Network models, stress testing and other tools for financial stability monitoring and macroprudential policy design and implementation
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EVALUATING THE NET BENEFITS OF MACROPRUDENTIAL POLICIES: A COOKBOOK

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Motivation

- Policies seek to address externalities (De Nicolo, Favara and Ratnovski, 2012)
  - Correlated risk taking of financial institutions during expansionary phase
  - Fire sales amplify the contractionary phase
  - Contagion propagates shocks through networks
- Externalities ⟹ Systemic Risk Indicators
- Indicators ⟹ Output forecast
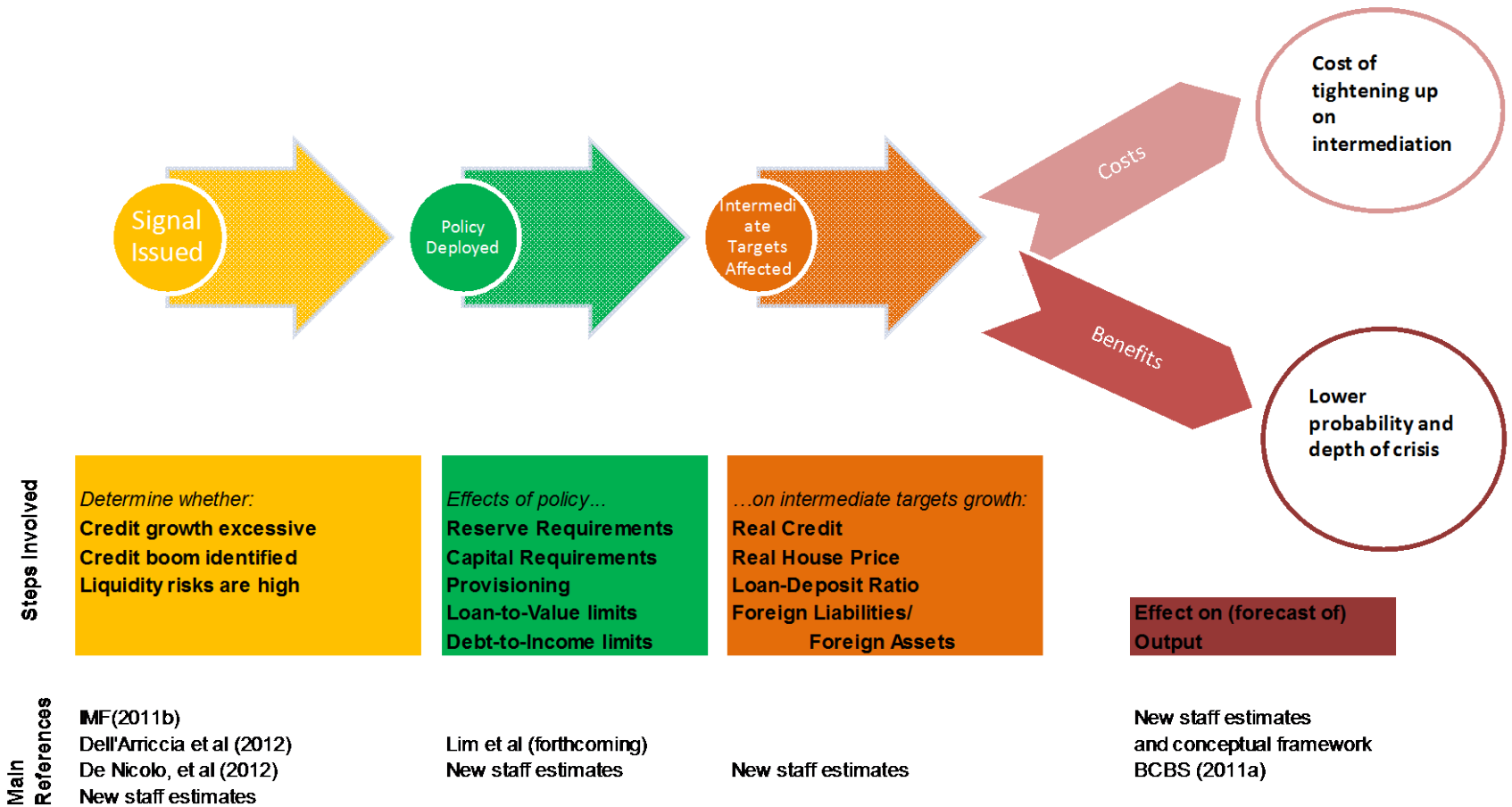- **Measuring net benefits of policy: in terms of output forecast**

Steps

- Framework for evaluating net benefits of policy
  - Benefits: lower probability and depth of crisis
  - Costs: lower intermediation and output from overestimating risks
- Measurements of ingredients
  - Probability of crisis: What are the warning signs?
  - Depth of output loss: What is the damage following a crisis?
  - Output loss if no crisis: What are the costs of policy?
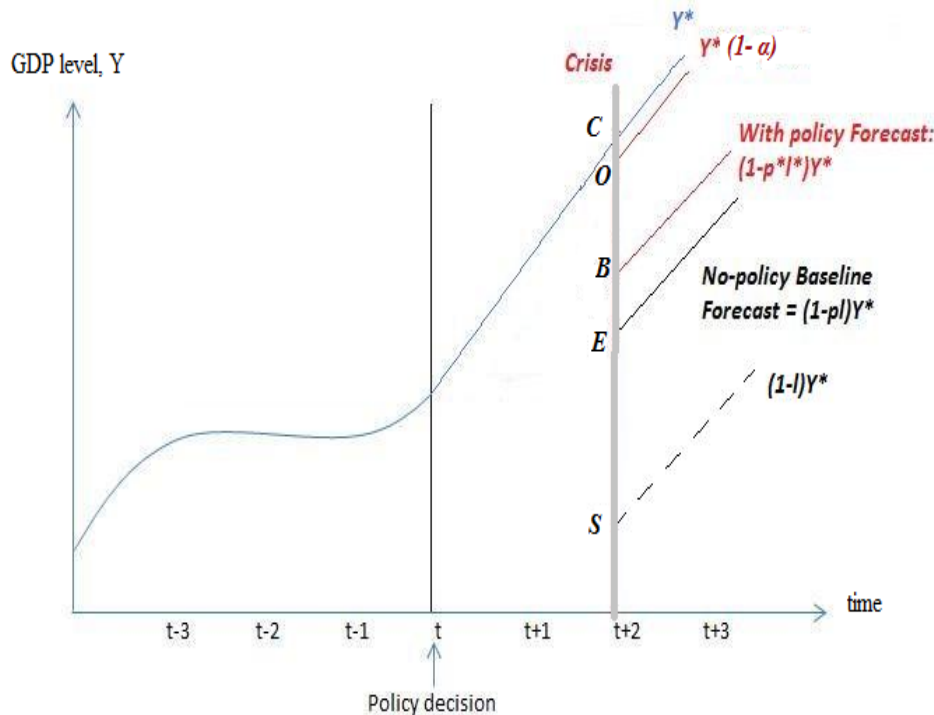 - How effective are policies?
    - Leakages

Policy Time Line

Signal Issued

Policy Deployed

Intermediate Targets Affected

Costs

Benefits

Cost of tightening up on intermediation

Lower probability and depth of crisis

Steps Involved

Determine whether:
Credit growth excessive
Credit boom identified
Liquidity risks are high

Effects of policy...
Reserve Requirements
Capital Requirements
Provisioning
Loan-to-Value limits
Debt-to-Income limits

...on intermediate targets growth:
Real Credit
Real House Price
Loan-Deposit Ratio
Foreign Liabilities/
Foreign Assets

Effect on (forecast of) Output

Main References

IMF(2011b)
Dell'Arriccia et al (2012)
De Nicolo, et al (2012)
New staff estimates

Lim et al (forthcoming)
New staff estimates

New staff estimates

New staff estimates and conceptual framework
BCBS (2011a)

Concept

GDP level, Y

Y^*

$Y^*(1-\alpha)$

Crisis

C

O

With policy Forecast:
$(1-p^*l^*)Y^*$

B

E

**No-policy Baseline
Forecast = (1-pl)Y^***

$(1-l)Y^*$

S

time

t-3   t-2   t-1   t   t+1   t+2   t+3

Policy decision

Signal that there is rapid credit and house price growth

Inputs: *GDP forecast (level) without crisis: Y**
Probability of crisis: No-policy baseline p
With policy p*
Loss given crisis: No-policy baseline l
With policy l*
Cost of policy on Y*: α

Net Benefits of Policy

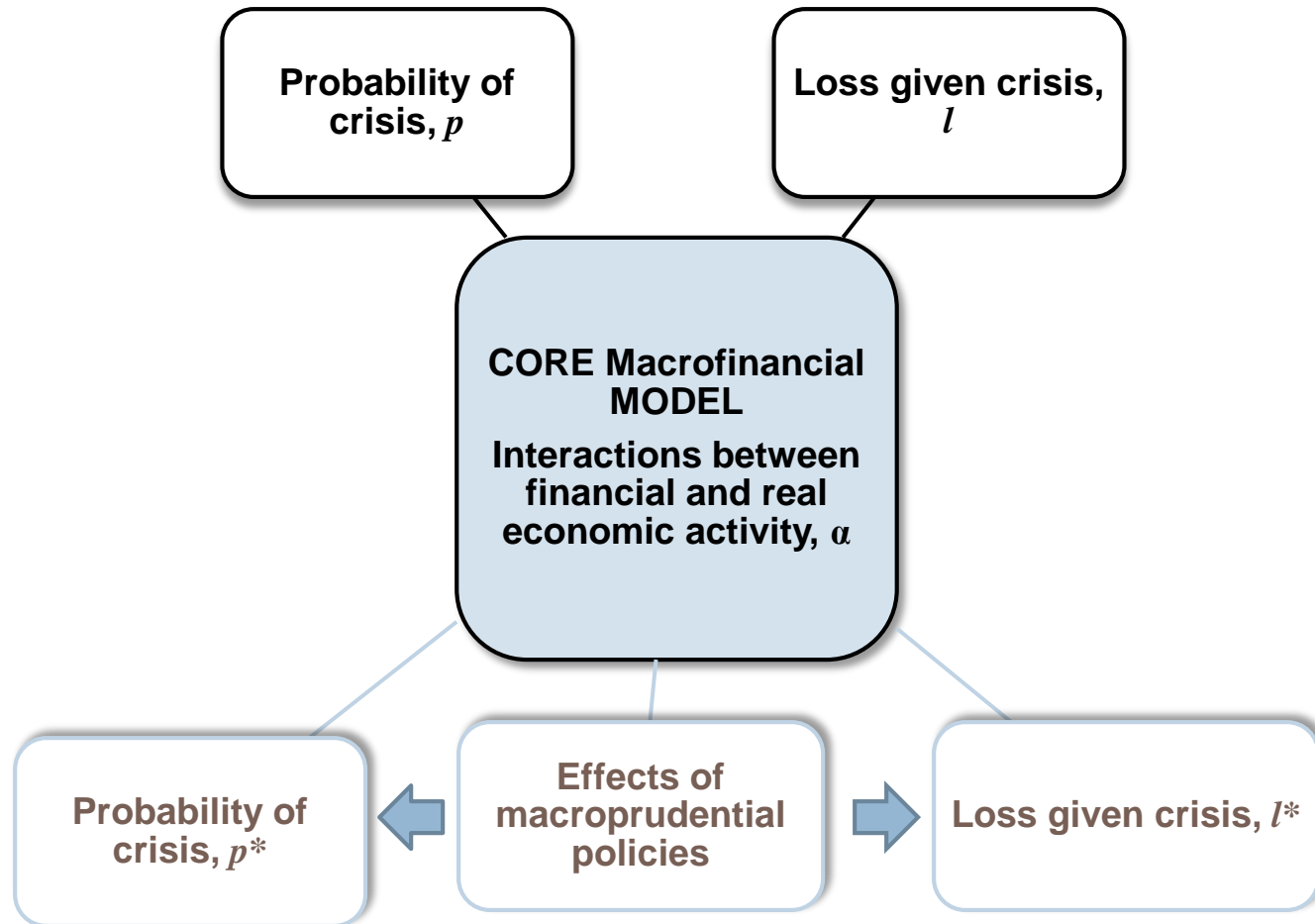Expected Y loss without policy: 1-*pl*

Expected Y loss with policy: 1-p_*l_*

Cost of policy: Over-regulation and loss in intermediation and output, α

$$\frac{1-p^*l^*}{1-pl} - \frac{1}{1-\alpha} \geq 0$$

Analytical Building Blocks

Probability of crisis, p

Loss given crisis, l

CORE Macrofinancial MODEL

Interactions between financial and real economic activity, α

Probability of crisis, $p*$

Effects of macroprudential policies

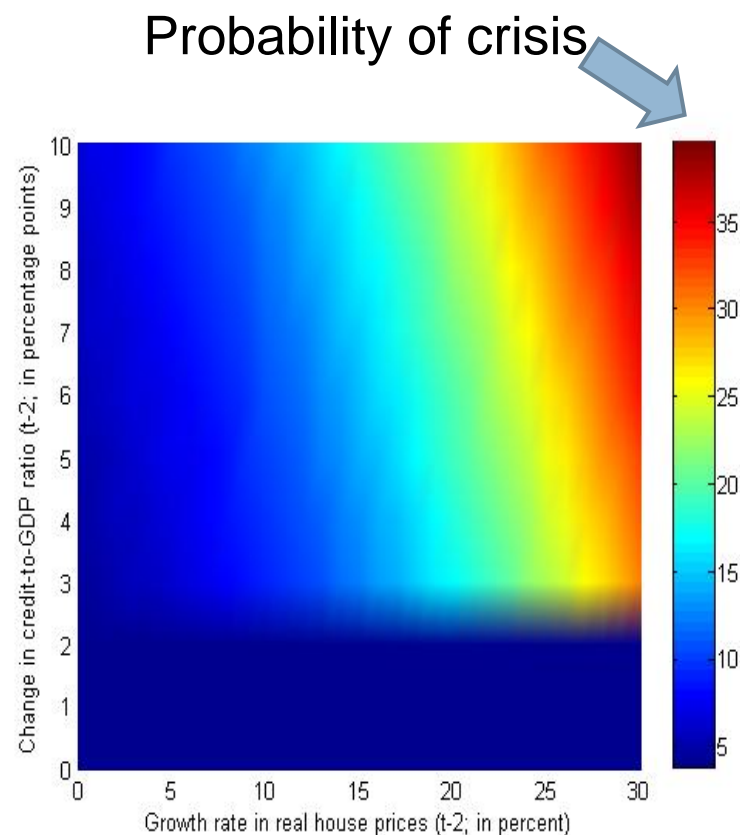Loss given crisis, $l*$

"p": Early Warning—Credit!

- Credit aggregates are key.
  - Low chance of missing a crisis: change in Credit/GDP
    >3-5 pp (IMF GFSR,2011)
  - Low chance of overregulation
    "gap">1.5 s.d. & growth>10% (Dell'Ariccia et al, 2012)
- Range better than one threshold
  - Flag risks at the lower (GFSR) threshold and escalate concerns and implement policies by the Dell'Ariccia et al threshold
- All sources of credit, not just from banks

"p": Early Warning—Combine!

- Panel Logit model (RE)
- 1970-2010, ADV & EM

- Prob (crisis):
  - Credit-GDP change (t-2)
  - Real house price $(RHP)_{(t-2)}$%
  - (DUM if Credit-GDP change >3) * $RHP_{(t-2)}$%

Probability of crisis

Credit and House Price Growth

"l": Loss Given Crisis

Model:

- Financial crisis: Laeven-Valencia (2010)
- Focus on GDP loss measures
- Measurement:
  - Take 5y window.
  - Compute % difference from potential output (based on 5y pre-crisis avg. growth rate).
  - When actual>potential, set at zero.
  - Cost of crisis = average difference over the window

Crisis Cost (% trend output)

Fall in GDP 1-5 years since financial crisis (in percent of the long-run forecast)
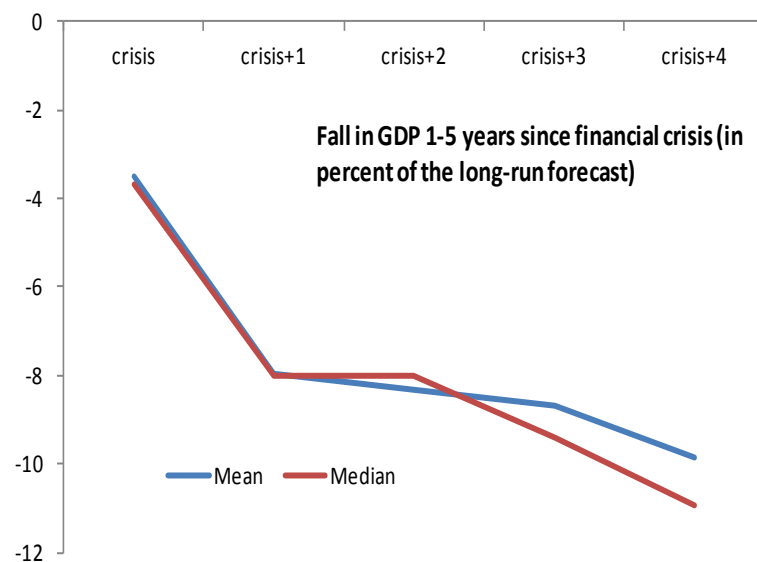
"I": Loss related to risk-taking

- Higher pre-crisis credit growth related to higher depth of crisis

- Robust across different depth measures

- Policies that reduce credit growth reduces depth

Depth of crisis

Dependent variable: cost

Explanatory variable	OLS estimation	Tobit estimation
Currency crisis dummy	3.004*	2.755*
	0.056	0.079
Change in credit to GDP (-2)	0.578***	0.575***
	0.000	0.000
Number of observations	67	67

Note: The dependent variable is the cost of a financial crisis ("cost") as described in the text.   The coefficients reported for each method are marginal effects, so are directly comparable. The p-values are shown under the estimated coefficients. ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels of confidence based on robust standard errors, respectively.
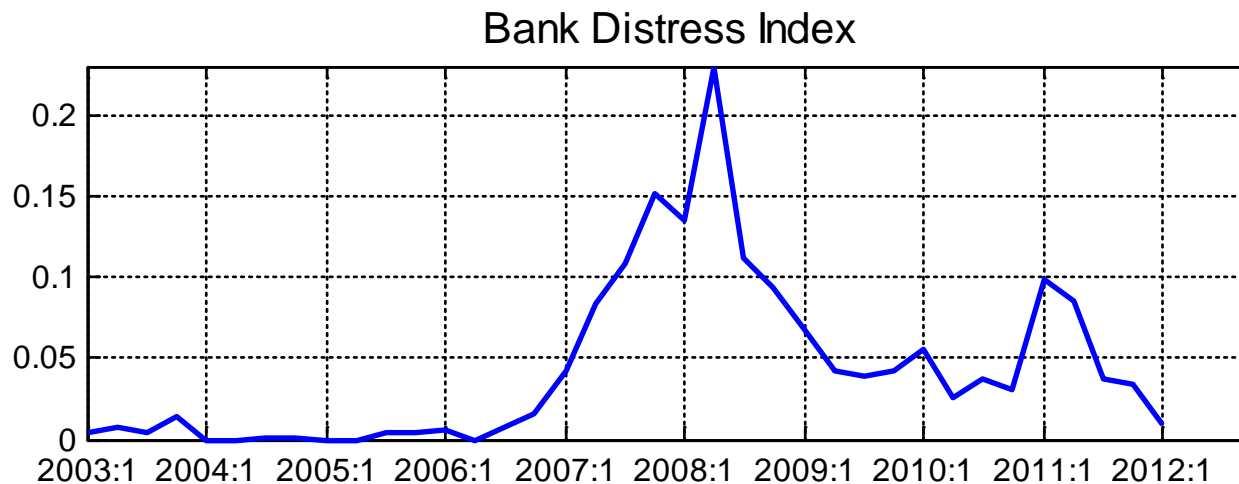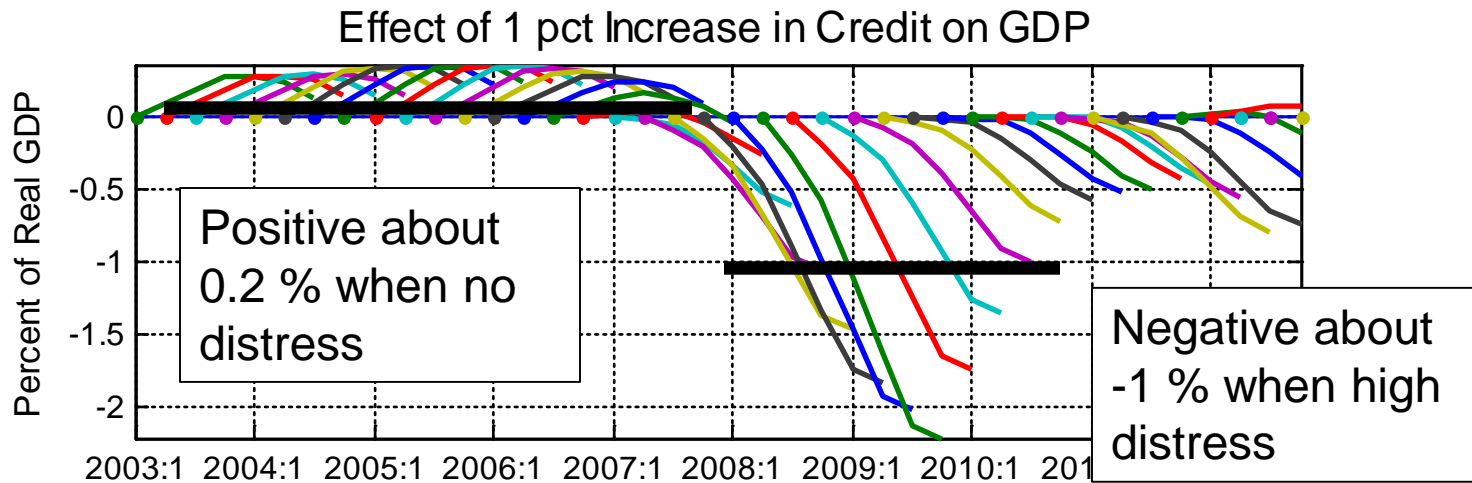
OLS and Tobit Marginal Effects

"α": Cost of Policy

- Acknowledge asymmetric effects of credit on real economic activity
  - Positive boost in normal times (healthy or unhealthy)
  - Debt overhang (of which bank credit can be symptomatic) and adverse effects in times of financial distress
- Need to combine empirical models with structural models (endogenous risk interactions between financial and real sectors)
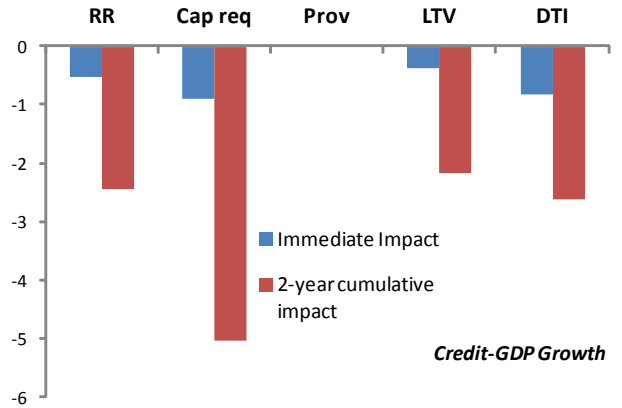
"α": Cost of Policy (concl.)

Effect of 1 pct Increase in Credit on GDP

Positive about 0.2 % when no distress

Negative about -1 % when high distress
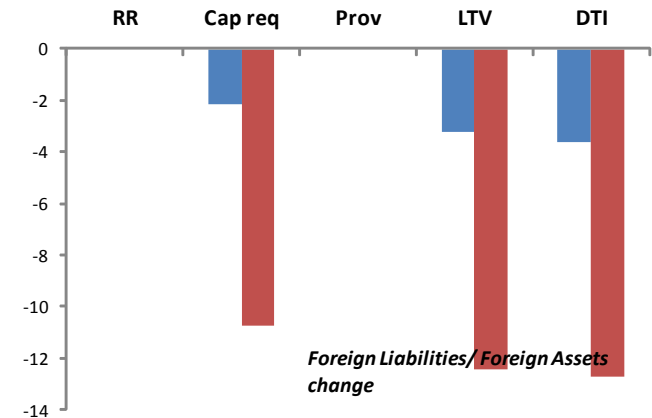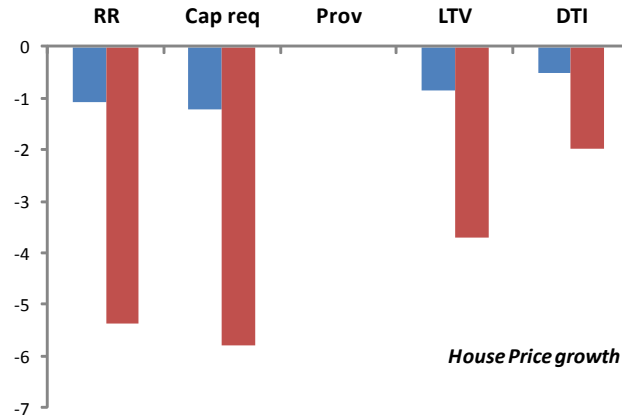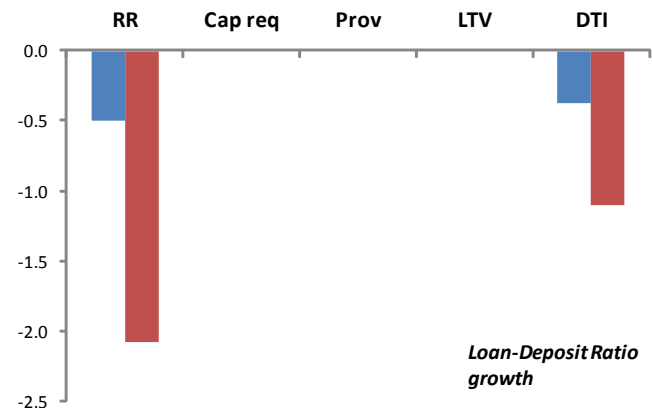
Bank Distress Index

Policy Effectiveness: Findings

Externality 1: Financial institutions take correlated risks during the boom phase

Externality 2: The risk of fire sales, that causes a decline in asset prices amplifying the contractionary phase of the financial cycle.

Credit-GDP Growth

Loan-Deposit Ratio growth

House Price growth

Foreign Liabilities/ Foreign Assets change

Policy Effectiveness: On Average

- *Credit growth and house prices (*intermediate targets related to correlated-risk taking externality): LTV/DTI limits, reserve requirements and risk weights effective

- *Loan/Deposit and Net open position* (intermediate targets related to fire sales externality)
  - tighter RRs and DTIs seem to work towards lowering the asset-liability funding mismatches.
  - LTV/DTI limits and higher risk weights slow capital inflows

"p*", "l*": Lower Probability and Depth, from Policy

- Policies affect indicators
- Indicators affect probability of crisis, p→ p*
- Indicators affect depth of crisis, l→ l*

Probability of crisis
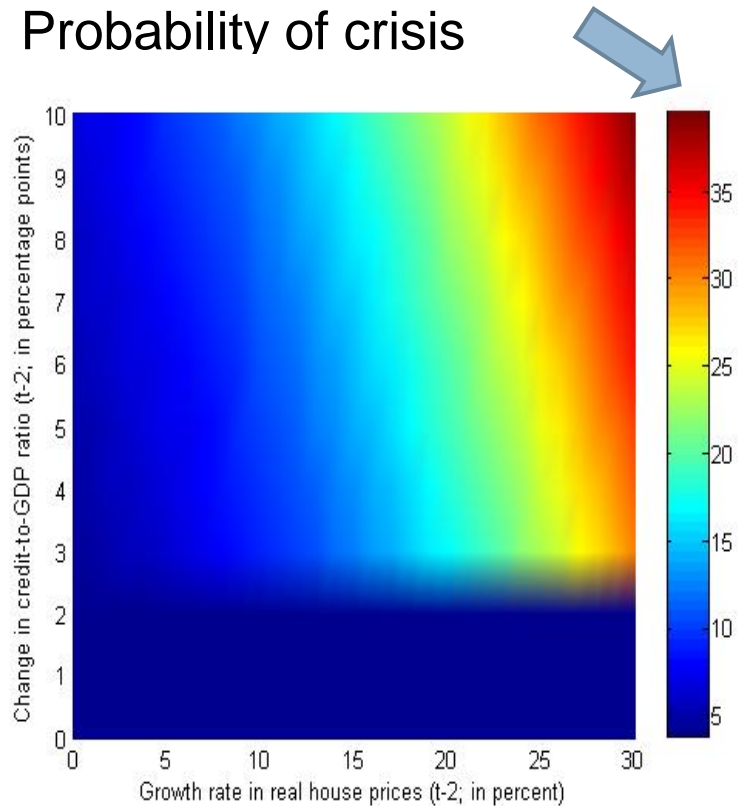
Credit and House Price Growth

Net Benefits of Policies

Baseline: Credit-to-GDP change=5pp; Real house price growth = 15%=> p =0.14; l =0.092 [1]	Average Effects of Tightening			
	Reserve Requirements (RR)	Capital Risk Weights	Loan-to-Value (LTV) limits	Debt-to-Income (DTI) limits
Credit Growth changes in two-years by (in percentage points) [2]	-2.45	-5.04	-2.18	-2.63
House price growth changes in two-years by (in percentage points) [3]	-5.36	-5.79	-3.70	-1.98
$p*$ [1]	0.045	0.038	0.045	0.044
Loss given crisis, $l*$ [4]	0.065	0.050	0.067	0.064
Cost on output forecast, α [5]	0.0049	0.0101	0.0044	0.0053
$(1 - p*l*)/(1-pl)-(1/1-\alpha)\gneqq 0?$ [6]	0.0051	0.0009	0.0056	0.0049

[1] See Figure 5 and Annex 5 for estimates of p and $p*$, given credit growth and house price growth. See Annex 4 and Figure 8 for l. [2] See Annex 6 Table 1 for the results on changes in the credit-GDP ratio. See the note under Figure 9 for the calculation of the two-year effects. [3] See Annex 6 Table 2 for the results on real house price growth. See the note under Figure 9 for the calculation of the two-year effects. [4] See Annex 4 and Figure 8: Average loss given crisis is 0.08. With slowing credit growth, loss is lowered. [5] For the United States, one percentage point lower credit growth reduces the output forecast by 0.2 percent. See Annex 3. [6] See expression 3.1 in the text for the expression on net benefits.

Policy Leakages

- Cross-border lending (Central and Eastern Europe)
  - RRs (and provisioning requirements) leak
  - Combine capital tools and LTV (Ext 1) and DTI (Ext 2)
- Foreign bank branches (UK)
  - Capital tools may not work fully (Aiyar et al)
  - Combine LTV and DTI
  - RR?
- Nonbank financial institutions (US)
  - LTV and DTI
  - Coordinate with other nonbank supervisors
  - Capital and RRs difficult to implement

Conclusions

- Early Warning model performance most important
- Role of credit key, but must combine with other indicators
- All sources of credit
- Net benefits higher with
  - Greater policy effectiveness
  - Sensitive to macro-financial linkages: credit-output sensitivities

Conclusions

- Most effective policies:
  - RRs, Risk weights (capital), LTV
- Policies have prolonged impacts
- Beware of policy leakages
  - Tailor tools to financial structure of country
- Basic recipe proposed in this paper: Country-specific flavors and garnishes encouraged!
- Improvements: More evidence on effectiveness; confidence intervals

20 Thank you

Comments and suggestions?

Evidence: Regression Results (1)

Table A6.1. Effects of Macroprudential Measures on Credit-to-GDP Ratio: Panel GMM Estimation (2000-2011)

Dependent variable: Credit/GDP y/y growth					
	I	II	III	IV	V
Credit/GDP growth $_{t-1}$	0.83 ***	0.89 ***	0.88 ***	0.90 ***	0.71 ***
	0.02	0.01	0.02	0.01	0.02
GDP Growth$_t$	0.33 ***	0.04	0.17 ***	0.00	0.02
	0.06	0.04	0.05	0.03	0.06
Lending rates$_t$	0.01	-0.14 ***	-0.02	-0.02	0.12 *
	0.02	0.03	0.02	0.04	0.07
Reserve requirement	-0.54 **				
	0.20				
Risk weights		-0.89 ***			
		0.25			
Provisioning			-0.38		
			0.31		
LTV				-0.39 **	
				0.16	
DTI					-0.82 ***
					0.26
Number of observations	638	631	542	705	374
Number of countries	15	15	13	17	9

Evidence: Regression Results (2)

Table A6.2. Effects of Macroprudential Measures on Real House Price Growth: Panel GMM Estimation (2000-2011)

Dependent variable: Real House prices y/y growth					
	I	II	III	IV	V
Real house price $_{t-1}$	0.86 ***	0.84 ***	0.84 ***	0.81 ***	0.77 ***
	0.02	0.01	0.02	0.01	0.02
GDP Growth$_t$	0.36 ***	0.28 ***	0.41 ***	0.33 ***	0.16 ***
	0.06	0.05	0.07	0.05	0.07
Lending rates $_t$	-0.04 **	-0.13 ***	-0.05 **	-0.67 ***	-0.24 **
	0.02	0.05	0.02	0.10	0.11
Reserve requirement	-1.07 **				
	0.26				
Risk weights		-1.24 ***			
		0.25			
Provisioning			-0.16		
			0.35		
LTV				-0.86 **	
				0.23	
DTI					-0.52 **
					0.24
Number of observations	433	431	428	593	307
Number of countries	11	12	11	15	8

Other Evidence on Effectiveness

Panel regression results for housing credit with asymmetric effects — Table 5

Policy	Actions	Tightening Individually Sum	4Q	Jointly Sum	4Q	Actions	Loosening Individually Sum	4Q	Jointly Sum	4Q
General credit	179	−2.24*	−1.05**	−2.14*	−0.86*	199	−0.20	0.18	0.22	0.37
		(1.34)	(0.51)	(1.25)	(0.48)		(1.60)	(0.71)	(1.58)	(0.67)
LTV limits	59	−7.13***	−3.04***	−2.33	−0.97	21	4.10	1.36	11.39*	4.74*
		(1.50)	(0.66)	(1.62)	(0.69)		(7.48)	(3.35)	(6.50)	(2.78)
DSTI limits	32	−13.42***	−6.19***	−10.98***	−5.05***	6	−17.17	−8.89	−18.75	−9.52
		(3.68)	(1.74)	(4.19)	(1.93)		(16.17)	(8.16)	(14.82)	(7.55)
Exposure limits	6	1.05	−0.59	2.57	0.69	4	−16.74***	−7.11*	−19.21***	−7.93**
		(10.72)	(4.40)	(9.96)	(4.07)		(6.13)	(3.69)	(5.60)	(3.23)
Risk-weighting	31	−6.78	−2.54	4.59	−1.58	13	11.34	4.03	10.73	3.60
		(3.97)	(1.56)	(4.00)	(1.53)		(7.69)	(3.09)	(7.79)	(3.12)
Provisioning	22	−5.45*	−1.64	−4.51*	−1.19	6	5.29	1.03	4.84	0.80
		(3.21)	(1.18)	(3.01)	(1.01)		(12.46)	(5.56)	(13.79)	(5.86)
Housing-related tax	48	−7.10**	−2.70**	−5.98**	−2.19*	60	−3.63	−2.13	−3.93	−2.24
		(2.93)	(1.31)	(2.55)	(1.15)		(3.74)	(1.77)	(3.78)	(1.76)

Notes. The dependent variable is annualised quarterly growth rate in real housing credit. Robust standard errors are in parentheses. Asterisks indicate statistical significance: *** for 1%, ** for 5% and * for 10%. The hypothesis of symmetric effects for the sum of the coefficients and the average four-quarter effect is rejected at the 5% level for LTV limits and risk-weighting.

Korea: Impact of Lowering LTV and DTI Limits

Long run effect on: (in percent)	Ten percentage point lower LTV limit	Ten percentage point lower DTI limit
Mortgage loans	-2.2	-2.0
House prices	-2.8	-1.1
Nominal GDP	-0.8	-0.3

Kuttner and Shim (2013)   Jacome and Mitra (2015)