Credit and Macroprudential Policy in a Small Economic Model of the Argentine Economy[1]

Horacio A. Aguirre   Emilio F. Blanco
Economic Research

BCRA

October, 2013

[1] Presentation prepared for the plenary meeting of the BIS CCA Research Network on "Incorporating Financial Stability Considerations into Central Bank Policy Models", México, DF, October 28 and 29, 2013; for internal use of the network only. All views expressed are the authors' own and do not necessarily represent those of the Central Bank of Argentina (BCRA).

Outline

- Motivation
- Baseline model
- Estimation and impulse-response functions
- Forecasting Performance
- The extended model: macroprudential policy
- Concluding remarks

Motivation

- The financial side of the macroeconomy is built into central bank models in diverse ways, without a unified and widespread framework (in particular:no workable mid- to small scale model).
- Modelling options basically comprise financial accelerator effects, collateral constraints, and the explicit representation of banking intermediaries (see Roger and Vlcek, 2011, for a survey of central bank literature: models generally built for North America and Europe).
- In Latin America, modelling efforts have only recently been made for the depiction of financial issues in the macroeconomy (motivation for this network!). Escudé (2008): a pre-crisis exception, full DSGE with financial intermediation and prudential policy.
- We aim to incorporate financial stability aspects into a small open economy model of the Argentine economy, completely estimated and suitable for short-term forecasting and simulation exercises.

Motivation

- The lack of an agreed framework to deal with financial stability in macroeconomic models also justifies the use of small structural ones, specially for applied work in central banks.
- Sámano Peñaloza (2011) enlarges a small macroeconomic model for Mexico with a financial block in order to determine the interplay of capital requirements and monetary policy.
- Szilagy et al (2013) add financial variables to a standard small model of the Hungarian macroeconomy. Both of these models, not explicitly derived from first order conditions of an optimization problem, show the basic New Keynesian structure.
- Other small macroeconometric models place some aspect of the financial market within an enlarged aggregate demand-aggregate supply plus monetary policy rule setting: Ramanauskas (2006), Dushku and Kota (2011), Hammersland and Bolstad (2012), Grech et al (2013).

Motivation

- Our model builds on previous work done for Argentina (Elosegui et al, 2007; Aguirre and Grosman, 2010), dealing with the financial dimension largely after Sámano Peñaloza (2011).
- Our approach is basically empirical, parameters should all be estimated (fully "letting the data speak"): contrast with design and implementation of large DSGE models, relying on calibration. Plus: smaller models forecast better than large ones (Canova, 2009).
- Descriptive and policy-oriented goals:
  - Enhance the depiction of an economy where real aspects may not be dissociated from financial ones.
  - Does incorporating aspects of financial intermediation improve short term forecast performance?
  - Does macroprudential policy lead to less variability of certain key variables? In particular, we include a macroprudential instrument (capital requirements) in addition to interest rates and foreign exchange intervention, so as to determine how it interacts with the other policy tools.

Baseline model

- Following work by Elosegui et al. (2007) and Aguirre and Grosman (2010): a small structural open economy model with a Taylor-type rule and foreign exchange market intervention, with the monetary effects that these imply.
- It incorporates a money market equation, providing a natural starting point for the introduction of a simplified financial block, where we describe credit market conditions (in the manner of Sámano Peñaloza, 2011).

Baseline model

Macroeconomic Block

- IS curve + Phillips curve + Taylor type rule
- IS: includes spread between the active rate of interest and the short term interest rate; as in Sámano Peñaloza (2011) and Szylagy et al (2013), this term captures the impact of credit market conditions on aggregate demand ("extra cost" above the short term interest rate that the non financial private sector has to pay in order to obtain resources).
- Phillips curve includes "imported" inflation.
- In addition to conventional interest rate response to prices and activity: a) concern for nominal exchange rate variability; b) involvement with financial stability. The short term rate also depends on its own lagged values, showing a desire to smooth interest rate movements; and on the "credit gap", i.e. the difference between current credit to the private sector and its steady state value.

Macroeconomic Block

$$g_t^y = \beta_1 \mathbb{E}_t g_{t+1}^y + \beta_2 g_{t-1}^y - \beta_3 \widehat{r}_t + \beta_4 \Delta \widehat{e}_t^{tri} - \beta_5 \widehat{sf}_t - \ldots$$
$$\ldots - \beta_6 \left(spread_{t-1} \right) + \varepsilon_t^y \quad (1)$$

$$spread_t = \widehat{i}_t^{act} - \widehat{i}_t \quad (2)$$

$$\widehat{\pi}_t = \alpha_1 \mathbb{E} \widehat{\pi}_{t+1} + (1 - \alpha_1) \widehat{\pi}_{t-1} + a_3 y_{t-1} + a_4 \Delta \widehat{e}_t^{tri} + \varepsilon_t^{\pi} \quad (3)$$

$$\widehat{i}_t = \gamma_1 \widehat{i}_{t-1} + \gamma_2 y_t + \gamma_3 \mathbb{E}_t \widehat{\pi}_{t+1}^a + \gamma_4 \widehat{\delta}_t + \gamma_5 \widehat{CR}_t + \varepsilon_t^i \quad (4)$$

Baseline model

FX Policy Block

- Modified UIP: effects of central bank operations in the foreign exchange market.
- The nominal exchange rate depends on expected depreciation, the difference between the local and the international interest rate, and a country risk premium that is made up of an endogenous component and an exogenous shock (Aguirre and Grosman, 2010; García Cicco, 2011).
- Endogenous RP is determined by interventions in the currency market: the central bank intervenes by buying or selling international reserves, and issuing or withdrawing bonds from circulation in order to sterilize the effects of intervention on the money supply.

FX Policy Block

$$\widehat{i}_t = \widehat{i}_t^* + \omega_1 \mathbb{E}_t \widehat{\delta}_{t+1} + (1-\omega_1)\widehat{\delta}_t + \omega_2 \widehat{b}_t + \omega_3 \Delta \widehat{res}_t + \widehat{\lambda}_t \quad (5)$$

$$\widehat{b}_t = \frac{1}{1-\phi}\left(\widehat{res}_t + \widehat{e}_t^d\right) - \frac{\phi}{1-\phi}\widehat{m}_t \quad \text{where} \quad \phi = \frac{m}{m+b} \quad (6)$$

$$\widehat{res}_t = \kappa_1 \widehat{res}_{t-1} - \kappa_2 \widehat{\delta}_t + \varepsilon_t^{res} \quad (7)$$

$$\widehat{m}_t = -\eta_1 \widehat{i}_t + \eta_2 \widehat{\pi}_t + \eta_3 \widehat{b}_t + \eta_4 \widehat{\delta}_t + \varepsilon_t^m \quad (8)$$

Financial Block

- Credit is basically a function of the output gap and the lending interest rate.
- Active (lending) rate is a function of the output gap, non performing loans and the short term rate; the spread emerges naturally as the difference between the lending and money market rate.
- We consider total credit to the private sector in terms of GDP, and rates on commercial loans; and non performing loans are exogenous.
- Credit as previously defined also feeds back into the "macroeconomic block" of the model through its inclusion in the interest rate rule.

Financial Block

$$\widehat{CR}_t = A_1 \widehat{g}^y_{t-1} - A_2 \widehat{i}^{act}_{t-1} + A_3 \widehat{CR}_{t-1} + \varepsilon^{CR}_t \tag{9}$$

$$\widehat{i}^{act}_t = B_1 \widehat{Delinq}_t - B_2 \widehat{g}^y_{t-1} + B_3 \widehat{i}_t + \varepsilon^{act}_t \tag{10}$$

$$\widehat{Delinq}_t = \rho^D_1 \widehat{Delinq}_{t-1} + \varepsilon^{Delinq}_t \tag{11}$$

Identities

$$\widehat{e_t^{tri}} \equiv \widehat{e^d}_t + c_1 \widehat{e^{US,R}}_t + c_2 \widehat{e^{US,E}}_t \quad (12)$$

$$\widehat{r}_t \equiv \widehat{i}_t - E_t \widehat{\pi}_{t+1} \quad (13)$$

$$\widehat{\Delta e^d}_t \equiv \widehat{\delta}_t + \widehat{\pi^*}_t - \widehat{\pi}_t \quad (14)$$

$$\widehat{g}_t^y \equiv \Delta y_t + \widehat{g^{\overline{y}}}_t \quad (15)$$

$$\widehat{\mu}_t \equiv \Delta \widehat{m}_t + \widehat{\pi}_t + \widehat{g}_t^y \quad (16)$$

Exogenous variables

$$\widehat{i^*}_t = \rho_1 \widehat{i^*}_{t-1} + \varepsilon_t^{i^*} \quad (17)$$

$$\widehat{\lambda}_t = \rho_2 \widehat{\lambda}_{t-1} + \varepsilon_t^{\lambda} \quad (18)$$

$$\widehat{\pi^*}_t = \rho_3 \widehat{\pi^*}_{t-1} + \varepsilon_t^{\pi^*} \quad (19)$$

$$\widehat{e^{US,R}}_t = \rho_4 \widehat{e^{US,R}}_{t-1} + \varepsilon_t^{e^{US,R}} \quad (20)$$

$$\widehat{e^{US,E}}_t = \rho_5 \widehat{e^{US,E}}_{t-1} + \varepsilon_t^{e^{US,E}} \quad (21)$$

$$\widehat{sf}_t = \rho_6 \widehat{sf}_{t-1} + \varepsilon_t^{sf} \quad (22)$$

$$\widehat{g^{\overline{y}}}_t = \rho_7 \widehat{g^{\overline{y}}}_{t-1} + \varepsilon_t^{g^{\overline{y}}} \quad (23)$$

Estimation

- We estimate the model completely through Bayesian techniques, based on quarterly data and for the 2003Q3-2011Q2 period;
  - this is the longest period spanning an homogeneous macroeconomic policy regime -the currency board regime adopted in 1991 was abandoned during the 2001-2002 crisis, after which a managed floating regime was adopted.
- Bayesian techniques prove particulary useful for this kind of situation: if one knows that structural change has taken place, this information can be included in a way not allowed by classical estimation methods.
  - We incorporate a priori information about the economy, thus potentially improving efficiency of estimates
  - Parameters are taken as random, data as fixed
  - Both features are relevant when the sample size is small due to structural breaks, as is the case of the period we focus on.

Estimation

- We apply a Random Walk Metropolis-Hastings algorithm (two chains of 50,000 replications each)
- The variance of the jumps is calibrated to achieve an acceptation rate between 0.2 and 0.4, which is considered an acceptable target to ensure that the search is global.
- The priors chosen are based on the posterior distributions from an estimation performed for the pre-crisis, currency board period. The set of observed variables Y is

$$Y = [\widehat{\pi}, \widehat{i}, \widehat{i^*}, \widehat{\pi}^*, \widehat{g}^y, \widehat{\delta}, \widehat{m}, \widehat{res}, \widehat{sf}, \widehat{e}^{US,R}, \widehat{e}^{US,E}, \widehat{CR}, \widehat{i}^{act}, \widehat{Delinq}]$$

Baseline model *(parameter estimates)*

parameters	prior mean	post. mean	conf. interval		prior	pstdev
α_1	0.3000	0.2049	0.1426	0.2635	*beta*	0.1000
α_3	0.0500	0.0171	0.0057	0.0281	*norm*	0.0350
α_4	0.1000	0.0662	0.0387	0.0903	*beta*	0.0500
β_1	0.3000	0.3087	0.2159	0.3902	*beta*	0.1000
β_2	0.5000	0.2945	0.1842	0.3930	*beta*	0.2000
β_3	0.1700	0.1738	0.1169	0.2237	*norm*	0.0500
β_4	0.2000	0.1322	0.0966	0.1577	*beta*	0.1000
β_5	0.3000	0.1655	0.1147	0.2157	*beta*	0.1000
β_6	0.3000	0.2498	0.2087	0.2938	*beta*	0.1000
ρ_1	0.5000	0.9591	0.9294	0.9906	*beta*	0.2000
ρ_2	0.5000	0.6375	0.5061	0.7637	*beta*	0.2000
ρ_3	0.5000	0.2914	0.1621	0.4294	*beta*	0.2000
ρ_4	0.7000	0.9605	0.9263	0.9964	*beta*	0.2000
ρ_5	0.7000	0.8649	0.7781	0.9435	*beta*	0.2000
ρ_6	0.5000	0.3416	0.2481	0.4307	*beta*	0.2000
γ_1	0.7000	0.7380	0.6544	0.8064	*beta*	0.2000
γ_2	0.0000	0.0488	0.0114	0.0866	*norm*	0.2000
γ_3	0.0000	0.0065	−0.0153	0.0289	*norm*	0.2000
γ_4	0.2000	0.0925	0.0574	0.1314	*beta*	0.1000
γ_5	0.0000	0.0019	−0.0106	0.0150	*norm*	0.2000
ω_1	4.0000	5.0777	4.0724	5.9714	*norm*	1.5000
ω_2	0.1000	0.0108	0.0037	0.0185	*beta*	0.0500
ω_3	1.0000	0.1125	0.0000	0.2545	*norm*	1.0000
η_1	1.2000	0.7343	0.5863	0.9042	*norm*	0.3000
η_2	0.5000	0.7570	0.6196	0.8979	*beta*	0.2000
η_3	0.5000	0.0213	0.0144	0.0289	*norm*	0.3000
η_4	0.5000	0.7239	0.6638	0.7838	*norm*	0.1000
κ_1	0.7000	0.9635	0.9324	0.9956	*beta*	0.2000
κ_2	0.1000	0.0934	0.0608	0.1249	*beta*	0.0500
A_1	0.3000	0.3538	0.3298	0.3787	*beta*	0.0500
A_2	0.1000	0.0408	0.0181	0.0751	*beta*	0.0500
A_3	0.3000	0.4513	0.4099	0.4950	*beta*	0.0500
B_1	0.3000	0.0302	0.0144	0.0453	*beta*	0.1000
B_2	0.3000	0.1927	0.1014	0.2684	*beta*	0.1000
B_3	0.3000	0.3790	0.3240	0.4409	*beta*	0.1000
ρ_1^D	0.5000	0.9808	0.9644	0.9970	*beta*	0.2000

Estimation: "goodness of fit"

Observed and estimated standard deviations of selected variables

		Credit-to-GDP	Active rate	Short term rate
Std.Dev. 2003-2011	Observed	0.1003	0.0074	0.0085
	Estimated	0.1026	0.0091	0.0110

Results: Impulse Response Functions

- Positive shock to the lending rate: credit decreases and the interest rate spread increases -the short term interest rate increases, but to a lesser degree than the active rate.
  - This affects the real side of the economy, with a negative effect on output growth.
  - As the short term interest rate increases, the nominal exchange rate depreciates -the impact on UIP means that a higher local rate, with no change in the international interest rate, translates into a depreciation of the local currency. Pass-through from the exchange rate to domestic prices entails a fall on the real interest rate.
  - The central bank acts by gradually increasing the short term rate and intervening in the foreign exchange market to reduce foreign exchange volatility.

Results: IRFs

Figure 1

Accumulated responses to 1 s.d. shock to the lending rate

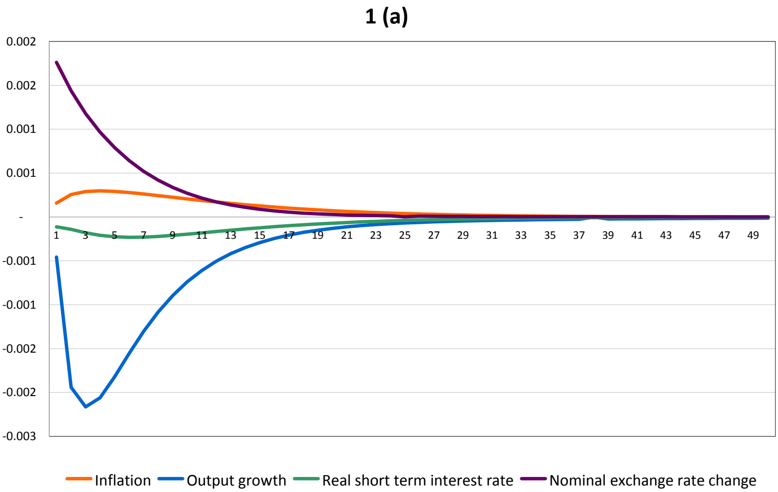
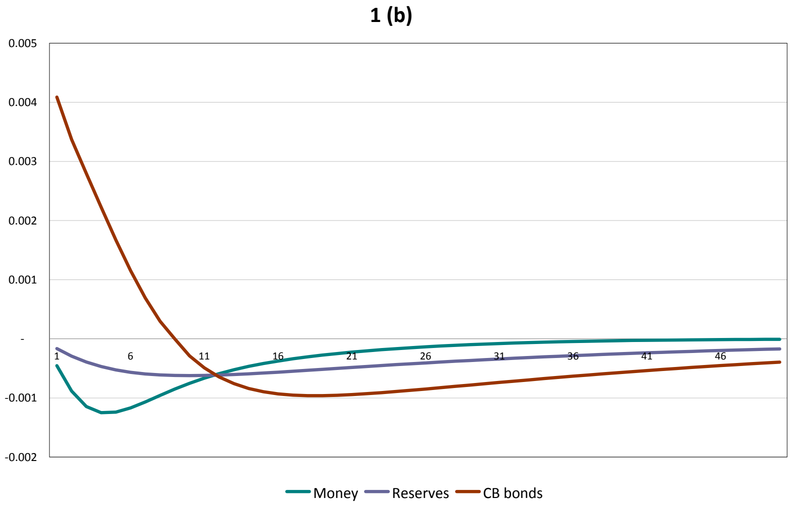


Figure 1 (cont)

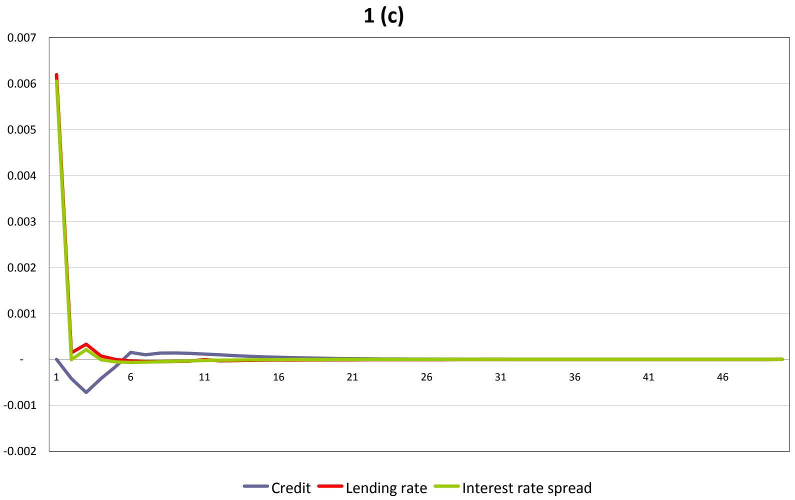
Accumulated responses to 1 s.d. shock to the lending rate



Results: IRFs

Figure 1 (cont)

Accumulated responses to 1 s.d. shock to the lending rate



Results: IRFs

- Shock to the passive rate: higher real (short term) interest rate, which goes together with nominal and real exchange rate appreciation.
  - Output is affected, but to a substantially lower degree than in the previous exercise.
  - The central bank reacts by (initially) buying reserves and sterilizing the monetary effect of its operations by issuing bonds. In the credit market, the lending rate goes up while credit diminishes -somewhat paradoxically, spread is reduced as the active rate is raised less than one-to-one with respect to the passive rate.
- We are aware that both exercises are just a crude approximation at describing the interplay between the credit market and the macroeconomy.

Results: IRFs

Figure 2

Accumulated responses to 1 s.d. shock to the short term interest rate

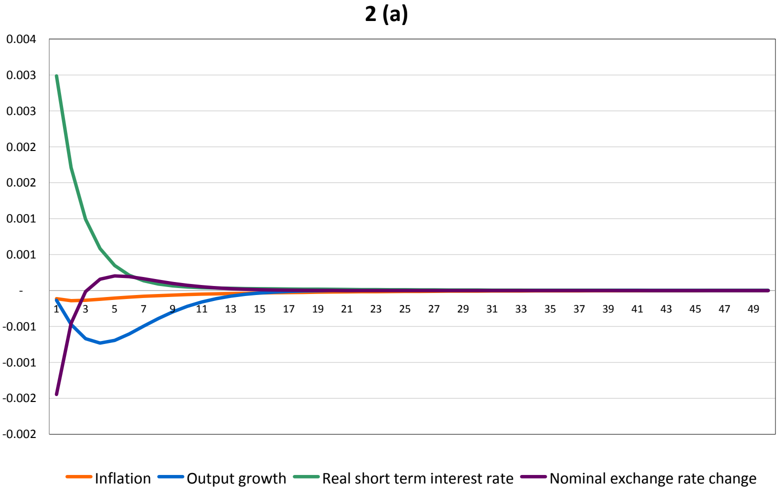


Figure 2 (cont)

Accumulated responses to 1 s.d. shock to the short term interest rate

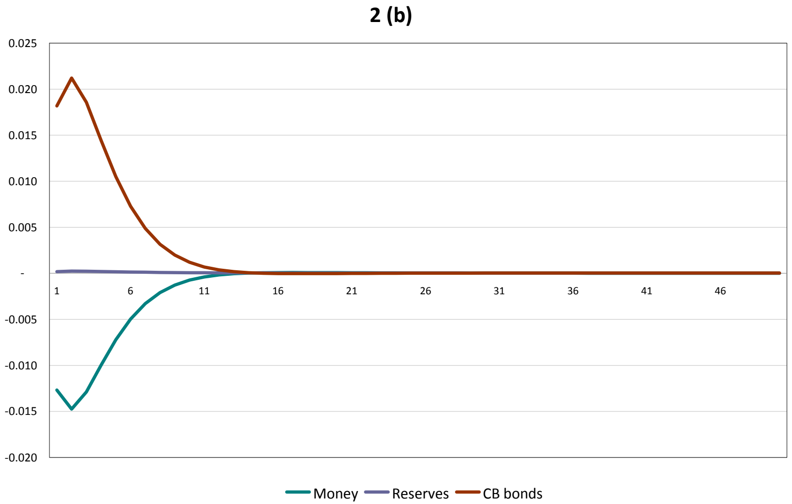
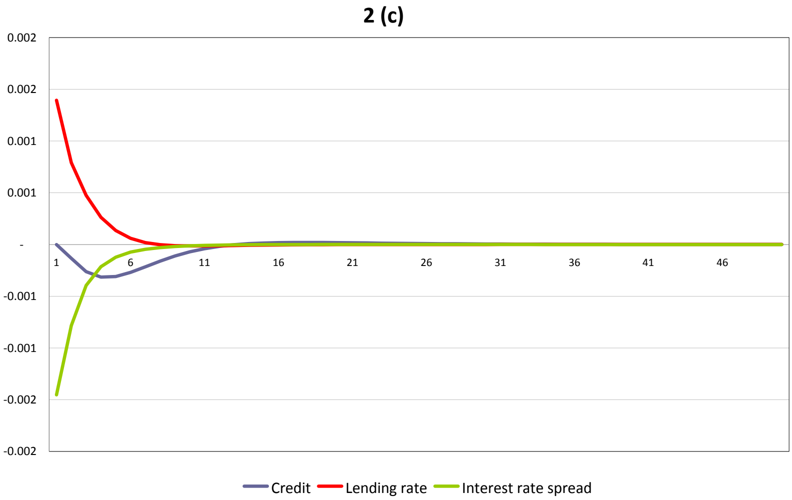


Figure 2 (cont)

Accumulated responses to 1 s.d. shock to the short term interest rate



Results: IRFs

- This exercise can also be done to analyze how a real shock is transmitted throughout the rest of the economy and the credit market
  - A positive shock to the IS curve increases output and decreases inflation; the short term interest rate increases, in both nominal and real terms -basically due to the reaction required by the Taylor rule. This leads to real exchange rate appreciation so the central bank buys reserves to "resist" it and issues bonds to sterilize the monetary effects of its operations.
  - An appreciated exchange rate (both in nominal and real terms) explains, via pass-through, why the direct effect of the shock is decreasing in inflation.
  - In turn, credit increases, the lending rate falls, and so does spread.

Results: IRFs

- In the cases of shock to the lending rate and to output, the spread is countercyclical in the sense that higher (lower) spread entails lower (higher) credit and output
- In contrast, when the short term interest rate is shocked, the spread appears to be procyclical -while credit also goes down, since the active rate is going up, the spread is reduced. Our interpretarion: the effect of decreased credit demand, together with lower output associated to a higher real rate, more than offsets the direct expansionary impact of a lower spread
- In all of the three cases, credit is procyclical.

Forecasting performance

- We compare the model with: a standard New Keynesian "three equation model" plus a UIP equation; a model augmented with sterilized intervention:
  - Out-of-sample forecasts for horizons of one quarter, two quarters and one year (that is 1, 2 and 4 steps),
  - for annual inflation, quarterly output growth, the short term interest rate (annual percentage rate) and quarterly nominal exchange rate depreciation.
- We evaluated forecasts through root mean squared error (RMSE) and mean absolute error (MAE); as several out-of-sample forecasts were produced for 1 and 2 steps, we averaged RMSEs and MAEs

Root Mean Squared Error (average of forecasts)			
	Model 1	Model 2	Model 3
		Inflation	
1q ahead	0.0003863	**0.0003601**	0.0004164
2q ahead	0.0012309	**0.0011084**	0.0013154
1y ahead	0.0041688	**0.0035105**	0.0043853
		short term interest rate	
1q ahead	0.0126731	0.0137405	**0.0095607**
2q ahead	0.0135622	0.0160373	**0.0097047**
1y ahead	0.0139850	0.0194395	**0.0094282**
		gdp growth	
1q ahead	0.0002387	0.0000251	**0.0000000**
2q ahead	0.0002925	0.0000247	**0.0000194**
1y ahead	0.0003280	0.0000564	**0.0000649**
		nominal depreciation	
1q ahead	0.0022511	0.0004011	**0.0000087**
2q ahead	0.0018259	0.0003705	**0.0000086**
1y ahead	0.0010593	0.0002172	**0.0000607**

Mean Absolute Error (average of forecasts)			
	Model 1	Model 2	Model 3
		Inflation	
1q ahead	0.0196534	**0.0189759**	0.0204060
2q ahead	0.0326056	**0.0310329**	0.0337317
1y ahead	0.0582519	**0.0538322**	0.0598371
		short term interest rate	
1q ahead	0.1125746	0.1172198	**0.0977789**
2q ahead	0.1163943	0.1263115	**0.0985099**
1y ahead	0.1181953	0.1387171	**0.0970527**
		gdp growth	
1q ahead	0.0154513	0.0050123	**0.0000900**
2q ahead	0.0170306	0.0049674	**0.0031620**
1y ahead	0.0174216	0.0060057	**0.0059572**
		nominal depreciation	
1q ahead	0.0474463	0.0200285	**0.0029536**
2q ahead	0.0848728	0.0384642	**0.0058586**
1y ahead	0.1140001	0.0508887	**0.0235807**

Forecasting performance

- Results show that for 1, 2 and 4-quarter forecasts of output growth, short term interest rate and foreign exchange variability, model 3 (baseline with credit market) outperforms the rest under both evaluation criteria.
- For inflation and at all time horizons, model 2 (forex market) delivers the forecast with lowest average errors.
- Thus, results confirm that models "enriched" to reflect foreign exchange operations, money market dynamics (model 2) as well as credit market conditions (model 3) imply gains in terms of out-of-sample forecasting of key macroeconomic variables.
- Differences between RMSEs and MAEs from the models are significant, as tested by the Giacomini-White procedure

Extended model: macroprudential policy

- We will focus on one of the most basic "macroprudential" financial system regulations: a capital adequacy ratio (CAR). Several variants:
- **First Option: Exogenous:** a purely exogenous ratio (akin to conventional prudential regulation)

$$\widehat{CAR}_t = \psi_0 + \psi_1 \widehat{CAR}_{t-1} + \varepsilon_t^{CAR}$$

Extended model: macroprudential policy

- **Second Option: Endogenous:** rules according to which adequate capital depends on macroeconomic or financial system variables
  - output gap

$$\widehat{CAR}_t = \psi_0 + \psi_1 \widehat{CAR}_{t-1} + \psi_2 \hat{y}_t + \varepsilon_t^{CAR}$$

  - credit gap

$$\widehat{CAR}_t = \psi_0 + \psi_1 \widehat{CAR}_{t-1} + \psi_2 \widehat{CR}_t + \varepsilon_t^{CAR}$$

  - interest rate spread

$$\widehat{CAR}_t = \psi_0 + \psi_1 \widehat{CAR}_{t-1} + \psi_2 spread_t + \varepsilon_t^{CAR}$$

- The CAR is included in the equation describing the active rate:

$$\widehat{i}_t^{act} = B_1 \widehat{Delinq}_t - B_2 \widehat{g}_{t-1}^{y} + B_3 \widehat{i}_t + B_4 \widehat{CAR}_t + \varepsilon_t^{act}$$

Model 4, exogenous CAR *(parameter estimates)*

parameters	prior mean	post. mean	conf. interval		prior	pstdev
α_1	0.3000	0.2404	0.2051	0.2967	beta	0.1000
α_3	0.0500	0.0590	0.0403	0.0807	norm	0.0350
α_4	0.1000	0.1533	0.1097	0.2021	beta	0.0500
β_1	0.3000	0.4147	0.3685	0.4653	beta	0.1000
β_2	0.5000	0.3068	0.2506	0.3604	beta	0.2000
β_3	0.1700	0.1706	0.1391	0.2044	norm	0.0500
β_4	0.2000	0.1249	0.0923	0.1563	beta	0.1000
β_5	0.3000	0.3797	0.3348	0.4260	beta	0.1000
β_6	0.3000	0.2593	0.2074	0.3072	beta	0.1000
ρ_1	0.5000	0.9565	0.9260	0.9896	beta	0.2000
ρ_2	0.5000	0.4216	0.3370	0.5231	beta	0.2000
ρ_3	0.5000	0.2199	0.1357	0.3044	beta	0.2000
ρ_4	0.7000	0.9604	0.9293	0.9954	beta	0.2000
ρ_5	0.7000	0.8796	0.7999	0.9699	beta	0.2000
ρ_6	0.5000	0.6536	0.5622	0.7879	beta	0.2000
γ_1	0.7000	0.5557	0.4857	0.6399	beta	0.2000
γ_2	0.0000	0.0522	-0.0029	0.1186	norm	0.2000
γ_3	0.0000	0.0081	-0.0267	0.0395	norm	0.2000
γ_4	0.2000	0.0929	0.0466	0.1322	beta	0.1000
γ_5	0.0000	0.0137	0.0032	0.0233	norm	0.2000
ω_1	4.0000	5.2828	4.4364	6.2797	norm	1.5000
ω_2	0.1000	0.0108	0.0045	0.0169	beta	0.0500
ω_3	1.0000	0.1043	0.0000	0.2294	norm	1.0000
η_1	1.2000	0.6806	0.5152	0.8385	norm	0.3000
η_2	0.5000	0.5772	0.4679	0.6966	beta	0.2000
η_3	0.5000	0.0178	0.0105	0.0248	norm	0.3000
η_4	0.5000	0.7044	0.6481	0.7583	norm	0.1000
κ_1	0.7000	0.9720	0.9476	0.9961	beta	0.2000
κ_2	0.1000	0.0860	0.0309	0.1430	beta	0.0500
A_1	0.3000	0.3687	0.3363	0.4051	beta	0.0500
A_2	0.1000	0.0521	0.0210	0.0841	beta	0.0500
A_3	0.3000	0.4543	0.4128	0.4871	beta	0.0500
B_1	0.3000	0.0440	0.0270	0.0585	beta	0.1000
B_2	0.3000	0.2577	0.1789	0.3298	beta	0.1000
B_3	0.3000	0.3032	0.2528	0.3602	beta	0.1000
B_4	0.3000	0.2093	0.1601	0.2590	beta	0.1000
ρ_1^D	0.5000	0.9764	0.9579	0.9954	beta	0.2000
ψ_0	0.5000	0.0105	0.0100	0.0110	beta	0.2000
ψ_1	0.7000	0.4417	0.2519	0.6413	beta	0.2000

Macroprudential policy: an empirical assessment

- We compute standard deviations of macroeconomic and financial variables under models 3-7.
- Exogenous capital requirements show lower volatility during the estimation period for: inflation, output growth, short term local and foreign interest rates, nominal (bilateral) exchange rate depreciation and bilateral real exchange rate depreciation with Brazil, money and credit.
- Capital requirements as function of interest rate spread would be linked to lower volatility in non performing loans and the bilateral real exchange rate with the euro.
- Implementing no capital requirements but policy based on both interest rate and foreign exchange intervention delivers lower volatility of international reserves and the lending interest rate.

Macroprudential policy: an empirical assessment

- Results suggest that for the 2003-2011 period, the interaction of monetary and foreign exchange policy (interest rate rules plus foreign exchange intervention) and macroprudential policy (capital requirements) generated lower volatility of key macroeconomic and financial variables than if no macroprudential policy would have been put in place.

Macroprudential policy: an empirical assessment

Estimated standard deviations of selected variables

	Model 3 Credit market, no CAR	Model 4 Exogenous CAR	Model 5 Endogenous CAR (y)	Model 6 Endogenous CAR (cred)	Model 7 Endogenous CAR (spread)
π	0.0311	0.0281	0.0422	0.0308	0.0633
i	0.0118	0.0091	0.0113	0.0100	0.0209
i^*	0.0099	0.0096	0.0099	0.0105	0.0096
δ	0.0411	0.0363	0.0386	0.0380	0.0509
g^y	0.0216	0.0215	0.0351	0.0226	0.0263
$e^{US,R}$	0.2398	0.2342	0.2511	0.2495	0.2609
$e^{US,E}$	0.0791	0.0896	0.0684	0.1225	0.0604
m	0.1479	0.0957	0.1066	0.1258	0.2511
res	0.4728	0.5582	0.5039	0.4896	0.4788
CR	0.1862	0.1569	0.1694	0.2086	0.1603
i^{act}	0.0088	0.0104	0.0142	0.0110	0.0417
$Delinq$	0.0806	0.0775	0.0761	0.0777	0.0745
CAR		0.0143	0.0271	0.0178	0.1742

Macroprudential policy: an empirical assessment

Rationalising lower variability of the exogenous CAR rule

- Size of the financial system: higher influence of the real economy on the financial system than otherwise?
- CAR rule actually in place during the estimation period is more similar to that of model 4 (exogenous): better fit to data?

- However, a measure of comparative fit suggests that the model with CAR as a function of credit would be the one of choice

Log data densities of alternative models

Model	Log data density
4 Exogenous CAR	1146.31
5 Endogenous CAR (y)	1135.84
6 Endogenous CAR (cred)	1170.10
7 Endogenous CAR (spread)	1135.95

Concluding remarks

- We estimated a small macroeconomic model of the Argentine economy, augmented to include explicit depiction of the credit market, active rates and interest rate spread; and an enriched description of monetary policy, with sterilized intervention in the foreign exchange market.
- Impulse-response functions of the estimated model:
  - Higher lending rates are associated to higher spread, lower credit and output growth; in turn, higher output implies lower interest rate spread and higher credit.
  - Impacts from the credit market to the rest of the economy should be further investigated to see whether a hypothesis of "financial cycles" (Borio,2012) may apply during the estimation period.
  - The financial system is affected by macroeconomic shocks: in particular, credit behaves in a procyclical way (in line, for instance, with evidence by Bebczuk et al, 2011).

Concluding remarks

- Is forecast performance improved by a structural macroeconomic model augmented with financial variables?
  - Yes: our estimated model predicts quarterly output growth, annual interest rates and quarterly foreign exchange rate depreciation with significantly higher accuracy than: a conventional "three equation plus UIP" macroeconomic model; and a model with sterilized intervention (but no "financial block).
  - This is evaluated for 1-, 2- and 4-step out-of-sample forecasts, and using RMSE and MAE forecast evaluation criteria.
  - The model with foreign exchange intervention, however, provides better forecasts of annual inflation.

Concluding remarks

- We enhanced the baseline model to find out whether macroprudential policy (capital adequacy rules) helped macroeconomic performance in any meaningful way during the estimation period.
- Just as previous results show that macroeconomic volatility is reduced when foreign exchange intervention is implemented in addition to interest rate rules (Escudé, 2009; Aguirre and Grosman, 2010), we find that
  - capital requirements contribute to desirable cyclical macroeconomic property –smoothing output, price, interest rate and credit volatility over the business cycle;
  - the interaction of monetary policy, foreign exchange intervention and prudential tools is, an a way, synergic.

Concluding remarks

- Further work: enriching specification, computing optimal policy; even within the limits of a small structural model, this could shed some more light on the interplay of monetary, foreign exchange and macroprudential policy -something we leave for the next step of this project
- In our assessment results are strong enough to suggest a likely role for regulation of the financial system in dampening macroeconomic fluctuations in a developing economy like Argentina.