Financial Crisis, Non-disclosure of Government Financial Assistance and Risk-Taking: The Case of Canadian Banks

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Abstract

We examine the effects of government liquidity infusion on the risk taking behavior of Canadian banks that have been touted as the world's soundest banks and find that banks that received government financial assistance subsequently experienced a decrease in risk. The reduction in risk is induced by a shift from non-interest income related activities to more traditional interest income generating activities. After controlling for bank specific risk factors, we find that whilst the liquidity infusion has made the banks safer, higher amounts of funds received induces higher investments in non-interest income related activities. Further analysis, aimed at disentangling the effects of the financial crisis from those of the liquidity infusion using observations of a control sample of banks that did not receive government support, shows that risk-taking by the banks in the aftermath of the financial crisis is significantly lower than that of the control sample.

JEL Classification: G01, G21; G28; G32
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1. INTRODUCTION

The recent financial crisis resulted in an unprecedented liquidity shock that necessitated a wave of capital infusions to financial firms around the world. In the aftermath of the crisis, Canadian banks were described as the soundest banks in the world. However, it has come to light that these banks received about $122 billion in federal government support (MacDonald, 2012; and Henderson, 2012) without public disclosure, suggesting that their sail through the financial crisis was not as smooth as commonly perceived. The non-disclosure of the liquidity infusion received by banks that were touted as the best managed banks in the world makes examination of the government liquidity infusion on the banks' risk taking an interesting undertaking.

Extant literature on government guarantees shows that financial guarantees create distortions in banks' value (Merton, 1977; O'Hara and Shaw, 1990), and undermine the disciplinary effect of depositors and creditors (Diamond and Rajan, 2011). There is however no consensus on how government guarantees affect the risk-taking behavior of firms that receive government financial assistance. On one hand, a number of studies assert that government guarantees encourage risk-taking because it reduces investors' incentives to monitor the banks, which in turn increases banks' *moral hazard* in terms of their desire to take on more risk (Flannery, 1998; Mailath and Mester, 1994). On the other hand, other studies, following the seminal work of Keeley (1990) suggest that government guarantees can cause a decrease in the banks' cost of capital as creditors demand lower rates. The lower cost of borrowing in turn, increases the banks' *charter value* and induces the banks to take less risk with the aim of protecting future rents (Cordella and Yeyati, 2003).

While prior studies find support for both the moral hazard and charter value hypotheses, more recent studies focusing on the financial crisis find evidence consistent with the moral hazard

argument. For instance, Duchin and Sosyura (2012) find that in the aftermath of the recent financial crisis, bailed out banks in the U.S. approved riskier loans and shifted investment portfolios towards riskier securities. Black and Hazelwood (2012) also show that large US banks originated riskier loans after they received financial support through the Troubled Asset Relief Program (TARP) relative to non-recipients. Gropp et al. (2011) also find that German banks whose government guarantees were removed reduced their credit risk, whilst Dam and Koetter (2012) find that the availability of government safety net increases German banks' moral hazard and risk-taking. In an international setting, Brandao-Marques et al. (2012) find government support to be associated with more risk-taking by banks. Similarly, Brei and Gadanecz (2012) find that rescued banks from 14 major economies did not make safer syndicated loans following their bailout. What is common about all these studies is that government financial support to the banks in these countries were publicly disclosed and extensively discussed in the media. In Canada, the government support was not publicly disclosed.

Previous work on disclosure and risk in the banking industry suggests that public disclosure of information about banks' current conditions and future prospects facilitates market discipline, which in turn can constrain risk taking (Hirtle, 2007).[1] Flannery (2001) and Bliss and Flannery (2002) argue that market discipline has two distinct components, namely investors' and creditors' ability to monitor and assess changes in a bank's condition, and their ability to influence management behavior. Market discipline could influence banks' behavior not only in terms of the response to a market reaction, but also in anticipation of one. Thus, market discipline could work by affecting management behavior *ex ante* so as to prevent a negative outcome and consequent market reaction (Hirtle, 2007).

[1] Market discipline refers to the idea that the actions of stakeholders such as creditors, counterparties, and shareholders of banks can influence the investment, operational, and risk-taking decisions of bank managers (Flannery 2001, Bliss and Flannery 2002).

Market discipline has occupied an increasingly prominent place in discussions relating to the banking industry in recent years. As Hirtle (2007) argues, bank supervisors have embraced market discipline as a complement to supervisory and regulatory tools for monitoring risk at individual banks and for limiting systemic risk in the banking system. Consequently, regulators have adopted a range of proposals for enhanced public disclosure of forward-looking risk information such as credit risk exposure. In fact, Basel II regulatory capital regime incorporates market discipline as the "third pillar" along with minimum capital standards and supervisory oversight (Basel Committee on Banking Supervision 2004).

Underlying much of the discussion relating to public disclosure and risk taking is the idea that greater disclosure and enhanced market discipline will lead to reductions in bank risk.[2] However, for market discipline to be effective, market participants must not only have sufficient information to assess the current condition and future prospects of the banks, but more importantly from the standpoint of our study, they have to receive the information in a timely manner. In this regard, the non-disclosure of the funds received by the Canadian banks which have been touted as the most efficient and well-managed banks in the world is revealing, and provides an interesting setting to examine the effects of non-disclosure of liquidity infusion on risk taking. If disclosure of government rescue programs that convey information about banks' current condition and future prospects facilitates market discipline and reduce risk taking as argued by Hirtle (2007), then the non-disclosure of government liquidity infusion can induce higher risk taking among banks since the effectiveness of market discipline will be reduced.

Alternatively, non-disclosure of the capital infusion can curtail the banks' appetite for risk, as the banks, realizing that they made a mistake by undertaking bets which have elevated their risk

[2]Enhanced market discipline means the costs of increased risk would be more fully borne by the bank and presumably this will play a larger role in bank's risk-taking decisions (Hirtle, 2007).

levels and have had to be financially supported without the public knowing about their precarious financial situation, might be more cautious in their investment and lending decisions so as not to further damage their franchise value and their relationship with the Central Bank. This in turn could lead the banks to assume less risk with the aim of protecting future rents. The effect of this alternative non-disclosure hypothesis is akin to that of the well-documented charter value hypothesis that posits that rescued banks that receive financing at lower cost have an incentive to take lower risk because their margins and charter value would be enhanced as a result of the government assistance. Thus, both our alternative non-disclosure hypothesis and the charter value hypothesis predict a reduction in bank risk taking after the liquidity infusion. Based on this discussion, it is reasonable to surmise that the risk taking behavior of Canadian banks that have received liquidity infusion will be different from that of banks in the U.S. or other countries where the financial assistance was publicly discussed.

Our study is different from prior studies in a number of ways. First, while the relationship between bank risk taking and government guarantees has been examined for other countries, there is little research that examines this issue in Canada, a jurisdiction with strong regulatory regime (i.e., strong capital requirements, strict bank supervision and mortgage market regulations) and a conservative appetite for risks. Exceptions include Saunders and Wilson (1999) who examine the impact of different regulatory regimes on bank capital and risk-taking choices in the US, UK, and Canada, and Atindehou and Gueyie (2001), Dai and Lapointe (2010), Calmes and Theoret (2010), Radic et al. (2011), Laeven and Levine (2009) and Brandao-Marques et al., (2012) who examine bank risk taking in cross country settings, including Canada. But the Canadian banking system is different from that of other developed markets. For example, five banks dubbed "the big five" dominate the banking sector in Canada. The five biggest banks hold combined assets of almost $3

trillion, representing about 85% of bank assets in the country (Office of the Superintendent of Financial Institutions Canada, 2010). The high concentration of bank assets presents a threat to financial stability in times of crisis because of the increased risk of contagion should any of the banks collapse. We take advantage of this unique setting within one country to examine the effects of the non-disclosure of government support on bank risk taking. Examining the risk taking behavior of banks that operate in such a concentrated banking market with strong regulatory regime adds to the regulation and risk taking literature.

Second, most prior studies examine the link between disclosure and risk, but we focus on the effect of non-disclosure and risk taking, and thus we examine the effect of market discipline (or lack of it) from a different perspective. Third, we examine how *ex post* performance is related to the non-disclosure of the information on liquidity infusion and risk. Specifically, we examine the impact of the non-disclosure of the liquidity infusion on the banks' operating performance. Banks can use the funds obtained from the government at lower cost to shore up returns. As Hirtle (2007) argues, examining performance as well as risk provides an additional window into the ways that market discipline plays out at banking companies, since investors and creditors care about the level of risk, as well as how efficiently a bank translates its risk exposures into profits and returns.

Our results are summarized as follows. First, we find that banks that received the liquidity infusion subsequently experienced a decrease in risk as measured by the *z-score*. The capital infusion and the reduction in risk helped boost the stability of the Canadian banking system. Second, we find that funds received are positively related to non-interest income, suggesting that whilst the liquidity infusion led to a reduction in risk, perhaps beyond a certain threshold higher amounts of money received induces higher risk taking. Third, using a small number of observations for banks that did not receive government support, we find that risk-taking by the recipient banks in

the post-liquidity infusion period is significantly lower than that of the control sample. Fourth, in an attempt to identify the sources of the reduction in risk, we decompose the *z-score* into its components parts and find that the reduction in risk seems to be caused by a shift from non-interest income related activities to more traditional interest generating activities.

The finding that the sample banks experienced a reduction in risk in the post-infusion period is consistent with our alternative non-disclosure hypothesis that suggests that the government assistance make the banks more conservative in their undertakings. These banks, realizing that they made a mistake by investing in risky instruments and have had to be financially supported without the public knowing about their precarious financial situation might now be more cautious in their investment decisions in order not to further damage their franchise value and their relationship with the politicians and regulators. Thus the desire to protect their reputation and international standing could influence the banks to assume less risk with the aim of protecting future rents. The reduction in risk is also consistent with the charter value hypothesis that suggests that the receiving financing at a lower cost can enhance banks' margins and charter value and this can reduce their incentive to take higher risk. Our results are different from those of recent studies including Black and Hazelwood (2012) for the effect of TARP on U.S. banks, Duchin and Sosyura (2011) for U.S publicly traded financial firms, Gropp et al. (2011), and Dam and Koetter (2012) for German banks. Interestingly, these studies find that government support (publicly disclosed and widely discussed in the media) tends to be associated with increases in banks' moral hazard and more risk taking.

The remainder of the paper is organized as follows. We discuss the features of the Canadian financial system in section 2. The data and methodology are presented in section 3. In section 4, we present the results. Robustness checks and comparison of our results to recent similar studies are presented in section 5, while section 6 concludes the paper.

2. CANADIAN FINANCIAL SYSTEM

2.1 Institutional Features

The Canadian banking system consists primarily of locally-owned banks, foreign banks with Canadian operations, and cooperative banks. However, six major banks, namely the Bank of Montreal, Scotiabank, TD Bank, Royal Bank, CIBC, and the National Bank dominate the banking system. These banks account for approximately 85% of the operations of the Canadian financial system (Office of the Superintendent of Financial Institutions Canada (2010). Historically, the financial services sector in Canada has been strong. No bank collapsed in Canada during the Great Depression of the 1930s and only two small regional banks have gone out of business since 1923 (Bones, 2009).

The structure of the Canadian financial system (including the mortgage and housing markets) is somewhat different from what exists in most other countries, especially the United States. Given the highly concentrated structure of the banking system and the key economic functions the banks perform, how they borrow funds, combined with the risks involved in their lending activities, could threaten their solvency. Therefore, over the years, the banks have been closely regulated to ensure the stability and efficiency of the Canadian financial system. As a result, the financial system has been characterized by stringent capital requirements, and tight mortgage market regulations, culminating in a conservative appetite for risk among the banks.

The regulation and supervision of banks is the shared responsibility of the Department of Finance and other federal financial regulatory authorities including the Bank of Canada, the Office of the Superintendent of Financial Institutions (OSFI), and the Canada Deposit Insurance Corporation (CDIC).[3] However, to ensure consistency and to minimize competing regulatory

[3] As discussed later, the shared system of financial regulation and supervision proved valuable during the recent global financial crisis.

objectives, the administration of the prudential regulation of Canadian financial institutions (banks and federally incorporated insurance companies) is under the jurisdiction of only one prudential regulator, the Office of the Superintendent of Financial Institutions (OSFI). The OSFI is part of the Federal Department of Finance which has the overall responsibility for federal financial sector policy.

The OSFI requires the banks to maintain capital in excess of international minimum requirements outlined in Basel II. While Basel II requires banks to hold minimum Tier 1 capital (defined as common shares, retained earnings and non-cumulative preferred shares to risk-adjusted assets) and Total capital ratios of 4% and 8% respectively, the OSFI requires Canadian banks to hold minimum requirements of 7% and 10% respectively. But, Canadian banks tend to hold substantially more capital above these increased minimum requirements as buffers. The average capital reserve (Tier 1 capital) for Canada's Big Six banks is 9.8% (Bones, 2009) which is several percentage points above the 7% required by Canada's federal bank regulator. This important regulatory factor seems to have helped the Canadian banks withstand the subprime crises better than banks in other countries.

Another very important regulatory factor that has contributed to the safety and soundness of the Canadian banking system is the ceiling on leverage ratio – the ratio of total assets to capital. The leverage ratio of the banks is capped at no more than 20x capital. While the ratios at major Canadian banks have risen steadily in recent years, the ceiling has ensured that the leverage among the major banks has remained markedly lower (an average of 18) than comparable figures for major banks in the US and UK which have an average leverage ratio of over 25x capital and other European banks with an average ratio of over 30x capital (Bones, 2009).

Major structural reforms to banking sector regulations in the late 1980s have also contributed to making the Canadian financial system more resilient and different from what exists in the US. Following the Federal Government's 1987 deregulation bill, most of the country's large investment houses were bought by the big five commercial banks. Unlike the US where each subsidiary of a banking conglomerate might be subject to a different regulatory authority (according to whether it is categorized as an insurance company, investment bank, or commercial bank), in Canada power was consolidated in the OSFI to regulate the whole entity. Consequently, the investment dealers have been subjected to the same stringent rules as the commercial banks.

An equally important feature that has contributed to the soundness of the Canadian financial system is how the mortgage finance markets are structured and regulated. The legislation relating to mortgages requires that all high-ratio residential mortgages made by banks (defined as those having an initial down payment of less than 20% of the value of the property) be insured against default by either the government–owned Canada Mortgage and Housing Corporation (CMHC) or private insurers. These mortgage insurers are backed by the federal government, and are required to use fairly conservative underwriting criteria. This regulatory requirement has curtailed the flourishing of the sub-prime mortgages which constitute about seven per cent of the mortgage market in Canada (Coyne, 2009). In addition, unlike the United States, home owners in Canada cannot reduce their federal or provincial taxes by the interest payment, as mortgage interest on residential properties is not deductible for tax purposes. These features partly explain why Canada did not experience tax-driven distortions in the level of housing debt and the same degree of housing boom and burst that occurred in many countries (Bones, 2009).

The Canadian financial system is indeed characterized by a high degree of concentration and a conservative and entrenched regulatory structure aimed at achieving a stable and efficient

financial system. According to the Reserve Bank of Canada, the three important reasons for regulating Canadian banks are to contain systemic risk, moral hazard, and to protect consumers.[4] To achieve these objectives, successive governments introduced the mechanisms described above to limit financial exposure and excessive risk-taking.

2.2. Canadian Banking System and the Financial Crisis

The Canadian banking system withstood the recent financial crisis fairly well and a number of factors contributed to this resilience. First, the conservative and entrenched regulatory structure and the institutional features described above served the Canadian banks well, as stronger supervision and bank capital oversight is usually associated with less risk taking before and during the financial crisis. Second, the shared system of financial regulation and supervision in Canada also proved valuable during the financial crisis because there were no conflicting policies from different regulatory agencies. Third, though the investment dealers and their parents (the big five banks) engaged in investment banking, currency hedging, etc as their counterparts in the US (albeit to a lesser degree), the regulatory structure where commercial banks and investment subsidiaries are subject to the same strict prudential rules served to stabilize the brokers, because as Coyne (2009) has argued, unlike Lehman Brothers or Bear Stearns for example that had neither parents with deep pockets nor prudential regulation to save it from disaster, Canadian investment banks, owned by the major banks, had both.

[4] Systemic risk may arise if a bank in the normal course of business takes excessive risks that result in its failing, other banks may fail or be threatened with insolvency because of their connections to the failed bank. This could threaten the broader financial system and the performance of the economy. The moral hazard motivation for regulating banks arises from the attempt to protect depositors from losses, for example, through deposit insurance. Because Canada has deposit insurance aimed at compensating depositors for losses resulting from a bank's insolvency, depositors will have little or no incentive to assess the riskiness of their deposits and investments. Riskier banks will attract deposits on the same conditions as less risky banks. Moreover, the belief that governments will intervene if a large bank fails undermines investor and depositor discipline.

There is no gainsaying that the Canadian banks weathered the recent financial crisis relatively better than other banks. The *Financial Times* calls Canada's banks "the envy of the world". Paul Volcker, the former Federal Reserve Chairman has touted Canada's banks as the model for what a reformed American system should look like. In fact, the World Economic Forum (2011) in its annual Global Competitiveness Report ranks Canada banking system as the soundest in the world.[5] As American banks have tumbled in value or collapsed during the recent financial crisis, Canadian banks have risen in relative terms. Of the 10 largest banks in North America measured by assets, four are now Canadian; a decade ago, none of the Canadian banks was in the top 10 (Coyne 2009).

Despite their reputation for being far better-capitalized than their global peers and the attendant global recognition that major Canadian banks emerged relatively unscathed from the meltdown that damaged many U.S. and European lenders, it appears that the banks did not sail through the crisis as smoothly as had been thought, as it has come to light that they received substantial financial support from the Canadian government to help them cope with the fallout from bad U.S. subprime mortgages. It appears that the record of the banks before the financial crisis was hardly unblemished. As Coyne (2009) argues, if Canada's banks did not issue the dodgy sub-prime mortgages that were at the root of the crisis, they were exposed to the sub-prime market in the US as they made risky investment decisions by buying derivative products based on subprime mortgages. For example, the CIBC, considered as Canada's most aggressive big bank, was forced to take a $3.5-billion charge on its portfolio of mortgage-backed securities in 2008. Collectively, the Canadian banks have taken some $20 billion in write-downs following the crisis (Coyne, 2009).

The Canadian Bankers' Association has argued that the reason for the financial assistance

[5] The U.S. came in at No. 40, and Germany and Britain ranked 39 and 44, respectively. Switzerland was No. 16 (Coyne, 2009).

provided by the Canadian government is somewhat different from that of some of its G-7 partners. According to Heinrich (2008), unlike banks in the U.S., Britain, and Germany, which needed to be bailed out with hundreds of billions of dollars in new capital, Canada's major banks were solid and solvent and that the capital infusion was just meant to insure the money banks routinely borrow from one another and thus keep their credit operations liquid. The capital injections and loan guarantees received by the troubled American and European banks carried a government seal of approval that tilted the playing field in favor of the recipients in terms of their capacity to borrow at a lower cost and that left Canada's big banks at a competitive disadvantage. Therefore, the capital infusion provided by the Canadian government was meant to level the field and not to aid troubled banks (Heinrich, 2008). In this paper, we take the liquidity infusion as given and analyze its impact on risk taking by the Canadian banks. As stated earlier the non disclosure of the government financial assistance could affect the risk taking behavior of the banks.

3. DATA AND METHODOLOGY

3.1. Data

Our sample consists of all the major Canadian banks, namely Bank of Montreal (BMO), Canadian Imperial Bank of Commerce (CIBC), TD Bank Financial Services (TD), Royal Bank of Canada (RBC), and Scotiabank.[6] This sample represents about 85 percent of bank assets and deposits in Canada (see Table 1). All these banks are chartered banks, i.e., commercial banks regulated by the Canadian Bank Act that run a range of activities including consumer and business loans, brokerage, investment dealing, and securitization. The other banks are mostly private banks or subsidiaries of foreign banks. It is difficult to ascertain whether or not the parents of these subsidiaries received financial support from their respective governments. Therefore, to avoid contamination, we

[6] We do not include the National Bank (the sixth largest Canadian bank) in our study because there is no data on financial support received by this bank.

excluded subsidiaries of foreign banks from the study. Also, lack of data precluded the inclusion of other private banks in the study. The banks started receiving the financial assistance in October 2008; therefore we use 2008 as our event year. Since changes in risk-taking can take some time to manifest, we use three years of pre- as well as three-years of post-event period data to examine whether the government financial assistance affected the banks' risk taking behavior. Thus, our study covers the period 2005-2011 with 2008 being the event year. Following Berger et al. (2011), we use data from bank balance sheet to analyze the risk taking behavior of the banks around the time of the crisis. The financial statements come from Compustat and Bloomberg databases.

Table 1 reports the market share of the banks as of the end of 2010. The Royal Bank of Canada (RBC), the largest of the Big Six banks had market share four times that of the National Bank (the smallest of the Big Six) and almost twice that of the CIBC (the smallest of the Big Five). Table 2 shows the estimated amounts offered by the Bank of Canada and CMHC to the Canadian banks (Macdonald (2012)). The data presented in Panel B shows that the funds received by the banks did not correspond to the size or market share of the banks. Rather, the smaller banks received more funds than the larger banks, with CIBC, Bank of Montreal and Scotia Bank receiving more funds than TD Bank and RBC.

[Insert Tables 1&2 here]

3.2. Methodology and variables description

We follow the literature and use the *z-score* as our main measure of risk to examine the effects of the financial assistance on the sample banks' risk-taking behavior. Other accounting-based measures of bank risk namely the *volatility of ROE* and *solvency ratio* are used for descriptive statistics and robustness checks purposes. The *z-score*, defined as the inverse of the probability of insolvency (Roy, 1952), is estimated as the return on assets plus capital-to-asset ratio (CAR),

divided by the standard deviation of return on assets. As is common in the literature (e.g., Laeven and Levine 2009; Duchin and Sosyura, 2012; Gropp et al., 2012), we use the natural logarithm of the *z-score* as our risk measure since it is less skewed and follows the normal distribution. A higher *z-score* indicates that the bank is more stable. ROE is calculated as net income divided by the book value of equity. We use a two-year moving window of quarterly ROEs to calculate the *volatility of ROE*. To reduce the impact of outliers and to avoid spurious inferences due to extreme values we winsorized ROE series at -100% and +100%. *Solvency ratio* is defined as the ratio of shareholders' equity divided by total assets. A higher ratio indicates enhanced financial position and improvement in the bank's going concern position.

To better understand whether and how the sample banks' risk-taking behavior is affected by the government financial support, we conduct a pooled cross-sectional time series regression analysis while controlling for bank characteristics and other variables that affect risk taking. Using individual bank's quarterly data and the least squares estimation technique, we estimate the following model for the sample firms:[7]

$$\begin{aligned} Risk_{i,j} = {} & \alpha_0 + \alpha_1 Post\_Infusion + \alpha_2 Funds\_Ratio + \alpha_3 Cred\_Risk + \alpha_4 Liq\_Risk \\ & + \alpha_4 Int\_Risk + \alpha_5 Size + \alpha_6 Leverage + u_{i,j} \end{aligned} \quad (1)$$

where $Risk_{i,j}$ is the *z-score* for bank *i* in quarter *j*. *Post_Infusion* is a dummy variable equal to 1 during the post-support period and 0 otherwise. The inclusion of this variable allows us to capture changes in risk-taking behavior of the banks following the receipt of the government support. *Fund ratio* is the ratio of funds received by the bank to total amount provided by the government. The ratio helps us ascertain whether risk taking depends on the amount of funds received from the government. Since bank risk taking incentives could be affected by other risk factors we control for

[7] Subscripts are suppressed for notational convenience.

three main bank risk factors, namely liquidity risk, credit risk and interest rate risk. Liquidity risk (*Liq_Risk*) is measured as the ratio of liquid assets to liquid liabilities;[8] *Cred_Risk* represents credit risk and is measured as the percentage of loan loss provision to total assets; *Int_Risk* represents the sensitivity of the bank's activities to interest rate changes, and is defined as the ratio of the absolute difference (gap) between short-term assets and short-term liabilities scaled by total assets.

We also control for the impact of firm characteristics such as size and leverage on risk. The literature suggests that highly leveraged firms tend to exhibit greater stock variance (Lev, 1974). To control for leverage effects, we use the ratio of deposit and non-deposit liabilities to total assets as an independent variable. Large firms are usually more stable and are characterized by less information asymmetry than smaller firms; therefore they have a higher potential to diversify away their risk. We include the natural logarithm of the book value of assets as our measure of size which is expected to be negatively related to bank risk. Robust standard errors are estimated using Petersen (2009) correction for firm clustering.

4. RESULTS

4.1 Preliminary results: Univariate analysis

We estimate the mean (median) and difference in mean (median) of each risk measure 3 years prior to and 3 years after the initial government financial assistance and present the results in Table 3. Aggregate results are reported in Panel A and the individual bank's estimates of the z-score are presented in Panel B. The results in Panel A show that there is no significant change in the mean (median) *z-score* following the receipt of the financial support. While we observe a decrease in the mean *volatility of ROE*, the change is not statistically significant. However, the median volatility of ROE increased after the banks received the financial support. In addition, we observe a significant

[8] Liquid assets are defined as cash and cash equivalents and commercial notes.

improvement in the solvency of banks following the government liquidity infusion. To better understand these seemingly divergent results we conduct individual mean and median z-scores tests and present the results in Panel B. The results show that changes in risk following the liquidity infusion are not uniform. The CIBC (considered to be the most aggressive of all the banks) and TD bank exhibit a significant increase in the *z-score* (i.e., a reduction in risk), but the Bank of Nova Scotia experienced a significant decrease in the z-score whilst the RBC and the Bank of Montreal show no statistically significant change in the *z-score* following the liquidity infusion.

[Insert Table 3 here]

In summary, the preliminary analysis shows no significant change in the aggregate z-score. The univariate test for the individual banks indicates that changes in risk are not uniform across the banks; some banks experienced a decrease in risk, whilst others experienced an increase in risk, thus producing an offsetting effect in the aggregate z-score. These results should however be interpreted with caution because the univariate tests are only suggestive and have no explanatory power. The analysis implicitly assumes that the only variable that affects bank risk is the liquidity infusion. Spurious inferences could be made from the analysis if we do not control for other factors that affect risk. In the following section we use multivariate cross-sectional analysis to examine changes in risk-taking behavior of the Canadian banks while controlling for other factors that can affect bank risk.

4.2. Multivariate analysis

In conducting the difference in mean tests, we implicitly assumed that the quarterly risk-measures are identically and independently distributed among the banks. We relax this assumption in this

section and use multivariate cross-sectional regression to examine changes in risk-taking behavior of the banks. Estimations are conducted using individual banks quarterly risk measures and the least squares estimation technique. In order to avoid spurious associations and to better gauge the drivers of banks risk-taking, we conducted the analysis using different risk measures and specifications. In the first specification, we examine whether risk-taking is affected by the liquidity infusion using the dummy variable (*Post_Infusion*) that equals 1 for the post-infusion period (2009-2011) and 0 otherwise.[9] The statistics provided in Table 2 show that the banks benefited from the capital infusions differently, with CIBC and Bank of Montreal receiving higher amounts than TD Bank or RBC. In order to examine how the level of government support affected risk-taking we include *Fund_Ratio* which is the amount of funding received weighted by the total amount provided by the government and examine its effects in a second specification. To control for other risk factors that can affect banks' risk taking behavior, we examine the impact of liquidity risk *(Liq_ratio*), credit risk (*Cred_risk*), interest rate risk (*Int_risk*), size and leverage in a third specification. Since bank's liquidity, interest and credit risks might in turn be affected by the liquidity infusion, these variables are orthogonalized with respect to the liquidity dummy in all regressions.[10] Given that Canadian banks have significant exposure to the US market where the financial crisis began and severely affected banks with operations there, we also include in the regression a measure of exposure to the US market, i.e., the percentage of revenue generated from the US. The results of the estimations are reported in Table 4.

[Insert Table 4 here]

[9] Analysis using a liquidity dummy that equals 1 during the period 2010-2011 and 0 otherwise produces similar results for all specifications and all risk measures.

[10] Liquidity, credit and interest risk variables are regressed on an intercept and the post-liquidity infusion dummy. Residuals from these regressions are used in all other regressions reported in this paper.

When the *z-score* is regressed on the liquidity dummy (Model 1), we observe that the post liquidity dummy variable is positive but not statistically significant. However, when the ratio of the amount received is included in the regression (Model 2) the positive post-Infusion dummy becomes statistically significant whereas the ratio of funds received exhibits a negative sign. These results indicate that the financial crisis and the liquidity infusion have a dual effect on the z-score. On one hand the banks experience a reduction in risk in the post liquidity infusion period (an effect that can be attributed to both the financial crisis and the liquidity infusion).[11] On the other hand higher amounts of funds received seem to increase the banks' appetite for risk. When we control for size and other factors that can affect banks' risk, the results remain the same; the post liquidity infusion period dummy variable remains positive and significant (suggesting a decrease in risk) and our measure of the size of financial support received remains negative and statistically significant. The coefficient of the US exposure variable is positive and strongly significant, suggesting that exposure to the larger US market reduces the risk of bankruptcy for the Canadian banks, perhaps due to the diversification of cash flows. However the risk increases in the post crisis period, as the coefficient of the interaction term comprising US exposure and the post-liquidity period is negative, albeit insignificant.

4.3. Sources of changes in risk (*z-score*)

Our multivariate regression results indicate that the *z-score* improves in the post-liquidity infusion period. The change in the *z-score* can emanate from improvement in profitability (return on assets), a reduction in asset return volatility, and/or changes in the capital adequacy ratio. To determine the main drivers of the change in the *z-score* we examine how its components are affected by the liquidity infusion by re-estimating model (3) using ROA, volatility of ROA, and CAR as dependent

[11] We attempt to disentangle the liquidity effect from the financial crisis effect in the next section.

variables. ROA is calculated as net income divided by total assets. To reduce the impact of outliers, and to avoid spurious inferences due to extreme values we winsorize the ROA series at -100% and +100%. We use a two-year moving window of quarterly ROAs to calculate the *volatility of ROA*. CAR, measured as Tier 1 capital, is defined as common shares, retained earnings and non-cumulative preferred shares to risk-adjusted assets. The results, reported in Table 6, indicate that ROA and the volatility of ROA reduce while the CAR improves in the post-infusion period. These results indicate that the improvement in the *z-score* that we observed in Table 4 emanates from reduction in the volatility of ROA and improvement in the CAR. The liquidity infusion thus makes the banks more stable.

The ratio of funds received is positive and significant in models (1) and (2), suggesting that while the liquidity infusion makes the banks more stable, higher amounts of funds received lead to increase in profitability and return volatility. Heinrich (2008) argues that Canada's major banks were solvent in the period preceding the financial crisis and did not need financial help. But the capital injections and loan guarantees that their competitors received carried a government seal of approval that tilted the playing field in the competitors' favor, which left Canada's big banks at a competitive disadvantage. Therefore, the Canadian government's capital infusion was meant to level the field for the Canadian banks. The coefficient of the ratio of funds received suggests that probably the government provided too much funds (given that the Canadian banks were solvent). The excess funds beyond what was needed to remain sound might have been used to engage in risky ventures.[12] Consistent with the diversification argument and reflecting the increased competition in the banking sector in the US, we observe that the coefficient of the US exposure dummy variable is negative and significant in the standard deviation of ROA and ROA regressions. It is also negative and significant in the CAR regression, which seems to indicate that the

[12] We examine this result further in the next section.

diversification effect from a US exposure reduce the risk of bank's assets and by extension the capital requirement. However, the coefficient of the interaction term (US exposure x Post_Infusion) is positive and significant in the standard deviation of ROA regression, suggesting that the exposure of the Canadian banks to the US market (the center of the financial crisis) increased the variability of return on assets of the banks in the post crisis period. Thus, it appears that the diversification benefits derived from the US market reduced in the aftermath of the crisis. The significantly positive coefficient of the interaction term in the CAR regression could perhaps be due to requirements by the US regulators for banks to increase their capital after the crisis.

[Please insert Table 5 here]

4.4 Further decomposition of the *z-score*

To provide further insights into the drivers of the components of the z-score, we further examine how the liquidity infusion affected the various sub components of ROA, a major component of the z-score. We classify bank incomes into two main categories, namely interest-related (direct) income which is generated from traditional banking activities such as borrowing and lending and is herein referred to as *ROA1* (interest income), and indirect or non-interest-related income which is generated from non-traditional and trading activities such as securitization, underwriting and asset management which we refer to as *ROA2* (non-interest income). We estimate *ROA1* as interest income divided by total assets and *ROA2* as non-interest income divided by total assets. The *Volatility of ROA1* and *Volatility of ROA2* are measured as the standard deviation of a 2-year rolling window of quarterly *ROA1* and *ROA2* respectively.

We estimate regression (1) using ROA1, ROA2, *Volatility of ROA1* and *Volatility of ROA2* as dependent variables with the view to identifying the sources of the changes in profitability and risk. The multivariate regression results of the sub-components of z-score are reported in Table 6.

We observe that interest income increases and non-interest income reduces following the financial crisis. Thus, the drop in profitability following the liquidity infusion that we report in Table 5 seems to be driven by the drop in non interest income overwhelming the increase in interest income. This finding suggests that banks shifted their activities away from non-interest activities towards more traditional and safer interest-generating activities, The fund received is significantly positive in ROA2 regressions and negative in ROA1 regressions, indicating that higher funds received create an incentive to invest in more non-interest and usually risky activities. The increase in CAR following the liquidity infusion is consistent with the findings of Duchin and Sosyura (2012) and indicates that the liquidity infusion enhances banks' safety.

[Insert Table 6 here]

4.5. Disentangling liquidity infusion effects from financial crisis effects

In the preceding section, we considered the liquidity infusion as given and examined its impact on the banks' risk taking behavior. The financial support was granted in the midst of financial crises. As a result, the effect of the liquidity infusion is confounded by the effect of the financial crisis. As argued by Gropp et al. (2012), studies on government liquidity infusion suffer from this confounding effect because it is difficult to disentangle the two effects. Nonetheless, in this section we attempt to distinguish the impact of the financial crisis on bank risk-taking from that of the government liquidity infusion.

As stated earlier, apart from interest income that banks generate from their normal lending activities, commercial banks generate significant non-interest income from off balance sheet transactions (OBS). Although the recent financial crisis has been linked to a surge in banks' non-interest and off-balance sheet (OBS) activities such as securitization and investments in subprime mortgages which led to an increase in bank risk-taking (see Brunnermeier, 2009; Bedendo and

Bruno, 2012), the positive impact of OBS activities on bank risk-taking has been recognized for non-crisis periods (Stiroh and Rumble, 2006; Calmes and Theoret, 2009). Recall that we decomposed the ROA (a key component of the *z-score*) into ROA1 (interest income), ROA2 (non interest income), volatility of ROA1, volatility of ROA2, and CAR. In this section, we argue that since the financial crisis led to economic downturn and liquidity crunch, we expect the financial crisis to impact negatively on both interest and non-interest activities (ROA2). However, the banks are likely to switch their activities to safer interest income activities with any capital injection they receive from the government; hence we expect the funds received to positively impact on ROA1. With this conjecture in mind, we reexamine the results in Table 6.

Consistent with our conjecture, we observe that non-interest incomes (ROA2) significantly decreased, while interest incomes (ROA1) increased following the liquidity infusion. Perhaps, as a result of the financial crisis, the banks became more conservative and shifted their activities from risky noninterest income related activities (e.g. investment in derivatives) to safer interest income related activities. Since banks would not normally lend much in times of financial crises and liquidity crunch of the magnitude experienced in 2008, we interpret the increase in ROA1 (interest income) and volatility of ROA1 in the post liquidity infusion period as an outcome of the liquidity infusion the banks received and the decrease in non interest incomes (ROA2) to be the outcome of the financial crisis.

A more intuitive way to disentangle the effect of the financial crisis from that of the liquidity infusion effect is to compare the risk taking behavior of banks that received government support to that of banks that did not receive government funds. All the chartered banks received government support during the financial crisis; however, two smaller regional banks did not receive liquidity infusion. We use quarterly observations of this control group, albeit small, to disentangle

the effect of the liquidity infusion from that of the financial crisis.[13] To do this, we introduce in equation 3 a new dummy variable, *Supported,* which is equal to 1 for banks that received government liquidity infusion and 0 otherwise, and its interaction with the post-infusion dummy. We then re-estimate equation (3) with the expanded sample and present the results in Table 7. The coefficient of the dummy variable *Supported* is positive and strongly significant at 1%, indicating that during our study period the banks that received the government assistance exhibit lower risk than the control sample. More interestingly however, the coefficient of the interaction term, *Post_Infusion x Supported* (our variable of interest that captures the liquidity infusion effects on risk taking) is consistently positive and significant in the *z-score* regression. The magnitude of the coefficient suggests that risk-taking by the test group following the liquidity infusion is significantly much lower than that of the control sample. The *Post-infusion* dummy remains positive in most of the regressions, albeit insignificant whereas the funds received remains negative and significant in almost all the regressions, suggesting that higher amount received induces higher risk taking.

The foregoing result must be interpreted with caution because the banks in the control sample are smaller than those in the test group and the number of quarterly observations used for the test is relatively small. Nonetheless, the analysis provides corroborative evidence for the earlier findings that risk taking by the banks that received capital infusion has reduced in the post liquidity infusion period.

[Insert Table 7 here]

5. FURTHER ANALYSIS AND DISCUSSION

[13] We do not include foreign banks operating in Canada in this control sample, since we do not know whether such banks received assistance from their respective governments and some of it trickled down to the subsidiaries.

5.1. Robustness checks

In this study, we use the z-score as our measure of risk and find that the sample banks experienced a reduction in risk after receiving the financial support from the government. To check the robustness of our results we use two alternate measures of risk as dependent variables, namely long-term solvency ratio and the volatility of ROE. We re-estimate equation (1) for our sample banks using these alternative risk measures as dependent variables.

The results are reported in Table 8. Consistent with our earlier findings based on the z-score, the sample banks experience a reduction in risk after the liquidity infusion as the volatility of ROE decreased and the solvency ratio increased in the post-infusion period. Consistent with the main results, *Funds received* is significantly positive in the volatility of ROE regression indicating that the risk appetite of banks that received higher amounts of funds money increased. The negative coefficient of the *Funds received* in the Solvency ratio regression is expected because given that *Solvency ratio* is the ratio of shareholders' equity to total assets, higher amounts of funds received increases total capital, which in turn reduces the shareholder's equity component of the capital. These results suggest that whilst the liquidity infusion led to a reduction in risks and an improvement in the safety of the banks, beyond a certain threshold, higher amounts of government funds received actually increase risk taking.

[Insert Table 8 here]

5.2. Relationship with other studies

Previous work on disclosure and risk in the banking industry suggests that public disclosure of information about banks' current condition and future prospects facilitates market discipline, which in turn can constrain risk taking. Extant literature also suggests that government guarantees may reduce market discipline because creditors anticipate their government guarantees and therefore

have fewer incentives to demand higher risk premia or monitor the bank's risk taking behavior. In line with the moral hazard hypothesis, the non-disclosure of the government financial support can induce higher risk taking by the banks. Alternatively, the non-disclosure of the liquidity infusion can reduce the banks' appetite for risk, as they become more cautious in their investment and lending decisions. Our finding that the banks experienced a reduction in risk in the post-infusion period is consistent with our alternative non-disclosure hypothesis. It is also consistent with the charter value hypothesis that government guarantees lower banks' financing cost, enhance their margins and charter values, which in turn reduce the banks' incentive to take higher risks.

As Table 9 shows, our results are different from those documented for the U.S. where the government support was publicly disclosed and extensively discussed in the media. Duchin and Sosyura (2012) find that banks that were bailed out by the U.S. government subsequently approved riskier loans, shifted investment portfolios towards riskier securities, and exhibited significant increase in measures of volatility and default risk. Similarly, Black and Hazelwood (2012) find evidence of increase in risk-taking by large banks that received TARP funds. For Germany, Gropp (2012) find that banks whose government guarantees were removed cut their credit risk and loan sizes, and increased their interest rates. They conclude that public guarantee is associated with high moral hazard effects. Although these studies use different measures of risk, one common thread in their findings is that government support (publicly discussed in the media) is associated with increases in banks' moral hazard and more risk taking. In this study we document a reduction in risk for Canadian banks that received undisclosed government financial assistance.

Whilst it appears that the non-disclosure of the liquidity infusion may account for the differences in the results, it is difficult to establish any causal relationship between the non-disclosure of the government support and bank risk taking. However, we offer an explanation based

on our alternative hypothesis that the non-disclosure of the capital infusion received banks that have been touted as the most conservative and well-managed banks in the world could help curtail the banks' appetite for risk. These banks, realizing that they made a mistake by investing in risky instruments and have had to be financially supported without the public knowing about their precarious financial situation might be more cautious in their investment decisions in order not to further damage their franchise value and their relationship with the politicians and regulators. Thus the desire to protect their reputation could influence them to assume less risk with the aim of protecting future rents.

[Insert Table 9 here]

The nature of the regulatory regimes could also explain our results. Recall that the Canadian banking system is highly concentrated; as a result, the banks have been closely regulated to ensure the stability and efficiency of the financial system. The financial system is characterized by stringent capital requirements, tight mortgage market regulations, lower leverage ratio requirements, and close supervision culminating in a relatively conservative appetite for risk taking. Stronger supervision and bank capital oversight affect risk taking before, during and after the financial crisis. Given the nature of the regime in Canada, regulator might have applied pressure on the banks that received the government financial support to reduce risk. On the other hand, rescued banks operating in an environment of less regulation could exhibit higher risk taking as the relatively loose regulatory regimes could have induced moral hazard as documented by studies listed in Table 9 that examine the effects of rescue programs on risk taking by US banks.[14]

6. CONCLUSION

[14] Given these institutional differences in the regulatory regimes, it would be interesting to test for differences in risk taking behavior of US and Canadian banks. However, that question is the subject of another study.

Unlike other countries where financial assistance provided by the government to banks during the financial crisis was publicly announced and discussed extensively in the media, in Canada the financial support provided to the banks was not publicly disclosed. Previous work on disclosure and risk in the banking industry suggests that public disclosure of information about banks' current conditions and future prospects facilitates market discipline, which in turn can constrain risk taking. The non-disclosure of the liquidity infusion can induce higher risk taking by the banks in Canada. Alternatively, the non-disclosure of the liquidity infusion can curtail the banks' appetite for risk, as the managers realizing that they undertook risky bets which elevated the banks' risk level will be more cautious in their investment and lending decisions and will have less incentive to take higher risk.

We examine the impact of government liquidity infusion on the risk-taking behavior of Canadian banks and find that the banks become more conservative as the liquidity infusion induces a reduction in risk as measured by the *z-score*. In an attempt to identify the sources of the reduction in risk we decompose the *z-score* into its various components and observe a shift by the recipient banks from non-interest related activities towards more traditional interest generating activities. We also find that the amount received is positively related to non-interest income. The results suggest that whilst the liquidity infusion led to a reduction in risks and an improvement in the safety of the banks, higher amounts of funds received increases bank risks taking. This finding is consistent with the conjecture that perhaps the government provided too much funds to the banks.

Using a small number of observations for banks that did not receive government financial support, we find that risk-taking by the recipient in the post-infusion period is much lower than that of the control sample. The finding that the banks experienced a reduction in risk in the post infusion period is consistent with our alternative non-disclosure hypothesis and charter value hypothesis

both of which posit a reduction in risk. Our findings however, contrast with those of Duchin and Sosyura (2012), Black and Hazelwood (2012), Gropp et al. (2011), and Dam and Koetter (2012) who find that government support during the financial crisis is associated with increase in banks' moral hazard and more risk taking in countries where government assistance was publicly disclosed. We argue that the conservative nature of the regulatory regime in Canada and the desire to protect their franchise value and their relationship with the politicians and regulators (with the aim of protecting future rents) could have influenced the banks to reduce risk.

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Table 1: Assets of major Canadian Banks

Federally regulated banks	Assets as of 2010 ($ billions)	Quarterly observations included in the study
Domestic		
Royal Bank of Canada	651	24
Toronto-Dominion Bank	568	24
Bank of Nova Scotia	507	24
Bank of Montreal	393	24
Canadian Imperial Bank of Commerce	335	24
National Bank of Canada	142	
Other domestic banks	58	
Total domestic	2,654	
Total foreign bank subsidiaries and branches	212	
Total	2,866	120

Source of asset values: Office of the Superintendent of Financial Institutions Canada (2010)

Table 2: Summary of government liquidity infusion by Bank (millions of dollars)

	CIBC		BMO		RBC		Scotia		TD		
Quarter	CMHC	Bank of Canada	CMHC	Bank of Canada	CMHC	Bank of Canada	CMHC	Bank of Canada	CMHC	Bank of Canada	Total
2008-Q4	2543.5	22471.8	3263.12	23588.1	893.5	9374.5	1366	21584.2	4333.87	13105.3	102524.0
2009 Q1	5760.5	26685.7	3452.12	26685.7	5659.5	14511.4	3616	26685.7	5893.87	0.0	118950.3
2009-Q2	3461.5	20766.0		20766.0	6738.5	11292.3	3209	20766.0	2259.87	0.0	89259.0
2009-Q3		22308.3		22812.9	1445.5	11516.5	795	21951.8	3092.87	3888.0	87810.9
2009-Q4		18238.6		19593.9		8267.3		17280.9	3666.87	10443.5	77491.0
2010-Q1		15820.2		16995.8		7171.0		14989.5	219.87	9058.7	64255.0
2010-Q2		8199.3		8808.6		3716.6		7768.8	2414.87	4694.9	35603.1

Source: This table is based on estimates provided by David MacDonald (2012), the author of "The big banks' big secret".

Table 3: Descriptive statistics and difference in mean (median) tests, Z score, Volatility of ROE, and Solvency ratio

This table shows descriptive statistics and difference in mean (median) tests for Z score, Volatility of ROE, and Solvency ratio. Differences in mean (median) tests compare the post-infusion (2009-2011) mean (median) statistics to the pre-infusion (2005-2007) mean statistics. T-statistics appear in parentheses and Wilcoxon, Mann-Whitney statistics appear in brackets. The symbols *, ** and ***indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

	3-year pre-infusion (2005-2007)					3-year post-infusion (2009-2011)					Difference	
Panel A: Aggregate difference in mean (median) tests												
	Mean (a)	25th p	Median (b)	75th p	SD	Mean (c)	25th p	Median (d)	75th p	SD	Mean (c-a)	Median (d-b)
Z-score	2.6664	2.2953	2.6633	3.1250	0.6070	2.7410	2.1008	2.5733	3.4650	0.7941	0.0746	-0.0900
											(0.627)	[0.171]
Volatility of ROE	0.1648	0.0359	0.0712	0.2206	0.1883	0.1459	0.0718	0.1059	0.1552	0.1274	0.0189	0.0347*
											(1.503)	[1.927]
Solvency ratio	0.0411	0.0373	0.0412	0.0450	0.0058	0.0455	0.0395	0.0440	0.0490	0.0090	0.0044***	0.0028***
											(3.4882)	[2.651]
Panel B: Individual difference in mean tests												
	3-year pre-infusion (2005-2007)					3-year post-infusion (2009-2011)					Difference	
Z-score	Mean	Median	SD			Mean	Median	SD			in Mean	
BMO	3.043	2.912	0.238			2.856	2.428	0.980			-0.187	
											(-0.586)	
CIBC	1.924	1.660	0.425			2.612	2.652	0.785			0.688**	
											(2.168)	
Scotia	3.200	3.085	0.122			2.751	2.539	0.404			-0.449**	
											(-2.143)	
RBC	2.626	2.532	0.114			2.372	2.471	0.282			-0.078	
											(0.433)	
TD	2.372	2.278	0.120			2.943	2.554	0.887			0.571*	
											(1.932)	

Table 4: Effects of government liquidity infusion on bank risk, (Z score)

This table presents regression results of the Z-Score on the infusion dummy (Post_Infusion), the funds received (Funds_ratio), other bank risk measures (Liq_Ratio, Int_Risk, and Cred_Risk), and other control variables (Size, Leverage). T-statistics appear in parentheses. The symbols *, ** and ***indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Z score			
	(1)	(2)	(3)	(4)
Intercept	2.647***	2.642***	14.440	15.430**
	(9.194)	(6.068)	(1.153)	(2.562)
Post_Infusion	0.095	0.917**	1.216**	0.962*
	(0.691)	(2.555)	(2.508)	(1.742)
Funds_Ratio		-4.043***	-3.812*	-2.944***
		(-3.343)	(-1.806)	(-2.950)
Liq_Ratio			-1.947***	-1.492***
			(-3.696)	(-3.456)
Cred_Risk[i]			-1.449***	-0.113***
			(-4.614)	(-3.784)
Int_ Risk			-1.512***	-1.451***
			(-2.682)	(-3.227)
Size			-0.962	-2.813***
			(-0.993)	(-3.482)
Leverage			3.706**	2.441**
			(2.206)	(2.090)
US Expo				5.400***
				(2.997)
*US_Expo*Post_Infusion*				-0.260
				(-0.272)
Firm fixed effects	yes	yes	yes	yes
Observations	120	120	120	120
Adjusted R^2	0.07	0.10	0.55	0.58

Table 5: Decomposition of the z-score

This table presents regression results of the components of the Z-score for the sample banks using ROA, Volatility of ROA, and CAR as the dependent variables. Each dependent variable is regressed on the infusion dummy (Post_Infusion), the funds received (Funds_ratio), other bank risk measures (Liq_Ratio, Int_Risk, and Cred_Risk), and other control variables (Size, Leverage). T-statistics appear in parentheses. The symbols *, ** and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

	ROA			Volatility ROA			CAR		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0.082	0.112***	-1.106	0.011***	0.033	0.786	0.285***	0.487***	15.845***
	(9.911)	(6.731)	(-1.494)	(9.121)	(1.208)	(1.584)	(6.722)	(5.956)	(3.358)
Post_Infusion	-0.004***	-0.009***	-0.010***	-0.002*	-0.004***	-0.004***	0.015***	0.019***	0.014*
	(-6.557)	(-7.311)	(-8.992)	(-1.750)	(-3.259)	(-2.801)	(3.640)	(2.967)	(1.818)
Funds_Ratio	0.085**	0.072***	0.004	0.012*	0.067**	0.009***	0.134*	0.664***	-0.017
	(2.298)	(3.074)	(1.325)	(1.926)	(2.581)	(4.457)	(1.865)	(3.707)	(-0.751)
Liq_Ratio		0.001	0.001		0.002***	0.002***		-0.006	0.000
		(0.019)	(0.105)		(2.743)	(2.539)		(-1.101)	(0.133)
Cred_Risk[i]		0.048	0.005**		0.331***	0.023***		-0.227***	-0.001***
		(0.927)	(2.315)		(5.762)	(4.434)		(-5.917)	(-2.705)
Int_ Risk		0.001***	0.001***		0.002**	0.002***		-0.006	-0.011***
		(3.336)	(2.788)		(2.438)	(2.645)		(-1.441)	(-2.608)
Size		0.009***	0.006***		0.003	0.005**		-0.029***	-0.093***
		(6.901)	(2.522)		(1.410)	(2.351)		(-4.644)	(-5.526)
Leverage		0.007***	0.008***		-0.007**	-0.007**			0.002
		(2.552)	(4.109)		(-2.092)	(-2.181)			(0.112)
US Expo			-0.008**			-0.009**			-0.067**
			(-2.296)			(-2.335)			(-2.211)
*US Expo*Post_Infusion*			0.002			0.005**			0.064***
			(0.737)			(2.385)			(3.015)
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	120	120	120	120	120	120	120	120	120
Adjusted R^2	0.34	0.44	0.47	0.18	0.55	0.58	0.39	0.58	0.62

Table 6: Further decomposition of the z-score: ROA1, ROA2, Volatility of ROA1, and Volatility of ROA2

This table presents regression results of the sub-components of the z-score for the sample banks using ROA1, ROA2, Volatility of ROA1 and volatility of ROA2 as dependent variables. Each dependent variable is regressed on the infusion dummy (Post_Infusion), the funds received (Funds_ratio), other bank risk measures (Liq_Ratio, Int_Risk, and Cred_Risk), and other control variables (Size, Leverage). T-statistics appear in parentheses. The symbols *, ** and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

	ROA1		Volatility ROA1			ROA2			Volatility ROA2			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	0.015***	0.121***	-0.470	0.002	0.013**	-0.167	0.020***	0.024	-0.785	0.004***	0.070	-0.456
	(9.638)	(6.948)	(-0.919)	(4.859)	(2.161)	(-1.127)	(5.379)	(0.492)	(-0.413)	(4.794)	(1.497)	(-0.287)
Post_Infusion	0.005***	0.009***	0.006***	0.002*	0.002**	0.001	-0.006***	-0.011***	-0.012***	-0.005***	-0.012***	0.009*
	(8.724)	(7.471)	(5.141)	(1.765)	(2.128)	(0.793)	(-3.125)	(-3.530)	(-3.918)	(-3.315)	(-4.019)	(1.703)
Funds_Ratio	-0.021***	-0.176***	-0.022***	-0.001	-0.021*	-0.002	0.012*	0.015**	0.034***	0.042***	0.452***	-0.015
	(-6.047)	(-6.458)	(-5.300)	(-1.561)	(-1.783)	(-1.016)	(1.832)	(2.453)	(3.561)	(4.794)	(7.008)	(-0.942)
Liq_Ratio		-0.002*	-0.003***		0.001***	0.002		-0.002	-0.001		-0.001	0.000
		(-4.050)	(-3.561)		(3.438)	(3.039)		(-0.857)	(-0.262)		(-0.139)	(0.132)
Cred_Risk[i]		-0.012	0.002		0.001	0.001		0.017	0.005		0.049***	0.001***
		(-0.747)	(0.539)		(0.886)	(0.673)		(1.586)	(0.748)		(3.096)	(3.370)
Int_ Risk		-0.001***	-0.001**		0.001**	0.001		-0.000	0.000		0.006***	0.004***
		(-2.069)	(-2.027)		(2.157)	(1.174)		(-0.024)	(0.030)		(3.702)	(2.699)
Size		-0.008***	-0.011***		-0.001*	-0.002		0.001	-0.006		-0.003	-0.007
		(-7.018)	(-5.548)		(-1.802)	(-3.328)		(0.209)	(-1.050)		(-1.097)	(-1.003)
Leverage		0.015*	0.017***		-0.008**	-0.002		0.029**	0.013		-0.033**	-0.032***
		(3.256)	(4.481)		(-1.988)	(-1.482)		(2.416)	(1.071)		(-2.601)	(-2.523)
US Expo			0.005			0.002			0.038***			-0.055***
			(1.361)			(0.149)			(2.691)			(-4.660)
*US Expo*Post_infusion*			0.006***			0.002			0.015***			-0.039***
			(2.617)			(2.349)			(2.049)			(-2.738)
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	120	120	120	120	120	120	120	120	120	120	120	120
Adjusted R^2	0.35	0.53	0.55	0.38	0.45	0.47	0.41	0.43	0.46	0.31	0.52	0.55

Table 7: Liquidity infusion *vs.* Financial Crisis

This table presents regression results of Z-Score on the financial support dummy (Supported), the post infusion dummy (Post_Infusion), the interaction between the post infusion dummy and the ratio of funds received (Post_infusion*Fund_ratio), other bank risks measures (Liq_Ratio, Cred_Risk and Int_rate_Risk), and other control variables (Size, Leverage). T-statistics appear in parentheses. The symbols *, ** and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Z score				
	(1)	(2)	(3)	(4)	(5)
Intercept	2.753***	2.749***	2.253***	2.012***	17.665***
	(8.400)	(8.757)	(6.258)	(4.236)	(2.573)
Supported	0.060***	0.058***	0.042***	0.034*	0.088*
	(5.119)	(4.255)	(3.852)	(1.753)	(1.710)
Post_Infusion	0.073	0.042	0.038	0.032	-0.257
	(1.366)	(1.578)	(1.361)	(1.431)	(-0.991)
*Post_Infusion*Supported*		0.869**	0.788**	0.726**	1.051
		(2.336)	(2.245)	(2.221)	(1.605)
Funds_Ratio		-3.971***	-3.226***	-1.021*	-2.591
		(-3.243)	(-3.087)	(-1.692)	(-0.978)
Liq_Ratio			-1.652**	-1.543***	-1.475***
			(-2.377)	(-2.923)	(-3.607)
Cred_Risk			-0.167***	-0.118***	-1.109***
			(-5.976)	(-4.258)	(-5.227)
Int_ Risk			-0.815***	-0.953**	-1.019***
			(-2.780)	(-2.452)	(-3.346)
Size				-0.158	-1.292**
				(-1.377)	(-2.119)
Leverage				2.750**	1.946
				(2.126)	(1.421)
US Expo					4.271**
					(2.107)
*US Expo*Post_Infusion*					-0.199
					(-0.133)
Firm fixed effects	yes	yes	yes	yes	yes
Observations	168	168	168	168	168
Adjusted R^2	0.16	0.18	0.31	0.34	0.36

Table 8: Effects of government liquidity infusion on Canadian bank risk, Robustness check

This table presents regression results the regression of Volatility of ROE, and Solvency on the infusion dummy (Post_Infusion), the funds received (Funds_ratio), other bank risk measures (Liq_Ratio, Int_Risk, and Cred_Risk), and other control variables (Size, Leverage). T-statistics appear in parentheses. The symbols *, ** and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Volatility ROE			Solvency Ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.174	0.320	-8.999	0.041***	0.152***	-5.234***
	(9.399)	(1.059)	(-0.253)	(8.831)	(8.427)	(-6.085)
Post_Infusion dummy	-0.205***	-0.273***	-0.321***	0.022***	0.028***	0.018***
	(-4.764)	(-4.652)	(-3.270)	(9.469)	(9.021)	(8.199)
Funds_Ratio	0.814***	0.763***	0.782***	-0.089***	-0.097***	-0.091***
	(3.619)	(5.285)	(3.214)	(-9.155)	(-9.824)	(-9.198)
Liq_Ratio		0.119**	0.112*		-0.001	0.000
		(2.114)	(1.889)		(-0.551)	(0.255)
Cred_Risk[i]		0.898***	0.011**		-0.022**	0.000
		(2.734)	(2.412)		(-2.272)	(0.843)
Int_ Risk		0.120***	0.118***		-0.005*	-0.005**
		(3.453)	(3.296)		(-1.874)	(-2.386)
Size		0.088	0.066		-0.009***	-0.028***
		(0.613)	(0.300)		(-6.560)	(-8.031)
Leverage		-0.945***	-0.913***		-0.015**	0.013***
		(-3.480)	(-2.748)		(2.069)	(2.537)
US Expo			-0.354			0.023***
			(-1.485)			(3.595)
*US Expo*Post_Infusion*			0.119			0.019***
			(0.508)			(3.562)
Year fixed effects	yes	yes	yes	yes	yes	yes
Observations	120	120	120	120	120	120
Adjusted R^2	0.32	0.43	0.43	0.41	0.48	0.51

Table 9: Comparison of our results to those of recent similar studies

This table compares the key findings of recent studies on government financial assistance and bank risk taking in countries where the government assistance was publicly disclosed and widely discussed in the media (e.g. U.S. and Germany), and Canada where the financial support was not disclosed and publicly not discussed.

Authors (Year)	Sample	Country covered	Measures of risk	Public disclosure	Major Findings
Gropp, Gruendl and Guettler (2012)	German Savings Banks	Germany	Z-score, loan size, interest rate spread	Yes	- Banks whose government guarantees were removed cut their credit risk and loan sizes, and increase their interest rates. - Public guaranteed seem to be associated with high moral hazard effects.
Duchin and Sosyura (2012)	Publicly-traded financial firms eligible for the Capital Purchase Program (CPP)	USA	Z-score, volatility of ROA, volatility of earnings, CAR, Beta, stock return volatility	Yes	-Bailed banks approve riskier loans and shift investment portfolios towards riskier securities. -Bailed banks appear safer but show significant increase in volatility and default risk.
Black and Hazelwood (2012)	Toxic Asset Repurchase Program (TARP) bank recipients	USA	Risk rating, interest spread, loan risk	Yes	- The risk of loan originations increased at large TARP banks. - Increase in risk-taking of large recipient of TARP funds.
Authors	Canadian banks	Canada	Z-score, volatility of ROA, CAR	No	- Bailout led to a reduction in risks and an improvement in the safety of the banks. -Banks shift from non-interest related activities towards interest generating (safer) activities.