Does macro-pru leak?
Evidence from a UK policy experiment

Shekhar Aiyar, Charles Calomiris and Tomasz Wieladek

Federal Reserve Bank of Chicago

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Two questions

1. Is bank lending affected by changes in regulatory capital requirements?
2. Do unregulated banks increase lending in response to tighter capital requirements on regulated banks?

Motivation

- An affirmative answer to the 2 questions underpins much of the UK and international macro-prudential policy debate.
  - Pro-cyclical capital charges to smooth credit cycle.
  - Basel III counter-cyclical capital buffer / reciprocity.
  - Turner (2010), Tucker (2009, 2011), Haldane (2010), BIS (2011).
- But empirical evidence on these questions is strikingly sparse.
  - *"There is to date only very limited empirical analysis of the effectiveness of macroprudential tools..."* BIS (2011)

Key to identification

- UK banking system has 3 types of banks
  - 1) UK-owned (Headquarter in UK)
  - 2) Foreign subsidiary (Headquarter abroad)
  - 3) Foreign branch (Headquarter abroad)
- 1 & 2 are regulated by the FSA
- 3 ➔ not regulated by FSA

Outline

- Data and Structure of UK Banking System
  - Quarterly FSA data on bank-specific capital requirements from 1998 through 2007.
  - BoE data on lending by regulated banks (UK-owned and foreign subsidiaries) and unregulated banks (foreign branches).
  - Unregulated branches of foreign banks comprise 173 of 277 banks operating in UK.

- Test whether higher capital requirements:

  (a) discourage lending by regulated banks (yes)

  (b) encourage lending by unregulated banks (yes)

FSA approach to bank regulation

- Most countries impose the Basel I capital requirement of 8% on whole banking system

- But UK was different:
  - Capital requirement regulation was discretionary to fill gaps in Basel I, such as interest rate risk, reputational risk, legal risk, etc……

- The FSA set bank-specific capital requirements
  - Capital requirement (trigger) ratios were reviewed every 18-36 month

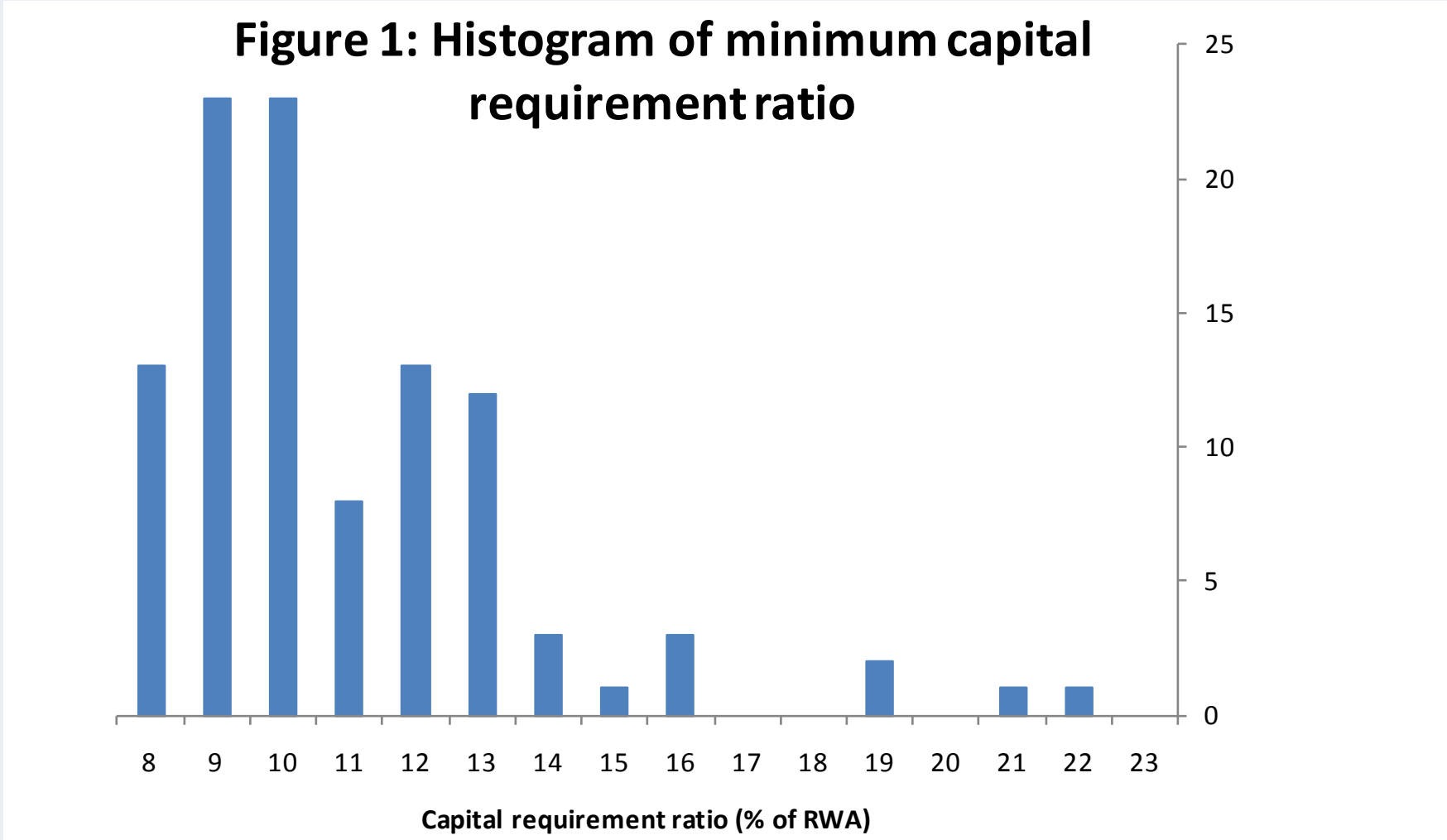
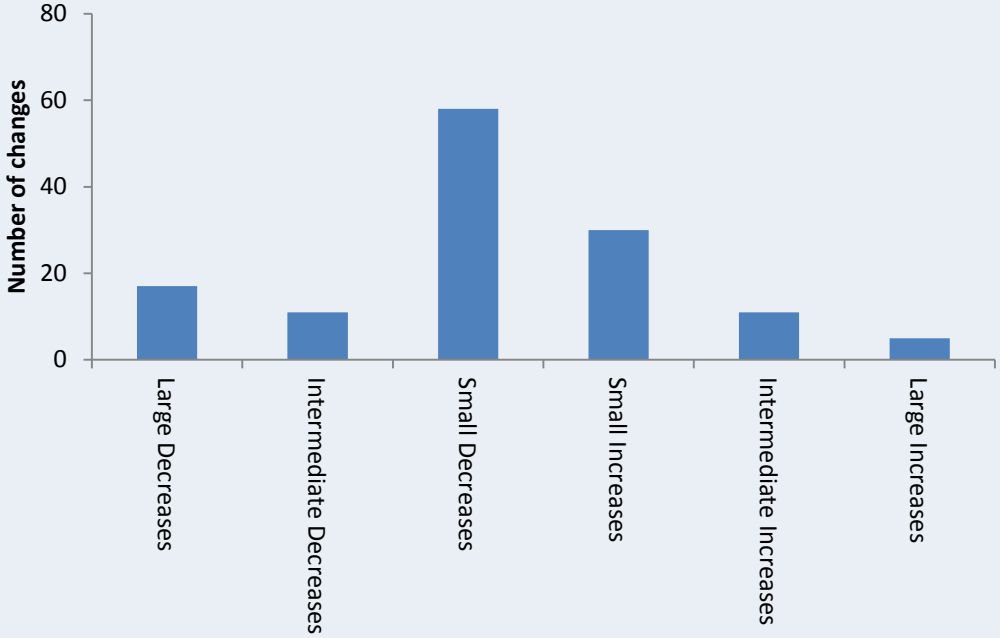


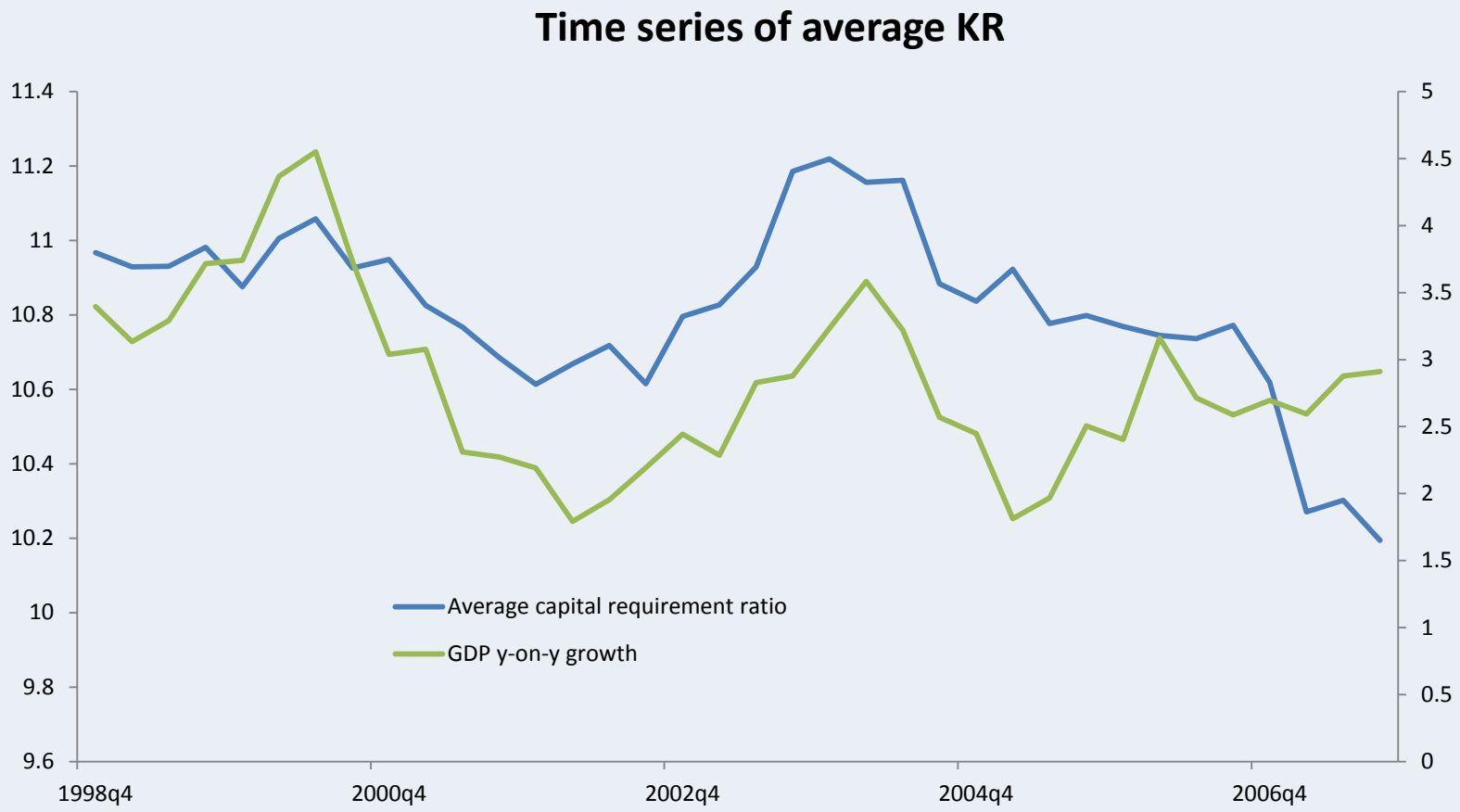
Figure 1: Histogram of minimum capital requirement ratio
25
20
15
10
5
0
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Capital requirement ratio (% of RWA)

Figure 2: Distribution of changes in capital requirement ratios by magnitude of change



Large decrease = DKR<-150bp
Intermediate decrease = -150bp<DKR<-100bp
Small decrease = -100bp<DKR<-10bp
Large increase = DKR>150bp
Intermediate increase = 150bp>DKR>100bp
Small increase = 100bp>DKR>10bp

Average capital requirement: Time-series variation



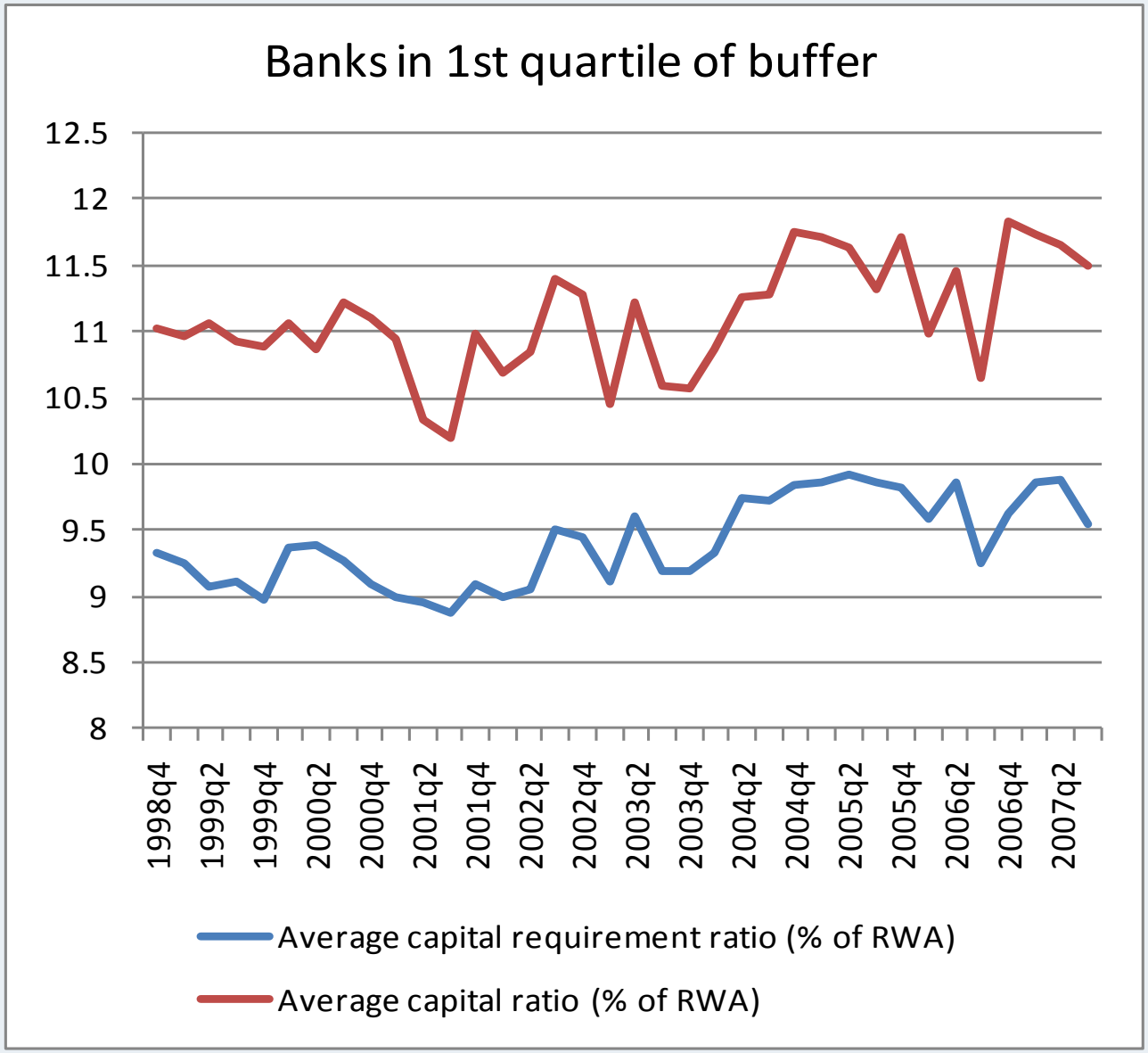
Theory

- 3 necessary conditions for cap reqs to affect lending

- 1) ***Equity must be a costly source of finance***
  - If Modgliani-Miller holds ➔ banks can adjust capital ratio costlessly w/o effect on lending (But equity can be more costly than debt, b/c of asymmetric information, agency, & different tax treatment)
  - Empirically ➔ equity capital is more costly to raise!
  - Bernanke (1983), Kashyap and Stein (1995), Peek and Rosengren (1997/2000) all document that shocks to bank capital have large effects on lending

Theory (II)

- 2) ***Capital requirements must bind***
  - Banks might adjust capital buffer instead and keep lending
  - Empirical evidence by Alfon et al (2005) and Francis and Osborne (2009) suggests that capital requirements do affect actual capital holdings.


Banks in 1st quartile of buffer
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
1998q4
1999q2
1999q4
2000q2
2000q4
2001q2
2001q4
2002q2
2002q4
2003q2
2003q4
2004q2
2004q4
2005q2
2005q4
2006q2
2006q4
2007q2
Average capital requirement ratio (% of RWA)
Average capital ratio (% of RWA)

Buffer Endogeneity

- Buffers are endogenous.
  - Banks with **high costs of raising capital will maintain largest buffers**. The responsiveness of capital ratio is low in response to capital requirement increase (neither numerator or denominator change much).
  - Banks with lower cost of raising capital have smaller buffers, and adjust capital more in response to requirement changes, and adjust lending less in response to those changes.

Theory (III)

- ***3) Limited substitution of alternative funding***
  - Effect on aggregate credit growth will be limited if other funding sources available.
  - But previous work suggests bank finance and bond finance to be imperfect substitutes.
  - Lending by unregulated banks (foreign branches) likely to be largest source of leakage.

Empirical approach- Does macro- pru “work”?

Standard FE panel data approach

$$\Delta L_{i,t} = \alpha_i + \sum_{k=0}^{3} \beta_{t-k} \Delta KR_{i,t-k} + \sum_{k=0}^{3} \gamma_{t-k} DEMAND_{i,t-k} + X\Pi + \varepsilon$$

where

- $\Delta L_{i,t}$ is growth rate of lending by *regulated* bank *i* at time *t*
- $\Delta KR_{i,t}$ is the change in the capital requirement ratio and α_i is a bank-specific fixed effect
- $$DEMAND_{i,t} = \sum_{q=1}^{15} s_{i,q} \left\{ \sum_{j \neq i} \Delta L_{j,t,q} \right\}$$

  where $s_{i,q}$ denotes the exposure of bank *i* to sector *q*.
- Better ways to capture demand: “adjusted” demand, “residual” demand.
- *X* is a matrix of control variables, including GDP growth, seasonal dummies and bank-specific balance sheet variables.

Table 4a: The impact of minimum capital requirements on bank lending 1/
Dependant variable: Rate of growth of lending

	1	2	3	4	5
Change in capital requirement ratio (summed lags)	-0.0676***	-0.0645***	-0.0657***	-0.0684**	-0.0716***
(Prob > F)	0.0021	0.002	0.002	0.013	0.0049
DEMAND (summed lags)		0.268	0.238	0.081	0.087
(Prob > F)		0.545	0.697	0.86	0.85
Demand variable		z	Adjusted z	Residual z	Residual z
GDP growth (summed lags)		0.0597**	0.0575**	.0475*	0.0496**
(Prob > F)		0.023	0.033	0.063	0.05
Inflation (summed lags)		-0.0014	-0.0011	-0.0054	-0.004
(Prob > F)		0.948	0.522	0.803	0.851
TIER1					-0.0008
(p-value)					0.203
BIG					0.005
(p-value)					0.8
RISK					-0.0003
(p-value)					0.117
SUB					0.018
(p-value)					0.14
Observations	2135	2114	2114	1909	1909

1/ This table presents results from fixed effects panel regressions of regulated banks. The dependant variable is the growth rate of bank lending to the real sector. Four lags each are used of the first four variables in the table: the change in capital requirement, the demand proxy, GDP growth and inflation. The table entries show the sum of coefficients for these lags, together with the probability that the sum of coefficients is significantly different from zero. The remaining coefficients are shown together with p-values. *, ** and *** denote significance at the 10%, 5% and 1% level respectively. The same conventions are followed in the remainder of the tables presenting regression results.

Endogeneity Robustness Checks

- We looked for correlation between capital requirement changes and other variables, both using leads and lags.

- What about write offs? It is correlated with loan-supply changes, but not with capital requirement changes.

- Controlling for this effect by adding lags, or leads, of write offs, to the loan-supply regression does not affect our results (Tables 4b and 4c).

Disaggregating

- Half of banks with lowest buffers show about a third smaller effect of other banks in their loan-supply responses to capital requirement changes, which is significant at the 5% level.

- Top size quartile of banks shows a similar magnitude (diminished) loan-supply effect, although this is not statistically significant. (In our second paper, we find that when controlling for the interplay between monetary policy and capital requirement changes, the size effect becomes robust and significant).

- (Heterogeneity investigated further in our third paper.)

Table 5: The interaction of minimum capital requirements with capital buffers and bank size
Dependant variable: Rate of growth of lending

	1	2	3	4
Change in capital requirement ratio (summed lags)	-0.083**	-0.149***	-0.079**	-0.072**
(Prob > F)	0.018	0.006	0.027	0.020
DEMAND (summed lags)	0.087	0.033	0.078	0.073
(Prob > F)	0.85	0.94	0.86	0.88
Demand variable	Residual z	Residual z	Residual z	Residual z
GDP growth (summed lags)	0.0473*	0.0512**	0.0483*	0.0492*
(Prob > F)	0.065	0.041	0.055	0.055
Inflation (summed lags)	-0.005	-0.007	-0.005	-0.004
(Prob > F)	0.821	0.756	0.81	0.822
BUF in 1st quartile (interaction) (summed lags)	0.057			
(Prob > F)	0.287			
BUF less than median (interaction) (summed lags)		0.119**		
(Prob > F)		0.049		
SIZE in 4th quartile (interaction) (summed lags)			0.0316	
(Prob > F)			0.522	
SIZE greater than median (interaction) (summed lags)				0.0009
(Prob > F)				0.98
Observations	1909	1909	1909	1909

Empirical approach: Does macro-pru "leak"?

Basic idea is to identify the lending response of unregulated branches to changes in lending by regulated banks induced by KR changes.

Instrument the change in lending by regulated banks using change in capital requirements.

$$\Delta L_{j,t}^{BRN} = \alpha_i + \beta \Delta L_{j,t}^{REGREF} + \gamma DEMAND_{j,t} + X\Pi + \varepsilon_{i,t}$$

Above, instrument $\Delta L_{j,t}^{REGREF}$ using $\Delta KR_{j,t}^{REGREF}$

To implement this idea we need to create, for each branch j, a reference group for regulated bank lending and KR.

Reference groups

Two methodologies for constructing reference group:

1. Aggregate reference groups.
   - Reference group for each branch is lending by all regulated banks and the average change in capital requirements.
   - Thus all branches have an identical reference group.

2. Branch-specific reference groups.
   - Exploit data on sectoral exposures of the branch.
   - Weight regulated bank lending using sectoral exposure pattern of the branch.
   - Weight KR using sectoral exposure pattern of branch.

Table 6: Leakages from regulation of bank capital (Instrumental Variables)
Dependant variable: Rate of growth of lending of resident foreign branches

	Aggregate IV			Branch-specific IV		
	1	2	3	4	5	6
Change in lending by all regulated banks (summed lags)	-2.275***	-1.60*	-1.925*	-3.12***	-2.66***	-2.248**
(Prob > F)	0.009	0.065	0.1	0.001	0.003	0.049
DEMAND (summed lags)		0.321***	0.323***		0.292	0.087
(Prob > F)		0.002	0.006		0.186	0.74
Demand variable		Residual z	Residual z		Residual z	Residual z
GDP growth (summed lags)			0.0067			-0.21
(Prob > F)			0.901			0.14
Inflation (summed lags)			-0.0701*			-0.094
(Prob > F)			0.1			0.16
SIZE			-0.0101			-0.023
(p-value)			0.454			0.478
KAR			-0.0001			-0.0002
(p-value)			0.9			0.846
WHL			0.0011			-0.006
(p-value)			0.808			0.45
Hansen J statistic	38.04	31.54	11.1	2.6	4.677	2.15
(Prob > chi-squared)	0	0	0.03	0.63	0.32	0.71
Anderson-Rubin Wald test statistic	55.25	44.42	18.42	43.88	37.05	22.5
(Prob > chi-squared)	0	0	0.018	0	0	0.004
Stock-Wright S statistic	53.17	42.56	18.18	41.85	35.06	21.55
(Prob > chi-squared)	0	0	0.019	0	0	0.005
Observations	2645	2645	2645	2490	2490	2490
Instrument	Change in average capital requirement of all regulated banks			Change in capital requirement of regulated banks weighted by sectoral exposures of branch		

How large are leakages?

- Response of unregulated branches to change in KR is 2.7 times the response of regulated banks (in opposite direction).
- Average lending by branches is £630,000, one-fifteenth of average lending by regulated banks of £9.5 million.
- There are more branches (173) than regulated banks (104).
- Multiply these ratios to get estimate of leakages
  100*2.7*(63/950)*(173/104) = 30%
- So leakages are roughly one-third of the gross impulse from changing capital requirements.

Conclusions

- Regulatory capital requirements affect bank lending .
- Evidence of substantial leakages (one-third).
- Reaffirms importance of international co-ordination, reciprocity under Basel III.
- Future research:
  - International spillovers.
  - Interaction with monetary policy.