Financial Heterogeneity and Central Bank Non-Standard Measures in a Monetary Union

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1 The views expressed are solely our own and do not necessarily reflect those of the European Central Bank, the Central Bank of Cyprus or the Eurosystem.
Expanded Asset Purchase Programme - APP

Motivation:

- In the aftermath of the economic crisis medium-term outlook for euro area inflation and economic conditions remained weak.
- Several central banks embarked on various forms of non-standard monetary policy measures.
- Expanded asset purchase programme (APP) by the ECB include among others the public sector purchase programme (PSPP).
- Second series of the targeted longer-term refinancing operations (TLTRO-II) by the ECB.
- Aim: To increase liquidity in the market, lower long-term interest rates, stimulating the economy and favoring the achievement of price stability.

Challenging since:

- Low inflation.
- Short-term policy rate at the effective lower bound.
- High levels of private debt in some countries of the union.
Relevant typology of impairments in the monetary policy transmission (financial frictions):

- Accounting for demand and supply determinants of credit
- Sovereign-bank nexus
- Bank credit channel (direct pass-through, portfolio rebalancing and bank capital channels)
- Risk taking behaviour by banks
- Monopolistic retail banking and staggered lending rate pass-through
- Risky debt contract
Structural modelling needs 2/2

Role for:
- Central bank asset purchase
- Interaction of bank credit channel with banks balance sheet conditions
- Role for global portfolio frictions and exchange rate response

Cross-country financial heterogeneity within the monetary union:
- Global economic environment
- BIG4 euro area countries
- Sovereign solvency risk
- Banking risk
- Corporate risk
- Trade linkages
- Financial linkages
This paper

- Designs a multi-country macro-financial DSGE model for the euro area [DE, FR, IT, SP, REA, RoW]
- Includes real-sovereign-financial interactions and provides a framework for analysing the macroeconomic transmission of non-standard measures
- Tries to identify the country-specific regularities which have implications to the effectiveness of non-standard measures
- Allows for cross-country financial (i.e. global portfolio frictions through which the rest of the world is able to trade euro area government bonds) and trade spillovers
- Evaluates the impact of the effective lower bound on the deposit interest rate
- Performs sensitivity analysis for different values of the relative diversion rate to government securities and household’s portfolio frictions
- Performs policy evaluation of:
  - Public sector purchase programme (PSPP) which is part of the euro area expanded asset purchase programme (APP)
  - Second series of the targeted longer-term refinancing operations (TLTRO-II)
- Investigates the role of regulatory and supervisory policies on the effectiveness of PSPP
Related literature

- Monetary multi-country models
  (e.g. EAGLE, Darracq Pariès et.al.(DJP))

- Monetary multi-country models featuring financial accelerator with corporate default
  (e.g. GIMF)

- Segmented banking and capital channel
  (e.g. Gerali et al., Darracq Pariès et al., MAPMOD, 3D)

- International financial spillovers
  (e.g. Kollmann)

- Sovereign banking nexus
  (e.g. Corsetti et al., Wijnbergen and Van der Kwaak)

- Central bank asset purchases
  (e.g. Gertler Karadi, Darracq Paries et.al.)
Model narrative

- **Banking sector**
  - Retail deposit branch
  - Bankers
    - Default when return on asset not sufficient to cover their repayments
    - Incentive constraint à la Gertler Karadi
  - Retail lending branches
  - Loan officers

- **Non-financial corporate sector**
  - Entrepreneurs
    - Default when income that can be seized by the lender falls short of the agreed repayment of the loan
  - Capital producers

- **Households**
  - Ricardians
    - Int. portfolio frictions
  - Non-ricardians
  - Wage setting

- **Goods-producing firms**
  - Intermediate goods
  - Final goods

- **Policy authorities**
  - Government
    - Defaults when unable to raise the funds necessary to honour its debt obligations
    - Long-term gov. bonds
  - Monetary authority
Bankers balance identity: Provision of loans and purchases of government securities are financed with deposits and banker’s net worth

\[ L_{BE,t} + Q_{G,t} B_{GB,t} = D_{B,t} + NW_{B,t} \]

- \( L_{BE,t} \): Loans to non-financial corporate sector
- \( B_{GB,t} \): Government securities purchased by banks at price \( Q_{G,t} \)
- \( D_{B,t} \): Deposits received by households
- \( NW_{B,t} \): Banker’s net worth

Banker’s operating profits

\[
OP_{t+1}^{b} (\omega_{b,t+1}) \equiv \omega_{b,t+1} R_{BLE,t} L_{BE,t} + R_{G,t+1} Q_{G,t} B_{GB,t} - \tilde{R}_{BD,t} D_{B,t} + \Pi_{D,t}^{R} + \Pi_{B,t+1}^{R}
\]

- \( \tilde{R}_{BD,t} \): Banker’s funding cost (including partial indexation to sovereign risk)
- \( \omega_{b,t+1} \): Idiosyncratic shock/risk of lack of diversification of loan exposures
- \( R_{BLE,t} \): Banker’s financing rate
Bankers 2/8

1\textsuperscript{st} friction: Limited liability with deposit insurance

- Bankers default when their return on asset is not sufficient to cover the repayments due to deposits. Therefore payoffs are always positive

\[ OP^b_{t+1} (\bar{\omega}_{b,t+1}) \geq 0 \]

- Default cutoff point \( \bar{\omega}_{b,t+1} \) is given by

\[
\bar{\omega}_{b,t+1} \equiv \frac{\tilde{R}_{BD,t} \left( \kappa^b_{E,t} + \kappa^b_{G,t} - 1 \right) - R_{G,t+1} \kappa^b_{G,t} - \frac{\Pi^R_{D,t}}{NW_{B,t}} - \frac{\Pi^R_{B,t+1}}{NW_{B,t}}}{\kappa^b_{b,t} R_{BLE,t}}
\]

- Leverage ratios

\[
\kappa^b_{b,t} = \kappa^b_{E,t} + \kappa^b_{G,t} = \frac{L_{BE,t}}{NW_{B,t}} + \frac{Q_{G,t} B_{GB,t}}{NW_{B,t}}
\]
Regulatory penalty is paid if the operating profit is less than a fraction $\nu_b$ of the risk weighted assets. Therefore the following inequality should hold

$$OP^{b}_{t+1} (\omega_{b,t+1}) \geq \nu_b \left( rw_{e,t} \omega_{b,t+1} R_{BLE,t} L_{BE,t} + rw_{g,t} Q_{G,t} B_{GB,t} \right)$$

Regulatory penalty cutoff point $\overline{\omega}_{b,t}^{\nu}$ is given by

$$\overline{\omega}_{b,t+1}^{\nu} \equiv \tilde{R}_{BD,t} \left( \kappa_{E,t}^{b} + \kappa_{G,t}^{b} - 1 \right) - \left( 1 - rw_{g,t} \nu_b \right) R_{G,t+1} \kappa_{G,t}^{b} - \frac{\Pi^{R}_{D,t}}{NW_{B,t}} - \frac{\Pi^{R}_{B,t+1}}{NW_{B,t}} > \overline{\omega}_{b,t+1}$$

- $\chi_b$ : regulatory penalty per unit of asset
- $rw_{e,t}$ : dynamic risk weights for corporate exposures (Basel III, based on the probability of default of entrepreneurs)
- $rw_{g,t}$ : risk weights on government exposures (zero in baseline)
Expected return on net worth from period $t$ to $t+1$:

$$
\mathbb{E}_t \left\{ \tilde{E} \left[ \text{OP}_{b,t+1} (\omega_{b,t+1}) \mid \omega_{b,t+1} \geq \bar{\omega}_{b,t+1} \right] - \tilde{E} \left[ \chi_b L_{BE,t} \mid \omega_{b,t+1} \leq \bar{\omega}_{b,t+1}^{\nu} \right] \right\}
$$

$R_{B,t+1}$: One-period return on bank net worth

$$
R_{B,t+1} \equiv R_{BLE,t} \kappa_{E,t}^b \left[ 1 - \Gamma_b (\bar{\omega}_{b,t+1}) \right] - \chi_b \left( \kappa_{E,t}^b + \kappa_{G,t}^b \right) \left( F \left( \bar{\omega}_{b,t+1}^{\nu} \right) - F \left( \bar{\omega}_{b,t+1} \right) \right)
$$

$\Gamma_b (\bar{\omega}) \equiv (1 - F_b (\bar{\omega})) \bar{\omega} + \int_0^{\bar{\omega}} \omega \text{d}F_b (\omega)$

$F \left( \bar{\omega}_{b,t+1}^{\nu} \right) =$ Probability of tilting the regulatory penalty

$F \left( \bar{\omega}_{b,t+1} \right) =$ Probability of default
Accumulation of the bankers’ net worth from period $t$ to period $t+1$

$$NW_{B,t+1} = \frac{R_{B,t+1}}{\Pi_{C,t+1}} NW_{B,t} = \tilde{R}_{B,t+1-s,t+1} NW_{B,t+1-s}$$

Banker’s objective is to maximise their terminal net worth when exiting the industry, which occurs with probability $(1 - \zeta_b)$

Value function

$$V_{B,t} = (1 - \zeta_b) \sum_{k=0}^{\infty} (\zeta_b)^k \Xi_{t,t+k+1} NW_{B,t+k+1}$$

Recursive formulation

$$V_{B,t} = (1 - \zeta_b) NW_{B,t} (x_{B,t} - 1)$$

with

$$x_{B,t} = 1 + \zeta_b \mathbb{E}_t \left[ \Xi_{t,t+1} \frac{R_{B,t+1}}{\Pi_{C,t+1}} x_{B,t+1} \right]$$
3rd friction: Incentive compatibility constraint

- Bankers can divert a fraction of their assets and transfer them without costs to the households
- Incentive compatibility constraint where the value function is higher than the diverted assets

\[ \nu_{B,t} \geq \lambda_b \left( \kappa_{E,t} + \delta_{b,t} \kappa_{G,t} \right) NW_{B,t} \]

- \( \lambda_b \): diversion rate for private loans
- \( \lambda_b \delta_{b,t} \): diversion rate for government securities

subject to:
- Default cutoff point \( \bar{\omega}_{b,t+1} \)
- Regulatory penalty cutoff point \( \bar{\omega}_{b,t+1}^{\nu} \)
- Incentive compatibility constraint
First order conditions

\[
\mathbb{E}_t \left[ \Xi_{t+1} \frac{\partial R_{B,t+1}}{\partial \kappa_E,t} \left( \zeta_b \sim X_{B,t} \right. \left. + (1 - \zeta_b) \right) / \Pi_{C,t+1} \right] = \mu_t \lambda_b
\]

\[
\mathbb{E}_t \left[ \Xi_{t+1} \frac{\partial R_{B,t+1}}{\partial \kappa_G,t} \left( \zeta_b \sim X_{B,t} \right. \left. + (1 - \zeta_b) \right) / \Pi_{C,t+1} \right] = \mu_t \lambda_b \delta_{b,t}
\]

\(\mu_t \geq 0\): Lagrange multiplier relating to the incentive constraint

- Aggregating across bankers, a fraction \(\zeta_b\) continues operating into the next period while the rest exits from the industry.

- The aggregate dynamics of bankers’ net worth

\[
NW_{B,t} = \zeta_b R_{B,t} \frac{NW_{B,t-1}}{\Pi_{C,t}} + \Psi_{B,t}
\]

- \(\Psi_{B,t}\): Endowment of new bankers = Starting net worth proportional to the assets of the old bankers.
Analytical first order conditions

\[
\frac{\partial R_{B,t+1}}{\partial \kappa_{E,t}^b} = R_{BLE,t} \left( 1 - \int_0^{\omega_{b,t+1}} \omega dF_b(\omega) \right) - \tilde{R}_{BD,t} \left( 1 - F_b(\omega_{b,t+1}) \right) + \chi_b \left[ \kappa_t dF_b \left( \omega_{b,t+1}^\nu \right) \left( \tilde{R}_{BD,t} - \left( 1 - \nu_b rw_{e,t+1} \right) \omega_{b,t+1}^\nu R_{BLE,t} \right) \right] \\
- \kappa_t dF_b \left( \omega_{b,t+1}^\nu \right) \left( \tilde{R}_{BD,t} - \omega_{b,t+1} R_{BLE,t} \right)
\]

\[
\frac{\partial R_{B,t+1}}{\partial \kappa_{G,t}^b} = \left( R_{G,t+1} - \tilde{R}_{BD,t} \right) \left( 1 - F_b(\omega_{b,t+1}) \right) + \chi_b \left[ \kappa_t dF_b \left( \omega_{b,t+1}^\nu \right) \left( \tilde{R}_{BD,t} - \left( 1 - \nu_b rw_{g,t+1} \right) R_{G,t+1} \right) \right] \\
- \kappa_t dF_b \left( \omega_{b,t+1}^\nu \right) \left( \tilde{R}_{BD,t} - R_{G,t+1} \right)
\]

\[
\kappa_t = \frac{\kappa_{E,t}^b + \kappa_{G,t}^b}{\left( 1 - \nu_b rw_{e,t} \right) R_{BLE,t} \kappa_{E,t}^b}
\]
Ricardian households 1/3

- **Ricardian households**
  - Financial assets: deposits, domestic private bonds, internationally traded private bonds, euro area government bonds, rest of the world government bonds

- **Global government bond frictions**

<table>
<thead>
<tr>
<th>Financial assets traded by ricardian households</th>
<th>Euro area countries</th>
<th>Rest of the world</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Domestic private bonds</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Internationally traded private bonds</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Euro area government bonds</td>
<td>✓</td>
<td>✓ with global portfolio frictions</td>
</tr>
<tr>
<td>Rest of the world government bonds</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Choose \( \{ C_{l,t}, D_t, M_{l,t}, B_{G,t+1}, B_{t+1}, B^*_t \} \) to maximise utility

\[
E_t \left[ \sum_{k=0}^{\infty} \beta^k \zeta_c \frac{(1 - \kappa)}{1 - \sigma} \left( \frac{C_{l,t+k} - \kappa \overline{C}_{l,t+k-1}}{1 - \kappa} \right)^{1 - \sigma} + \frac{\zeta_{db}}{1 - \eta_b} \left( \frac{D_{t+k}}{C_{l,t+k}} \right)^{1 - \eta_b} - \frac{1}{1 + \zeta_n} \left( N_{l,t+k} \right)^{1 + \zeta_n} \right]
\]

subject to the budget constraint

\[
\mathcal{M}_{l,t-1} + R_{D,t-1} P_{C,t-1} D_{t-1} + R_{G,t} Q_{G,t-1} P_{C,t-1} B_{GH,t-1} + R_{t-1} P_{C,t-1} B_{t-1} + (1 - \Gamma_{B^*}) R_{t-1}^* S_t^H,ROW P_{C,t-1}^* B_{t-1}^* + \left( 1 - \tau^N_t - \tau^W_h_t \right) W_{l,t} N_{l,t} + (1 - \tau^D_t) D V_{l,t} + T R_{l,t} + \Phi_{l,t} + \Xi_t + \Xi_{G,t} + \Pi_{BE,t} = (1 + \tau^C_t + \Gamma_v \left( V_{l,t} \right)) P_{C,t} C_{l,t} + P_{C,t} D_t + P_{C,t} Q_{G,t} \left[ B_{GH,t} + \frac{1}{2} \frac{\gamma_{bgh}}{B_{GH}} \left( B_{GH,t} - \widetilde{B}_{GH} \right)^2 \right] + P_{C,t} B_t + S_t^H,ROW P_{C,t}^* B_t^* + T_{l,t} + \mathcal{M}_{l,t}
\]

FOC for domestic long-term government bond holdings

\[
\beta E_t \left[ \frac{\Lambda_{l,t+1}}{\Lambda_{l,t}} \frac{\Pi_{C,t+1}}{R_{G,t+1}} \right] = 1 + \frac{\gamma_{bgh}}{B_{GH}} \left( B_{GH,t} - \widetilde{B}_{GH} \right)
\]
Ricardian households 3/3

- Rest of the world faces portfolio adjustment costs from euro area government bonds purchases defined as

\[ \Gamma_{B\ast_{GF}}(B\ast_{GF},t) \equiv \frac{1}{2} \frac{\gamma_{bgf}}{B\ast_{GF}} (B\ast_{GF},t - B\ast_{GF})^2 \]

- New equilibrium government bond holding condition for each euro area region

\[ B_{G,t} = B_{GB,t} + B_{GH,t} + B_{CB,t} + B\ast_{GF,t} \]

- Rest of the world FOC for euro area government bond holdings

\[ \beta E_t \left[ \frac{\Lambda_{I,t+1}}{\Lambda_{I,t}} \Pi_{C,t+1}^{-1} R_{G,t} S_{t+1}^{\text{ROW}} S_{t}^{\text{ROW}} \right] = \frac{\gamma_{bgf}}{B\ast_{GF}} (B\ast_{GF},t - B\ast_{GF}) \]
Retail deposit branches

Collect deposit from ricardian hhs and place them in the banking sector

Retail lending branches

Monopolistic competitors which levy funds from the wholesale banks to the non-financial sector

Lending branches set interest rates on a staggered basis

Loan officers

Provide loan contracts to entrepreneurs

Operate in a competitive environment (zero profits in equilibrium)
Non-ricardian households

- No access to financial assets

Wage setting

- Symmetric for the two types of households
- Households supply differentiated labor services in monopolistically competitive markets
- Households setters of the nominal wages
- Wages are determined by staggered nominal contracts
Intermediate goods-producing firms
- Monopolistic competition
- Internationally tradable and nontradable consumption and investment goods

Final goods-producing firms
- Perfect competition
- Uses as inputs all intermediate goods
- Produce nontraded final goods for consumption and investments

Capital producers
- Using tradable investment goods, a segment of perfectly competitive firms produce a stock of fixed capital subject to quadratic adjustment costs

Entrepreneurs
- Finance their purchase of capital stock with net worth and one-period loan from the loan officers
- Pre-determined lending rates
- Limited recovery ratio of entrepreneurs assets that banks can recover in case of default
- Default will occur when the entrepreneurial income that can be seized by the lender falls short of the agreed repayment of the loan
Government

- Fiscal instruments
- Sovereign risk (default when unable to raise the funds necessary to honour its debt obligations)
- Long-term sovereign debt (perpetuities which pay geometrically-decaying coupons)

Monetary authority

- Interest rate rule of Taylor-type
- Non-standard measures:
  - Public sector purchase programme (PSPP)
  - Second series of the targeted longer-term refinancing operations (TLTRO-II)
Multi-country global model covering six regions/countries with cross border international linkages through:

- Financial-banking
- Trade

Countries

- Germany
- France
- Italy
- Spain
- Rest of euro area
- Rest of the world
Strategy

- **Parameters**
  - Steady state
  - Dynamics

- **Strategy**
  - Information on deep parameters
  - Target steady state values of endogenous variables
  - Target IRFs (e.g. prior information of pass-through)

- **Cross-country heterogeneity**
  - Macro environment
  - Fiscal instruments
  - Sovereign risk
  - Trade
  - Banking sector (i.e. riskiness, loans to GDP)
  - Corporate sector (i.e. riskiness, lending rates)
Detailed calibration

- Bankers
- Retail banking branches
- Summary of lending rate decomposition
- Sovereign risk and long-term bonds
- Fiscal policy and instruments
- Monetary policy
- Main macro variables
- Households
- Government bond frictions in the household sector
- Capital producers and firms
- Entrepreneurs
Baseline public sector purchase programme (PSPP)

Baseline scenario design

- PSPP as announced in January 2015 (next chart blue line)
- Monthly purchases of 60 billion per month from March 2015 to September 2016, amounting to 1.14 trillion
- Equivalent to approximately 9.6% of euro area 2014 GDP level
- Share of purchases proportional to the nominal GDP of the corresponding country
- Monthly flow of purchases through news shocks in the build-up phase
- Peaks at 9.6% of annual GDP
- Subsequently decaying following an AR(1) process, consistent with the assumption that bonds are 10-year equivalent and would be held to maturity
- Calibration consistent with event studies of government bond yield reaction

Environment

- Baseline scenario with active standard monetary policy and home bias in government bonds holdings
- Cross-border spillovers from baseline scenario
- Effective lower bound on deposit interest rates
- Global portfolio frictions and effective lower bound
PSPP portfolio holdings as a percent of euro area 2014 GDP level

Notes: PSPP_1, PSPP_2 and PSPP_3 correspond to the public sector purchase programme of the expanded asset purchase programme as communicated in January 2015, December 2015 and March 2016, respectively.
Baseline PSPP transmission 1/2

Note: Central bank asset purchases approximately amounting to 9.6 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP). Horizontal axis: quarters. Vertical axis: annual percentage-point deviations, except for sovereign bond purchases, sovereign bonds held by hhs and sovereign bonds held by banks which are expressed as a percent of annual real GDP. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
Baseline PSPP transmission 2/2

Notes: Central bank asset purchases approximately amounting to 9.6 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP). Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, monetary policy rate and real exchange rate depreciation as annual percentage-point deviations. GDP, its components and banks loans are reported in real terms. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
Baseline PSPP: Cross-country spillover effects 1/2

Notes: Central bank asset purchases approximately amounting to 9.6 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP). Horizontal axis: quarters. Vertical axis: annual percentage-point deviations, except for sovereign bond purchases, sovereign bonds held by hhs and sovereign bonds held by banks which are expressed as a percent of annual real GDP. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
Baseline PSPP: Cross-country spillover effects 2/2

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Baseline PSPP: Subject to the effective lower bound

Notes: Central bank asset purchases approximately amounting to 9.6 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP) subject to the effective lower bound. Horizontal axis: quarters. Vertical axis: annual percentage-point deviations, except for sovereign bond purchases, sovereign bonds held by hhs and sovereign bonds held by banks which are expressed as a percent of annual real GDP. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
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Baseline PSPP: Global portfolio frictions subject to the effective lower bound 1/2

Notes: Central bank asset purchases approximately amounting to 9.6 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP) subject to the effective lower bound and with global portfolio frictions. Horizontal axis: quarters. Vertical axis: annual percentage-point deviations, except for sovereign bond purchases, sovereign bonds held by hhs and sovereign bonds held by banks which are expressed as a percent of annual real GDP. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
Baseline PSPP: Global portfolio frictions subject to the effective lower bound 2/2

Notes: Central bank asset purchases approximately amounting to 9.6 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP) subject to the effective lower bound and with global portfolio frictions. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, monetary policy rate and real exchange rate depreciation as annual percentage-point deviations. GDP, its components and banks loans are reported in real terms. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
PSPP sensitivity analysis: Sovereign yield multipliers

Sensitivity analysis of sovereign yield multipliers to a PSPP shock for different values of:

- $\delta_b$: relative diversion rate to government securities
- $\chi_H$: household’s portfolio frictions
PSPP sensitivity analysis: Output multiplier

Sensitivity analysis on the response of output after 8 quarters to a PSPP shock for different values of:

- $\delta_b$: relative diversion rate to government securities
- $\chi_H$: household's portfolio frictions
PSPP sensitivity analysis: Lending rate pass-through

Sensitivity analysis on the pass-through from sovereign yield to lending rate to a PSPP shock for different values of:

- $\delta_b$: relative diversion rate to government securities
- $\xi^R_E$: probability of not re-optimizing lending rates
Scenario design

Public sector purchase programme

- PSPP as announced in January 2015, December 2015 and March 2016 (next chart red line)
- Recalibrations of the programme treated as unexpected by agents
- Equivalent to approximately 15% of euro area 2014 GDP level
- Share of purchases proportional to the nominal GDP of the corresponding country
- Monthly flow of purchases through news shocks in the build-up phase

Second series of the targeted longer-term refinancing operations

- Provide long-term financing to credit institutions at attractive conditions for periods up to four years
- Downward impact on banks’ average funding cost
- This funding cost relief is simulated according to an AR(2) rule

Role of regulatory and supervisory policies on the effectiveness of PSPP

- In the case of high bank riskiness, risk shifting impairs the transmission of APP and leads to higher bank riskiness over the medium-term
- Regulation (increase in capital requirements) can deter risk shifting and restore the transmission of APP
PSPP portfolio holdings as a percent of euro area 2014 GDP level

- Evolution of PSPP_1 portfolio, divided by euro area 2014 GDP level
- Additional "stock" of assets due to extension by 6 months + 2y reinvestment (PSPP1 - PSPP2), divided by euro area 2014 GDP level
- Additional "stock" of assets due to expansion by 20bn + 2y reinvestment (PSPP2 - PSPP3), divided by euro area 2014 GDP level
- Evolution of PSPP_1 portfolio + 6 month extension + 2y reinvestment (PSPP1 - PSPP3, all in terms of 2014 GDP level)

Notes: PSPP_1, PSPP_2 and PSPP_3 correspond to the public sector purchase programme of the expanded asset purchase programme as communicated in January 2015, December 2015 and March 2016, respectively.
PSPP: Global portfolio frictions subject to the effective lower bound 1/2

Notes: Central bank asset purchases approximately amounting to 14 percent of annual real GDP in eight quarters (equivalent to the January 2015 PSPP) subject to the effective lower bound and with global portfolio frictions. Horizontal axis: quarters. Vertical axis: annual percentage-point deviations, except for sovereign bond purchases, sovereign bonds held by hhs and sovereign bonds held by banks which are expressed as a percent of annual real GDP. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
PSPP: Global portfolio frictions subject to the effective lower bound 2/2

Notes: Central bank asset purchases approximately amounting to 14 percent of annual real GDP in eight quarters (equivalent to the March 2016 PSPP) subject to the effective lower bound and with global portfolio frictions. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, monetary policy rate and real exchange rate depreciation as annual percentage-point deviations. GDP, its components and banks loans are reported in real terms. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
Second series of the targeted longer-term refinancing operations (TLTRO-II)

Funding cost relief from TLTRO-II (in percentage points)

<table>
<thead>
<tr>
<th>Year</th>
<th>EA</th>
<th>DE</th>
<th>FR</th>
<th>IT</th>
<th>ES</th>
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<tr>
<td>2016</td>
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<td>2017</td>
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<tr>
<td>2018</td>
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<td>0.15</td>
<td>0.18</td>
<td>0.24</td>
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<tr>
<td>2019</td>
<td>0.18</td>
<td>0.15</td>
<td>0.18</td>
<td>0.24</td>
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</tbody>
</table>

AR(2) approximations of funding cost relief from TLTRO-II
TLTRO-II: Subject to the effective lower bound 1/1

Notes: Second series of the targeted longer-term refinancing operations subject to the effective lower bound and with global portfolio frictions. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, monetary policy rate and real exchange rate depreciation as annual percentage-point deviations. GDP, its components and banks loans are reported in real terms. DE = Germany; FR = France; IT = Italy; SP = Spain; REA = Rest of euro area.
PSPP: Role of regulatory and supervisory policies in the case of high bank riskiness

- In the case of high bank riskiness, risk shifting impairs the transmission of APP and leads to higher bank riskiness over the medium-term.
- Regulation (increase in capital requirements) can deter risk shifting and restore the transmission of APP.

A framework for analysing the country specific macro economic transmission of non-standard measures focusing on:

- the bank credit channel
- the exchange rate channel and
- the cross border spillovers emerging from financial and trade spillovers

The importance of the macroeconomic environment is stressed through simulations that assume:

- Deposit interest rate have reached its effective lower bound
- Global portfolio frictions leading to a stronger exchange rate channel of purchases

It performs policy evaluation of:

- The public sector purchase programme
- The second series of the targeted longer-term refinancing operations
Monopolistic competitors which collect deposit from ricardian hhs and place them in the banking sector.

Deposit branches set interest rates on a staggered basis à la Calvo:
- \( 1 - \xi_D^R \) prob. to re-optimize
- \( \xi_D^R \) prob. to leave interest rate at its previous period level

CES aggregation of the differentiated deposits:
\[
D = \left[ \int_0^1 D(j) \frac{1}{\mu_D^R} \, dj \right]^{\mu_D^R}
\]

Retail deposits are imperfect substitute with elasticity of substitution \( \frac{\mu_D^R}{\mu_D^R - 1} < -1 \) and mark-up \( \mu_D^R \).

Chooses \( \hat{R}_{D,t}(j) \) to maximize its intertemporal profit.

\[
\mathbb{E}_t \left[ \sum_{k=0}^{\infty} \left( \beta \xi_D^R \right)^k \frac{\Lambda_{t+k}}{\Lambda_t} \left( R_{BD,t+k} D_{t+k}(j) - \hat{R}_{t,D}(j) D_{t+k}(j) \right) \right]
\]

\[
D_{t+k}(j) = \left( \frac{\hat{R}_{D,t}(j)}{R_{D,t}} \right)^{-\frac{\mu_D^R}{\mu_D^R - 1}} \left( \frac{R_{D,t}}{R_{D,t+k}} \right)^{-\frac{\mu_D^R}{\mu_D^R - 1}} D_{t+k}
\]
Retail lending branches

- Monopolistic competitors which levy funds from the wholesale banks
- Lending branches set interest rates on a staggered basis a la Calvo
  - \( 1 - \xi^R_E \) prob. to re-optimise
  - \( \xi^R_E \) prob. to leave interest rate at its previous period level

- CES aggregation of the differentiated deposits: \( L_{E,t} = \left[ \int_0^1 L_{E,t}(j) \frac{1}{\mu^R_E} \, dj \right]^{\mu^R_E} \)

- Retail loans are imperfect substitute with elasticity of substitution \( \frac{\mu^R_E}{\mu^R_E - 1} > 1 \) and mark-up \( \mu^R_E \)
- Chooses \( \hat{R}_{LE,t}(j) \) to maximize its intertemporal profit.

\[
\mathbb{E}_t \left[ \sum_{k=0}^{\infty} \left( \beta \xi^R_E \right)^k \frac{\Lambda_{I,t+k}}{\Lambda_{I,t}} \left( \hat{R}_{LE,t}(j) L_{E,t+k}(j) - R_{BLE,t+k}(j) L_{E,t+k}(j) \right) \right]
\]

where the demand from the loan officers is given by

\[
L_{E,t+k}(j) = \left( \frac{\hat{R}_{LE,t}(j)}{R_{LE,t}} \right)^{\frac{\mu^R_E}{\mu^R_E - 1}} \left( \frac{R_{LE,t}}{R_{LE,t+k}} \right)^{\frac{\mu^R_E}{\mu^R_E - 1}} L_{LE,t+k}
\]
Loan officers

- Provide loan contracts to entrepreneurs
- Operate in a competitive environment (zero profits in equilibrium)
- Receive one-period loans from the retail lending branches which pays a gross nominal interest rate $R_{LE,t}$.
- Maximise its discount intertemporal flow of income
- FOC

$$\mathbb{E}_t \left[ \beta \frac{\Lambda_{l,t+1}}{\Lambda_{l,t}} \left( \tilde{R}_{LE,t+1} - R_{LE,t} \right) \right] = 0$$

- $\tilde{R}_{LE,t+1}$ the state-contingent returns on the loan portfolio
- $\beta \frac{\Lambda_{l,t+1}}{\Lambda_{l,t}}$ is the stochastic discount factor of the ricardian households
Entrepreneurs 1/3

- Buy the capital stock $K_t$ from the capital producers at real price $Q_t$.
- Transform capital stock into an effective capital stock $u_{t+1}K_t$ by choosing the utilisation rate $u_{t+1}$.
- Adjustment of the capacity utilization rate entails some adjustment costs per unit of capital stock $\Gamma_u(u_{t+1})$.
- The effective capital stock is rented out to intermediate goods producers at a nominal rental rate of $r_{K,t+1}$.
- Sell back the depreciated capital stock $(1 - \delta)K_t$ to capital producer at price $Q_{t+1}$.
- Gross nominal rate of return on capital

\[
R_{KK,t+1} = \frac{((1 - \tau^K_{t+1})(r_{K,t+1}u_{t+1} - \Gamma_u(u_{t+1}))T_{I,t+1} + \tau^K_t \delta T_{I,t+1} + (1 - \delta)Q_{t+1})}{Q_t \Pi_{t+1}}
\]
Entrepreneurs 2/3

- Finance their purchase of capital stock with net worth $NW_{E,t}$ and one-period loan $L_{E,t}$ from the loan officers

$$Q_tK_t = NW_{E,t} + L_{E,t}.$$ 

- Pre-determined lending rates $R_{LLE,t}$ at the previous time period (not the return to the lender) => More pronounced interactive effects between macroeconomic developments and the credit market, since it implies that the realisation of aggregate shocks has an impact on the lender’s balance sheet.

- Limited recovery ratio $\chi_e$ of entrepreneurs assets that banks can recover in case of default.

- Default will occur when the entrepreneurial income that can be seized by the lender falls short of the agreed repayment of the loan (draws of multiplicative idiosyncratic shock $\omega_{e,t+1}$ below a certain threshold $\bar{\omega}_{e,t+1}$

$$\bar{\omega}_{e,t+1}\chi_eR_{KK,t+1}\kappa_{e,t} = (R_{LLE,t} + 1) (\kappa_{e,t} - 1)$$

- Corporate leverage $\kappa_{e,t} = \frac{Q_tK_t}{NW_{E,t}}$. 
The contracting problem of entrepreneurs consists in maximising next period return on net worth for lending rate and leverage:

\[
\max \{ R_{LE,t} \mid \mathbb{E}_t \left[ (1 - \chi_e \Gamma_e(\bar{\omega}_e, t+1)) R_{KK,t+1} \kappa_{e,t} \right] \}
\]

subject to the participation of constraint of the lender and the default threshold FOC

\[
\mathbb{E}_t \left[ (1 - \chi_e \Gamma_e(\bar{\omega}_e, t+1)) R_{KK,t+1} \kappa_{e,t} \right] = \frac{\mathbb{E}_t \left[ \chi_e \Gamma'_e(\bar{\omega}_e, t+1) \right]}{\mathbb{E}_t \left[ \Xi_{t+1} G'_e(\bar{\omega}_e, t+1) \right]} \mathbb{E}_t \left[ \Xi_{t+1} \right] R_{LE,t}
\]

The ex-post lending rate to the lender on the loan contract is

\[
\tilde{R}_{LE,t} = G(\bar{\omega}_e, t) \chi_e R_{KK,t} \frac{\kappa_{e,t-1}}{\kappa_{e,t-1} - 1}
\]

Net worth

\[
NW_{E,t} = \zeta_e (1 - \chi_e e(\bar{\omega}_e, t)) R_{KK,t} \kappa_{e,t-1} \frac{NW_{E,t-1}}{\Pi_t} + \Psi_{E,t}
\]
Using tradable investment goods, a segment of perfectly competitive firms produce a stock of fixed capital.

capital law of motion

\[ K_t = (1 - \delta)K_{t-1} + \left[ 1 - \Gamma_l \left( \frac{l_t \varepsilon_t^l}{l_{t-1}} \right) \right] l_t \]

subject to quadratic adjustment costs

\[ \Gamma_l \left( \frac{l_t \varepsilon_t^l}{l_{t-1}} \right) \equiv \frac{\gamma_l}{2} \left( \frac{l_t \varepsilon_t^l}{l_{t-1}} - 1 \right)^2 \]

The augmented stocks are sold back to entrepreneurs at the end of the period \( t \) at the same prices

Capital producer choose \( \{K_t, I_t\} \) to maximise intertemporal profits

\[
\max_{\{K_t, I_t\}} \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \frac{\Lambda_{t+k}}{\Lambda_{t,t}} \left\{ Q_{t+k}(K_{t+k} - (1 - \delta)K_{t+k-1}) - P_{l,t+k}I_{t+k} \right\}
\]
Non-ricardian households

- No access to financial assets
- Maximise utility

\[
\max \left\{ C_{J,t}, M_{J,t} \right\} \left\{ E_t \left[ \sum_{k=0}^{\infty} \beta^k \left( \frac{1 - \kappa}{1 - \sigma} \left( \frac{C_{J,t+k} - \kappa C_{J,t+k-1}}{1 - \kappa} \right)^{1-\sigma} - \frac{1}{1 + \zeta_n} (N_{J,t+k})^{1+\zeta_n} \right) \right] \right\}
\]

- subject to budget constraint

\[
\left( 1 + \tau_t^C + \Gamma_V (v_{J,t}) \right) P_{C,t} C_{J,t} + M_{J,t} = \left( 1 - \tau_t^N - \tau_t^W \right) W_{J,t} N_{J,t} + TR_{J,t} - T_{J,t} + M_{J,t-1} + \Phi_{J,t}
\]

- Transaction cost: \( \Gamma_V (v_{J,t}) \equiv \gamma_{v,1} v_{J,t} + \gamma_{v,2} v_{J,t}^{-1} - 2 \sqrt{\gamma_{v,1} \gamma_{v,2}} \)

- Consumption-based velocity of money: \( v_{J,t} = \frac{P_{C,t} C_{J,t}}{M_{J,t}} \)
Sovereign risk and long-term gov. bonds

- **Sovereign risk**: default when government is unable to raise the funds necessary to honour its debt obligations

  \[
  p_t^{\xi_G} \approx E_t \left\{ F_g \left[ B_{Y,t+1}; B_{Y}^\text{max}, \alpha_b, \beta_b \right] \right\}
  \]

  \[
  \xi_{G,t} = \begin{cases} 
  \xi_{G}^\text{max}, & \text{with probability } p_t^{\xi_G} \\
  0, & \text{with probability } 1 - p_t^{\xi_G} 
  \end{cases}
  \]

  \[
  = p_t^{\xi_G} \xi_{G}^\text{max}
  \]

- **Long-term sovereign debt**: Government securities are perpetuities which pay geometrically-decaying coupons \([c_g, (1 - \tau_g)c_g, (1 - \tau_g)^2 c_g,...]\)

- **The nominal return** on sovereign bond holding

  \[
  R_{G,t+1} = \frac{c_g + (1 - \tau_g)Q_{G,t+1}}{Q_{G,t}} \left( 1 - p_{t+1}^{\xi_G} \xi_{G}^\text{max} \right)
  \]
Monetary policy

- **Standard monetary policy**: Interest rate rule, of Taylor-type, specified in terms of quarterly inflation rate and quarterly output growth

\[
R_{D,t} = \max \left( RD, R_{D,t}^* \right)
\]

\[
R_{D,t}^* = \phi_R \left( R_{D,t-1}^* \right) + (1 - \phi_R) \left[ \left( RD \right) + \phi_\Pi \left( \Pi_{C,t} - \Pi \right) \right] + \phi_Y (\Delta Y_t - 1)
\]

- **Non-standard measures**: Public sector purchase programme

\[
B_{CB,t} = \rho_{CB1} B_{CB,t-1} + \rho_{CB2} \left[ \gamma_0 \varepsilon_{CB,t} + \gamma_1 \varepsilon_{CB,t-1} + \gamma_2 \varepsilon_{CB,t-2} + \ldots + \gamma_n \varepsilon_{CB,t-n} \right]
\]

- **Non-standard measures**: Second series of the targeted longer-term refinancing operations

\[
\Lambda_{m,t} = (1 - \rho_{\Lambda m1} - \rho_{\Lambda m2}) \overline{\Lambda}_m + \rho_{\Lambda m2} \Lambda_{m,t-1} + \rho_{\Lambda m2} \Lambda_{m,t-2} + \varepsilon_{\Lambda m,t}
\]
<table>
<thead>
<tr>
<th>Parameter</th>
<th>DE</th>
<th>FR</th>
<th>SP</th>
<th>IT</th>
<th>REA</th>
<th>ROW</th>
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<tbody>
<tr>
<td>Sensitivity of funding cost to sov. spread</td>
<td>$\Lambda_{\psi}$</td>
<td>0.600</td>
<td>0.600</td>
<td>0.600</td>
<td>0.600</td>
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<tr>
<td>St.dev. of idiosyncratic shock</td>
<td>$\sigma_b$</td>
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<td>0.036</td>
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<td>0.000</td>
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<td>Regulatory bank capital ratio (percent)</td>
<td>$\nu_b$</td>
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<td>8.000</td>
<td>8.000</td>
<td>8.000</td>
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<td>Regulatory penalty</td>
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<tr>
<td>Risk weight on corporate loans</td>
<td>$r_{w_e}$</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
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<td>Risk weight on government bond holdings</td>
<td>$r_{w_g}$</td>
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<td>0.000</td>
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<tr>
<td>Diversion rate for loans</td>
<td>$\lambda_b$</td>
<td>0.241</td>
<td>0.239</td>
<td>0.166</td>
<td>0.149</td>
<td>0.216</td>
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<tr>
<td>Relative diversion rate for gov. bonds</td>
<td>$\delta_b$</td>
<td>1.200</td>
<td>1.300</td>
<td>3.700</td>
<td>3.600</td>
<td>2.000</td>
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<td>Household transfer to bankers</td>
<td>$\Psi_B/L_{BE}$</td>
<td>0.004</td>
<td>0.002</td>
<td>0.005</td>
<td>0.006</td>
<td>0.004</td>
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<td>Continuation probability of bankers</td>
<td>$\zeta_b$</td>
<td>0.933</td>
<td>0.955</td>
<td>0.923</td>
<td>0.917</td>
<td>0.936</td>
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<table>
<thead>
<tr>
<th>Variable</th>
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<tr>
<td>Prob. of violating regulatory req. (percent)</td>
<td>$1 - (1 - F(\overline{\omega}_b))^4$</td>
</tr>
<tr>
<td>Prob. of default (percent)</td>
<td>$1 - (1 - F(\overline{\omega}_b))^4$</td>
</tr>
<tr>
<td>Ratio of gov. bonds held by banks to loans</td>
<td>$Q_{GB}B_{GB}/L_{BE}$</td>
</tr>
<tr>
<td>Bank NFC loans to GDP</td>
<td>$L_E/(4Y)$</td>
</tr>
<tr>
<td>Bank leverage to loans</td>
<td>$\kappa_E$</td>
</tr>
<tr>
<td>Bank leverage to gov. bonds</td>
<td>$\kappa_G$</td>
</tr>
<tr>
<td>Funding cost spread (percent)</td>
<td>$4(\Psi - 1)$</td>
</tr>
<tr>
<td>Bank capital wedge from agency cost (percent)</td>
<td>0.200</td>
</tr>
<tr>
<td>Bank capital wedge net of agency cost (percent)</td>
<td>0.400</td>
</tr>
<tr>
<td>Total bank capital wedge (percent)</td>
<td>$4(R_{BLE}/\tilde{R}_{BD} - 1)$</td>
</tr>
</tbody>
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### Retail banking branches

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Retail deposit branches</th>
<th>Retail lending branch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td>Elasticity of substitution of dif. deposits</td>
<td>$\mu^R_D$</td>
<td>1.000</td>
</tr>
<tr>
<td>Prob. of not re-opt. deposit rates (percent)</td>
<td>$\xi^D$</td>
<td>1.000</td>
</tr>
<tr>
<td>Elasticity of substitution of dif. loans</td>
<td>$\mu^R_E$</td>
<td>1.003</td>
</tr>
<tr>
<td>Prob. of not re-opt. lending rates (percent)</td>
<td>$\xi^E$</td>
<td>60.00</td>
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<tr>
<td>Variable</td>
<td>Retail deposit branches</td>
<td>Retail lending branch</td>
</tr>
<tr>
<td>Deposit spread (percent)</td>
<td>$4(R_D/R_{BD} - 1)$</td>
<td>0.000</td>
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</table>
## Summary of lending rate decomposition

<table>
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<th>Parameter</th>
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<th>SP</th>
<th>IT</th>
<th>REA</th>
<th>ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding cost spread (percent)</td>
<td>$4(\Psi - 1)$</td>
<td>0.29</td>
<td>0.55</td>
<td>0.94</td>
<td>1.10</td>
<td>0.72</td>
</tr>
<tr>
<td>Bank capital wedge from agency cost (percent)</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Bank capital wedge net of agency cost (percent)</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Monopolistic wedge (percent)</td>
<td>$4(R_{LE}/R_{BLE} - 1)$</td>
<td>1.19</td>
<td>0.49</td>
<td>1.16</td>
<td>1.21</td>
<td>0.94</td>
</tr>
<tr>
<td>Credit risk compensation (percent)</td>
<td>$4(1 + R_{LLE}/R_{LE} - 1)$</td>
<td>0.24</td>
<td>0.24</td>
<td>0.53</td>
<td>0.63</td>
<td>0.37</td>
</tr>
<tr>
<td>Total commercial lending spread (percent)</td>
<td>$4(1 + R_{LLE}/R_{BD} - 1)$</td>
<td>2.32</td>
<td>1.88</td>
<td>3.24</td>
<td>3.56</td>
<td>2.64</td>
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### Sovereign risk and long-term bonds

<table>
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<tr>
<th>Parameter</th>
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<th>SP</th>
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<th>ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government debt-to-annual GDP ratio (percent)</td>
<td>$B_{GY}$</td>
<td>$B_{max}$</td>
<td>63.7</td>
<td>61.8</td>
<td>49.3</td>
<td>87.5</td>
</tr>
<tr>
<td>Mean of distribution</td>
<td>$B_{GY}$</td>
<td>$B_{max}$</td>
<td>180.6</td>
<td>157.8</td>
<td>108.2</td>
<td>136.8</td>
</tr>
<tr>
<td>Std. dev. of prob. of default distribution</td>
<td>$\sigma_{B_{GY}}$</td>
<td>$\xi_{max}$</td>
<td>42.90</td>
<td>38.43</td>
<td>25.54</td>
<td>21.94</td>
</tr>
<tr>
<td>Loss given default (percent)</td>
<td>$\xi_{G}$</td>
<td>$\xi_{max}$</td>
<td>37.00</td>
<td>37.00</td>
<td>37.00</td>
<td>37.00</td>
</tr>
<tr>
<td>Duration of government bond perpetuity</td>
<td>duration</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Coupon payment</td>
<td>$c_g$</td>
<td>0.028</td>
<td>0.030</td>
<td>0.033</td>
<td>0.034</td>
<td>0.031</td>
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<tr>
<td>Decaying rate for coupon payments</td>
<td>$\tau_g$</td>
<td>0.020</td>
<td>0.020</td>
<td>0.020</td>
<td>0.020</td>
<td>0.020</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>DE</th>
<th>FR</th>
<th>SP</th>
<th>IT</th>
<th>REA</th>
<th>ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sov. bond spread sens. to debt-to-GDP (percent)</td>
<td>$\Lambda_{B_{GY}}$</td>
<td>0.035</td>
<td>0.070</td>
<td>0.170</td>
<td>0.230</td>
<td>0.120</td>
</tr>
<tr>
<td>Sovereign risk premium (percent)</td>
<td>$4RP_G$</td>
<td>0.480</td>
<td>0.920</td>
<td>1.560</td>
<td>1.840</td>
<td>1.200</td>
</tr>
<tr>
<td>Gov. bond spread net of sovereign risk (percent)</td>
<td>$4(R_G(1 - \xi_G)/R_{BD} - 1)$</td>
<td>0.562</td>
<td>0.846</td>
<td>1.709</td>
<td>1.857</td>
<td>1.154</td>
</tr>
<tr>
<td>Total government bond spread (percent)</td>
<td>$4(R_G/R_{BD} - 1)$</td>
<td>1.043</td>
<td>1.768</td>
<td>3.275</td>
<td>3.706</td>
<td>2.357</td>
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## Fiscal policy and instruments

<table>
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## Monetary policy

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## Main macro variables

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# Households

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# Government bond frictions in the household sector

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## Capital producers and firms

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<tr>
<td>Prices - domestic nontradables</td>
<td>ξ_N</td>
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<td>Prices - exports</td>
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<td><strong>Degree of indexation</strong></td>
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<td><strong>Degree of indexation</strong></td>
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<td>Substitution btw. consumption good imports</td>
<td>μ_Mc</td>
<td>3.500</td>
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<td>Substitution btw. investment good imports</td>
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### Entrepreneurs

<table>
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<tr>
<th>Parameter</th>
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<th>FR</th>
<th>SP</th>
<th>IT</th>
<th>REA</th>
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</thead>
<tbody>
<tr>
<td>St.dev. of idiosyncratic shock</td>
<td>$\sigma_e$</td>
<td>0.173</td>
<td>0.174</td>
<td>0.269</td>
<td>0.308</td>
<td>0.224</td>
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<tr>
<td>Monitoring cost</td>
<td>$\mu_e$</td>
<td>0.070</td>
<td>0.070</td>
<td>0.070</td>
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<tr>
<td>Continuation probability of entrepreneurs</td>
<td>$\zeta_e$</td>
<td>0.984</td>
<td>0.985</td>
<td>0.982</td>
<td>0.982</td>
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<tr>
<td>Recovery ratio in case of default (percent)</td>
<td>$\chi_e$</td>
<td>25.58</td>
<td>25.17</td>
<td>47.61</td>
<td>44.82</td>
<td>36.26</td>
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#### Variable

<table>
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<tr>
<th>Parameter</th>
<th>Formula</th>
<th>DE</th>
<th>FR</th>
<th>SP</th>
<th>IT</th>
<th>REA</th>
<th>ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob. of default (percent)</td>
<td>$1 - (1 - F(\omega_e))^4$</td>
<td>1.985</td>
<td>1.985</td>
<td>3.552</td>
<td>3.940</td>
<td>2.771</td>
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<td>Leverage</td>
<td>$\kappa_e$</td>
<td>1.193</td>
<td>1.189</td>
<td>1.323</td>
<td>1.265</td>
<td>1.257</td>
<td>1.222</td>
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<tr>
<td>Indebtedness to annual GDP (percent)</td>
<td>$L_e / (4Y)$</td>
<td>34.00</td>
<td>35.00</td>
<td>61.00</td>
<td>44.00</td>
<td>43.00</td>
<td>40.00</td>
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<tr>
<td>External financing premium (percent)</td>
<td>$4(1 + R_{KK}/R_{LE} - 1)$</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
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<tr>
<td>Credit risk compensation (percent)</td>
<td>$4(1 + R_{LLE}/R_{LE} - 1)$</td>
<td>0.237</td>
<td>0.237</td>
<td>0.531</td>
<td>0.635</td>
<td>0.375</td>
<td>0.379</td>
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<tr>
<td>Total commercial lending spread (percent)</td>
<td>$4(1 + R_{LLE}/R_{BD} - 1)$</td>
<td>2.320</td>
<td>1.880</td>
<td>3.240</td>
<td>3.560</td>
<td>2.640</td>
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