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by Étienne Bordeleau and Christopher Graham

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Abstract

The recent crisis has underlined the importance of sound bank liquidity management. In response, regulators are devising new liquidity standards with the aim of making the financial system more stable and resilient. In this paper, the authors analyse the impact of liquid asset holdings on bank profitability for a sample of large U.S. and Canadian banks. Results suggest that profitability is improved for banks that hold some liquid assets, however, there is a point at which holding further liquid assets diminishes a banks' profitability, all else equal. Moreover, empirical evidence also suggests that this relationship varies depending on a bank's business model and the state of the economy. These results are particularly relevant as policymakers devise new standards establishing an appropriate level of liquidity for banks. While it is generally agreed upon that banks undervalued liquidity prior to the recent financial crisis, one must also consider the trade-off between resilience to liquidity shocks and the cost of holding lower-yielding liquid assets as the latter may impact banks' ability to generate revenues, increase capital and extend credit.

JEL classification: G21, G32,G33
Bank classification: Financial System Regulation and Policies, Financial Institutions, Financial Stability

Résumé

Texte

Classification JEL : G21, G32,G33
Classification de la Banque : Réglementation et politiques relatives au système financier, Stabilité financière, Services financiers

1.0 Introduction

Liquidity was an instrumental factor during the recent financial crisis. As uncertainty led funding sources to evaporate, many banks quickly found themselves short on cash to cover their obligations as they came due. In extreme cases, banks in some countries failed or were forced into mergers. As a result, in the interest of broader financial stability, substantial amounts of liquidity were provided by authorities in many countries, including Canada and the United States (Longworth 2010; Bernanke 2008).

In the aftermath of the crisis, there is a general sense that banks had not fully appreciated the importance of liquidity risk management and the implications of such risk for the bank itself, as well as the wider financial system.[1] As such, policymakers have suggested that banks should hold more liquid assets than in the past, to help self-insure against potential liquidity or funding difficulties. This has led to an international desire for common measures and standards for liquidity risk, culminating in ongoing work by the Basel Committee on Banking Supervision (BCBS 2010).

Since liquid assets such as cash and government securities generally have a relatively low return, holding them imposes an opportunity cost on a bank. In the absence of regulation, it is reasonable to expect banks will hold liquid assets to the extent they help to maximize the firm's profitability. Beyond this, policymakers have the option to require larger holdings of liquid assets, for instance, if it is seen as a benefit to the stability of the overall financial system. That said, the aim of this paper is not to establish the ideal level of liquid asset holdings, but rather to help distinguish empirically, whether banks' holdings of liquid assets have a significant impact on their profitability. Should this be the case, such basic empirical information is crucial to proper calibration in the context of domestic and international liquidity regulation. While regulation can make the financial system more resilient to liquidity shocks, calibration should recognize any associated costs to the efficiency of financial intermediation as this could result in higher borrowing costs for other agents in the system.

In short, while controlling for other factors, this paper finds evidence, based on a panel of Canadian and American banks from 1997 to the end of 2009, that profitability is improved for banks that hold some liquid assets, however, there is a point at which holding further liquid assets diminishes a banks' profitability, all else equal. These findings are conceptually in line with relevant literature and are consistent with the idea that the opportunity cost of holding low-return assets eventually outweighs the benefit of any increase in the bank's liquidity resiliency as perceived by funding markets.

In the context of this relationship, estimated results suggest some evidence of further positive benefit to holding additional liquid assets for institutions that follow a less traditional, more volatile (i.e., more market-based) banking model. Likewise, there is a similar estimated benefit to holding more liquid assets when economic conditions deteriorate.

The remainder of this paper sets forth this evidence, beginning with some stylized facts and regulatory context. This is followed by a brief description of the relevant literature and the

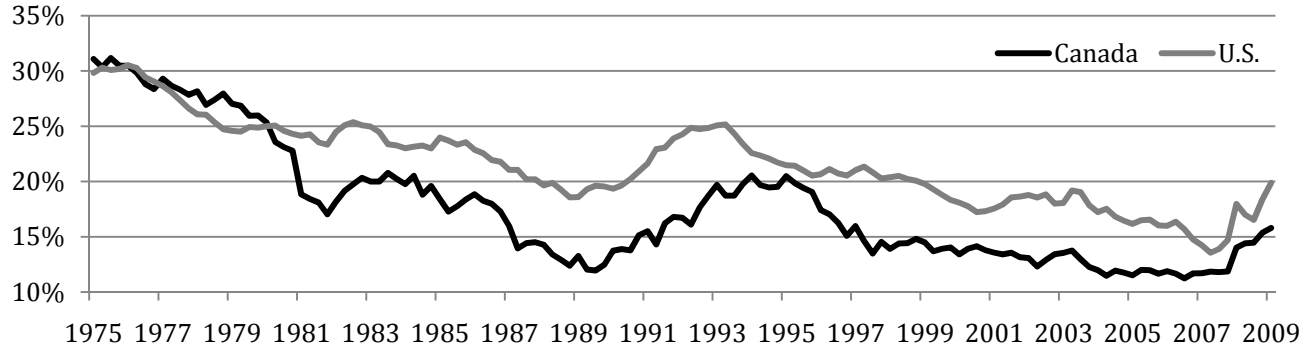
[1] For a framework assessing systemic liquidity risk, see Gauthier, He and Souissi (2010).

empirical framework as applied in this paper. Finally, the empirical results are presented and policy implications are drawn.

2.0 Stylized Facts and Regulatory Context

As shown in Figure 1, banks in Canada and the United States had been holding a declining share of their balance sheet in liquid assets, such as cash and government securities, prior to the onset of the recent financial crisis.[2] Indeed, in reaction to the funding and liquidity pressures experienced during the crisis, banks, in aggregate, began to hold considerably more liquid assets. While there was an opportunity cost of holding liquid assets given their relatively low return, banks and supervisors recognized the operational benefits of additional liquidity, along with the benefits in terms of market perception. A relatively strong liquid asset pool could represent a more robust bank to investors and funding markets.

Figure 1: Liquid assets as a percentage of total assets



Source: U.S. Flow of Funds & Canada TDS database
Liquid assets are defined as cash, interbank deposits and government-issued and insured securities

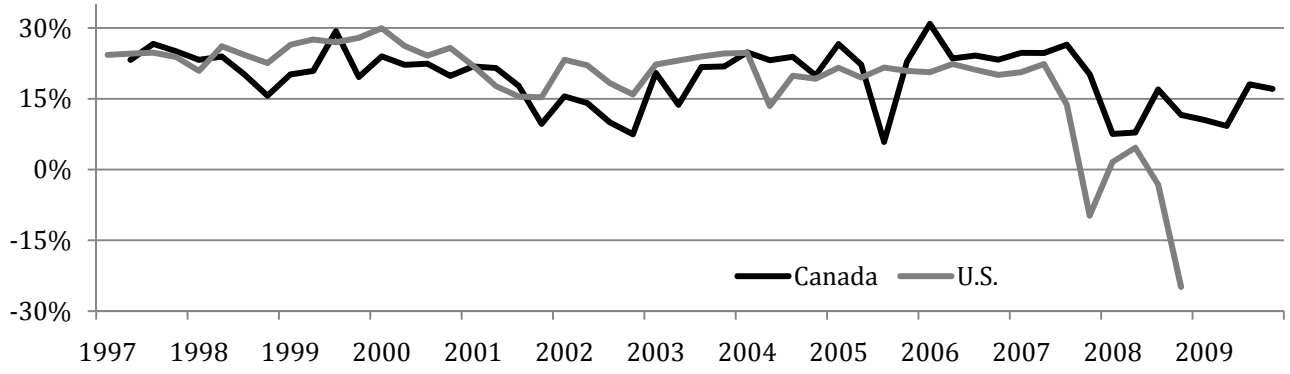
In fact, it was during the crisis that authorities in various countries saw the need for a consistent standard to monitor and improve bank liquidity. As such, the G20 recommended that the Basel Committee on Banking Supervision (BCBS) establish "a global framework for promoting stronger liquidity buffers at financial institutions" (Working Group 1 of the G20 2009). This framework, published in December 2010 and subject to an observation period over coming years, would include, among other things, a requirement that internationally-active banks hold enough liquid assets to cover their net cash outflows over a 30-day stress scenario (BCBS 2010). In broad terms, this regulatory standard is meant to ensure banks are self-insured to withstand a specified idiosyncratic and market-wide liquidity shock. Not surprisingly, however, the calibration of such a standard is key to its impact on banks and the financial system as a whole. For reasons such as

[2] As an aside, accounting differences help explain the level difference between the liquid asset ratio for Canadian and U.S. banks. As is discussed later in this paper and in Appendix B, U.S. accounting allows banks to report their derivative positions net of master netting agreements, while Canadian banks report derivatives on a gross basis. All else equal, this will deflate the U.S. measure of total assets relative to the Canadian measure.

this, it is crucial to understand the impact that a change in bank's liquid asset holdings has on its stability and profitability.

Figure 2 presents historical data on a weighted average of return on equity (ROE) for Canadian and U.S. banks since 1997. Of note, banks in the United States experienced considerable losses throughout the financial crisis, while those in Canada generally did not. Combining the information in both Figure 1 and Figure 2, it is unclear through visual observation what the impact of additional liquid assets has been on the profitability of Canadian and U.S. banks. As such, this paper takes an empirical approach to investigate this question while controlling for other relevant factors.

Figure 2: Return on Equity



Source: U.S. FRY-9C Reports & Canada TDS database, weighted average.

3.0 Literature and Empirical Framework

A broad literature exists surrounding the analysis of liquidity holdings for firms.[3] While a very limited number of studies appear to include liquidity as an explanatory variable for bank profitability, this relationship is not the focus of those papers and the empirical results are mixed.[4] To our knowledge, there is no existing empirical work directly focusing on the specific question considered in the current paper: whether banks' holdings of liquid assets have a significant impact on their profitability. However, we are able to draw on relevant concepts in some related

[3] The economics and finance literature analyse four possible reasons for firms to hold liquid assets; the *transaction motive* (Miller and Orr 1966), the *precautionary motive* (Opler, Pinkowitz, Stulz, and Williamson 1999), the *tax motive* (Foley, Hartzell, Titman, and Twite 2007) and finally the *agency motive* (Jensen 1986). An overview of the rationale behind those motives can be found in Bates, Kahle and Stulz (2008).

[4] For example, Bourke (1989) finds some evidence of a positive relationship between liquid assets and bank profitability for 90 banks in Europe, North America and Australia from 1972 to 1981, while Molyneux and Thornton (1992) and Goddard, *et al* (2004) find mixed evidence of a negative relationship between the two variables for European banks in the late 1980s and mid-1990s, respectively. Liquid assets are generally included as a control variable in these studies with very limited discussion around the estimated parameter.

literature dealing with the impact of capital on bank profitability and of the impact of liquid assets on bank credit risk.

Berger (1995) analyses the statistical relationships between bank earnings and capital for U.S. banks over the period of 1983-1989 and finds that, contrary to what one might expect in situations of perfect capital markets with symmetric information (see Modigliani and Miller (1958, 1963)), there is a positive relationship between capital and return on equity. This result, according to the author, is consistent with the "*expected bankruptcy cost hypothesis*." More specifically, Berger's results suggest that banks with higher levels of capital see their funding costs decrease to such an extent that it more than offsets the cost of issuing additional capital.[5] While Berger (1995) applies the concept of the "*expected bankruptcy cost hypothesis*" in the realm of capital, it is also conceptually applicable to the impact of liquid assets on profitability, whereby banks holding more liquid assets benefit from a superior perception in funding markets, reducing their financing costs and increasing profitability.

At the same time, a recent paper by Morris and Shin (2010) develops a model where the total credit risk of a bank is decomposed into "*insolvency risk*" ("the conditional probability of default due to deterioration of asset quality if there is no run by short-term creditors") and "*illiquidity risk*" ("the probability of a default due to a run when the institution would otherwise have been solvent"). The model provides a formula for "*illiquidity risk*" and the authors show that an increase in the liquidity ratio of a bank decreases the probability of an "illiquid" default.[6]

These two concepts can be drawn together in the context of the current paper. If an increase in the relative liquid assets holdings of a bank decreases its probability of default, and if the *"expected bankruptcy cost hypothesis"* is indeed correct, then holdings of liquid assets should exhibit a positive relationship with bank profits. At the same time, holding liquid assets imposes an opportunity cost on the bank given their low return relative to other assets, thereby having a negative effect on profitability. Thus, overall, we expect liquid assets to exhibit a non-linear relationship to bank profitability in which increasing liquid assets would improve a bank's profitability through the *"expected bankruptcy cost hypothesis",* as long as the marginal benefit of holding additional liquid assets outweighs the opportunity cost of their low relative return.

Concurrently, the impact of liquid assets on profitability can be affected by other factors such as the bank's business model, or exogenous economic conditions. This idea is, in fact, analogous to existing literature on international reserve holdings. This literature has argued that emerging market economies accumulate reserves to self-insure against capital flow volatilities and sudden stops (Aizenman and Marion 2003; Stiglitz 2006).[7] Furthermore, recent work by Jeanne and

[5] These findings are consistent with literature on market discipline in banking (see Gilbert (1990), Berger (1991)).
[6] Morris and Shin (2010) conceptually defines the liquidity ratio as "realizable cash on the balance sheet to short term liabilities." In turn, "realizable cash" is defined as liquid assets plus other assets to which a haircut has been applied.
[7] A sudden stop is generally defined as a sudden slowdown in emerging market capital inflows, with an associated shift from large current account deficits into smaller deficits or small surpluses. Sudden stops are "dangerous and they may result in bankruptcies, destruction of human capital and local credit channels" (Calvo, 1998).

Rancière (2009) suggests that the optimal level of a small country's international reserves increases with the amount of short-term debt the country has, and with the probability of a sudden stop. Clear parallels can be drawn between this literature and the need for banks to self-insure against liquidity and funding shocks, as illustrated by the recent financial crisis.

Therefore, in our framework, we suppose that the impact on profitability of a bank's holdings of liquid assets (i.e., reserves), depends on the amount of funding that comes due in the short-term and on the general state of the economic cycle. The latter can be interpreted as a proxy for the likelihood of a "sudden stop" or freeze in funding markets.[8] All else equal, if a bank is more reliant on short-term funding, it may need to hold more liquid assets in order to maximize profits. Likewise, if the economic cycle is in a downturn and investors interpret this as an increase in the likelihood of a freeze in funding markets, banks would likely need to self-insure (by increasing their holdings of liquid assets) in order to maximize profits.

Finally, to control for other factors affecting bank profitability, we refer to the literature addressing determinants of bank profitability (Demirguc-Kunt and Huizinga, 1998, 2000; Goddard, Molyneux and Wilson, 2004; Ho and Saunders 1981; Molyneux and Thorton, 1992). Drawing from this work, we include macroeconomic factors such as interest rates, unemployment, inflation and output growth as control variables in our profit equation.

4.0 Data and Empirical Estimation

The econometric framework is presented in Equation (1). In short, the dependent variable, profitability, is regressed against a non-linear expression of relative liquid asset holdings, as well as a set of control variables, *X*.

$$\pi_{i,t} = \alpha_0 + \alpha_1 la_{i,t-1} + \alpha_2 la_{i,t-1}^2 + \alpha_3 la_{i,t-1} \cdot stfunding_{i,t} + \alpha_4 la_{i,t-1} \cdot \dot{gdp}_{i,t} + X\beta + u_{i,t} \quad (1)$$

More specifically, to test for the key relationship of interest between liquid assets and profitability (π), Equation (1) expresses the liquid asset ratio (*la*) as a nonlinear polynomial of order two, as well as the product of real GDP growth (*gdp)*, and a proxy for short-term funding reliance (*stfunding*), respectively. Moreover, since creditors must first observe the relative liquidity of a bank before adjusting their views on its credit risk, all liquid asset terms are lagged by one period.[9]

[8] Note that Morris and Shin (2010) also consider the amount of short-term funding and credit conditions when modelling bank credit risk.

[9] Measures of leverage or capital adequacy, included as control variables, are also lagged, given that the interpretation is similar under the "expected bankruptcy cost hypothesis".

To more clearly illustrate the form of the estimated relationship between liquid assets and profitability, Equation (2) presents the marginal impact on profits of the liquid assets ratio. As noted above, this relationship is a function of the liquid assets ratio, a measure of short-term funding reliance and general macroeconomic conditions. Indeed, setting Equation (2) equal to zero allows one to solve for the reduced-form profit-optimizing level of the liquid assets ratio, given by Equation (3).

$$\frac{\partial \pi_{i,t}}{\partial la_{i,t-1}} = \alpha_1 + 2 * \alpha_2 la_{i,t-1} + \alpha_3 stfunding_{i,t} + \alpha_4 g\dot{d}p_{i,t} = 0, \quad (2)$$

$$la^*_{i,t-1} = \frac{-(\alpha_1 + \alpha_3 stfunding_{i,t} + \alpha_4 g\dot{d}p_{i,t})}{2 * \alpha_2}. \quad (3)$$

4.1 Data

Table A.1 in Appendix A provides a summary of the variables used for empirical estimation, along with their definitions and some descriptive statistics. Of note, the dependent variable, profitability (π), is measured as return on equity or return on assets as noted, and relative liquid assets, *la*, are measured as the ratio of cash, government-issued and government-guaranteed securities and interbank deposits relative to a bank's total assets. Note that, because of accounting differences in the netting of derivatives on the balance sheet between U.S. GAAP and Canadian GAAP, we imperfectly adjust Canadian banks' total assets, as used in the liquid assets ratio, using the impact of master netting agreements (See Appendix B for details).

Control variables include quarterly growth in real GDP, unemployment and core inflation, as well as a measure of balance sheet leverage, measured as the ratio of assets to shareholders' equity (in the baseline model).

With respect to the short-term funding variable, ideally, one wants to measure a bank's reliance on relatively flighty short-term funding. Unfortunately, available data are not as granular as desired, since they cover all types and sources of funding coming due within one year.[10] There may be very significant differences in the stability of various sources of short-term funding. For instance, insured retail demand deposits are likely to be much more stable than short-term market (wholesale) funding. To address this data issue, we assume that a bank's business model (i.e.: commercial bank versus universal bank) and the structure of its funding (short-term versus long-term) are related and use the former as a proxy. Indeed, sample correlations between the market-related proportion of a bank's income (i.e., trading and investment income relative to gross income) and measures of the term of funding are positive and statistically significant at the

[10] Moreover, available Canadian data are based on maturity of the interest rate rather than the maturity of the funding itself.

1% level.[11] As a robustness check, equation (1) will also be estimated using repos as a proxy for the term of funding.

The dataset used for estimation contains a panel of quarterly observations for 55 U.S. bank holding companies (BHC) and 10 Canadian banks, spanning the period from 1997Q1 to 2009Q4.[12] U.S. BHC data are taken from the FRY-9C regulatory filings while Canadian data are drawn from regulatory reports to the Office of the Superintendent of Financial Institutions (OSFI).

The model is estimated using a panel two-step GMM procedure with bank and time fixed-effects, in which only the macroeconomic variables are treated as exogenous. To help correct for endogeneity, all other explanatory variables are instrumented with three lags of themselves.[13] Moreover, we use a kernel-based method with automatic bandwidth selection developed by Newey-West (1994) to obtain heteroskedastic and autocorrelation consistent (HAC) standard errors and covariance estimation.

4.2 Baseline Results

Column 1 of Table A.2 presents the baseline estimation results in which return on equity is regressed on the liquid asset ratio (in level form and as a product of GDP growth and a product of market income share), along with the control variables for GDP growth, inflation and balance sheet leverage. Note that the estimation gives an adjusted R-squared (around 0.58) that is in line with the current literature, and also shows desirable characteristics with respect to the instrumental variables used.[14]

Turning to the key results, the estimated relationship between liquid assets and bank profitability is as expected. Coefficients for the liquid assets ratio, its square, its product with GDP growth, and its product with a proxy for reliance on short-term funding are all statistically significant at the 1% level. As expected, we find evidence of a non-linear relationship between profitability and liquid asset holdings. More specifically, as illustrated in Figure 3, the negative coefficient on α_2 indicates that profitability is maximized, according to this reduced-form model, at $la^*_{i,t-1}$. In other words, the relationship takes the form of a downward-concave parabola and to the extent the

[11] Funding term is measured by either repurchase agreements or funding maturing within one year as a share of total liabilities.

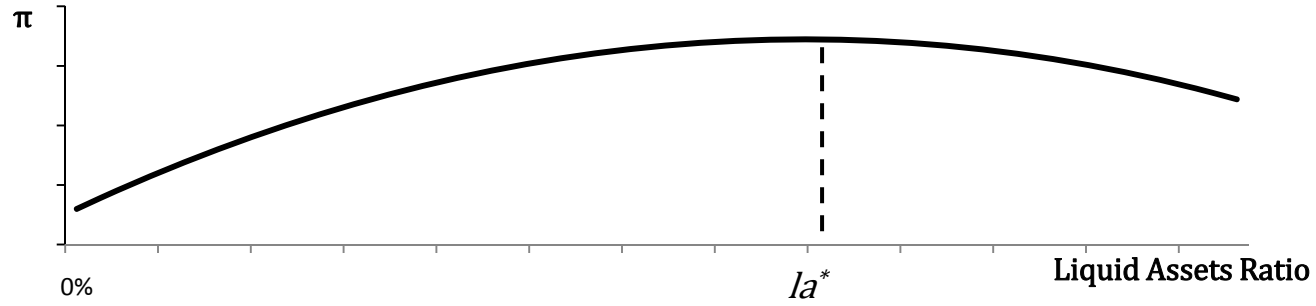
[12] Banks were included in the sample if they held at least $USD10 billion in assets as of 2008Q4.

[13] Endogeneity may be present with respect to liquidity in the sense that profits may be a source of additional liquidity for banks. Preliminary work by Aspachs, Nier and Tiesset (2005), for instance, models the liquidity of U.K. banks using profits as one explanatory variable. However, the estimated parameter on profits is generally not statistically significant.

[14] We test for the validity of our instruments (i.e.: uncorrelated with the error term) using the Sargan-Hansen test of overidentifying restrictions (Sargan, 1958; Hansen 1982). P-values of our Hansen's J-Statistics indicate that we cannot reject the null hypothesis that the instruments are valid. We also test for underidentification (i.e.: that the excluded instruments are correlated with the endogenous regressors) using the Kleibergen-Paap (2006) rk rank statistic, a heteroskedasticity-robust LM version of the Anderson (1951) canonical correlations test. P-values for this test statistic indicate that we cannot reject the null hypothesis that the model is identified (i.e.: the matrix of the reduced form coefficients is full rank) for all our regressions.

relationship is relatively flat around the maximum ($la^*_{i,t-1}$), the cost associated with holding more or less liquid assets will be limited in range around the maximum. Estimation also suggests a negative coefficient, as anticipated, for the interaction term with GDP growth and a positive coefficient for the product with the proxy for reliance on short-term funding.

Figure 3



Taken together, these results suggest that, all else equal, profitability is improved for banks that hold some liquid assets, however, there is a point at which holding further liquid assets diminishes a banks' profitability, all else equal.[15] This finding is consistent with the idea that funding markets reward banks for holding some liquid assets, but at some point this benefit is outweighed by the opportunity cost of holding such low-yielding assets. At the same time, as macroeconomic conditions deteriorate, increasing the likelihood of market illiquidity, the reduced-form profit-optimal level of liquid assets $la^*_{i,t-1}$ increases (recall Equation (3) above), confirming the intuition drawn from Jeanne and Rancière (2009). Likewise, as a bank increases its reliance on capital-market-related revenues (a proxy for reliance on short-term funding), the estimated reduced-form profit-optimal level of liquid assets also increases, as in Morris and Shin (2010). In short, profit incentives should encourage banks to hold more liquidity in times of weak economic growth or when they maintain a less-traditional business model.[16]

Estimated coefficients on the macroeconomic control variables are generally in line with the existing literature. GDP growth is estimated to have a positive and statistically significant impact on bank profitability, while the level of unemployment, through a higher probability of default on loans, has a negative impact. Meanwhile, the lagged rate of inflation exhibits a negative and statistically significant relationship with profitability. This result differs from the empirical literature (Beckmann, 2007; Demirguc-Kunt and Huizinga, 1998), which typically finds a positive relationship. However, since banks, through their traditional role of maturity transformation, lend

[15] Given the fact that banks may choose to increase the riskiness and return of "non-liquid" assets to improve profitability all else equal, the positive (negative) impact of liquid assets on profitability may be over (under) estimated. The ratio of risk-weighted assets to total assets was used in an attempt to control for the riskiness of assets, but was found not to be statistically significant at conventional levels, in part because of high multicollinearity with the liquid assets ratio. Moreover, risk-weighted assets might not adequately reflect the riskiness of a bank's activities as it tends to exhibit procyclical bias (Bordeleau, Crawford and Graham 2009).

[16] Not surprisingly, the non-linearities between liquid assets and profitability presented here are particularly relevant over the period of the recent economic crisis.

long and borrow short, it is to be expected that higher inflation would decrease their margins and profitability.[17] Similarly, inflation can penalize banks through their holdings of longer-term low-yielding liquid assets.

In general, the baseline results are intuitively consistent with the related literature.

4.3 Some Robustness Checks

In this section, the robustness of our key results is tested using a variety of alternative estimation specifications. First, return on assets (ROA) is used as an alternative measure of bank profitability. Using ROA as the dependent variable of the model, the estimated sign and significance of all variables remain consistent with the baseline specification, as shown in column 1 of Table A.3. The sole exception to this is leverage, which takes a negative estimated coefficient when regressed on ROA.[18] This, however, makes sense conceptually, given the use of a different dependent variable. Consider an example where a bank increases its leverage by acquiring additional assets relative to a constant equity base. The estimation results suggest that, in this case, the additional assets would increase banks' net income relative to this constant equity base (i.e., ROE), but not in relation to the expanded level of assets (i.e., ROA).[19]

As a second robustness test of the baseline model, an alternative proxy for short-term funding reliance is interacted with the liquid assets ratio. As shown in column two of Table A.2, using the ratio of outstanding repurchase agreements to total liabilities gives the expected sign, but is not statistically significant.[20]

Column 3 of Tables A.2 and A.3, present results using risk-weighted Tier 1 regulatory capital as an alternative measure of leverage or capital adequacy in lieu of simple balance sheet leverage. Given that the Tier 1 ratio is expressed as capital per risk-weighted asset, the inverse of balance sheet leverage (assets to equity), its statistically significant negative (positive) coefficient with regard to ROE (ROA) gives the same interpretation as the baseline leverage results. Thus, overall, increasing assets (either risk-weighted or non-risk-weighted) relative to balance sheet or regulatory capital will improve bank profitability.

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[17] More specifically, consider the situation where a bank lends money at a certain rate of interest. If inflation rises going forward, the bank will still receive the same interest on the loan, while it will need to pay higher rates of interest (reflecting inflation) on their shorter-term borrowing.

[18] Recall that leverage is measured as a multiple of equity, so increased leverage means less capital for a given level of assets.

[19] These findings are consistent with the "expected bankruptcy cost hypothesis" where the benefits of lower relative capital increase ROE despite higher associated funding costs.

[20] Other potential proxies for short-term funding reliance were also tried, including the ratio of repos to total assets or total funding, as well as the ratio of total deposits to total assets, total liabilities or total funding. In each case, the estimated coefficient had the expected sign (positive for repo ratios and negative for deposit ratios), but was not statistically significant. Unfortunately, U.S. and Canadian regulatory bank data do not provide sufficient granularity to construct better measures of reliance on short-term funding.

Results of the baseline specification were also robust to the exclusion of the time dummy variables (see Tables A.4 and A.5). This alternative specification generally corroborates the baseline results, although it generates significantly decreased explanatory power, and the estimated impact of macroeconomic control variables is somewhat increased.

The baseline model was also estimated using two-stage least squares rather than GMM, giving qualitatively the same results.[21]

4.4 Difference in the Impact of Liquidity for Canadian Relative to U.S. Banks

To test whether Canadian bank profitability exhibits a different relationship toward holdings of liquid assets relative to U.S. banks, we introduce a country dummy variable for Canada interacted with the liquid assets ratio. Equations (1), (2) and (3) above become Equations (4), (5) and (6), with *CAD* representing a dummy variable taking the value of one for Canadian banks and zero for U.S. banks. Estimation results are presented in Table A.6 with column one corresponding to the baseline specification referred to in the previous section (Column 1 of Table A.2).

$$\pi_{i,t} = \alpha_0 + \alpha_1 la_{i,t-1} + \alpha_2 la_{i,t-1}^2 + \alpha_3 la_{i,t-1} \cdot stfunding_{i,t} + \alpha_4 la_{i,t-1} \cdot \dot{gdp}_{i,t} + \boldsymbol{\alpha_5} la_{i,t-1} \cdot \boldsymbol{CAD} + X\beta + u_{i,t}, \quad (4)$$

$$\frac{\partial \pi_{i,t}}{\partial la_{i,t-1}} = \alpha_1 + 2 * \alpha_2 la_{i,t-1} + \alpha_3 stfunding_{i,t} + \alpha_4 \dot{gdp}_{i,t} + \boldsymbol{\alpha_5 CAD} = 0, \quad (5)$$

$$la_{i,t-1}^* = \frac{-(\alpha_1 + \alpha_3 stfunding_{i,t} + \alpha_4 \dot{gdp}_{i,t} + \boldsymbol{\alpha_5 CAD})}{2 * \alpha_2}. \quad (6)$$

Coefficients for the interactive dummy variable are estimated to be negative and statistically significant in the baseline specification. This result is robust with respect to the use of return on assets as the dependent variable, as shown in column 2 of Table A.6. In general, these findings suggest that, *ceteris paribus*, the level of liquid assets required to maximize profits is lower for banks in Canada than in the United States. However, this result may primarily reflect data issues. As mentioned previously, accounting differences tend to inflate total assets for Canadian banks, relative to their U.S. counterparts. Although an attempt has been made to reduce this divergence, the adjustment is imperfect and such structural dissimilarities could still exaggerate differences in the estimated impact of liquid assets on bank profitability in Canada relative to the United States. Moreover, the sample period used for estimation is significantly influenced by the recent financial crisis. Over this period, Canadian banks generally performed better than U.S. banks, producing comparatively more profits for a given level of liquid assets. Nonetheless, setting aside data

[21] Results available upon request.

concerns, this result could reflect differences in market perception across Canadian and U.S. banks. More specifically, investors and fund providers could demand that U.S. banks hold additional liquid assets in comparison to Canadian banks due to unobserved structural factors (e.g., regulatory framework, conservative management, universal banking model, etc.).

5.0 Conclusion and Policy Implications:

This paper presents empirical evidence regarding the relationship between liquid asset holdings and profitability for a panel of Canadian and U.S. banks over the period of 1997 to 2009. In short, results suggest that a nonlinear relationship exists, whereby profitability is improved for banks that hold some liquid assets, however, there is a point beyond which holding further liquid assets diminishes a banks' profitability, all else equal. Conceptually, this result is consistent with the idea that funding markets reward a bank, to some extent, for holding liquid assets, thereby reducing its liquidity risk. However, this benefit is can eventually be outweighed by the opportunity cost of holding such comparatively low-yielding liquid assets on the balance sheet.

At the same time, estimation results provide some evidence that the relationship between liquid assets and profitability depends on the bank's business model and the risk of funding market difficulties. Adopting a more traditional (i.e., deposit and loan-based) business model allows a bank to optimize profits with a lower level of liquid assets. Likewise, when the likelihood of funding market difficulties is low (proxied by economic growth), banks need to hold less liquid assets to optimize profits.

Although, to our knowledge, there is no existing literature addressing these specific issues, the empirical results presented in this paper are in line with similar concepts in the broader literature related to capital, credit risk and international reserves.

From a policy perspective, the results of this paper are highly relevant, particularly given ongoing regulatory reform following the recent financial crisis. As policymakers devise new standards establishing an appropriate level of liquidity for banks, helping to ensure adequate stability for the overall financial system, the empirical results of this paper suggest they should bear in mind the trade-off between resilience to liquidity shocks and the cost of holding lower-yielding liquid assets. While holding liquid assets will make banks more resilient to liquidity shocks, thus reducing the negative externalities they might impose on other economic agents, holding too many may impose a significant cost in terms of reduced profitability. Indeed, as retained earnings are the primary means of organic capital generation, low profits may prevent banks from expanding and extending additional credit to the real economy. These benefits and costs are equally applicable both for individual institutions and the financial system as a whole.

Preliminary results in this paper also suggest that Canadian banks may have needed to hold less liquid assets over the estimation period than did U.S. banks, in order to optimize profits. While this could perhaps point to favourable market perception of the regulatory framework and

conservative, universal banking model in Canada, these results should be interpreted with caution due to data concerns.

More generally, this paper marks a first attempt to empirically address the relationship between liquid assets and bank profitability. In interpreting the estimation results, it should be kept in mind that this work uses a reduced form model and, despite econometric adjustments, may not fully account for endogeneity between variables (e.g., availability of liquid assets). This is particularly important in terms of discussing any optimal level of liquid asset holdings relative to profits.

Going forward, this paper could serve as a stepping stone for additional work. One could apply the current framework to additional countries, perhaps focusing on those with and without pre-existing bank liquidity requirements. One could also explicitly model the determinants of bank liquid asset holdings or go one step further and establish a general equilibrium model including bank profitability and liquidity.

In any event, the current paper serves as an initialstep, highlighting an important, if elementary, relationship, relevant to the regulation of banks.

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Appendix A:

Table A.1: Variable definitions and descriptive statistics

Symbol	*Definitions*	*Sample mean*	*Standard Deviation*
ROE	Pre-tax annualized return on total shareholders' equity	0.1799	0.1276
ROA	Pre-tax annualized return on total assets	0.0154	0.008578
$\dot{gdp}$	Quarter-over-quarter growth rate of real GDP	0.01194	0.007913
$\dot{cpi}$	Quarter-over-quarter growth rate of core CPI (core inflation rate)	0.005988	0.006014
Unemployment	Unemployment rate	5.3539	1.1353
Leverage	Ratio of total assets to total shareholders' equity	12.6958	4.6222
Tier1	Tier 1 capital ratio (Tier 1 capital as a share of risk-weighted assets - Basel I definition for U.S. banks; For Canadian banks Basel I definition until 2007Q1 and Basel II definition from 2007Q2 on).[22]	0.09673	0.02262
la	Liquid assets as a share of total assets.[23]	0.1926	0.09320
Mkt_income	Trading- and investment-banking-related revenues as a share of gross income (interest income and non-interest income)[24]	0.03394	0.05570
Repos	Reverse repurchase agreements as a share of total liabilities	0.07928	0.06322

Table A.2: Estimation Results with Bank and Time Fixed-Effects – Return-on-Equity

	(1)	(2)	(3)
VARIABLES	ROE	ROE	ROE
unemployment	-0.0397***	-0.0379***	-0.0531***
$\dot{gdp}$	3.132***	3.523***	4.082***
$\dot{cpi}_{t-1}$	-0.0286	-0.0165	-0.474
la_{t-1}	0.695***	0.615***	0.948***
la_{t-1}^2	-1.006***	-0.763***	-1.112***
$la_{i,t-1} mkt\_income_{i,t}$	1.783**		1.965**
$la_{i,t-1} repos_{i,t}$		0.332	
$la_{i,t-1} \dot{gdp}_{i,t}$	-16.98***	-18.40***	-22.34***
$leverage_{t-1}$	0.00747***	0.00603***	
$Tier1_{t-1}$			-1.068***
Observations	2875	2877	2835
R-squared	0.580	0.577	0.581
R-bar	0.562	0.559	0.563
p-value of Hansens J-Statistic	0.373	0.449	0.743
p-value of underidentification LM statistic	0.000	0.000	0.000

[22] U.S. banks have not yet officially adopted Basel II.

[23] Liquid assets are defined as: cash and equivalents, deposits at other financial institutions, government and government-guaranteed securities.

[24] More specifically, market-related income is defined as "trading income", "fees and commissions from securities brokerage" and "investment banking advisory and underwriting fees and commissions", based on available data.

Table A.3: Estimation Results with Bank and Time Fixed-Effects – Return-on-Assets

VARIABLES	(1) ROA	(2) ROA	(3) ROA
unemployment	-0.00338***	-0.00320***	-0.00373***
$\dot{gdp}$	0.356***	0.386***	0.370***
$\dot{cpi}_{t-1}$	0.0253	0.0309	0.0204
la_{t-1}	0.0674***	0.0611***	0.0574***
la_{t-1}^2	-0.0838***	-0.0643***	-0.0785***
$la_{i,t-1} mkt\_income_{i,t}$	0.0977**		0.122**
$la_{i,t-1} repos_{i,t}$		0.0171	
$la_{i,t-1} \dot{gdp}_{i,t}$	-1.872***	-2.012***	-1.938***
$leverage_{t-1}$	-0.000306**	-0.000358***	
$Tier1_{t-1}$			-0.0112
Observations	2875	2877	2835
R-squared	0.788	0.786	0.788
R-bar	0.779	0.777	0.779
p-value of Hansens J-Statistic	0.186	0.233	0.725
p-value of underidentification LM statistic	7.66e-06	6.35e-06	5.45e-06

Table A.4: Estimation Results with Bank Fixed-Effects[25] – Return-on-Equity

VARIABLES	(1) ROE	(2) ROE	(3) ROE
unemployment	-0.0272***	-0.0240***	-0.0343***
$\dot{gdp}$	6.442***	6.848***	6.672***
$\dot{cpi}_{t-1}$	-3.973***	-3.971***	-4.570***
la_{t-1}	1.059***	0.998***	1.352***
la_{t-1}^2	-1.111**	-0.863***	-1.316***
$la_{i,t-1} mkt\_income_{i,t}$	2.001**		2.154**
$la_{i,t-1} repos_{i,t}$		0.272	
$la_{i,t-1} \dot{gdp}_{i,t}$	-20.51***	-21.35***	-22.88***
$leverage_{t-1}$	0.00835***	0.00575***	
$Tier1_{t-1}$			-0.791***
Observations	2875	2877	2835
R-squared	0.112	0.107	0.114
R-bar	0.0885	0.0833	0.0909
p-value of Hansens J-Statistic	0.450	0.522	0.765
p-value of underidentification LM statistic	0.000273	5.05e-05	0.000134

[25] In the case of bank fixed-effects only, the variance-covariance matrix is made robust to autocorrelation and heteroskedasticity using the Arellano (1987) method as suggested by Wooldridge (2002).

Table A.5: Estimation Results with Bank Fixed-Effects – Return-on-Assets

VARIABLES	(1) ROA	(2) ROA	(3) ROA
unemployment	-0.00210***	-0.00184***	-0.00207***
$\dot{gdp}$	0.548***	0.581***	0.534***
$\dot{cpi}_{t-1}$	-0.368***	-0.365***	-0.378***
la_{t-1}	0.0945***	0.0880***	0.0889***
la_{t-1}^2	-0.0992***	-0.0788***	-0.104***
$la_{i,t-1} mkt\_income_{i,t}$	0.124**		0.142**
$la_{i,t-1} repos_{i,t}$		0.0162	
$la_{i,t-1} \dot{gdp}_{i,t}$	-1.813***	-1.915***	-1.773***
$leverage_{t-1}$			0.0171
$Tier1_{t-1}$	-0.000363**	-0.000453***	
Observations	2875	2877	2835
R-squared	0.175	0.169	0.174
R-bar	0.153	0.147	0.152
p-value of Hansens J-Statistic	0.164	0.197	0.392
p-value of underidentification LM statistic	0.000273	5.05e-05	0.000134

Table A.6: Estimation Results with Country Dummy Variable[26] – Return on Equity and Return on Assets

VARIABLES	(1) ROE	(2) ROA
unemployment	-0.0388***	-0.00331***
$\dot{gdp}$	3.171***	0.350***
$\dot{cpi}_{t-1}$	0.00381	0.0221
la_{t-1}	0.748***	0.0678***
$CAD * la_{t-1}$	-0.413*	-0.0293*
la_{t-1}^2	-1.090***	-0.0862***
$la_{i,t-1} mkt\_income_{i,t}$	1.837**	0.100**
$la_{i,t-1} \dot{gdp}_{i,t}$	-16.60***	-1.782***
$leverage_{t-1}$	0.00783***	-0.000298**
Observations	2875	2875
R-squared	0.580	0.788
R-bar	0.562	0.779
p-value of Hansens J-Statistic	0.547	0.237
p-value of underidentification LM statistic	0.00602	0.00602

[26] Bank and time fixed-effects.

Appendix B:

This appendix aims to explain one major difference across U.S. and Canadian accounting standards: the treatment of offsetting derivative positions under U.S. GAAP and IFRS.[27] Under IFRS, derivatives are accounted for on the balance sheet as "positive market values from derivatives" (asset side) and "negative market values from derivatives" (liabilities side) whereas under U.S. GAAP, they are accounted for as "derivatives post netting". This means that, under U.S. GAAP, if a master netting agreement exists between two counterparties, then they are allowed to report their net derivatives positions on their balance sheets.

Table B.1: Stylized example of OTC derivative netting

Counterparties	Positive market value (assets)	Negative market value (liabilities)	Derivatives post netting (U.S. GAAP)
C1	12	-5	+7
C2	20	-20	0
C3	5	-10	-5
Total under IFRS	37	-35	

To provide a numerical example, Table B.1 shows how netting can affect the balance sheet of a bank with three counterparties (C1, C2, C3) with different OTC derivatives exposures. Positive values are classified as assets, while negative values are classified as liabilities. Assume that master netting agreements exist between the bank and its counterparties. Thus, under IFRS, the value of derivatives assets/liabilities would be the vertical sum of the second and third columns of Table A.1. Alternatively, under U.S. GAAP, banks can net the value of positive and negative exposures to a single counterparty. In this example, the same bank would report derivative assets of 7 and liabilities of 5 under U.S. GAAP, compared to 37 and 35, respectively, under IFRS.

Thus, any cross-country comparison of total bank assets must account for such differences in derivatives accounting standards.

[27] Canadian GAAP follows very closely the IFRS rules in this case.