

# Banks Interconnectivity and Leverage

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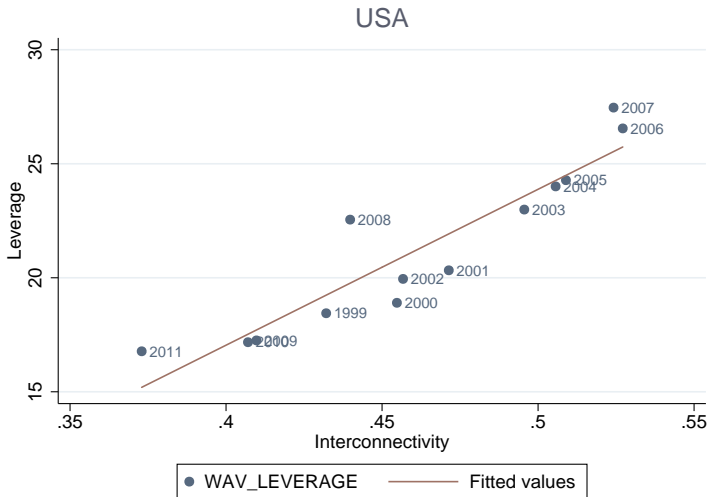
Third BIS Research Network meeting on  
Global Financial Interconnectedness  
Basel, 1-2 October 2015

# Motivation: Two Interesting Recent Trends

Figure: Interconnectivity (Left) and Leverage (Right)



# Motivation: An Interesting Correlation



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- Are the simultaneous increases in interconnectivity and leverage related?
- What are the forces that have induced banks to become more interconnected and leveraged?

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- Empirical Analysis
  - Analysis of the association between interconnectivity and leverage.
  - Exploration of the empirical implication of the two mechanisms built in the theoretical model.

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- Empirical Analysis
  - Positive correlation between interconnectivity and leverage:
    - Across time
    - Across countries,
    - Across (and within) financial institutions.
  - Negative relation between interconnectivity and return differentials:
    - Interconnectivity and leverage co-movement likely driven by diversification cost.

- Interconnectedness (see conference program...)
  - Theoretical
    - Allen and Gale (2000), Freixas et al. (2000), Allen et al. (2012),
    - David and Lear (2011), Eiser and Eufinger (2014),
    - Acemoglu et al. (2015).
  - Empirical
    - Cetorelli and Goldberg (2012), Cai et al. (2014), Hale et al. (2014), Peltonen et al. (2015).
- Bank Leverage
  - Adrian and Shin (2010, 2011, 2014),
  - Eichberger and Summer (2005),
  - Devereux and Yetman (2010).
- Interlink between interconnectedness and leverage
  - Shin (2009), Hahm, Shin and Shin (2013), Gennaioli et al. (2013).



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- Risky investments creates demand for insurance  $\rightarrow$  banks sell  $\alpha_t k_t$  investment to other banks and buy *diversified* portfolio  $f_t$  from other banks at price  $1/R^i$ .

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- Agency problems limit the degree of diversification: convex cost  $\varphi(\alpha_t)k_t$ , with  $\varphi(\alpha_t) = \chi\alpha_t^\gamma$ ,  $\gamma > 1$

# Model: Bank's Maximization Problem

- The problem solved by the bank can be written recursively as

$$V_t(a_t) = \max_{c_t, l_t, k_t, \alpha_t, f_t} \ln(c_t) + \beta \mathbb{E}_t V_{t+1}(a_{t+1}) \quad (1)$$

subject to:

$$c_t = a_t + \frac{l_t}{R_t^l} - \frac{k_t}{R_t^k} + \frac{[\alpha_t - \varphi(\alpha_t)]k_t}{R_t^i} - \frac{f_t}{R_t^i}$$

$$a_{t+1} = z_{t+1}(1 - \alpha_t)k_t + f_t - l_t.$$

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$$a_{t+1} = z_{t+1}(1 - \alpha_t)k_t + f_t - l_t.$$

- We solve the problem by transforming it in a standard portfolio choice with a risky asset ( $\bar{k}_t = (1 - \alpha_t)k_t$ ) and a riskless asset ( $-\bar{l}_t = f_t - l_t$ ) (as in Merton, 1971).

# Model: Leverage and Interconnectivity (1)

- We define bank leverage as the ratio of total bank assets and total bank equities:

$$LEVERAGE = \frac{K_t/R_t^k + F_t/R_t^l}{K_t/R_t^k - L_t/R_t^l}. \quad (2)$$



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- We define interconnectivity as the ratio of aggregate non-core liabilities (assets sold to other banks) over aggregate assets:

$$INTERCONNECTIVITY = \frac{\alpha_t K_t/R_t^l}{K_t/R_t^k + F_t/R_t^l}. \quad (3)$$

## Proposition (2.1)

*For empirically relevant parameters, leverage and interconnectivity are*

- *Strictly decreasing in the diversification cost,  $\chi$ .*
- *Strictly increasing in the return spread,  $R_t^k / R_t^l$ .*

# Model: Return Differential

- The return differential is defined as the difference between the return in total assets (revenue) and the return on total liabilities (cost):

$$DIFFERENTIAL = \frac{K_t + F_t}{K_t/R_t^k + F_t/R_t^i} - \frac{L_t + \alpha_t K_t}{L_t/R_t^l + \alpha_t K_t/R_t^i} \quad (4)$$

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## Proposition (2.2)

*The bank return differential is*

- *Strictly increasing in the diversification cost,  $\chi$ .*
- *Strictly increasing in the return spread,  $R_t^k/R_t^l$ , if  $\chi$  is sufficiently large.*

- Data from Bankscope
- Sample 1999-2011
- 32 OECD Countries
- 14,000 Financial Institutions
- Winsorized at 1 and 99 percentile

Table

Interconnectivity

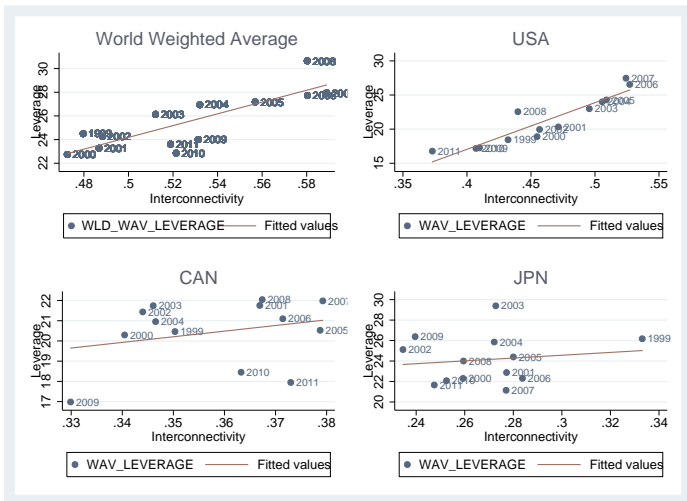
Leverage

# Variable Definitions

$$INTERCONNECTIVITY_{it} = \frac{LIABILITIES_{it} - DEPOSITS_{it}}{ASSETS_{it}}$$

$$LEVERAGE_{it} = \frac{ASSETS_{it}}{ASSETS_{it} - LIABILITIES_{it}}$$

# Interconnectivity and Leverage: Country-level (1)



# Interconnectivity and Leverage: Country-level (2)

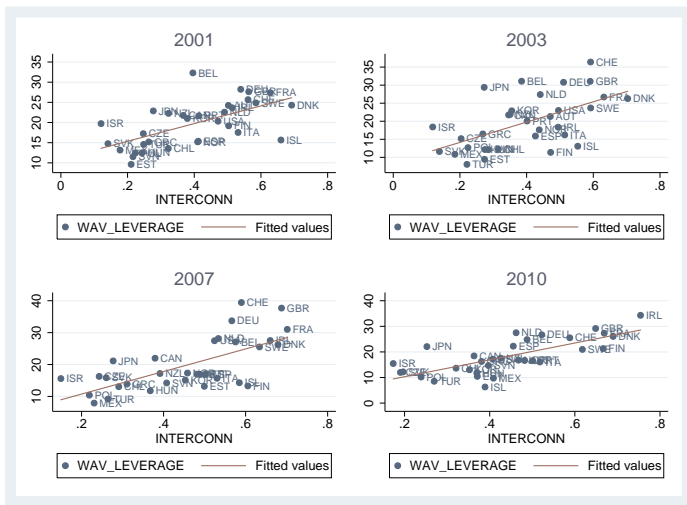


Figure: Leverage and Interconnectivity, Across countries, Selected Years



# Interconnectivity and Leverage: Firm-level (1)

Table: Very Large Financial Institutions (1999-2011)

Dep Variable	A/E	A/E	A/E
INTERCONN	31.648*** (1.978)	29.363*** (2.968)	32.485*** (8.090)
size	0.315 (0.398)	-0.231 (0.422)	3.421 (2.118)
Specialisation FE	No	Yes	No
Country FE	No	Yes	No
Time FE	No	Yes	Yes
Banks FE	No	No	Yes
R-squared	0.263	0.505	0.200
N	1214	1214	1214

Notes: Standard Errors in Parenthesis

\*, \*\*, \*\*\* Statistically Significant at 10%, 5% and 1%

# Interconnectivity and Leverage: Firm-level (2)

Table: All financial institutions

Dep Variable	A/E	A/E	A/E
Time Period	1999-2011	1999-2007	2003-2007
INTERCONN	2.896***	2.192***	1.240***
	(0.126)	(0.133)	(0.173)
size	2.831***	2.897***	3.249***
	(0.024)	(0.026)	(0.038)
Banks FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
R-squared	0.090	0.118	0.126
N	176108	125361	69334

Notes: Standard Errors in Parenthesis

\*, \*\*, \*\*\* Statistically Significant at 10%, 5% and 1%

# Interconnectivity and Return Differential

$$DIFFERENTIAL_{it} = \frac{INT\_INCOME_{it}}{AV\_ASSETS_{it}} - \frac{INT\_EXP_{it}}{AV\_LIABILITIES_{it}}.$$

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- The model predicts:

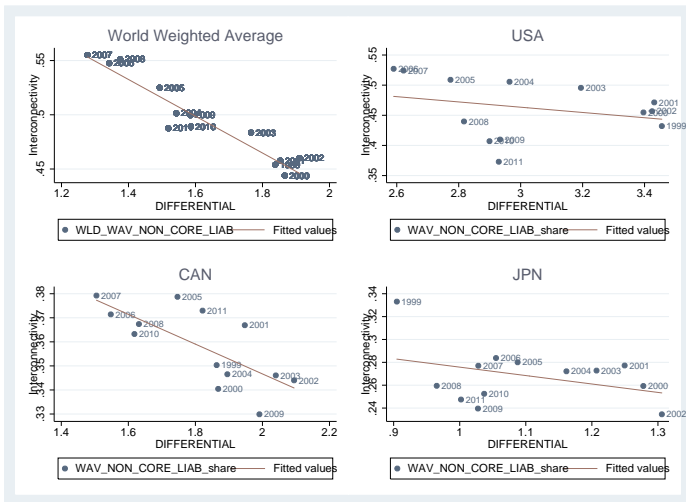
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- The model predicts:
  - a positive correlation between interconnectivity and return differentials if  $R_t^k / R_t^l$  is the main force at play

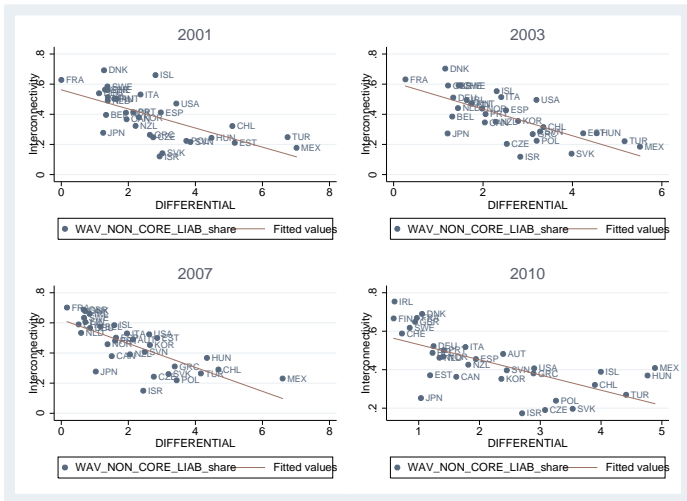
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- The model predicts:
  - a positive correlation between interconnectivity and return differentials if  $R_t^k / R_t^l$  is the main force at play
  - a negative correlation between interconnectivity and return differentials if  $\chi$  is the main force at play

# Interconnectivity and Differential: Country-level (1)



# Interconnectivity and Differential: Country-level (2)





# Interconnectivity and Differential: Firm-level (1)

Table: Very Large Financial Institutions (1999-2011)

Dep Variable	INTERCONN	INTERCONN	INTERCONN
Differential	-0.098*** (0.007)	-0.114*** (0.009)	-0.026** (0.013)
size	-0.015** (0.008)	-0.006 (0.008)	0.071** (0.033)
Specialisation FE	No	Yes	No
Country FE	No	Yes	No
Time FE	No	Yes	Yes
Banks FE	No	No	Yes
R-squared	0.210	0.674	0.217
N	963	963	963

Notes: Standard Errors in Parenthesis

\*, \*\*, \*\*\* Statistically Significant at 10%, 5% and 1%

# Interconnectivity and Differential: Firm-level (2)

Table: All Financial Institutions (1999-2011)

Dep Variable	INTERCONN	INTERCONN	INTERCONN
Differential	-0.048*** (0.001)	-0.024*** (0.001)	-0.007*** (0.001)
size	0.044*** (0.000)	0.031*** (0.000)	0.021*** (0.003)
Specialisation FE	No	Yes	No
Country FE	No	Yes	No
Time FE	No	Yes	Yes
Banks FE	No	No	Yes
R-squared	0.328	0.562	0.035
N	169308	169308	169298

**Notes:** Standard Errors in Parenthesis

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- Positive relation between leverage and interconnectivity.

# Conclusions

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- The upward trends observed prior to the crisis likely to have been driven by financial innovation.
- Planned (partly ongoing) research:
  - Analyze the impact of interconnectivity on the post-Lehman fall in credit growth,
  - Analyze the implications for systemic risk.

THANK YOU!!!  
for Suggestions, Comments, Complaints:  
**[alessandro.barattieri@carloalberto.org](mailto:alessandro.barattieri@carloalberto.org)**

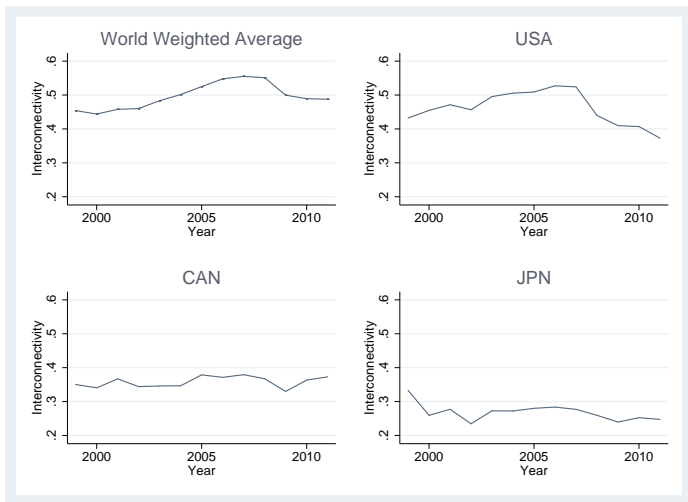
# Summary Statistics

	Number Obs		Total Assets		Leverage		Interconnectivity	
	Total	%	mean	s.d.	mean	s.d.	mean	s.d.
ALL	211291		7812.9	245	12.7	8.6	0.16	0.23
of which:								
MEGA BANKS	1303	0.6	635986.1	565491	25.7	13.8	0.54	0.23
Commercial Banks	118156	55.9	5964.5	65249.8	10.8	5.6	0.10	0.19
Investment Banks	3438	1.6	28948.2	95661.3	17	18.8	0.63	0.29

Notes: Millions of USD. Back to [Main](#)

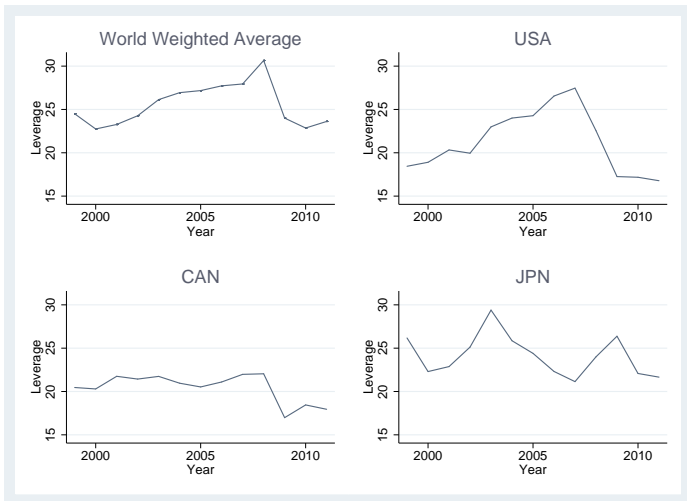


# Interconnectivity, Selected Countries



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# Leverage, Selected Countries



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