Countercyclical prudential tools in an estimated DSGE model

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First Conference on Financial Stability
Cemfi and Banco de España
25 May 2017

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Motivation

- Basel III strengthens prudential requirements and introduces systemic risk tools: e.g. a counter-cyclical capital buffer.
- Some jurisdictions already use other macro-prudential instruments to mitigate procyclicality.
  - For example, dynamic loan loss provisions in Spain and several Latin American countries.
- The implementation of Basel III, its effectiveness and complementarity with other tools have deserved considerable attention in policy circles and academic research.

Objective and outline

- Contribute by:
  - Developing a DSGE model of a small-open economy with a banking sector and endogenous loan's default.
  - Estimating the model with data for Uruguay: dollarized banking system and dynamic provisions since 2001.
  - Conducting "what if" analysis under counter-cyclical capital requirements and dynamic loan loss provisions.
- Work in progress:
  - Present here the model and a comparison of IRFs to internal and external shocks.
  - One of many inputs to policy and for assessing alternative risk scenarios.

The Model

- Households:
  - Provide labor and consume final goods.
  - Demand money (pesos) and deposits (dollars).
  - Also invest in foreign bonds in dollars.

  ▸ Households equations

- Entrepreneurs:
  - Manage the stock of capital.
  - Have heterogeneous productivity with costly-state verification.
  - Endogenous default (à la Bernanke, Gertler and Gilchrist, 1999).
  - Liability dollarization.

  ▸ Entrepreneurs equations ▸ Other features and shocks

- Banks:
  - Competitive banking sector financed by deposits and bank capital.
  - Lend to entrepreneurs (optimal contracting) and buy foreign assets.
  - Dollarized.
  - Subject to bank regulations.

Banks: balance sheet

- Balance sheet constraint is:

$$L_t + B_t^b + LLP_t = (1 - \tau_t)D_t + N_t^b,$$

where

- L_t are loans and B_t^b are holding of foreign assets.
- LLP_t is the flow of loan loss provisions (the stock is LLR_t).
- D_t are deposits and τ_t is the reserve requirement.
- N_t^b is bank capital.
- LLR_t and N_t^b are pre-determined at t.

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- Bank's loses due to default on loans at $t+1$ are $(R_t^L - \tilde{R}_{t+1}^L)L_t$.

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- Bank's loses due to default on loans at $t+1$ are $(R_t^L - \tilde{R}_{t+1}^L)L_t$.
- Hence, the utilization of loan loss provisions in $t+1$ is:

$$LLU_{t+1} = \min\left\{(R_t^L - \tilde{R}_{t+1}^L)L_t, LLR_t + LLP_t\right\}$$

- The stock of loan loss provisions evolves according to

$$LLR_{t+1} = LLR_t + LLP_t - LLU_{t+1}.$$

Banks: objective function

- Bank's objective function is:

$$E_t \left\{ r^*_{t,t+1} \left[\tilde{N}^b_{t+1} - PEN_{t+1} \right] \right\} - COST_t$$

where $r^*_{t,t+1}$ is a discount factor.

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- Income at $t+1$ is:

$$\tilde{N}^b_{t+1} = \tilde{R}^L_{t+1} L_t + B^b_t R^*_t + LLU_{t+1} - (R^D_t - \tau_t) D_t.$$

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- Portfolio-adjustment costs are:

$$COST_t = s_t [S^L L^2_t + (B^b_t)^2].$$

where s_t is an exogenous shock.

Banks: target level of capital

- Empirical evidence shows that banks target a desired level of bank capital γ_t above the minimum required by regulation γ_t^R.
- $\gamma_t - \gamma_t^R$ is the desired buffer due to precautionary reasons (γ_t^0) and bankers' forecast of economic conditions.

$$\gamma_t = \gamma_t^R + \gamma_t^0 + \alpha_d(E\{\text{def}_{t+1}\} - \text{def}_{ss}) + \alpha_l(E\{\Delta L_{t+1}\} - \Delta L_{ss}).$$

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- Bank capital is costly, so that too large buffers are not profitable.
- We take the following modeling shortcut:

$$PEN_{t+1} = \frac{\phi_D}{2}\left(\frac{\tilde{N}_{t+1}^b}{\tilde{A}_{t+1}^b} - \gamma_t\right)^2 \tilde{N}_{t+1}^b$$

where assets in $t+1$ are

$$\tilde{A}_{t+1}^b = \tilde{R}_{t+1}^L L_t + B_t^b R_t^* + LLU_{t+1} + \tau_t D_t$$

Bank regulation

- The model features several bank regulations:
  - Capital requirements (minimum and counter-cyclical): γ_t^R
  - Loan loss provisions (static and dynamic): LLP_t
  - Reserve requirements: τ_t

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- In the exercises we consider:
  - Benchmarks:
    - Constant minimum capital requirement: $\gamma_t^R = \gamma_0^R$
    - Static loan loss provisions: $LLP_t = l_0 \text{def}_t L_t$
  - Counter-cyclical capital requirement:
    - Feedback to real credit growth: $\gamma_t^R = \gamma_0^R + \alpha_l^R(\Delta L_t - \Delta L_{ss})$
    - Feedback to real GDP growth: $\gamma_t^R = \gamma_0^R + \alpha_y^R(\Delta Y_t - \Delta Y_{ss})$
  - Dynamic loan loss provisions:
    - $LLP_t = l_0 \text{def}_t L_t + l_1(\text{def}^{ss} - \text{def}_t) l_0 L_t$

Calibration and estimation

- Calibration:
  - Financial targets (average 2008-2015):
    - Quarterly default rate: 1.3 % (default / loans)
    - Quarterly active rate: 2.4 % (loans interest / loans)
    - Quarterly passive rate: 0.3 % (deposit interest / deposits)
    - Loans share: 48 % (loans / (loans + bonds))
    - Capital adequacy ratio: 8.49 % (capital / assets)
    - Minimum capital requirement: 4.88 % (minimum capital / assets)
    - Provisions coverage ratio: 6.73 % (provisions / loans)
- Estimation, Bayesian approach: Estimation results Goodness of fit
  - Macro variables: growth of output, consumption, investment, inflation, policy rate, nominal depreciation, world interest rate, country premium, inflation and output of commercial partners.
  - Financial variables: growth of credit, deposits, bank's capital, default rate, spread, regulatory capital and provisions.

What explains financial variables?

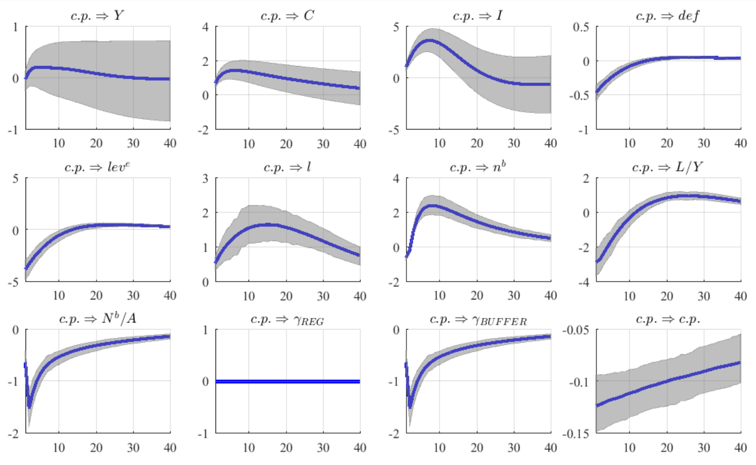
Variance decomposition

Source of shocks	Credit growth	Default	Bank capital growth
International financial factors	68	62	45
Domestic real factors	28	8	1
Entrepreneurs productivity shock	1	24	0
Bank costs	1	0	37
Others	2	6	17

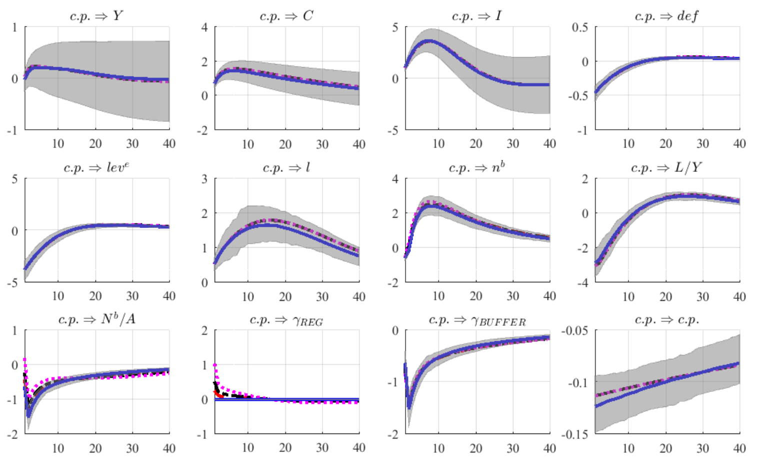
"What if" analysis

- Observe and compare the dynamics of real and banking variables under different regulations:
  - Benchmark with constant minimum capital requirement and static provisions.
  - Countercyclical capital buffer with feedback to credit growth and to GDP growth.
  - Dynamic provisions.
- For two positive (expansionary) shocks:
  - A reduction to the country risk premium.
  - A reduction to the idiosyncratic risk premium of entrepreneurs.

Positive country risk premium shock: Benchmark



Positive country risk premium shock: CCB
Real credit growth rule $\gamma_t^R = \gamma_0^R + \alpha_l^R(\Delta L_t - \Delta L_{ss})$



Solid blue: baseline no rule. Dashed red: $\alpha_l^R = 0{,}5$. Dashed black: $\alpha_l^R = 1{,}0$. Dotted magenta: $\alpha_l^R = 2{,}0$.

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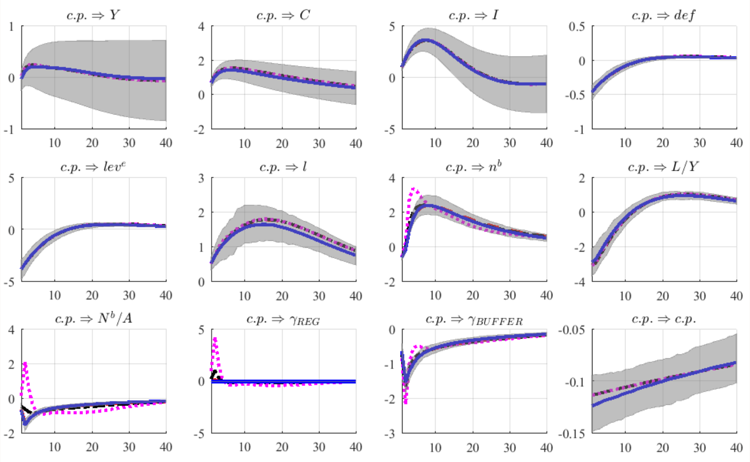

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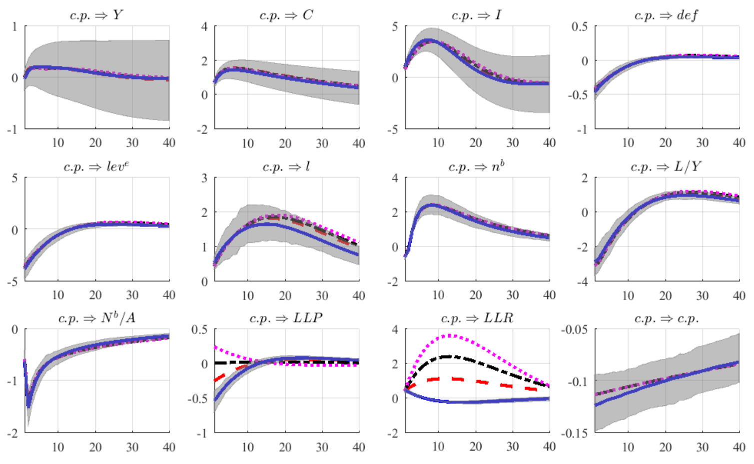


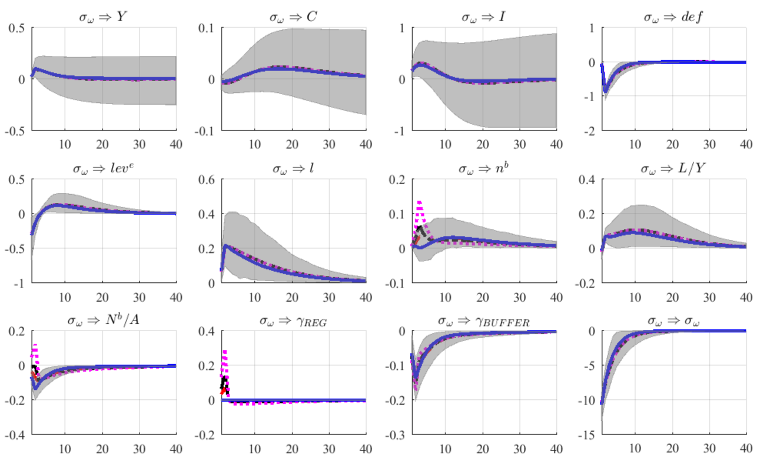
Solid blue: static prov ($l_1 = 0$). Dashed red: ł$_1$ = 0,5. Dashed black: ł$_1$ = 1,0. Dotted magenta: ł$_1$ = 1,5.

▸ Auxiliary chart

Positive country risk premium shock: comparison

- Counter-cyclical capital buffer:
  - Generates buffer without major counter-cyclical real effects.
  - GDP rule has quicker and stronger effects over bank capital.
  - Notice: credit/GDP decreases!
    Not trivial its use as a guide for countercyclical policy.
- Dynamic provisions:
  - Generate buffer with some real effects.
- In terms of buffering and smoothing cycles under external positive financial shocks, dynamic provisions seems to outperform CCB.

Positive entrepreneurs risk premium shock: CCB
Real credit growth rule $\gamma_t^R = \gamma_0^R + \alpha_l^R(\Delta L_t - \Delta L_{ss})$



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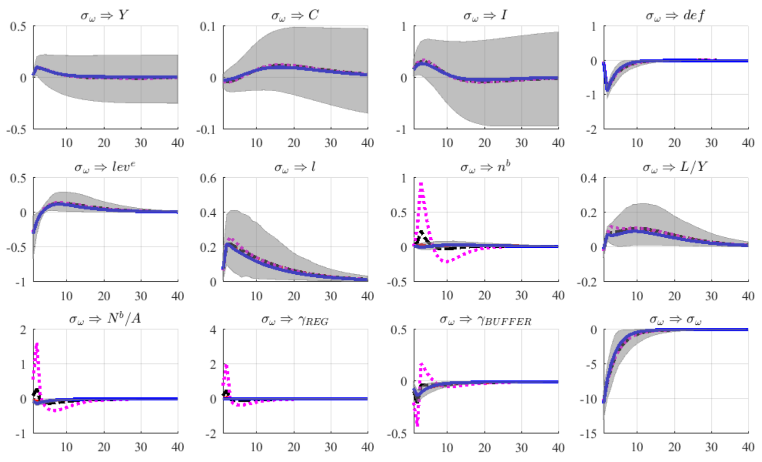

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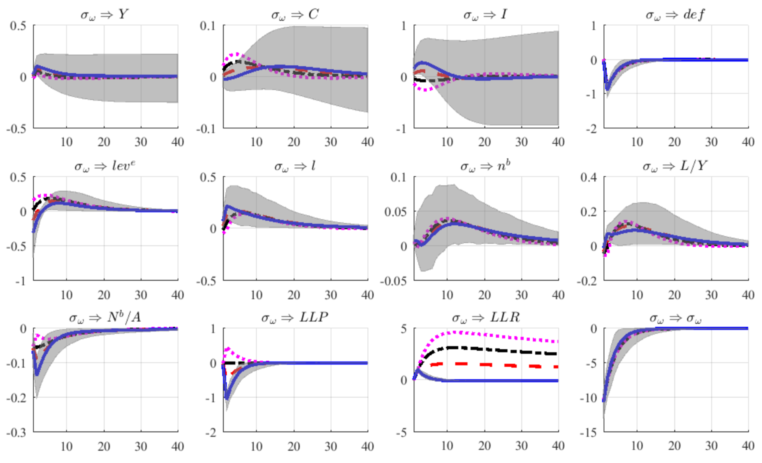

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Final remarks

- CCB and dynamic provisions are effective in generating buffers that may cover future losses.
- They may or may not have counter-cyclical real effects.
- Source of shocks matters to:
  - Select the policy tool: dynamic provisions seems to outperform CCB under external financial shocks.
  - Select the indicator variable for the CCB rule: credit to GDP does not seem adequate under external financial shocks.
  - Calibrate the size of the dynamic provisioning: the same calibration may be excessively counter-cyclical if the shock is domestic instead of external.

Thanks

Thank you for your attention!

Households

- Continuous of mass 1.
- Utility function: $v_t\left[u(c_t,h_t)+\nu_t\frac{(M_t^a)^{1-\sigma_M}-1}{1-\sigma_M}\right]$, where

$$M_t^a = \left[(1-o_M)^{\frac{1}{\eta_M}}\left(\frac{S_tD_t}{P_t}\right)^{\frac{\eta_M-1}{\eta_M}}+o_M^{\frac{1}{\eta_M}}\left(\frac{M_t^d}{P_t}\right)^{\frac{\eta_M-1}{\eta_M}}\right]^{\frac{\eta_M}{\eta_M-1}}$$

- Budget constraint with financial assets

$$B_t+S_tB_t^*+M_t+S_tD_t...= \\ R_{t-1}B_{t-1}+S_tR_{t-1}^*B_{t-1}^*+M_{t-1}+S_tR_{t-1}^DD_{t-1}+...$$

◂ The model

Entreprenuers

- At the end of each period they buy new capital (K_t), financed with net worth (N_t) and loans from banks (L_t) such that $Q_t K_t = N_t + L_t S_t$, where Q_t is the price of capital and S_t is the exchange rate.

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- Heterogeneous technology: if they buy $Q_t K_t$ at t they obtain $\omega_{t+1} R^e_{t+1} Q_t K_t$ in $t+1$:
  - ω_{t+1} is i.i.d. with cdf $F_t(\omega_{t+1})$, $E(\omega_t) = 1$ and std dev σ_t (exogenous).
  - R^e_{t+1} is the aggregate return on capital.

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  - R^e_{t+1} is the aggregate return on capital.
- Costly state verification: ω_t is private information. It may be verified by third parties by paying a monitoring cost μ (as a fraction of income).

◂ The model

Entreprenuers: default and optimal loan contract

- The optimal debt contract specifies an interest rate on the loan R_t^L and a cut-off value $\bar{\omega}_{t+1}$ such that:
  - Entrepreneurs with low realizations of productivity default, the bank pays the monitoring cost and seizes the defaulting entrepreneurs' assets.
  - Entrepreneurs with sufficiently high productivity pay the established interest rate and keep the difference.

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  - Entrepreneurs with sufficiently high productivity pay the established interest rate and keep the difference.
- The optimal contract: choose $lev^e_t = \frac{Q_t K_t}{N_t}$, $\bar{\omega}_{t+1}$ and R^L_t to maximize expected return to entrepreneurs, subject to banks' participation constraint (opportunity cost: $\tilde{R}^L_{t+1}$).

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- In equilibrium, $\tilde{R}_{t+1}^L$ is the realized return on loans.
- In equilibrium, the fraction of loans in default is $\text{def}_t = F_{t-1}(\bar{\omega}_t)$.

The model

The Model

- Other features:
  - Production using capital and labor.
  - Endowment of commodities.
  - Habits in consumption.
  - Investment adjustment costs.
  - Sticky prices and wages.
  - Delayed pass-trough.
  - Interest rate rule.
  - Ricardian fiscal policy.
- "Macro" shocks:
  - Domestic: Productivity, consumption, investment, government expenditures, production of commodities, demand for liquidity.
  - External: Interest rates, country premium, deviations from UIP, foreign output and inflation, price of commodities.

◂ The model

Estimation: selected parameters

Cuadro: Estimation

Param.	Description	Estimation
μ	Monitoring costs	0.03
υ	Survival rate of entrepreneurs	0.90
ϕ_B	Elasticity of bank penalty function	150
γ_{DEF}	Banks capital default component	0.08
γ_L	Banks capital credit component	0.09
$\rho_{\sigma\omega}$	Persistence entrepreneurs' shock	0.74
$\epsilon_{\sigma\omega}$	Std. dev. entrepreneurs' shock	0.10
ρ_{γ_0}	Exogenous capital rule persistence	0.98
$\rho_{\gamma_{reg}}$	Banks capital buffer persistence	0.97
ϵ_{γ_0}	Exogenous capital rule std. dev.	0.34
$\epsilon_{\gamma_{reg}}$	Banks capital buffer std. dev.	0.27

Return

Goodness of fit

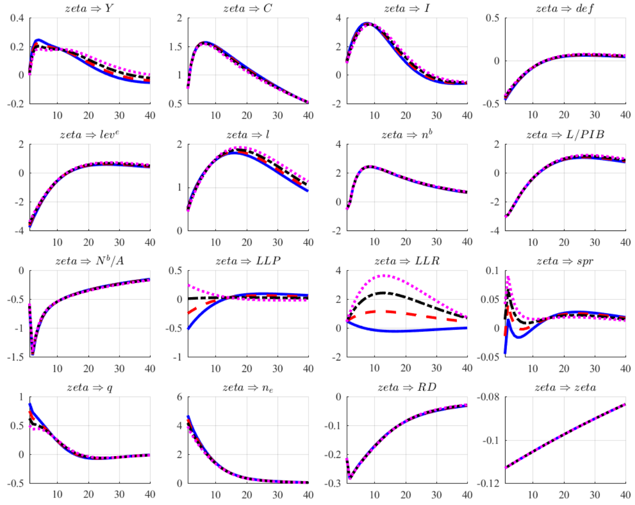
Cuadro: Standard deviations (%)

Variable	Data	Base
GDP growth	1.41	1.85
Cons. growth	1.49	2.15
Inv. growth	4.66	2.23
Country premium	0.28	0.79
R	0.83	1.00
Default	0.31	2.5
Bank's capital growth	5.3	6.6
Credit growth	7.28	6.75
Deposits growth	3.15	7.37
Required buffer capital growth	17.61	11.22
Bank's buffer capital growth	7.66	19.01

Return

Auxiliary chart

Return



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