

Investment Dealer Collateral and Leverage Procyclicality *

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July 27, 2018

Abstract

This paper introduces a novel data set to examine the relationship between leverage and asset growth in the Canadian investment broker-dealer sector over the period of 1992 to 2010. Investment dealers have highly procyclical leverage, in that leverage growth is highly correlated with asset growth. This is largely due to collateralized borrowing, whereby increases in asset values lead to increases in collateral (margin deposits), allowing investment dealers to borrow against these deposits, and purchase more assets. Of course, decreases in collateral value have the opposite effect and margins can be destabilizing if investment broker-dealers are forced to de-leverage.

JEL classifications: G24

Keywords: investment banks; leverage procyclicality; collateral; funding liquidity

*We thank IIROC, especially Nellie Gomes and Louis Piergeti for providing data and support. Additional thanks to Toni Ahnert, Evren Damar, Toni Gravelle, Sheisha Kulkarni, David Martinez-Miera, Teodora Paligorova and Ilya Strebulaev for their useful comments and advice as well as seminar participants at the University of Waterloo. Vathy Kamulete and Chloé Yao provided excellent research assistance. Contacts: Jason Allen (corresponding author): jallen@bankofcanada.ca, Andrew Usher: usherster@gmail.com. The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada.

1 Introduction

The focus on leverage among financial institutions has increased since the global financial crisis of 2008. Several papers have found a strong positive correlation between asset growth and leverage among financial institutions—leverage procyclicality—originally documented by Adrian and Shin (2010).¹ They argue this correlation results from active management of assets and liabilities. If a firm did not respond to positive asset shocks by increasing its assets through borrowing, the shock would lead to a decrease in leverage – which is rejected by the data. A persuasive argument put forth is that a key channel of this transmission from assets to leverage is the repurchase agreement (repo) market, where investment banks are key players and only the largest commercial banks operate. Financial institutions that fund themselves on a short-term basis via the repo market can more easily purchase assets and increase leverage than financial institutions that fund themselves, for example, through retail deposits.

Using panel-data methods on a novel data-set on the population of Canadian investment broker-dealers, we find a strong positive correlation between asset growth and leverage (defined as assets/capital) for the investment dealer industry. A 1% increase in asset growth is correlated with a 0.9% increase in leverage. We call this leverage procyclicality. However, we also find strong leverage procyclicality irrespective of whether firms access the repo market. Those with repo market access are in fact not statistically different than those who don't access the repo market. For Canadian investment dealers at least, access to the repo market is not the only reason for leverage procyclicality. We also find a strong correlation between the liquidity of bank assets and leverage. Over 90% of assets are liquid for the majority of firms, including loans receivables, which are collateralizable, but also substantial cash holdings. This level of liquidity could explain differences in leverage procyclicality between broker-dealers and commercial banks.

We show that cash-on-hand is an important determinant of leverage procyclicality for institutions without access to the repo market. Rather than take on short-term debt, some institutions manage to target leverage through a combination of collateralized borrowing and cash management. When a buying opportunity arises firms use cash, not only short-term debt. In Adrian and Shin (2010), for example, a firm with \$100 in securities, \$10 in equity and \$90 in debt facing a \$1 price increase in the value of their securities will choose to go to the repo market and take on \$9 of debt to purchase \$10 worth of the security. Many broker-dealers in our data, however, use cash, or a combination of cash and short-term debt. A firm will purchase \$10 worth of securities as well, but not only with debt.

We also find that loans-receivables play a role in leverage procyclicality. Loans receivables are

¹This includes Kalemli-Ozcan *et al.* (2012), Baglioni *et al.* (2013), Damar *et al.* (2013), Beccalli *et al.* (2015) and Laux and Rauter (2017).

interesting for two reasons. First, loans receivables can be used as collateral to increase borrowing. Second, loans receivables can be used for rehypothecation. That is, loans receivables that are pledged by one institution can be repledged or even sold. Primary dealers provide hedge funds with cash, for example, on condition that they can rehypothecate the pledged assets. As asset prices go up, for example, so too does the value of collateral, allowing broker-dealers to increase borrowing. Furthermore, broker-dealers involved in rehypothecation could introduce a multiplier effect whereby not only the bank who holds the collateral benefits from the increase in prices, but so too does the original pledger. We find that it is broker-dealers involved in the repo market that also collateralize their loans receivables.

The contribution of this paper is decomposing the different roles played by funding and asset liquidity on leverage procyclicality. The largest holding of liquid assets are margins on deposit, contributing to one-third of total assets followed closely by securities.² This suggests a collateral channel for leverage. As asset prices increase, the value of a bank's margins as well as their securities holdings increase. This allows the investment bank to borrow in order to purchase more assets. Borrowing against the elevated values of collateral in order to target leverage is what induces procyclicality, as argued by Adrian and Shin (2010). This result suggests an important collateral channel for financial instability (Geanakoplos (2009)). As asset prices fall, so does the value of collateral. As modeled by Chowdhry and Nanda (1998), decreases in asset prices lower the prices of collateral, which diminishes the ability of leveraged dealers to purchase risky assets. This is because for some risky assets to be held by other risk averse investors they require a risk premium.³ This results in prices falling further and can lead to price instability.⁴ This can even lead to fire-sales and financial instability if there is an episode of market illiquidity or greater uncertainty about market fundamentals, as highlighted by Brunnermeier and Pedersen (2009).

In addition to traditional collateral we also find that loans receivables, although a relatively small fraction of the balance sheet, contribute to leverage procyclicality, especially for institutions who access the repo market. Loans receivables can be pledged as collateral in the same way a broker-dealer pledges its own securities. This generates another channel to access cheap funding that generates procyclical leverage. Asset-based lending has recently increased in popularity among non-financial firms, potentially leading to an increase in leverage procyclicality for these firms.

The remainder of the paper is organized as follows. Section 2 describes the Canadian investment banking industry. Section 3 presents the data, while section 4 presents our analysis of leverage

²Margins are the difference between a securities price and its collateral value.

³This fact is captured in different ways by Adrian and Boyarchenko (2015), Adrian and Shin (2014), Aymanns and Farmer (2015), and Ma (2018), for example, who all study the impact of Value-at-Risk constraints on the risk premium for assets correlated with leverage. Danielsson *et al.* (2004) is an early paper that documents price dynamics and the impact of Value-at-Risk constraints on generating procyclicality.

⁴Similar arguments are made in the macro-economics literature linking credit constraints over the business cycle. See for example Kiyotaki and Moore (1997).

procyclicality. Section 5 concludes.

2 Investment dealers in Canada

Investment brokers (acting on behalf of customers) and dealers (acting on behalf of the firm) have increasingly become a large and interconnected part of the financial system, bringing more interest in understanding their activities and role in the financial system (Rosengren (2014)).

The investment-dealer market that exists in Canada today is relatively young. In 1987 important changes to the Canadian Bank Act introduced universal banking to Canada largely driven by the demand of large retail banks to enter the securities business and the investment banks demand to access larger capital markets. Prior to 1987 there were explicit restrictions on the types of securities banks could engage in. For example, banks were prohibited from underwriting corporate securities, and until 1992 banks could not engage in portfolio management or investment counseling (Freedman (1996)). As the share of corporate debt shifted from bank loans to bonds, equity and paper, Canadian banks grew exceedingly concerned about their own profitability. At the same time Canadian broker-dealers recognized they needed a larger capital base in order to compete internationally. Within less than a year following amendments to the Bank Act in 1987, therefore, five of the big 6 Canadian banks bought an existing dealer and one bank started de novo.⁵ Prior to 1987 there were also severe restrictions on foreign access to the Canadian dealer market. Post-reform there was a large influx of foreign dealers.

3 Data

Financial data is collected monthly and analyzed by the Investment Industry Regulatory Organization of Canada (IIROC), who require all investment broker-dealer firms in Canada to complete monthly regulatory financial reports (Form 1 of the IIROC Rule Book).⁶ IIROC is a self-regulatory organization that oversees investment dealer activity in debt and equity markets in Canada as well as personal and wholesale investing. We have access to financial reports for the period 1992 to 2010. Total assets of firms regulated by IIROC grew in nominal terms from \$32 billion in January 1992 to \$337 billion by December 2010.

⁵TD Bank founded Toronto Dominion Securities Inc. in 1987. TD Bank would later buy Waterhouse Securities in 1996 for \$715 million. BMO purchased a majority share of Nesbitt Burns; RBC purchased a majority share of Dominion Securities; BNS purchased McLeod Young Weir; CIBC purchased a majority share of Wood Gundy; and National purchased Levésque Beaubien.

⁶The Canadian Investor Protection Fund provides insurance of up to \$1 million against investment dealer insolvency for clients. The blank report schedules are publicly available. <http://tinyurl.com/11st4v4>.

IIROC was created in 2008 through a consolidation of the Investment Dealers Association of Canada and Market Regulation Service Inc. In terms of prudential requirements, IIROC enforces a minimum capital requirement (risk-adjusted capital), and also requires that dealers hold more margin for assets that are riskier and less liquid. They are also the market-conduct regulators, monitoring dealer behavior, and ensuring dealers follow a set of Market Integrity Practices.⁷

Our data contains IIROC-member investment dealers in Canada from January 1992 to December 2010. IIROC’s membership nearly doubled from 119 to 201 over this period. Income and balance sheet data are reported for each firm on a monthly basis.⁸ Furthermore, firms are grouped into five categories based on size and business lines.⁹ The criteria of the groups are outlined in Table 1.

Table 1: **Groups of Investment Broker-Dealers in Canada**

Groups as defined in 2010. Not shown are what is known as Introducing brokers (group A). Introducing brokers advise clients but must perform transactions through another broker.

Group	Regulatory capital	Clients	Example
B	>\$400 million	Retail + Institutional	BMO Nesbitt Burns
C	>\$5 million	Institutional	Barclays Capital Canada
D	>\$5 million	Retail	HSBC Securities Canada
E	<\$5 million	Institutional	Bloomberg Tradebook Canada
F	<\$5 million	Retail	yourCFO Advisory Group

Figure 1 shows the total assets of all groups divided by the total assets of all chartered banks in Canada. This graph highlights that investment broker-dealers make up a substantial fraction of the Canadian financial system. As a share of the banking system they grew from 4% in 1992 to more than 12% prior to the financial crisis of 2007-2009. This is larger than trust & loan and credit unions’ assets combined as a percentage of chartered banks (excluding Caisses Desjardins). As a share of the Big 6 assets, their investment bank subsidiaries represent approximately 9%.¹⁰

Before discussing leverage, some discussion of the major categories of assets and liabilities is warranted. For more detailed definitions, see Table 6 in the Appendix. Assets are composed of liquid assets, other allowable assets (assets that can be readily convertible to cash), and non-allowable assets. The main items in liquid assets are cash, loans receivable, securities borrowed and resold,

⁷These practices, available on IIROC’s website, govern issues like front running and client priority.

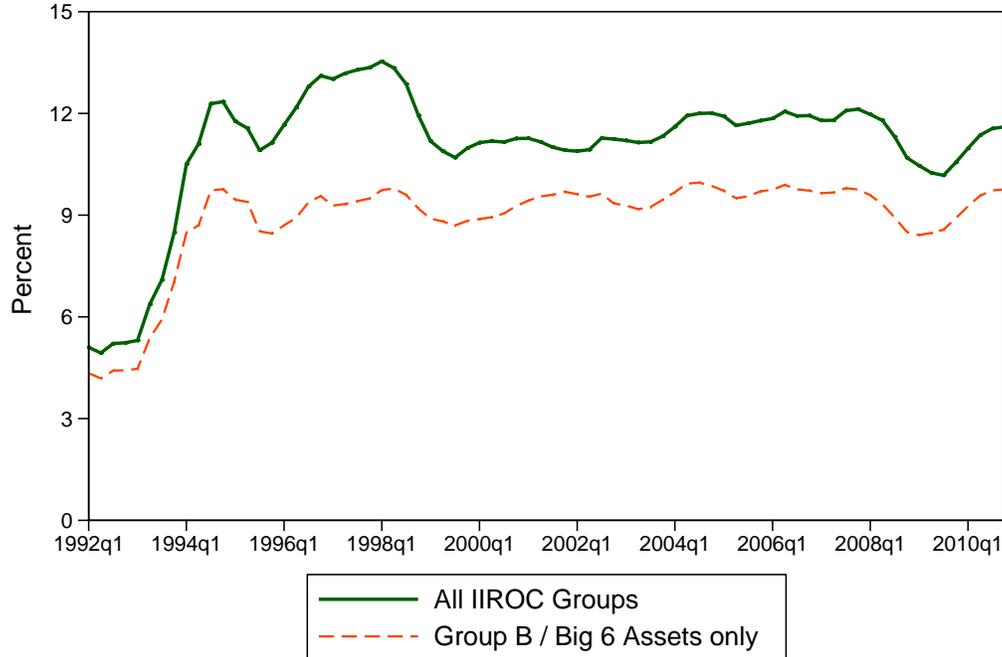
⁸For confidentiality reasons we do not have access to firm names but instead firm identifiers which remain constant through time. In addition, we note that there are 325 firms in total—119 is the minimum and 201 maximum for any one period. This points to substantial entry and exit over our sample period and therefore we use an unbalanced panel.

⁹We exclude from our analysis throughout this paper firms that appeared for less than one year in our data as well as firms that in 2010 were members of Group A. Group A are firms known as introducing brokers. They can advise clients but must perform transactions through a broker in one of the other groups (B-F).

¹⁰The Big 6 banks in Canada are Bank of Montreal, Banque Nationale, Canadian Imperial Bank of Commerce, Royal Bank, Scotiabank, TD-Canada Trust.

Figure 1: **Total Assets: Investment Broker-Dealers over Chartered Banks**

Groups as defined in 2010. Group B includes many of the subsidiaries of the largest chartered banks. Chartered bank data are from TDS (Tri-Agency Data Sharing System), which is bank level data shared between the Bank of Canada, the Office of the Superintendent of Financial Institutions, and the Canada Deposit Insurance Corporation.



IIROC: Jan. 1992 – Dec. 2010
 TDS: Jan. 1992 – Dec. 2010 (Includes all Chartered Banks)

securities owned by the firm and their clients, and client accounts. Allowable assets include receivables and recoverable and overpaid taxes. Non-allowable assets include receivables, fixed assets, capitalized leases, and investments in subsidiaries, among other items.

Major categories of liabilities include current liabilities, long-term liabilities, and financial statement capital. Major items in current liabilities include overdrafts, loans payable, securities loaned and repurchases agreements (repos), securities sold short, and client accounts. We use loans payable, securities loaned and repos as a measure of wholesale funding, similar to Adrian and Shin (2010). Long-term liabilities include deferred income taxes and capitalized leases and lease-related liabilities.¹¹

Capital employed includes non-current portions of capitalized leases, subordinated loans from industry and non-industry investors, capital stock and contributed surplus, and retained earnings and undivided profits. Prior to April 1, 2000, standby subordinated debt was also included in capital employed.¹² We define leverage as assets divided by capital employed.

¹¹Deferred income taxes and capitalized leases were included in capital prior to 1993. Subsequently, non-current capitalized leases was split into a category for long-term liabilities and financial statement capital.

¹²Standby subordinated debt is a form of contingent capital. It reflects the commitment from the lender to advance

Table 2 presents summary statistics on leverage and our key explanatory variables. Leverage here is defined as assets over capital as in Adrian and Shin (2010). A more familiar definition of leverage might be debt over assets which for financial institutions is typically over 85% (Gornall and Strebulaev (2013)). We present the variables by investment dealer-broker group (B-F). The number of firms in each group varies from 8 on average in group B to 65 on average in group F. Group B are the large multi-product institutions and mostly affiliated with one of the Big 6 national banks. Group B investment dealers have the highest leverage, on average 20.5 but the seventy-fifth percentile is 27.9. Leverage is on average lower in groups C-F, although there is substantially more dispersion, reaching close to 0 and 100.¹³ For firms with very high leverage, many are in their final year before failure or amalgamation (perhaps confirming a *shadow of death* result – see Griliches and Regev (1995)). Some firms, however, have high leverage but also large early warning balances suggesting that were in good standing.¹⁴

Figure 2 shows leverage for all groups over time. The median leverage has largely fallen over the sample period. There is substantial heterogeneity across firms in terms of the level of leverage, suggesting firms do not target the same leverage, even though the correlation between leverage growth and asset growth is very high, suggesting they (almost) all target leverage. Group B has the highest average leverage, followed by group C.

From Table 2 we see that all investment dealers have a very high ratio of liquid assets to total assets, on average ranging from 88% to 98%. In terms of assets, group B banks are about 18 times larger than group C, who are approximately twice as large as group D, who are more than 25 times larger than E and F. Repos are an important mechanism in Adrian and Shin (2010) as they are here, at least for the largest investment dealers. Approximately 26% of firms (18% of total observations) do not participate in the repo market, however, and repos as a fraction of total liabilities is relatively small for almost all firms.

Figure 3 presents figures of leverage growth and asset growth for the given investment dealer groups. All groups present a strong indication that leverage is procyclical, although to varying degrees. For example, the correlation between leverage growth and asset growth in group F (small retail investors) appears to be much less than B, C, or E. The degree of procyclicality for all groups, however, is substantially greater than what is reported by Damar *et al.* (2013) for Canadian banks on a consolidated basis. This, in addition to the fact that the bank regulator, the Office of the Superintendent of Financial Institutions, places leverage limits on federally regulated banks

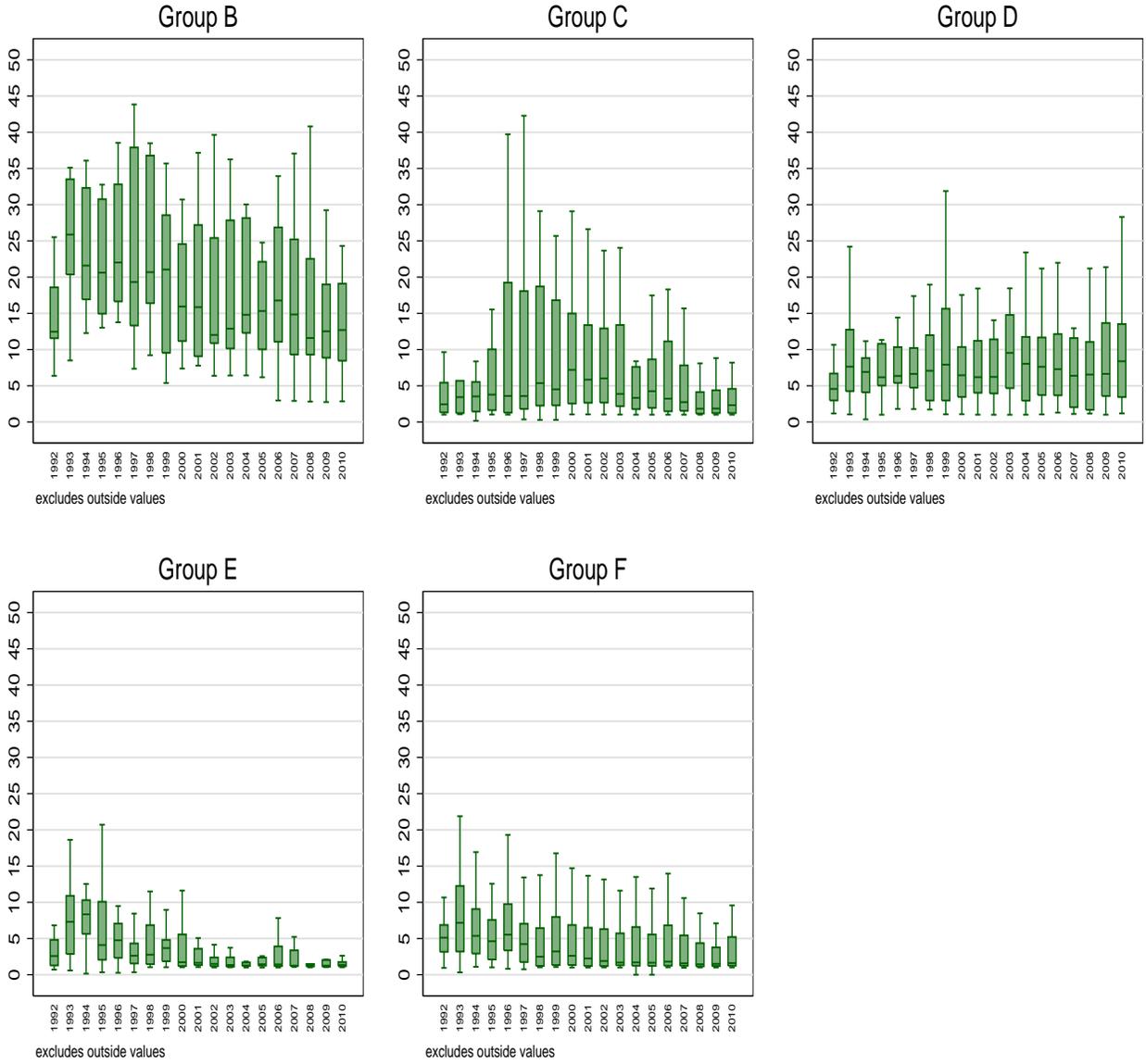
a certain amount on demand. Therefore cash is only transferred when needed. To avoid circumvention IIROC added a margin charge for deposits with a provider of capital.

¹³In the period before the elimination of stand-by subordinated debt, several firms had stand-by facilities that when added with their regular capital exceeded their asset holdings. This causes their leverage to be less than one.

¹⁴IIROC uses an early warning system to monitor potentially vulnerable members. Any member with risk-adjusted capital less than 5% of total margin is a category 1 warning and a member with risk-adjusted capital less than 2% of total margin is a category 2. Sanctions for violations are outlined in IIROCs instructions to members.

Figure 2: Leverage over time

Leverage is defined as assets over capital. Data are at calendar year end. Observations where leverage was greater than 50 are excluded.



Source: IIROC 1992–2010. Converted from monthly to annual (last observation).

consolidated balance sheet, highlights that the retail side of banking in Canada is less procyclical than the broker-dealer side.

Table 2: Descriptive Statistics for Main Variables in Leverage Regressions

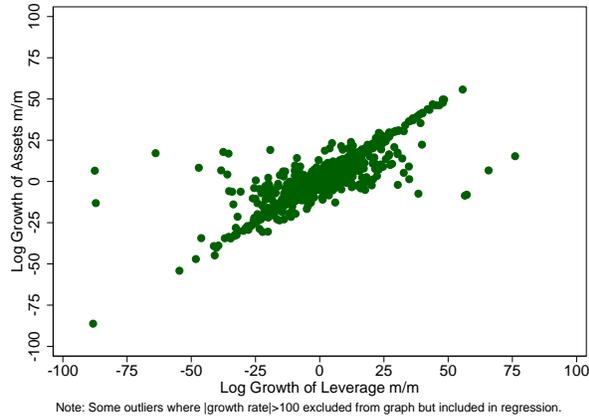
The sample period is from 1992 to 2010. Leverage is assets over total capital. Repos included loans payable and securities borrowed. Total capital includes equity or partner capital as well as subordinated debt. Group membership as of 2010. The number of members, N , is the average between 1992 and 2010.

	Mean	Std. Dev.	p25	p50	p75
Group B (N=8)					
leverage	20.50	10.85	11.37	19.00	27.90
Total assets (Millions)	17119.74	14827.92	4011.52	13776.33	28307.37
Total liabilities (Millions)	16237.84	14251.49	3800.39	13214.95	26988.32
Total capital (millions)	937.83	952.22	241.40	708.91	1166.83
liquid assets /total assets	0.98	0.04	0.98	0.99	0.99
repos / total liabilities	0.32	0.20	0.19	0.34	0.46
Group C (N=40)					
leverage	11.41	19.81	1.44	3.53	10.45
Total assets (Millions)	857.33	2226.67	16.07	88.13	546.28
Total liabilities (Millions)	771.78	2061.14	5.26	44.51	380.85
Total capital (millions)	87.50	250.60	6.62	18.82	63.94
liquid assets /total assets	0.88	0.19	0.87	0.96	0.99
repos / total liabilities	0.13	0.24	0.00	0.00	0.13
Group D (N=46)					
leverage	8.55	9.22	2.58	6.73	10.86
Total assets (Millions)	278.38	1106.23	18.87	61.53	168.68
Total liabilities (Millions)	254.24	1082.00	11.19	52.23	146.91
Total capital (millions)	24.73	48.61	4.50	8.86	22.84
liquid assets /total assets	0.90	0.15	0.90	0.96	0.98
repos / total liabilities	0.04	0.09	0.00	0.00	0.02
Group E (N=11)					
leverage	7.14	12.72	1.21	1.74	6.84
Total assets (Millions)	9.10	18.66	1.19	3.39	9.95
Total liabilities (Millions)	7.51	18.52	0.18	1.24	8.11
Total capital (millions)	1.61	1.59	0.68	1.03	1.96
liquid assets /total assets	0.91	0.12	0.89	0.96	0.99
repos / total liabilities	0.02	0.10	0.00	0.00	0.00
Group F (N=65)					
leverage	4.35	6.40	1.20	1.54	5.01
Total assets (Millions)	7.24	17.56	0.93	1.90	7.10
Total liabilities (Millions)	5.90	16.96	0.15	0.57	5.41
Total capital (millions)	1.47	2.39	0.61	0.97	1.69
liquid assets /total assets	0.87	0.14	0.81	0.92	0.97
repos / total liabilities	0.01	0.07	0.00	0.00	0.00

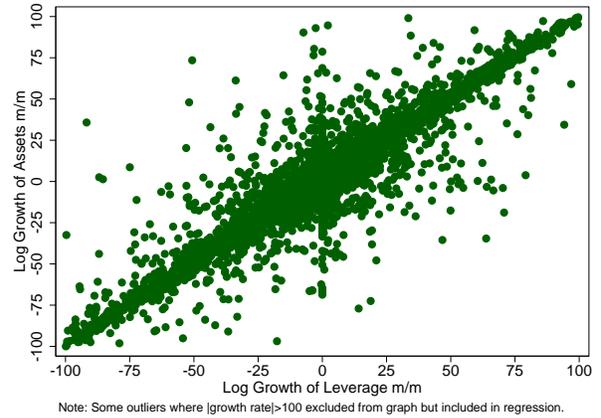
Figure 3: Leverage and Asset Growth

Leverage is defined as assets over capital. Data are at calendar year end. Observations where the absolute value of the growth rate >100 are excluded from graph but included in regression. Group membership as of 2010.

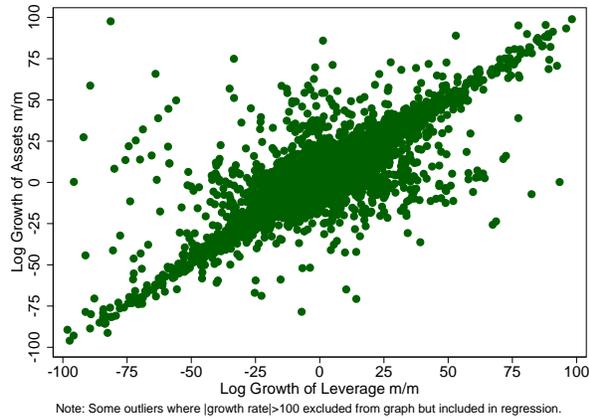
(a) Group B



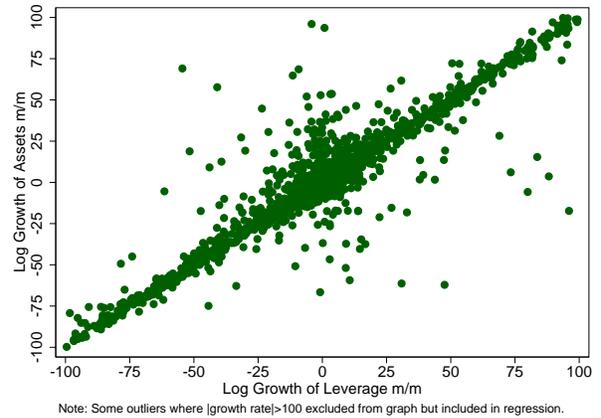
(b) Group C



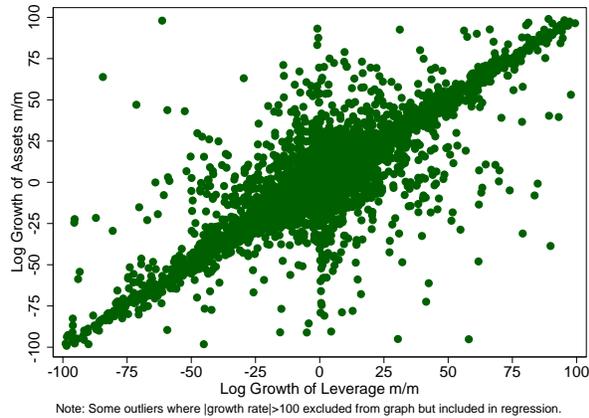
(c) Group D



(d) Group E



(e) Group F



4 Leverage

We estimate panel regressions with monthly firm-level data which attempt to explain the growth rate of leverage with the growth rate of assets. All growth rates – leverage, repos/loans payable, and assets are calculated in logs. The correlation we try to capture is presented in Figure 3. There is a clear strong positive correlation between leverage and asset growth. Standard errors are clustered at the firm level to allow for arbitrary correlation and heteroscedasticity. We account for firm heterogeneity by including firm fixed-effects for all specifications.¹⁵ Results are presented in Table 3. The first specification only includes a lag of the log of leverage to account for the possibility that leverage may be over-differenced. Adrian and Shin (2010) interpret this coefficient as a test of mean-reversion. Leverage is mean-reverting in our sample, suggesting that banks target leverage. The second specification adds the main variable of interest, asset growth. This specification is presented in equation (1).

$$\Delta \log(\text{Leverage}_{it}) = \alpha_{0i} + \alpha_1 \log(\text{Leverage}_{it-1}) + \alpha_2 \Delta \log(\text{Assets}_{it}) + \gamma X_{it} + u_{it}. \quad (1)$$

Similar to Adrian and Shin (2010) we find a strong positive correlation between asset growth and leverage. In the third specification we add the share of liquid assets to total assets to specification 2. Firms with more liquid assets can more flexibly change their leverage when the value of their balance sheet assets changes than firms with less liquid assets. Unlike Damar *et al.* (2013) our measure of liquidity is positive and statistically significant. This suggests that investment dealers with more liquid assets might be more flexible and thus more able to leverage up (down) their balance sheet than less liquid firms, especially the commercial banks studied in Damar *et al.* (2013).

In Table 4 we break-down the distribution of assets into its various components. On average cash makes up about 20% of assets, suggesting substantial flexibility. We further break-down cash holdings by whether or not the broker-dealer uses the repo market. We find that the average cash holdings for broker-dealers who use the repo market are half those of the broker-dealers who do not. A firm can easily reduce its cash holdings, for example, in combination with borrowing as a rapid response to an increase in asset prices and in order to target leverage. It is cheaper, however, to use the repo market than to hold cash, but not all institutions have access to the repo market. On average securities owned make up about 30% of assets. Mark-to-market accounting will naturally lead to changes in the valuation of these assets.¹⁶ Larger on average than even securities owned, however, are ‘other liquid assets’, which are margins on deposit at various clearing houses and financial institutions. These margins allow investment dealers to trade with high leverage. Any increase in an investment dealers portfolio, therefore, will increase the value of its margins. For a fixed haircut, an increase in the value of collateral allows the investment dealer to borrow

¹⁵The assumptions for a random coefficients model are strongly rejected using a Hausman test.

¹⁶There is not much evidence that fair-value accounting contributes to procyclicality. See for example Laux and Leuz (2010).

against the increase in collateral value. The same is true as prices fall – the value of collateral falls, diminishing the ability of levered broker-dealers to purchase risky assets, leading to lower prices. To a large extent this is what generates procyclicality in our sample, as we will see in Table 5.¹⁷ Finally, loans receivables are a smaller fraction of the balance sheet, on average just over 5% of total assets. Broker-dealers who do not use (or have access to, this is not observable) the repo market do not have loans receivables. We will see that the correlation between the growth rate of loans receivables and leverage is substantial. This is because loans receivables are pledgable collateral for inexpensive financing. This will be true for those broker-dealers active in the repo market.

Returning to the liability side, in the fourth specification of Table 3, we return to Adrian and Shin (2010) and estimate a model with mean-reversion and the growth rate of repo/loan payable. Similar to the management of liquid assets, firms with access to short-term funding are those that can most flexibly manipulate their leverage and balance sheet when the value of the assets on their balance sheet changes. First, there is a large drop in the number of observations because many firms do not participate in repo markets. This suggests that not every firm is able to leverage their balance sheet using repos/loans payable. Conditioning on participating in this market, however, there is a positive correlation between the growth of repo/loans payable and leverage. Finally we find that while there is a link between leverage procyclicality and repos it is not solely firms that access that market and would prefer to use repos to cash. The coefficient for non-repo users from specification 5 is only slightly smaller (.881) than the coefficient for all firms (.905) and the marginal effect of repo use is statistically insignificant.

Given the importance of liquid assets in our leverage regressions, Table 5 looks at procyclicality by asset class. All liquid asset classes exhibit positive correlation between leverage and asset growth. The largest correlation between leverage growth and assets is margins. The coefficient on cash is relatively small, suggesting that even though cash should be highly flexible and therefore allow investment dealers to easily increase leverage when asset prices increase, the actual correlation is relatively weak. The correlation is of course weakest for institutions who have access to the repo market. The coefficient on the growth in securities is almost as large as that for margins. This suggests that the mark-to-market of these assets contribute to the positive correlation with leverage growth. Finally, the coefficient on loans receivables is significant for both institutions who access the repo market and those who do not, although larger for the latter group. This suggests that loans receivables are a pledgeable source of collateral for funding purposes. They can also be used for rehypothecation, although we do not have direct evidence on this type of behavior.

¹⁷See Morris and Shin (2008) for an example of how changes in margins are sufficient to produce procyclical leverage.

Table 3: **Leverage Regressions**

Leverage is defined as assets to capital. Assets and leverage are logged and the growth rate is their first difference. The lag of log leverage is included to make this a partial adjustment model. Liquid assets are included to control for the differing ability to adjust assets of differing liquidity. Repos include securities borrowed and loans receivable. I(Repo) is an indicator equal to 1 for whether a firm at any point during our sample had a positive level of repos and 0 otherwise. Standard Errors are clustered at the firm level. *** p<0.01.

	$\Delta \text{Log(Lever.)}$				
$\text{Log(Leverage)}_{t-1}$	-0.187*** (0.0244)	-0.0231*** (0.00276)	-0.0311*** (0.00410)	-0.129*** (0.0237)	-0.0311*** (0.00410)
$\Delta \text{Log(Assets)}$		0.911*** (0.0134)	0.905*** (0.0140)		0.881*** (0.0267)
Liquid Assets/Assets			0.120*** (0.0295)		0.120*** (0.0294)
$\Delta \text{Log(Repo)}$				0.0496*** (0.00800)	
I(Repo) X $\Delta \text{Log(Assets)}$					0.0299 (0.0298)
Firm FEs	Y	Y	Y	Y	Y
Observations	38,732	38,732	38,727	9,388	38,727
Number of Firms	325	325	325	166	325

Table 4: **Composition of Assets**

This table provides summary statistics on the composition of broker-dealer assets over the period 1992 to 2010.

variable	mean	sd	p25	p50	p75
Cash	20.55	23.54	2.01	11.20	32.14
I(repo)	11.6	15.4	0.8	5.6	16.6
I(no repo)	24.0	25.2	2.7	15.1	30.0
Loans receivables	5.06	13.96	0.00	0.00	0.00
I(repo)	16.3	21.3	0	6.8	26.6
I(no repo)	0.6	5.0	0	0	0
Securities	30.12	27.17	7.27	23.84	47.67
Other liquid assets (margin deposits)	33.12	27.32	9.25	27.57	53.55
Other allowable assets	0.89	3.40	0.00	0.03	0.42
Non-allowable assets	10.31	14.63	1.52	4.30	13.48

Table 5: **Leverage Regressions by asset class**

Leverage is defined as assets to capital. Each asset variable as well as leverage is logged and the growth rate is their first difference. The lag of log leverage is included to make this a partial adjustment model. Repos include securities borrowed and loans receivable. Standard Errors are clustered at the firm level. *** p<0.01, ** p<0.05.

VARIABLES	(1) $\Delta \log(\text{leverage})$	(2) $\Delta \log(\text{leverage})$
$\text{Log}(\text{leverage})_{t-1}$	-0.157*** (0.0187)	-0.0989*** (0.0173)
$\Delta \text{ cash}$	0.0272*** (0.00422)	0.0126** (0.00505)
$\Delta \text{ loans receivables}$	0.0248*** (0.00449)	0.0305*** (0.00546)
$\Delta \text{ securities}$	0.0506*** (0.00523)	0.0839*** (0.0171)
$\Delta \text{ margin deposits}$	0.121*** (0.0169)	0.129*** (0.0240)
$\Delta \text{ other allowable assets}$	0.00865*** (0.00283)	-0.00198 (0.00225)
$\Delta \text{ non-allowable assets}$	-0.00364 (0.00791)	-0.0221 (0.0165)
$\Delta \text{ Log(Repo)}$		0.0365*** (0.00677)
Observations	36149	9281
R^2	0.282	0.319
Number of firms	325	160

5 Conclusion

This paper finds a strong positive correlation between asset growth and leverage for Canadian investment broker-dealers. In that respect we confirm previous research on leverage procyclicality by Adrian and Shin (2010), Kalemli-Ozcan *et al.* (2012), Baglioni *et al.* (2013), Damar *et al.* (2013), and Beccalli *et al.* (2015) that have focused on commercial banks. Instead, here we find strong evidence of leverage procyclicality for broker-dealers, which have been suspected as the source of procyclicality but for which the data has been lacking. Part of this is driven by access to short term funding, such as repos, which allows broker-dealers to flexibly adjust their balance sheet. However, we demonstrate that access to the repo market is not crucial. We show that broker-dealers use cash and loans receivables for funding and it is large swings in collateral, held in margin accounts that generates procyclical leverage. This result suggests an important channel for financial instability. As asset prices fall, so does the value of collateral, leading to further reductions in the demand for risky assets as in Chowdhry and Nanda (1998). This can potentially lead to fire-sales and financial instability if there is an increase in market illiquidity or uncertainty about fundamentals, as highlighted by Brunnermeier and Pedersen (2009).

References

- ADRIAN, T. and BOYARCHENKO, N. (2015). Intermediary leverage cycles and financial stability. Federal Reserve Bank of New York staff report No. 567.
- and SHIN, H. (2010). Liquidity and Leverage. *Journal of Financial Intermediation*, **19**, 418–437.
- and — (2014). Procyclical leverage and Value-at-Risk. *The Review of Financial Studies*, **27**, 373–403.
- AYMANN, C. and FARMER, J. (2015). The dynamics of the leverage cycle. *Journal of Economic Dynamics and Control*, **50**, 155–179.
- BAGLIONI, A., BECCALLI, A. B. and MONTICINI, A. (2013). Is the leverage of european banks pro-cyclical? *Empirical Economics*, **45**, 1251–1266.
- BECCALLI, E., BOITANI, A. and GIULIANONIO, S. D. (2015). Leverage pro-cyclicality and securitization in US banking. *Journal of Financial Intermediation*, **24**, 200–230.
- BRUNNERMEIER, M. and PEDERSEN, L. (2009). Market liquidity and funding liquidity. *Review of Financial Studies*, **22**, 2201–2238.
- CHOWDHRY, B. and NANDA, V. (1998). Leverage and market stability: The role of margin rules and price limits. *Journal of Business*, **71**, 179–210.

- DAMAR, E., MEH, C. and TERIJIMA, Y. (2013). Leverage, balance sheet size and wholesale funding. *Journal of Financial Intermediation*, **22**, 639–662.
- DANIELSSON, J., SHIN, H. and ZIGRAND, J. (2004). The impact of risk regulation on price dynamics. *Journal of Banking & Finance*, **28**, 1069–1087.
- FREEDMAN, C. (1996). Financial Structure in Canada: The Movement Towards Universal Banking. In A. Saunders and I. Walter (eds.), *Universal Banking: Financial System Design Reconsidered*, 20.1, Irwin Professional Publishing.
- GEANAKOPOLOS, J. (2009). The leverage cycle. In D. Acemoglu, K. Rogoff and M. Woodford (eds.), *NBER Macroeconomics Annual*, pp. 1–65.
- GORNALL, W. and STREBULAIEV, I. (2013). Financing as a supply chain: the capital structure of banks and borrowers. NBER working paper 19633.
- GRILICHES, Z. and REGEV, H. (1995). Firm productivity in Israeli industry 1979-1988. *Journal of Econometrics*, **65**, 175–203.
- KALEMLI-OZCAN, S., SORENSEN, B. and YESILTAS (2012). Leverage across firms, banks, and countries. *Journal of International Economics*, **88**, 284–298.
- KIYOTAKI, N. and MOORE, J. (1997). Credit cycles. *Journal of Political Economy*, **105**, 211–248.
- LAUX, C. and LEUZ, C. (2010). Did fair-value accounting contribute to the financial crisis? *Journal of Economic Perspectives*, **24**, 93–118.
- and RAUTER, T. (2017). Procyclicality of U.S. bank leverage. *Journal of Accounting Research*, **55**, 237–273.
- MA, S. (2018). Heterogeneous intermediaries and asset prices. Working paper.
- MORRIS, S. and SHIN, H. (2008). Financial regulation in a system context. *Brooking Papers on Economic Activity*, pp. 229–261.
- ROSENGREN, E. (2014). Broker-dealer finance and financial stability. Keynote remarks: Conference on the Risks of Wholesale Funding sponsor.

Table 6: Definitions

Variable	Definition	Lines	Mark-to-market
LIQUID ASSETS			
Cash	Cash on deposit with Acceptable Institutions, funds deposited in trust for RRSP and similar accounts, Cash held in trust with Acceptable Institutions due to free credit ratio calculation	A1, A2, A3	N/A
Loans receivable, securities borrowed, and re-sold	Amount of loan receivable, or cash delivered as collateral for securities borrowed and resold.	A6	Varies
Securities owned	Long positions including accrued interest on money market, bonds, equities, options, and other securities, securities owned and segregated due to free credit ratio calculation	A7	Y
Other liquid assets	Variable base deposits and margin deposits with Acceptable Clearing Corporations, margin deposits with regulated entities, syndicate and joint trading accounts, brokers and dealers trading balances, receivable from carrying broker or mutual fund, clients' accounts	A4, A5, A9, A10, A11, A12	Varies
ALLOWABLE ASSETS			
Receivables	Commissions and fees, interest and dividends, and other receivables from Acceptable Institutions	A16, A17, A18	N
Recoverable and over-paid taxes	Overpayment of prior years' income taxes or current year installments, GST receivables, capital tax, Part IV tax, sales and property taxes	A14, A15	N
NON ALLOWABLE ASSETS			
Receivables	Commissions and fees, interest and dividends, and other receivables from institutions other than Acceptable Institutions	A22, A23	N
Fixed assets	Fixed assets at depreciated value	A24	N
Capitalized leases	A lease that has the economic characteristics of ownership	A26	N
Investments in subsidiaries	Investments in and advances to subsidiaries and affiliates	A27	N
Other assets	Other deposits with Acceptable Clearing Corporations, deposits and other balances with non-acceptable clearing corporations, stock exchange seats, other assets (prepaid expenses, intangibles, advances to employees, etc.)	A20, A21, A25, A28	Varies
CURRENT LIABILITIES			
Overdrafts, loans, securities loaned and repurchases	Amount of bank overdrafts, loans payable, and cash received as collateral for securities loaned and repurchase agreements	A51	Varies
Securities sold short	Short positions including accrued interest on money market, bonds, equities, options, and other securities	A52	Y
Clients' accounts	Clients' trading accounts - credit	A54	Varies
Other current liabilities	Syndicate and joint trading accounts, brokers and dealers, income taxes payable, deferred income taxes, bonuses payable, accounts payable and accrued expenses, capitalized leases and lease-related liabilities, other current liabilities	A53, A55, A56, A57, A58, A59, A60, A61	Varies
LONG TERM LIABILITIES			
Deferred income taxes	Non-current portion of deferred income taxes	A63	N
Non-current portion of capitalized leases	Non-current portion of capitalized leases and lease-related liabilities	A64	N
Other long-term liabilities	Other long-term liabilities, details to be attached by the firm to the form where applicable	A66	N
CAPITAL EMPLOYED			
Non-current portion of capitalized leases	Non-current portion of capitalized leases where it can be demonstrated that the lease presents no additional liability to the member firm	A68	N
Subordinated loans - approved non-industry investors	A loan whose repayment is subordinated to claims of general creditors subject to a three party legal agreement obtained from an investor subject to approvals of Joint Regulatory Body	A69	N
Subordinated loans - industry investors	A loan whose repayment is subordinated to claims of general creditors subject to a three party legal agreement obtained from a chartered bank or other lending institution	A70	N
Capital stock	Capital stock and contributed surplus	A71	N
Retained earnings	Retained earnings or undivided profits	A72	N
Standby subordinated debt	A loan whose repayment is subordinated to claims of general creditors subject to a three party legal agreement obtained from a Canadian chartered bank. The lender promises to lend a fixed amount on demand by either the firm or Self-Regulatory Organization.	N/A	N

All units in thousands. Taken from the IIROC joint regulatory financial questionnaire and report.