Leverage, Balance Sheet Size and Wholesale Funding

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INTRODUCTION

- Leverage procyclicality could amplify aggregate volatility (Adrian and Shin, 2010; Panetta and Angelini et al., 2009).

- This paper provides further evidence on these issues using Canadian data.

- Questions:

  1. How does leverage procyclicality depend on wholesale funding?

  2. How does it change with market conditions?

  3. How does it relate to market volatility?

WHAT WE DO

- Use monthly balance-sheet data on all federal deposit taking institutions in Canada.

- Group FIs by the use of wholesale funding (WSF).

  - ▶ WSF includes uninsured deposits, repos and banker's acceptances.

  - ▶ WSF is a liquid but potentially unstable source of funding.

- Empirical analyses:

  - ▶ Apply the two-step procedure as in Kashyap-Stein (2000) to identify leverage procyclicality in Canada.

  - ▶ Analyze if banking-sector leverage procyclicality is correlated with equity-market volatilities.

PREVIEW OF MAIN FINDINGS

- We find evidence of leverage procyclicality (i.e., positive correlations between changes in balance-sheet size and leverage) in Canada.

  - ▶ Heavy users of wholesale funding are more likely to show stronger leverage procyclicality.

  - ▶ Their procyclicality become even stronger when short-term funding markets are more liquid.

- Banking sector procyclicality can forecast equity market volatilities.

OUTLINE

- Introduction

- Illustration of Asset-Leverage Correlation by Funding Source

- Data

- Empirical Analysis

- Results

- Conclusion

Illustration: Asset-Leverage Correlation by Funding Source

- Define: Leverage (Lev) $= \frac{\text{Total Assets}}{\text{Equity}}$

- Suppose two banks with different funding patterns: Bank 1 is funded by WSF and Bank 2 by retail deposits.

	Bank 1				*Bank 2*	
Assets	Liability			Assets	Liability	
200	Ret. Dep.	0		200	Ret. Dep.	190
	WSF	190			WSF	0
	Equity	10			Equity	10

- Lev(Bank 1) = Lev(Bank 2) $= \frac{200}{10} = 20$

Illustration: Asset-Leverage Correlation by Funding Source

- Adrian-Shin Channel: Suppose bank's marked-to-market assets appreciate in value by 1 %.

	Bank 1				*Bank 2*	
Assets	Liability			Assets	Liability	
202	Ret. Dep.	0		202	Ret. Dep.	190
	WSF	190			WSF	0
	Equity	12			Equity	12

- Lev(Bank 1) = Lev(Bank 2) = $\frac{202}{12}$ = 16.8

Illustration: Asset-Leverage Correlation by Funding Source

- Suppose both banks actively manage its balance sheet and try to re-lever up by increasing non-equity funding.

- Bank 1 raises \$38 of WSF while Bank 2 can raise a half of it due to the "sluggish" nature of retail deposits.

<table>
<tr><td colspan="3">Bank 1</td><td colspan="3">Bank 2</td></tr>
<tr><td>Assets</td><td colspan="2">Liability</td><td>Assets</td><td colspan="2">Liability</td></tr>
<tr><td>240</td><td>Ret. Dep.</td><td>0</td><td>221</td><td>Ret. Dep.</td><td>209</td></tr>
<tr><td></td><td>WSF</td><td>228</td><td></td><td>WSF</td><td>0</td></tr>
<tr><td></td><td>Equity</td><td>12</td><td></td><td>Equity</td><td>12</td></tr>
</table>

- Now, Lev(Bank 1) $= \frac{240}{12} = $ **20**, and Lev(Bank 2) $= \frac{221}{12} = $ **18.4**

Illustration: Asset-Leverage Correlation by Funding Source

- Movements in assets and leverage, $(\%\Delta Assets, \%\Delta Leverage)$, are

    - Bank 1: $(1\%, -16\%)$ then $(19\%, 19\%)$.

    - Bank 2: $(1\%, -16\%)$ then $(9.4\%, 9.4\%)$.

- Asset-leverage correlation is higher for Bank 1 that uses WSF.

DATASET – TDS

Tri-Agency Database System (TDS) developed by BoC, OSFI and CDIC.

- Monthly balance sheet data for all federally chartered deposit-taking institutions in Canada.

- We exclude foreign branches, and fully-owned subsidiaries of other Canadian banks.

- Sample period: January 1994 - December 2009 (192 months).

CATEGORIZING FIs BY WHOLESALE FUNDING USE

- Define the wholesale funding (WSF) ratio:

$$\% \text{ WSF} = \frac{\text{Non-personal deposits} + \text{Repos} + \text{BAs}}{\text{Total Liabilities} + \text{Total Equity}}$$

- *For each month*, FIs are divided into three categories:

  - **No WSF**: $\% \text{ WSF} = 0$

  - **Low WSF**: $\% \text{ WSF} <$ Median of all non-zero $\%$ WSF

  - **High WSF**: $\% \text{ WSF} \geqslant$ Median of all non-zero $\%$ WSF

Monthly Changes in Assets and Leverage (1994-2009)
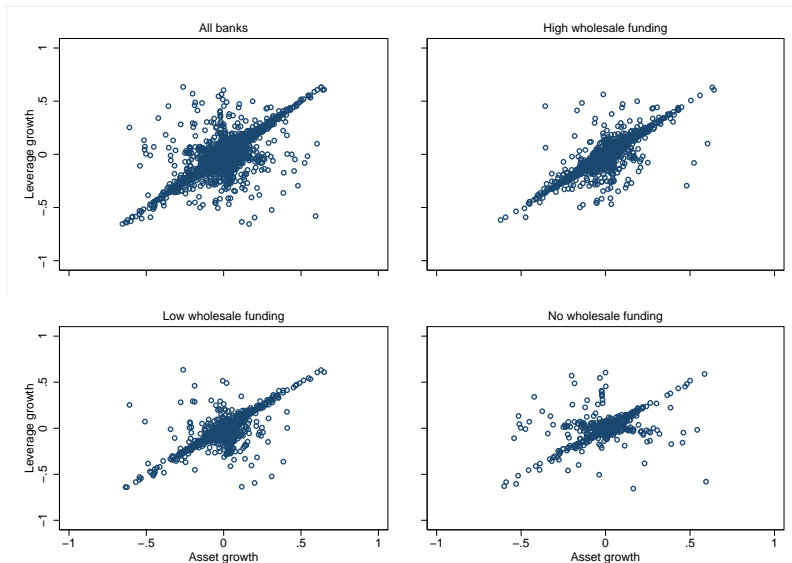
EMPIRICAL ANALYSIS: STRATEGY

A "two-step" setup similar to the literature on monetary transmission (Kashyap and Stein, 2000).

- **Step 1:** Estimate correlations of asset-leverage changes for *each month*.
    - ▶ Only bank-level balance sheet data is used in this step.
    - ▶ These correlations are estimated for *each WSF group*.

- **Step 2:** Determine how these correlations change with market-wide liquidity and macroeconomic conditions *over time*.
    - ▶ Only market-wide financial and macroeconomic variables are used.
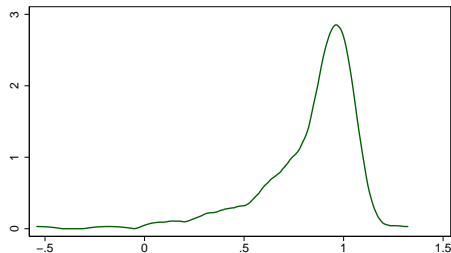
EMPIRICAL ANALYSIS: STEP 1

In the first step, run the following regression **once for each month**:

$$
\begin{aligned}
\Delta \ln(\text{Leverage})_{i,t} &= \psi_{1,t} + \psi_{2,t} \cdot Low_{i,t} + \psi_{3,t} \cdot No_{i,t} \\
&+ \beta_{1,t} \cdot \Delta \ln(Assets)_{i,t} \\
&+ \beta_{2,t} \cdot \Delta \ln(Assets)_{i,t} \cdot Low_{i,t} \\
&+ \beta_{3,t} \cdot \Delta \ln(Assets)_{i,t} \cdot No_{i,t} \\
&+ \beta_{4,t} \cdot \ln(ACM\ Limit_{i,t}) \\
&+ \beta_{5,t} \cdot Liquid_{i,t} \\
&+ \beta_{6,t} \cdot Merger_{i,t} \\
&+ \beta_{7,t} \cdot \ln(Leverage)_{i,t-1} + \epsilon_t
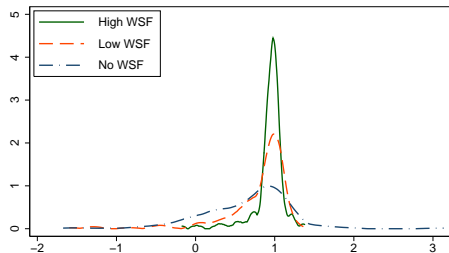\end{aligned}
$$

Correlations: $\beta_{1,t}$ (high WSF), $\beta_{1,t} + \beta_{2,t}$ (low WSF), and $\beta_{1,t} + \beta_{3,t}$ (no WSF).

STEP 1 RESULTS: Kernel Density Estimates of Correlations

All Banks

By WSF Group

- Concentration around $1 \Rightarrow$ positive asset-leverage correlations.
- Fat left tail for No WSF $\Rightarrow$ weak correlations for this group.

STEP 1 RESULTS: Statistics of Correlations

	All Banks	High WSF	Low WSF	No WSF
Mean (μ)				
Whole Sample (μ_{whole})	0.833	0.933	0.787	0.654
1990s (μ_{90})	0.930	0.952	0.872	0.915
2000s (μ_{00})	0.774	0.921	0.735	0.550
$H_0 : \mu_{90} = \mu_{00}$	25.36***	1.23	5.90**	16.74***

SUMMARY OF STEP 1 RESULTS

- Overall, positive correlations between asset-leverage changes.

  ▶ Leverage is procyclical as in Adrian-Shin (2010).

- Higher positive correlations for FIs that use wholesale funding.

- Correlations have decreased between the 1990s and 2000s.

- The differences among WSF groups and the changes over time seem to validate the empirical approach.

EMPIRICAL ANALYSIS: STEP 2

Use estimated correlations (β's) from Step 1 as dependent variables and run time-series regressions **for each group separately** on:

- Funding liquidity variables:

    - Repo: Total volume of repo market transactions

    - BA: Total outstanding banker's acceptances

    - CP: Total outstanding financial sector commercial paper

- TED Spread

- GDP

EMPIRICAL ANALYSIS: STEP 2

$$\xi_{j,t} = \eta \quad + \quad \sum_{q=0}^{1} \theta_{1q} \cdot \Delta \ln(Repo)_{t-q} + \sum_{q=0}^{1} \theta_{2q} \cdot \Delta \ln(CP + BA)_{t-q}$$

$$+ \quad \sum_{q=0}^{1} \theta_{3q} \cdot \Delta \ln(GDP)_{t-q} + \sum_{q=0}^{1} \theta_{4q} \cdot \Delta TED\ Spread_{t-q} + \epsilon_{j,t},$$

where $j =$ High WSF $(\xi_{j,t} = \beta_{1,t})$,
Low WSF $(\xi_{j,t} = \beta_{1,t} + \beta_{2,t})$ or
No WSF $(\xi_{j,t} = \beta_{1,t} + \beta_{3,t})$.

STEP 2 RESULTS: Selected Explanatory Variables

	All Banks	High WSF	Low WSF	No WSF
$\Delta \ln(Repo)$	0.388**	0.327**	0.298	-0.016
$\Delta \ln(Repo)_{-1}$	0.045	-0.048	-0.027	0.342
$\Delta \ln(CP + BA)$	1.323**	0.452	0.186	0.180
$\Delta \ln(CP + BA)_{-1}$	0.982*	0.0445	4.143**	-0.209
$\Delta \ln(GDP)$	0.062	0.032	-0.023	0.123
$\Delta \ln(GDP)_{-1}$	0.017	-0.063*	-0.075	0.309***
$\Delta TED\ Spread$	-0.094	-0.059	-0.169	-0.232
$\Delta TED\ Spread_{-1}$	-0.008	-0.009	0.077	-0.129
No. of obs.	190	190	190	168
F-Stat	3.85***	1.56	1.73*	2.12**

SUMMARY OF STEP 2 RESULTS

- Funding liquidity matters:

  - ▶ When funding markets are more liquid, FIs that use WSF are more likely to expand balance-sheet size through higher leverage.

  - ▶ Liquidity in the repo market is correlated with leverage procyclicality of high WSF banks.

  - ▶ Liquidity in the BA and CP markets is correlated with leverage procyclicality of low WSF banks.

PROCYCLICALITY AND MARKET VOLATILITIES

Is there a relationship between banking-sector leverage procyclicality and market volatilities?

$$Volatility_t = \lambda_0 + \lambda_1 Correlation_{t-1} + \lambda_2 Correlation_{t-1} \cdot Crisis_t + \lambda_3 Crisis_t + \upsilon_t,$$

where

- "*Volatility*" is GARCH(1,1)-implied variance of Toronto Stock Exchange returns.

- "*Correlation*" is the WSF-weighted Δasset–Δleverage correlation across banks.

- "*Crisis*" is a dummy for the period over July 2007 to December 2009.

PROCYCLICALITY AND MARKET VOLATILITIES

Variable	GARCH-Implied Volatility	
	Coefficient	S. E.
Correlation	0.487**	0.229
Crisis	2.558**	1.202
Correlation · Crisis	0.937	1.857
Constant	0.868***	0.102
Observations	191	
F	3.210**	

- Higher leverage procyclicality forecasts higher equity-market volatilities.

- Higher volatility during the crisis but no association with leverage procyclicality.

CONCLUSION

- This paper has analyzed the evolution of leverage with respect to balance sheet size in the Canadian banking industry.

- Use of wholesale funding plays an important role:
  - ▶ High WSF banks display stronger leverage procyclicality.
  - ▶ When funding markets are more liquid, leverage is more procyclical.
  - ▶ Banking-sector leverage procyclicality is correlated with market volatilities.

- Policy implications:
  - ▶ Potential increase in volatility through the Adrian-Shin mechanism.
  - ▶ Counter-cyclical capital buffer and liquidity standards could help.

Table: Balance Sheet Composition, % of Total Assets, 2009 December

	All Banks	High WSF	Low WSF	No WSF
Total Assets	100	100	100	100
Cash	6	8	6	10
Loans	58	57	66	75
Mortgage	21	14	33	64
Non-mortgage	37	42	33	11
Securities	29	27	23	12
Public Sector	8	8	11	9
Private Sector	15	14	9	3
Derivative Related	6	6	3	0
Other Assets	7	8	5	3
Total Liabilities	95	95	94	79
Retail Deposit	30	19	50	32
Wholesale Funding	48	60	30	0
Other Liabilities	18	16	14	47
Equity	5	5	6	21

SAMPLE: Grouping of FIs by WSF

- Number of banks in each group and the entire sample:

	High WSF	Low WSF	No WSF	Total Sample
Mean	26.59	26.06	14.79	67.44
Min	20	19	1	54
Max	33	32	30	75

SAMPLE: Grouping of FIs by WSF

- Wholesale funding use seems to be relatively stable. The transition matrix shows high persistence:

| | Group at $t+1$ | | |
Group at t	High WSF	Low WSF	No WSF
High WSF	96.29%	3.51%	0.2%
Low WSF	3.56%	94.22%	2.22%
No WSF	0.05%	3.84%	96.11%