Does Macro-Pru Leak? Empirical Evidence from a UK Natural Experiment

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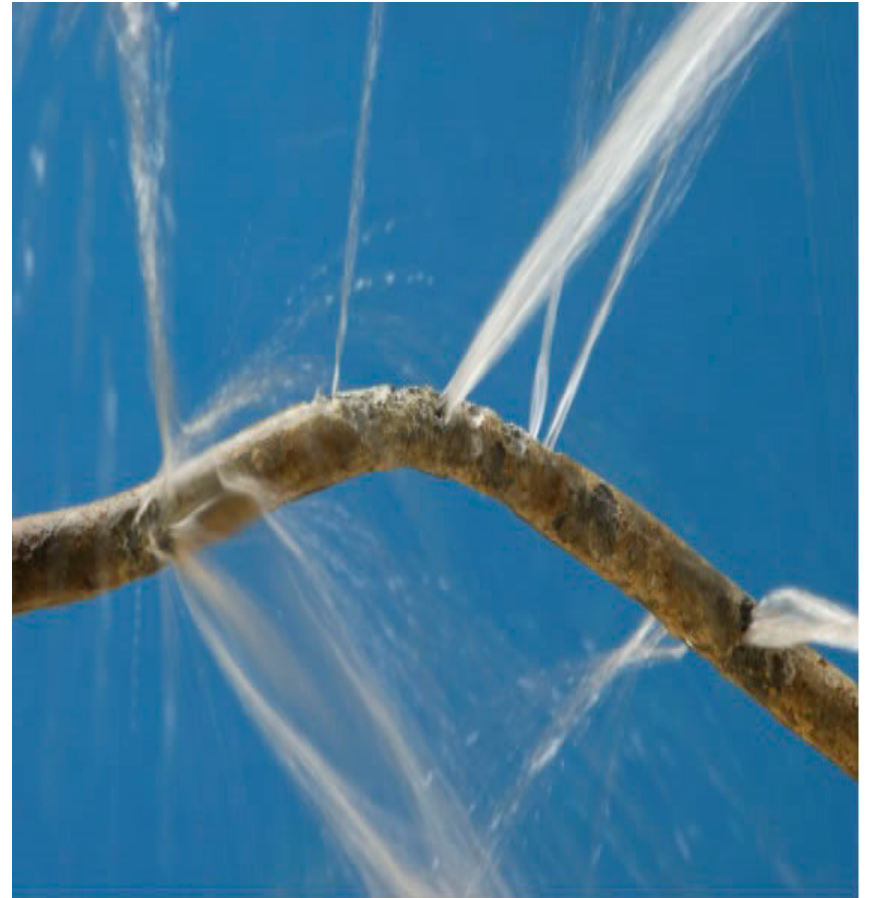
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Does macro-pru leak?
Evidence from a UK policy experiment

Shekhar Aiyar, Charles Calomiris and Tomasz Wieladek

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

- 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

Table 2: Summary Statistics

Variable	Entity	Units	Mean	SD	Min	Max	Obs
Capital requirement ratio	Regulated banks	%	10.8	2.26	8	23	2,630
Change in capital requirement ratio	Regulated banks	Basis points	-1.4	29.7	-500	500	2,524
Lending to real economy	Regulated banks	£ 000s	9,483	28,510	0	274,140	2,630
Lending to real economy	Foreign branches	£ 000s	630	893	0	10,175	3,976
Change in lending to real economy	Regulated banks	%	0.8	16.5	-98.3	85.3	2,503
Change in lending to real economy	Foreign branches	%	0.3	20.9	-98.7	98.4	3,792

Figure 2: Distribution of changes in capital requirement ratios by magnitude of change
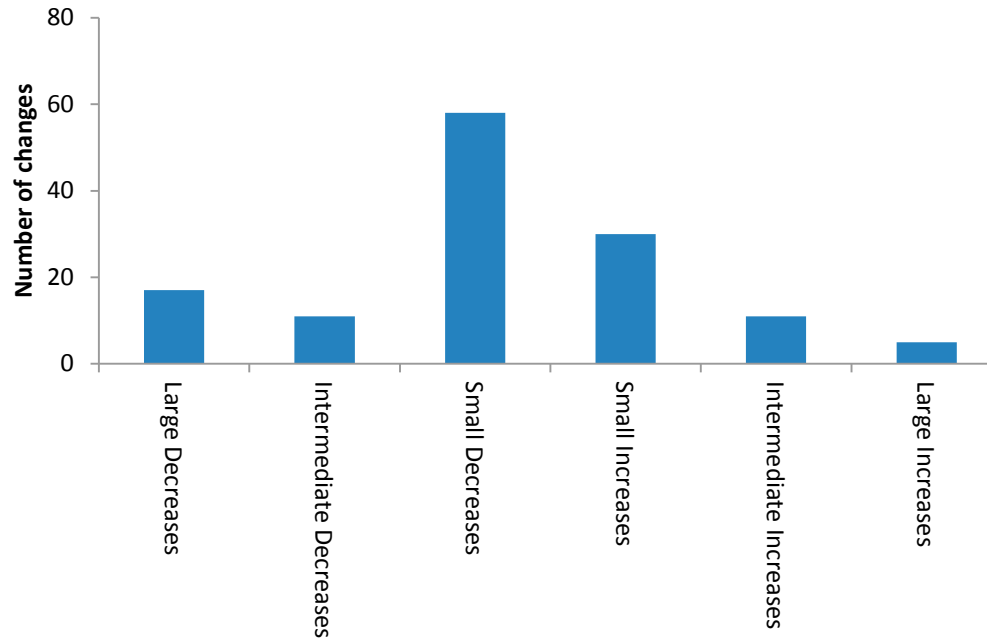
Large decrease = DKR<-150bp
Intermediate decrease = -150bp<DKR<-100bp
Small decrease = -100bp<DKR<-10bp
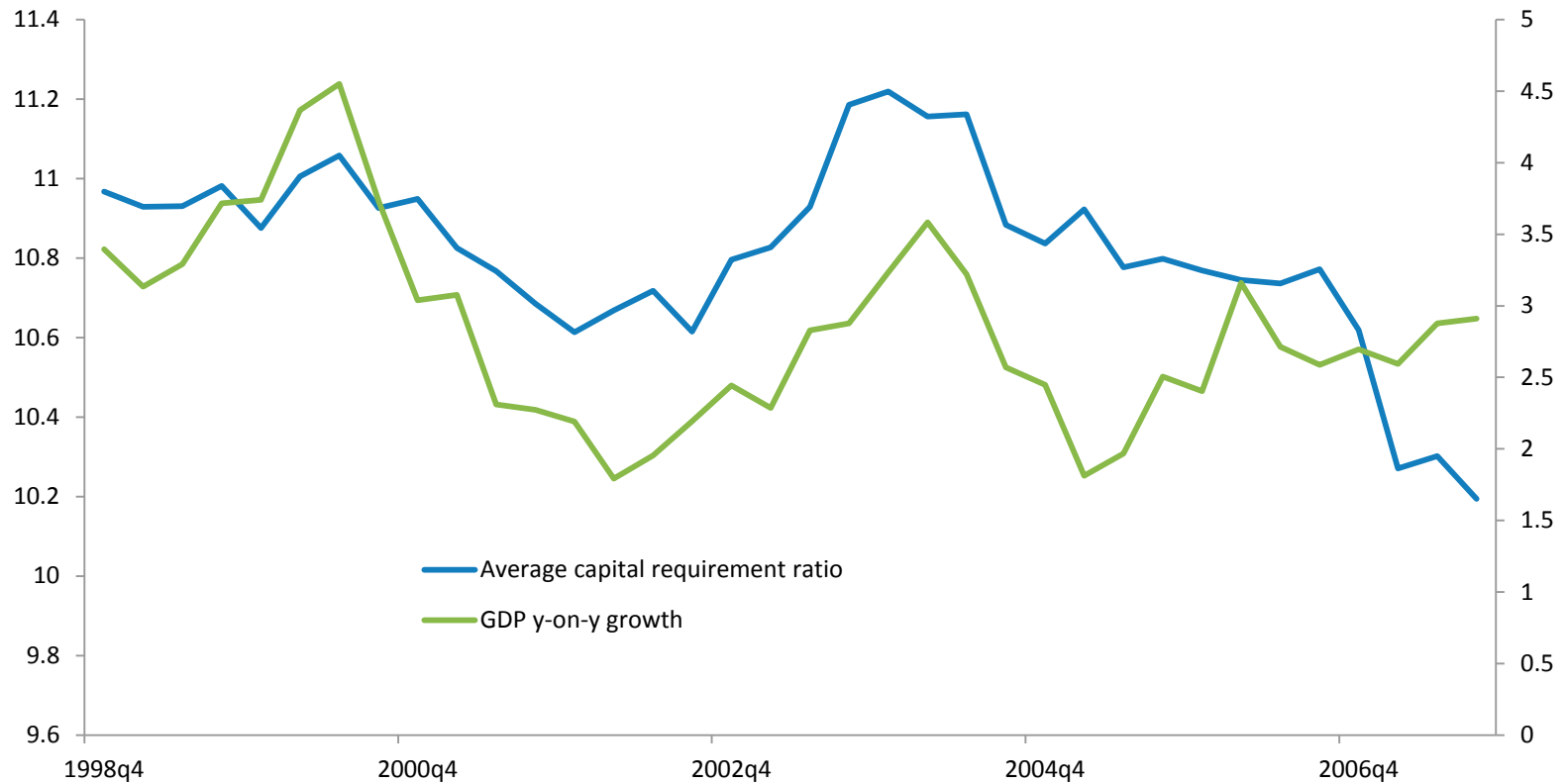Large increase = DKR>150bp
Intermediate increase = 150bp>DKR>100bp
Small increase = 100bp>DKR>10bp

Average capital requirement: time-series variation

Time series of average KR

Average capital requirement: time-series variation (2)

Weighted time series average of KR

Legend: Weighted average KR ratio — Year-on-year GDP Growth

Bank Characteristics Related to Capital Requirements

Table 3: Average capital requirement ratio by various bank attributes 1/

	Percentiles			
Variable	25 <	25-50	50-75	> 75
Writeoffs 2/	10.36	10.44	10.15	11.57
(Mean value within quartile)	(0.00)	(0.13)	(0.48)	(2.48)
Size 3/	12.30	11.06	10.63	9.54
(Mean value within quartile)	(0.03)	(0.10)	(0.32)	(5.16)
Retail Deposits 4/	12.45	10.79	10.08	10.21
(Mean value within quartile)	(3.0)	(15.4)	(44.3)	(73.6)
Sectoral Specialisation 5/	10.51	10.87	10.90	11.25
(Mean value within quartile)	(16.1)	(39.4)	(59.3)	(89.4)

1/ The mean values of the variables within each quartile are provided in brackets below the   associated mean capital requirement.
2/ Defined as total amount written-off as a share of risk-weighted assets.
3/ Defined as asset size relative to total assets of the banking system.
4/ Defined as the sum of sight and time deposits as a fraction of total liabilities.
5/ Defined as lending to the sector to which the bank has the greatest exposure in percent of
   total lending by the bank to all non-financial non-household sectors.

Theory

- Need 3 necessary conditions for capital requirements 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.

All Banks
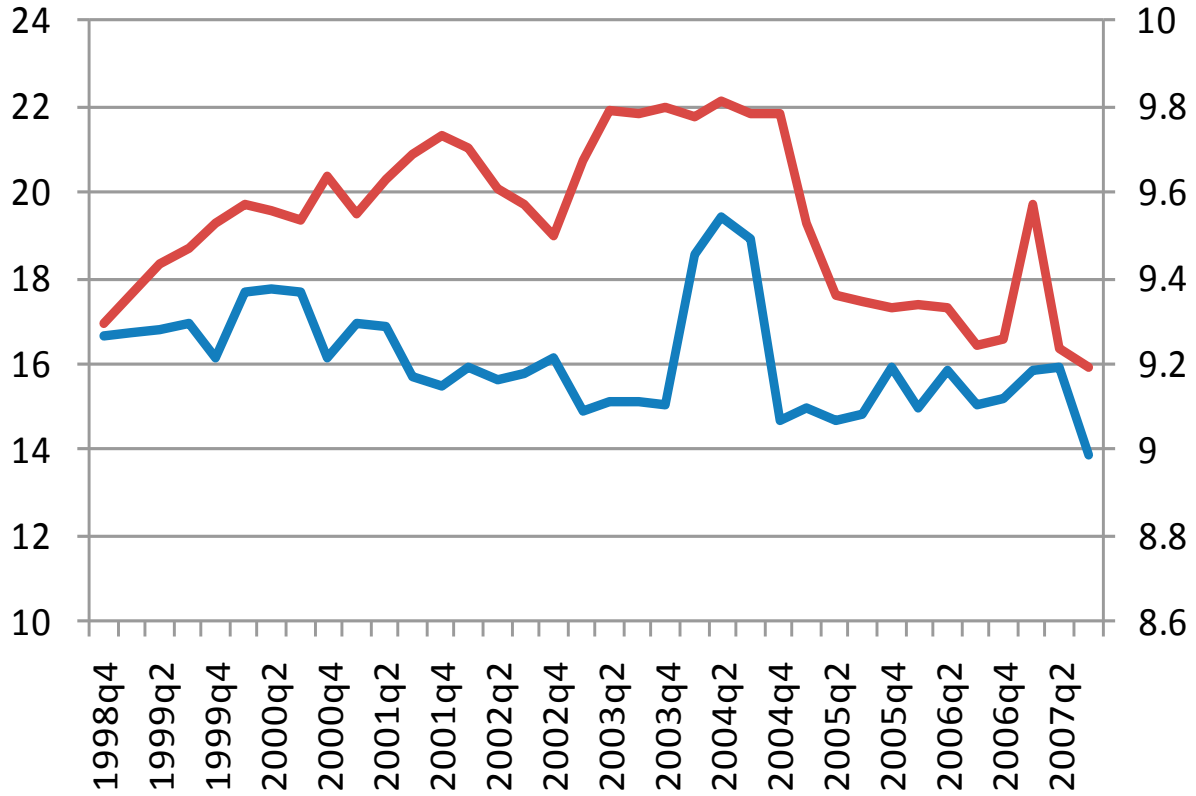
Average capital ratio (weighted by assets)

Average capital requirement ratio (wtd by assets)

Banks in 1st quartile of buffer

Average capital requirement ratio (% of RWA)

Average capital ratio (% of RWA)
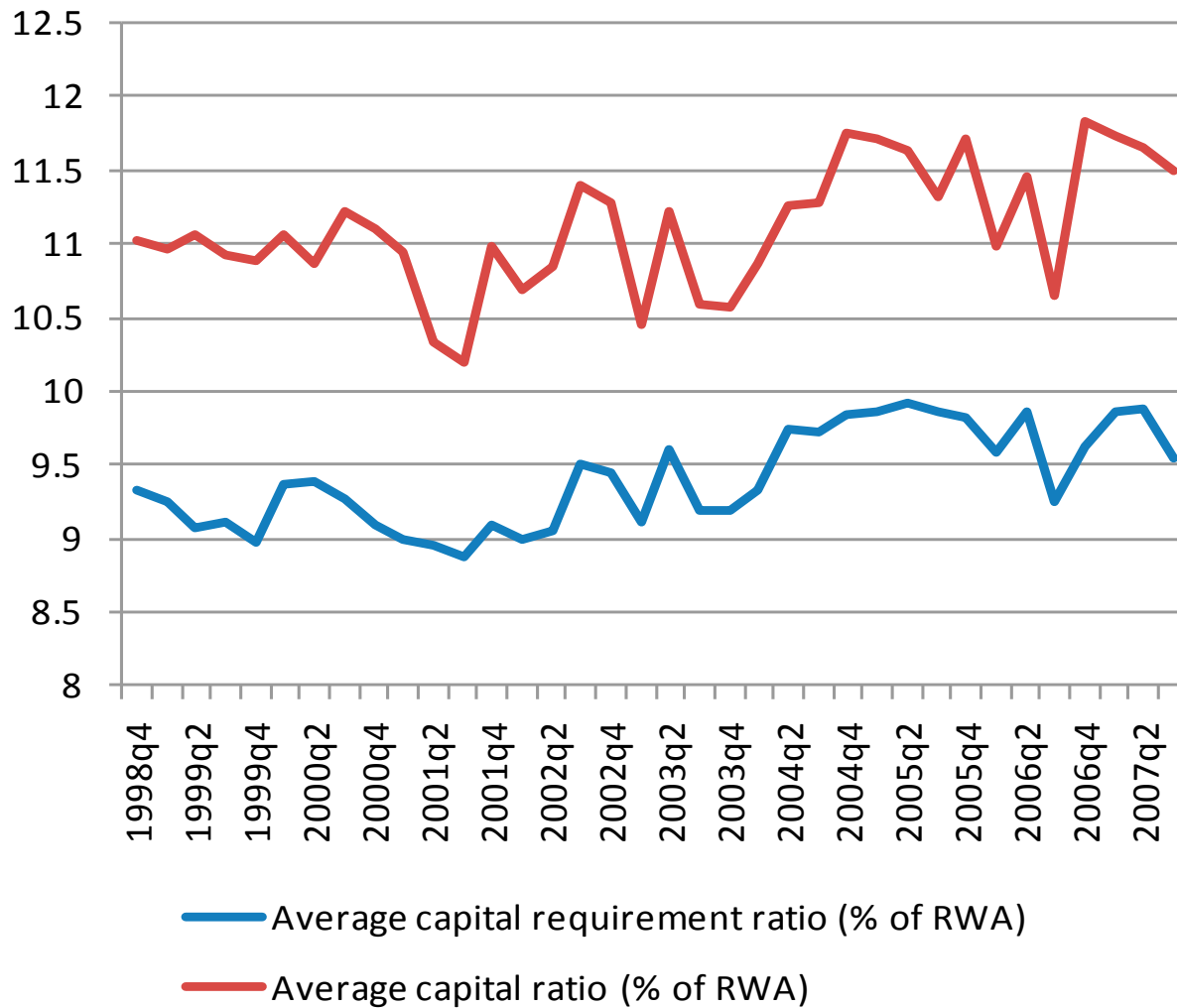
Banks in 2nd quartile of buffer

- Average capital requirement ratio (% of RWA)
- Average capital ratio (% of RWA)
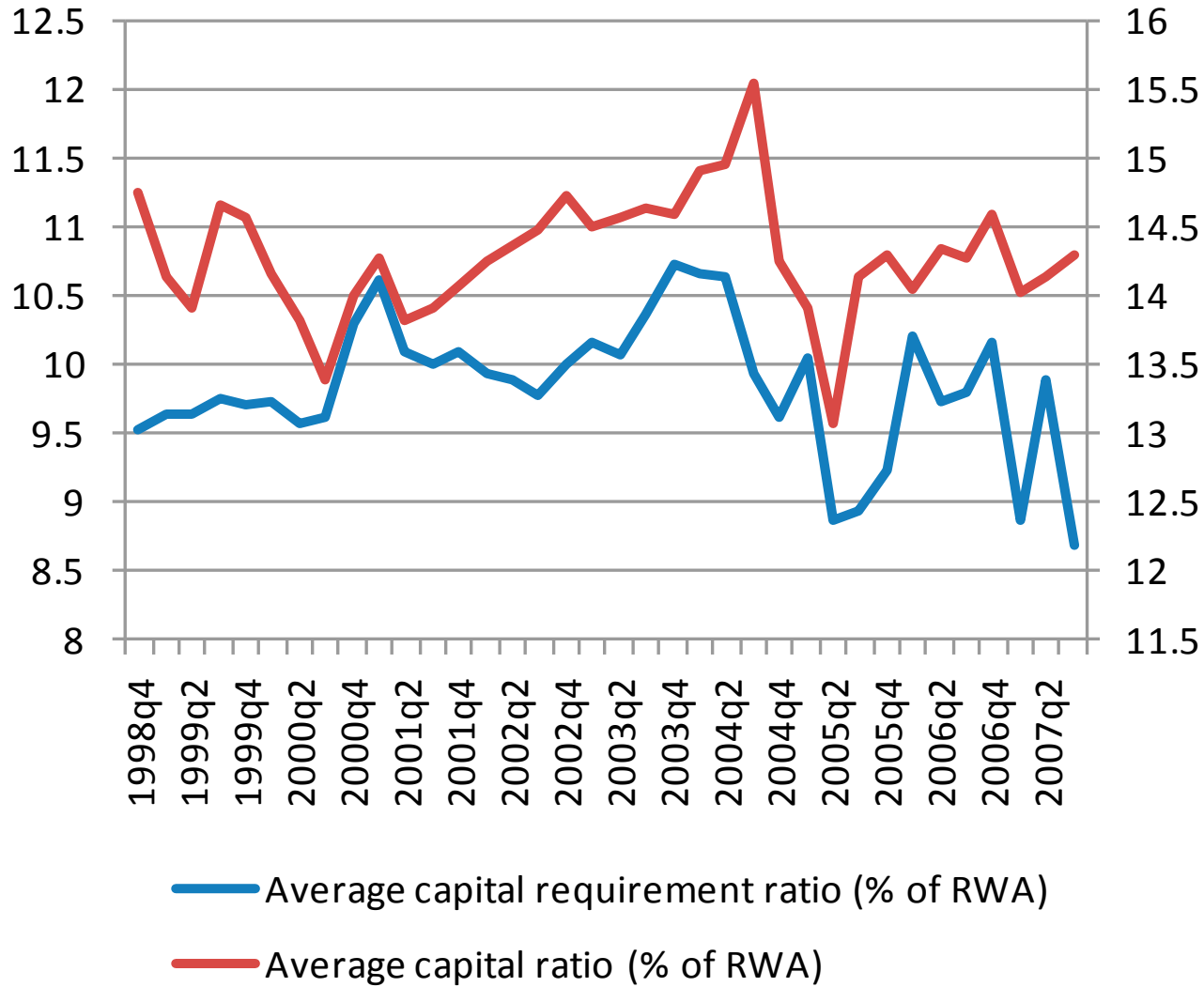
Banks in 3rd quartile of buffer

— Average capital requirement ratio (% of RWA)

— Average capital ratio (% of RWA)
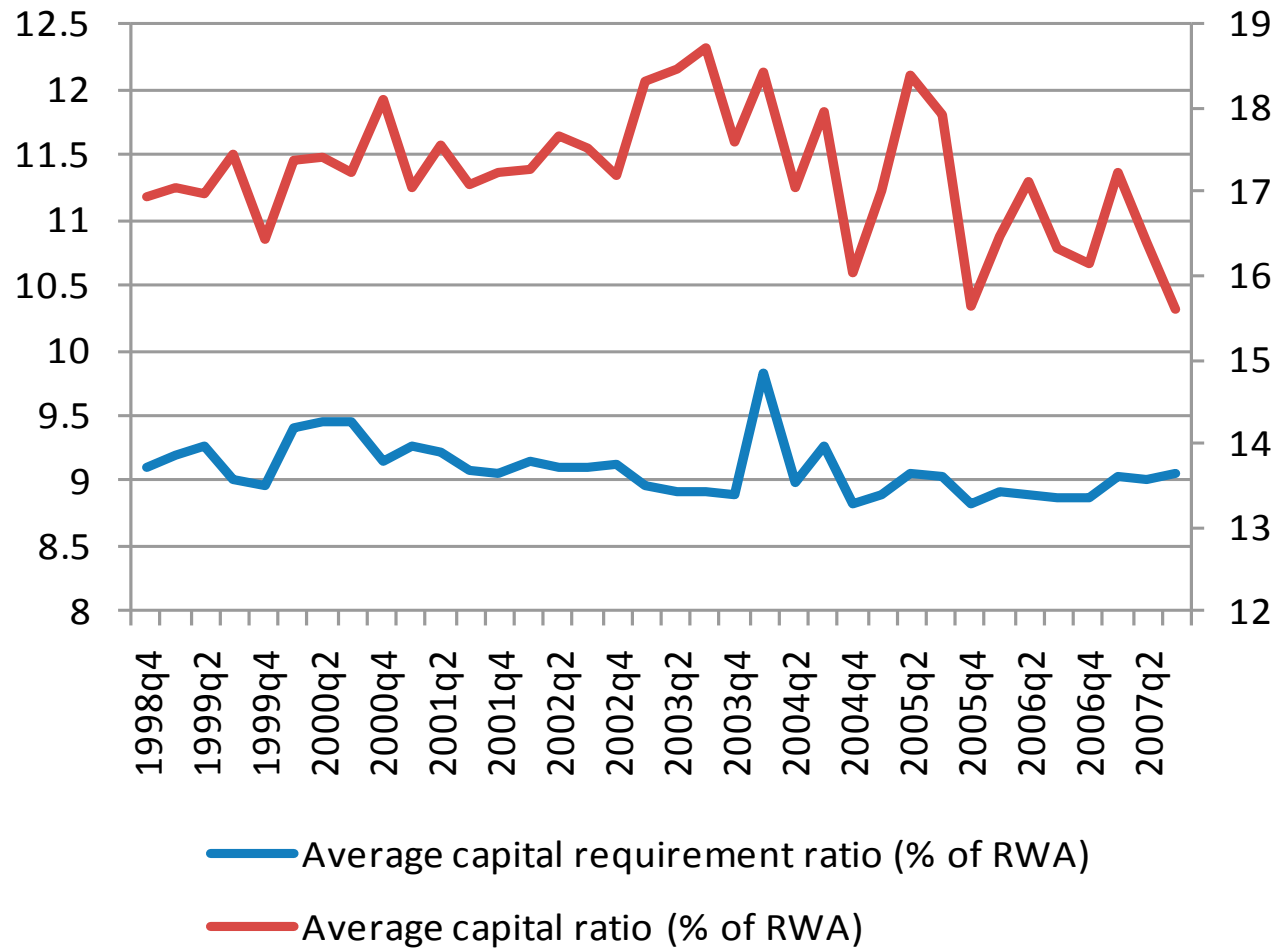
Banks in 4th quartile of buffer

Average capital requirement ratio (% of RWA)

Average capital ratio (% of RWA)
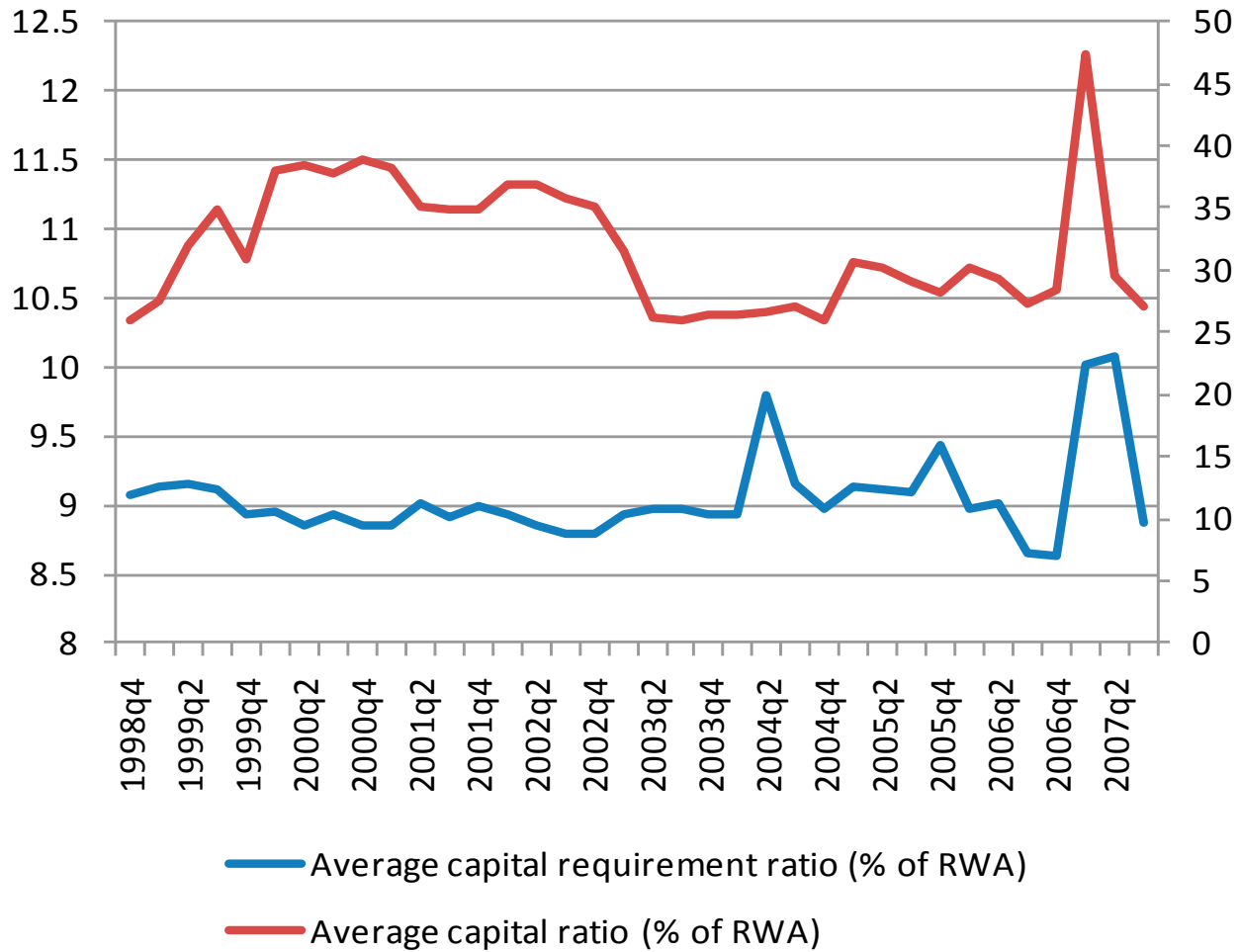
Theory (III)

- **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 4: 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***	-0.0666***	-0.0684***	-0.0906***	-0.0904***
(Prob > F)	0.0021	0.0026	0.0016	0.0046	0.0049
DEMAND (summed lags)		0.374	0.27	0.272	0.201
(Prob > F)		0.315	0.653	0.46	0.596
Demand variable		z	Adjusted z	Residual z	Residual z
GDP growth (summed lags)					0.0145
(Prob > F)					0.532
TIER1					-0.0008
(p-value)					0.159
BIG					0.009
(p-value)					0.641
RISK					-0.0003
(p-value)					0.09
SUB					0.01
(p-value)					0.621
Observations	2135	2114	2114	1826	1826

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 three variables in
the table: the change in capital requirement, the demand proxy and the rate of growth of GDP. 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 co-efficients 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.

Table 4b: The impact of minimum capital requirements and loan quality on bank lending 1/
Dependant variable: Rate of growth of lending

	1	2	3	4	5
Change in capital requirement ratio (summed lags)	-0.0677***	-0.065***	-0.0676***	-0.0915***	-0.0924***
(Prob > F)	0.0022	0.003	0.002	0.005	0.005
Change in write-offs (summed lags)	-0.0172	-0.0175	-0.0179	-0.0353**	-0.0352**
(Prob > F)	0.264	0.225	0.247	0.023	0.027
DEMAND (summed lags)		0.385	0.316	0.289	0.225
(Prob > F)		0.289	0.593	0.395	0.521
Demand variable		z	Adjusted z	Residual z	Residual z
GDP growth (summed lags)					0.018
(Prob > F)					0.421
TIER1					-0.0008
(p-value)					0.146
BIG					0.0088
(p-value)					0.652
RISK					-0.0003
(p-value)					0.078
SUB					0.0087
(p-value)					0.676
Observations	2114	2114	2114	1826	1826

1/ This table is identical to Table 4 apart from the inclusion of four lags of the change in loan write-offs, where write-offs
are measured in percent of risk weighted assets.

Table 4c: The impact of minimum capital requirements and loan quality on bank lending 1/
Dependant variable: Rate of growth of lending

	1	2	3	4	5
Change in capital requirement ratio (summed lags)	-0.0534***	-0.0513***	-0.0539***	-0.0838***	-0.0839***
(Prob > F)	0.006	0.007	0.006	0.007	0.007
Change in write-offs (summed leads)	0.0109	0.0129	0.0107	-0.018***	-0.0163**
(Prob > F)	0.6	0.539	0.619	0.009	0.025
DEMAND (summed lags)		0.563	0.659	0.343	0.321
(Prob > F)		0.175	0.305	0.437	0.477
Demand variable		z	Adjusted z	Residual z	Residual z
GDP growth (summed lags)					0.0128
(Prob > F)					0.606
TIER1					-0.0002
(p-value)					0.635
BIG					0.0116
(p-value)					0.672
RISK					-0.0004
(p-value)					0.505
SUB					0.0095
(p-value)					0.742
Observations	1826	1812	1812	1560	1560

1/ This table is identical to Table 4 apart from the inclusion of four leads of the change in loan write-offs, where write-offs
are measured in percent of risk weighted assets.

Buffer Endogeneity

- Buffers are endogenous.
  - Banks with **high costs of raising capital will maintain largest buffers.**
  - 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.
- Analogy to investment literature: Firms with highest cash holdings also exhibit greater cash flow sensitivity of investment (Calomiris, Himmelberg, Wachtel 1995, Almeida, Campello and Weisbach 2004, Acharya, Almeida and Campello 2006).

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)	-0.106***	-0.179***	-0.102**	-0.091***
(Prob > F)	0.008	0.006	0.012	0.008
DEMAND (summed lags)	0.272	0.240	0.278	0.271
(Prob > F)	0.46	0.54	0.46	0.47
Demand variable	Residual z	Residual z	Residual z	Residual z
BUF in 1st quartile (interaction) (summed lags)	0.07			
(Prob > F)	0.21			
BUF less than median (interaction) (summed lags)		0.135**		
(Prob > F)		0.05		
SIZE in 4th quartile (interaction) (summed lags)			0.04	
(Prob > F)			0.472	
SIZE greater than median (interaction) (summed lags)				0.014
(Prob > F)				0.954
Observations	1826	1826	1826	1826

Leakages: Do foreign branches have a large real economy presence?

Figure 8: Sectoral pattern of lending by foreign branches

Legend: ■ Share of lending by foreign branches ◆ Log total lending (RHS)
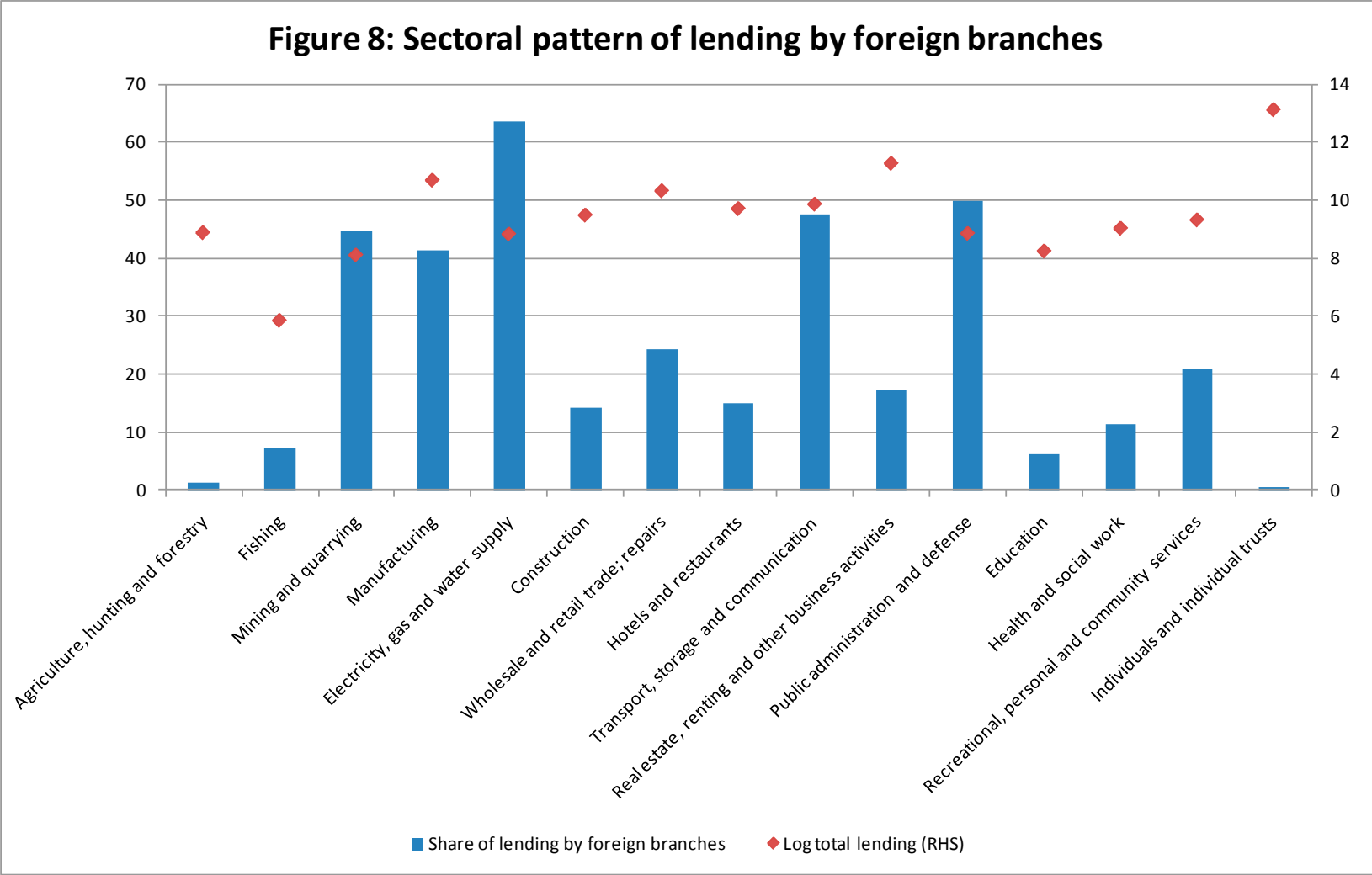
Empirical approach- Does macro- pru "leak"?

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

<u>Instrument</u> 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 <u>reference group</u> 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 <u>all regulated banks</u> and the <u>average change in capital requirements.</u>
    *   Thus all branches have an identical reference group.

2. Branch-specific reference groups.
    *   Exploit data on <u>sectoral exposures</u> 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***	-1.602*	-2.001**	-3.12***	-2.656***	-2.916**
(Prob > F)	0.009	0.065	0.012	0.0014	0.003	0.036
DEMAND (summed lags)		0.322***	0.398***		0.291	0.225
(Prob > F)		0.0018	0.0002		0.186	0.201
Demand variable		Residual z	Residual z		Residual z	Residual z
GDP growth (summed lags)			0.076**			-0.063
(Prob > F)			0.021			0.135
SIZE			-0.017			-0.025
(p-value)			0.217			0.274
KAR			0.0001			-0.0001
(p-value)			0.86			0.887
WHL			0.0014			-0.0063
(p-value)			0.76			0.33
Observations	2648	2645	2645	2490	2490	2490
Sargan statistic	38.04	31.54	6.77	2.6	4.67	2.64
(Prob > chi-squared)	0	0	0.15	0.63	0.32	0.62
Instrument	Change in average capital requirement of all regulated banks			Change in capital requirement of regulated banks weighted by sectoral exposures of branch		

So how large are leakages?

- Response of unregulated branches to change in KR is 2.9 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*2.9*(63/950)*(173/104) = 32%

- So leakages are roughly <u>one-third</u> of the initial impulse from changing capital requirements.

Conclusion

- Evidence that regulatory capital requirements affect bank lending.

- Evidence of substantial leakages (one-third).

- Reaffirms importance of international co-ordination, reciprocity under Basel III.

- Future research:

    – Role of internal capital markets.

    – Interaction with monetary policy.