial variables.

These scenarios can be used:

- To provide the policy maker of an idea of what are the consequences in case of materialization of risks
- To test the resilience of financial sector in case of materialization of risks;
- To run counterfactual exercises: what are the effects of some specific instrument activation?

A different set of macrofinancial models can be used: Econometric/ more or less structural macroeconomic models.

The output of this model will be a set of macroeconomic and financial scenarios, to be used in the macropru analysis.

Calibration

Calibration can be performed according to different types of models. In the macroprudential analysis, the main calibration approaches are:

- (Macroprudential) stress test models: models that test the resilience of economic agents (i.e. banks, households, firms, insurances, etc.)
- Macroeconomic models (DSGE, SVAR, GVAR, econometric models as FRB/US): these models help to assess the costs and benefits related to the activation of the macroprudential instruments;
- Indicators based instruments: with this approach, indicators are directly mapped onto the levels of macroprudential instruments (i.e. Basel rule, O-SII buffers).

NB: in any calibration exercise, expert judgment applies to take into account the limits that each calibration model has.

The stress-test approach

Stress tests are econometric and accounting models that link the macroeconomic and financial scenarios to the financial conditions of individuals (i.e. solvency of banks).

For example, for the banking sector:

- Different scenarios are considered (baseline vs adverse);
- The stress test models link the macroeconomic scenarios to the returns of the different blocks of the banks' balance sheet $\rightarrow$ this allows computing the evolution of profits and of CET1;
- Similarly, the risk weighted assets (RWA) are linked to the evolution of the macroeconomic scenarios;
- In conclusion, the solvency in terms of the capital ratio (e.g. CET1/RWA) can be assessed for each bank.

The macroprudential stress-test

The Stress test models were born as a microprudential tool.

NB: analysis is generally conducted at micro level and in partial equilibrium. This means that these models risk to lose the additional effects that can derive from the fact that the macroeconomic stress affect all the participants of the market (i.e. general equilibrium effect).

For this reason, the stress tests become macroprudential when they include:

- Contagion effects: modeled through satellite models (i.e. networks);
- Dynamic balance sheet: portfolios reallocation following macroeconomic shocks (e.g. reduction in credit supply);
- Macro feedback effects related to the activation of the macropru instruments (e.g. further deterioration of the macroeconomic scenarios following the activation of macropru instruments)

The instruments will be calibrated in order to ensure the resilience of the financial sector to the possible adverse scenarios.

Macroeconomic models: costs and benefits

Macroeconomic models help to quantify the costs and the benefits related to the activation of macrofinancial instruments.

In order to allow calibration, the macroeconomic models need to incorporate a transmission channel from the macroprudential instruments to the macroeconomic and financial variables.

The activation of a instrument can be related to macroeconomic costs (e.g. in terms of GDP, credit growth, welfare)

For assessing benefits, macroeconomic models need to consider the effects on solvency of agents (e.g. probability of defaults of banks)or differences in the ability of banks to recapitalize in normal vs. stressful times.

For example, the activation of the CCyB is associated to:

- Costs: it forces banks to turn towards a more costly source of funding (equity)
- Benefits: reduction in banks' default frequency, and hence in resources lost in bankruptcy.
- The instrument can be calibrated by maximizing the net benefits, in terms of expected loss of GDP (or Welfare in the best cases) ($EL = PD * LGD$) subject to a MaP action.

Calibration with respect to an indicator or a rule

Instruments can be calibrated according to the level of an indicator (simple or composite).

In this sense, the most famous rule is the Basel III rule:

$$\text{Required } \frac{\text{capital}}{\text{RWA}}: \quad \nu_t = \underbrace{\nu}_{\text{noncyclical}} + \underbrace{\phi_\nu}_{\text{cyclical (rule)}} \left(\frac{Credit_t}{GDP_t} - \frac{Credit}{GDP} \right) + \underbrace{\epsilon_t^\nu}_{\text{cyclical (unexp.)}}$$

Considering the instruments tackling the structural risk, the O-SII and the G-SII buffers are calibrated according to the cluster associated to the bank.

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France: The institutional framework

$\Rightarrow$ EU: CRD4/CRR banking regulation provides national authorities with a full set of macropru instruments in line with Basel III principles.
$\Rightarrow$ France: Haut Conseil de Stabilite Financiere (HCSF) is the authority in charge of macropru measures *upon proposal of BdF's governor*.

HCSF has authority over two bank capital-based macropru measures in particular:

- Systemic risk buffer (SRB): noncyclical buffer
- Countercyclical capital buffer (CCyB): cyclical buffer

Operational contribution: This work fleshes out the approach developed at the BdF/DSF to calibrate CCyB and SRB, and it contributes to the analytical support to BdF governor's proposal to HCSF.

The analytical framework for MaP policy

Menu and methodology: Strategies for impact analysis and MaP design:

1. CCyB: dual objective (resilience and "taming the cycle")
   1. Hybrid strategy: focus is more on resilience of banks to adverse event; methodology: macropru top-down stress testing tool;
   2. Structural strategy: focus is more on taming the cycle / maximize welfare; methodology: BIII-type rule in DSGE model)

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2. SRB (objective: mitigate long-run inefficiencies in banking sector; methodology: optimal long-run welfare analysis in DSGE model)

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Hybrid approach

Objective of the macroprudential authority: Prevent banks from falling below the noncyclical regulatory threshold level under a stressful scenario.

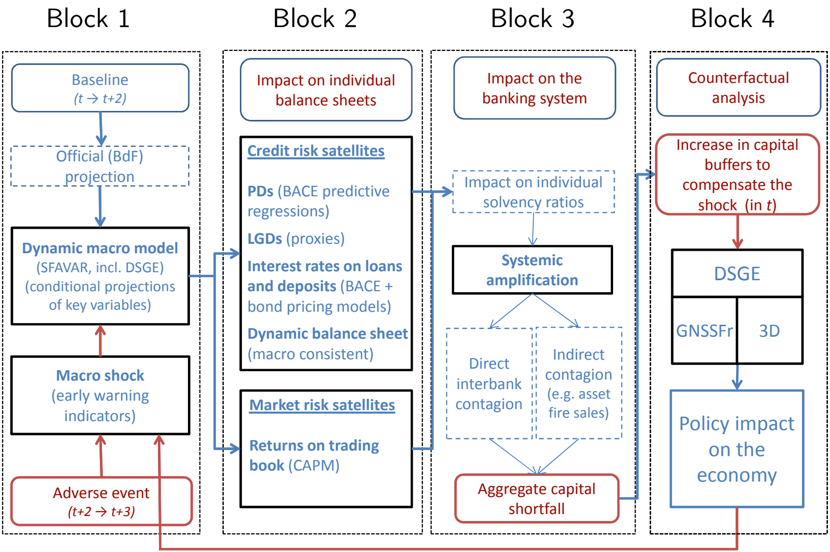
Methodology: systemic risk analysis for scenario design, top-down stress testing tool (cum contagion), and a DSGE model for policy impact analysis:

1. Block 1: scenario design
2. Block 2: impact on individual banks
3. Block 3: contagion
4. Block 4: policy impact

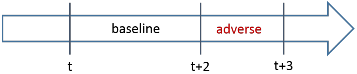
If a capital shortfall is anticipated, activate today CCyB to offset the shortfall:

- The scenario is resimulated to account for the contractionary effects of such a CCyB increase on economic activity.
- Rerun stress testing exercise under exacerbated scenario to update the prescribed calibration.
- Repeat until convergence...

Hybrid approach



Hybrid approach: Block 1: Macroeconomic context



Step 1 (baseline scenario): Matches BdF's baseline projections (BMPE) of annual growth rates of GDP and inflation over 2017q1-2019q4. Conditional on this, we perform projections of the remaining variables included in the projecting model (here: VAR-type model) by using standard filtering techniques. ▸ Model

Step 2 (systemic risk analysis): Instantaneous adverse shock at 2019q1 in connection to ERS [Evaluation des risques du systeme financier francais].

Step 3 (adverse scenario): Scenario is completed by constructing an adverse scenario over 2019q1-2019q4 simulated with a structural model (here: SVAR).

⇒ *The adverse event shown here is illustrative. An adverse event originating from an abrupt broad-based reversal of compressed global risk premia due to a change in investor preferences and higher risk aversion. It would propagate to EU stock market indices with an adverse effect on CAC40 valuations.*
⇒ *Implemented as a -40% shock to CAC40 valuations joint with a 2 s.d. bank risk shock; frequency:* $< 0.5\%$ *p.a.*

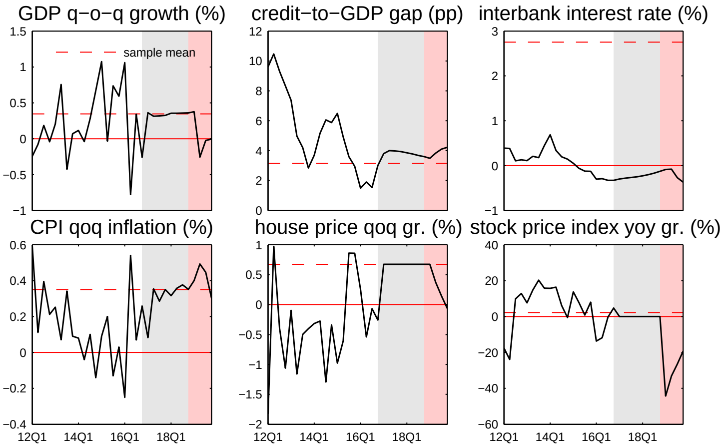


Figure : Illustrative scenario. Baseline projection from 2016q4 onwards (grey area). Adverse event from 2019q1 onwards (red area). An adverse event originating from an abrupt broad-based reversal of compressed global risk premia due to higher risk aversion, propagated to EU stock market indices with an adverse effect on CAC40 with a −40% shock to CAC40 valuations joint with a 2 s.d. bank risk shock.

Hybrid approach: Block 2: Top-down stress testing tool

Numerator (CET1):

- Net interest income: loans on banking book maturing within the stress testing period are renegotiated at new prices, functions of projected default probabilities, losses-given-default and interest rates on different asset classes; deposits maturing within the stress testing period renegotiated at projected deposit rates.
- Net market income: returns on trading book related to market returns via CAPM beta/LRMES (Acharya et al., 2013).
- Provisions: driven by projected default probabilities on asset classes in banking book.

Denominator (RWA):

- driven by projected default probabilities and losses-given-default using internal ratings-based (IRB) formulas for risk weights.

$\Rightarrow$ *Banks capital ratios drop when the adverse event occurs (2019q1), with 2 out of the 6 main French banks falling slightly below the respective threshold levels (min. CET1/RWA + prospective BIII CCoB + structural buffers + P2R).*

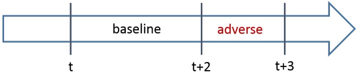
Hybrid approach: Block 3: Contagion

Contagion develops through:

- direct losses on interbank equity and debt
- indirect losses due to fire sales (that may set-off upon bank failures)
- margin calls on collateralized interbank debt as soon as the market value of assets is depleted

▸ Model

Hybrid approach: Block 4: Policy impact



Recall: objective metric under this approach is to prevent banks from falling below the noncyclical regulatory threshold level in the adverse event.

⇒ Top-down stress testing tool offers an indication of a systemic capital shortfall.

⇒ Utilize a DSGE with nontrivial financial intermediary sector to conduct counterfactual analysis:

- Generate a counterfactual scenario under suggested activation of the CCyB (at t)
- Update capital shortfall
- Iterate to convergence

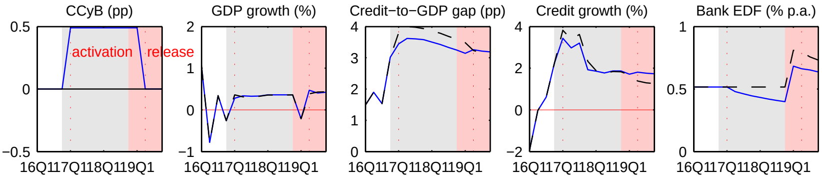
▸ Models

Hybrid approach: Quantitative example

	bank 1	bank 2	bank 3	bank 4	bank 5	bank 6
end-2017	-0.0003	-0.0004	-0.0004	-0.0002	-0.0003	-0.0003
end-2018	-0.0004	-0.0006	-0.0005	-0.0003	-0.0005	-0.0004
end-2019	-0.0433	-0.0432	-0.0369	-0.0456	-0.0432	-0.0384
end-2019+contagion	-0.0921	-0.0768	-0.0599	-0.0996	-0.0800	-0.0793

End-of-period losses in CET1/RWA relative to the 2016Q4 level for the main 6 French banks under the illustrative scenario. Contagion amplification at end-2019 corresponds to extreme market stress.

Scenario for key variables without (dashed black) and with (solid blue) CCyB:



⇒ Required activation to meet the objective is modest, and so is macro impact.

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Structural approach

Required $\frac{\text{capital}}{\text{RWA}}$: $\nu_t = \underbrace{\nu}_{\text{noncyclical}} + \underbrace{\phi_\nu}_{\text{cyclical (rule)}} \left(\frac{Credit_t}{GDP_t} - \frac{Credit}{GDP} \right) + \underbrace{\epsilon_t^\nu}_{\text{cyclical (unexp.)}}$

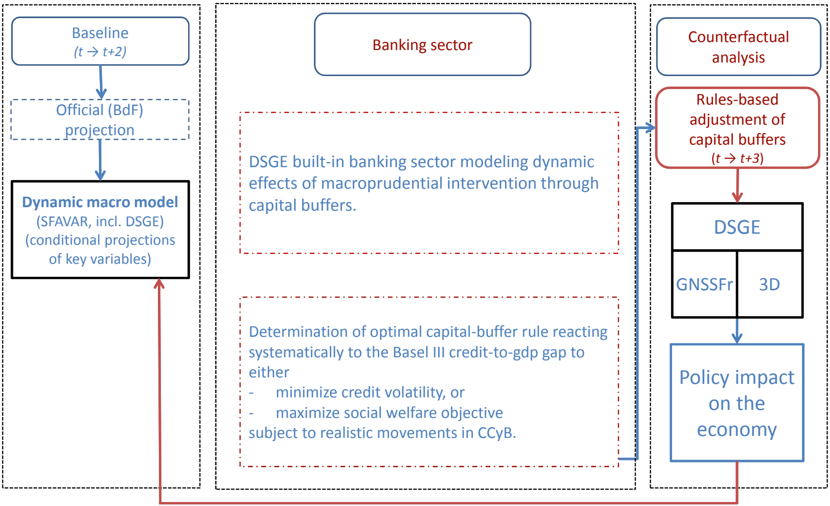
Objective of the macroprudential authority: predictable policy reaction s.th.

$$\phi_\nu = \arg\min \{ var(\text{credit growth}) + \lambda var(\nu_t) \}$$

where λ reflects the policymaker's priorities when trading off a reduction in credit volatility and a variation in the instrument of an acceptable magnitude (e.g., BCBS 2012 envisages a CCyB $\in [0, 2.5\%]$).

Methodology: DSGE model for macroprudential policy evaluation.

Structural approach



Structural approach

Two DSGEs used alternatively:

More

- Gerali et al. (JMCB 2010) estimated on key French data by Bayesian methods.
- 3D model by Clerc et al. (IJCB 2015) matching level and volatility of key French data.

3D	**GNSSFr**
Real model	Nominal model
Long-run benefits to macropru buffers	No long-run benefits to macropru buffers
Long-run costs to macropru buffers	Long-run costs to macropru buffers
Captures limited amount of dynamic correlations	Captures several dynamic correlations
Models default probabilities	No default

A caveat: We are being conservative in that both DSGEs give maximal impact on the economy of CCyB increase:

$\Rightarrow$ banks have voluntary buffers – we assume they maintain them constant

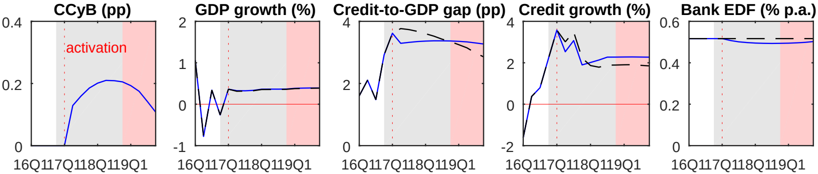
$\Rightarrow$ direct finance exists in the real world – we assume it away

$\Rightarrow$ banks can issue new equity – we assume they can't

Structural approach: Quantitative example

(Regime shift from $\phi_{\nu} = 0$ in 2017q1 to optimized value.)
$\Rightarrow$ Prescribed reaction is positive: it implies a positive CCyB whenever credit gap is larger than its average value of $\sim 3\%$.

3D:



Scenarios for key variables without (dashed black) and with (solid blue) CCyB.

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Conclusion

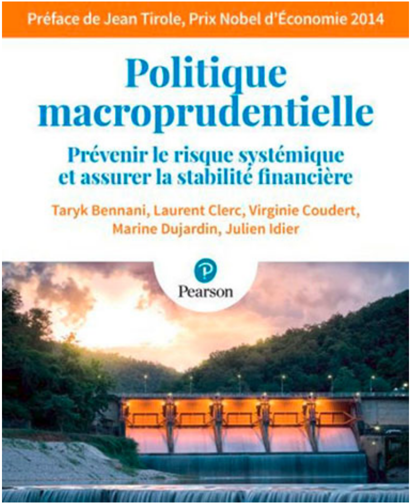
Comparative advantages of the three main approaches for calibration:

- CCyB-Structural: Considers how CCyB rule affects expectations and is robust to adverse event but banks' balance sheets are highly stylized. Results are sensitive to how much we are willing to let the CCyB vary
- CCyB-Hybrid: Detailed view of balance sheet across banks but highly dependent on adverse event whose relevance should be assessed in the light of early warning/systemic risk analysis. Results are sensitive to threshold capital level.

Overall:

- Stress test assess resilience;
- DSGE models assess more risk mitigation;
- Costs and benefits look central to sum up the different pieces of information coming out of the different models (...but still very challenging.)

Politique Macroprudentielle (2017)



Appendix

Annex: GNSSFr model

Based on Gerali-Neri-Sessa-Signoretti (JMCB, 2010): DSGE with banks, households and firms.

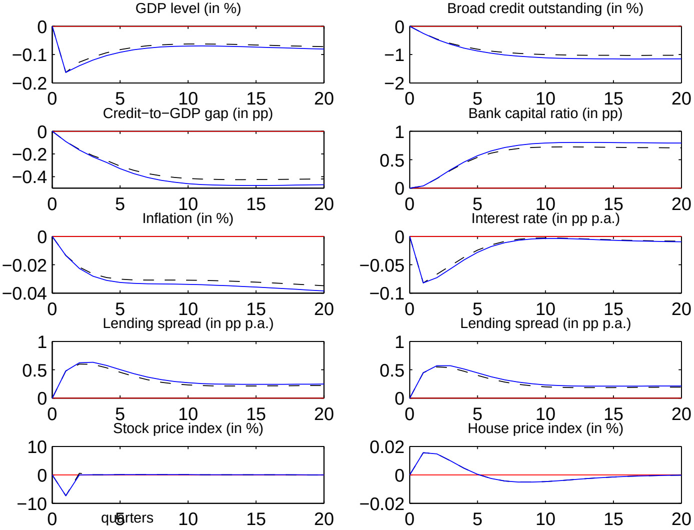
$$K_t = (1-\delta)K_{t-1} + P\&L_{t-1}$$

$$P\&L_{t-1} = r^b_{t-1}B_{t-1} - r^d_{t-1}D_{t-1} - \frac{\kappa}{2}\left(\frac{k_{t-1}}{B_{t-1}} - target_{t-1}\right)^2 k_{t-1}$$

Estimated by likelihood methods on French data using 10 time series (real, nominal and credit variables).

Annex: GNSSFr model

Effect of an unexpected 1pp permanent increase in required capital:



Annex: 3D model

Clerc et al. (IJCB, 2015): real model in which banks, households and firms can default after idiosyncratic and aggregate shocks.

$\Rightarrow$ Banks: limited liability and funding cost externalities, and limited participation in bank equity market $\Rightarrow$ both incentivize excessive leverage.
Return on bank debt (deposits):

$$\tilde{R}_{d,t} = (1 - \gamma\Psi_{b,t})R_{d,t}$$

where $R_{d,t}$ is risk-free rate, $\Psi_{b,t}$ is average bank default probability.
Bankers' net worth:

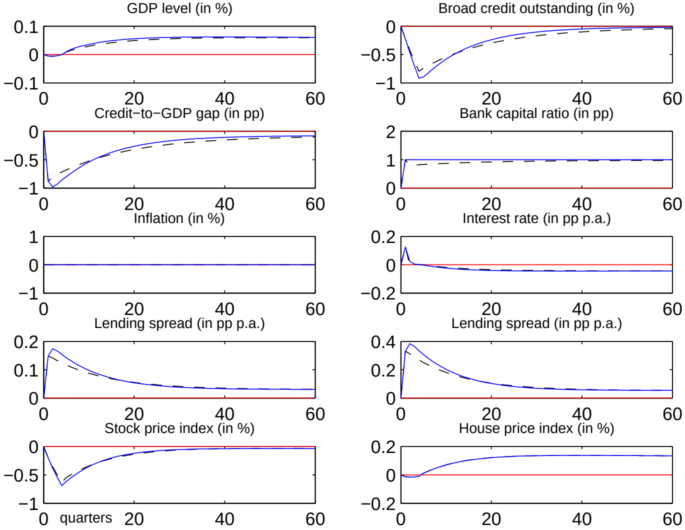
$$n_{b,t+1} = (1 - \chi_b)\tilde{\rho}_{t+1} n_t$$

where $\tilde{\rho}$ is realized ROE.

Estimated to match 1st and 2nd moments of French data and to capture dynamic correlation of credit and GDP.

Annex: 3D model

Effect of an unexpected 1pp permanent increase in required capital: ▸ Back ▸ Back 2



Annex: Forecasting tool

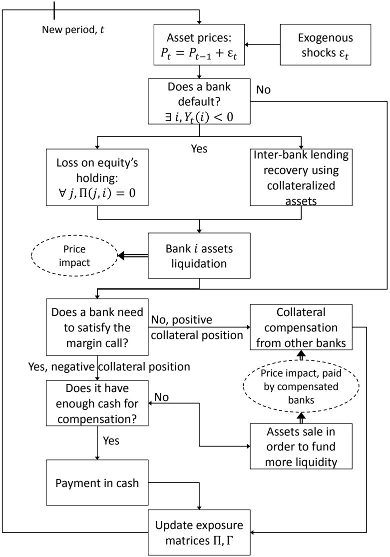
To generate a medium term projection conditional on the available BMPE (baseline scenario) we estimate a VAR using 10 detrended quarterly time series over 1993q1-2016q3:

π_o	oil price yoy inflation
e	EUR/USD real exchange rate
i	3m Euribor
by	credit-to-GDP gap (hp filtered, λ=4d5)
Δy	real GDP qoq growth rate
Δd	real dividends qoq growth rate
π	consumer price qoq inflation
Δq_h	real house price qoq inflation
$i_{10} - i$	10y-3m interest-rate spread
Δcac	real stock price index (CAC40) yoy growth rate

Same Wold ordering is behind SVAR used to design the adverse scenario.

Back

Annex: Idier-Piquard (2016)



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