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## Does regulatory regime matter for bank risk taking? A comparative analysis of US and Canada

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**Abstract** The banking structure in the US is less concentrated, more competitive and less restrictive, whereas that of Canada is more concentrated, less competitive, and more restrictive. In the wake of the worst financial crisis in 2008, most US banks were bailed out while Canadian banks sailed through the crisis relatively unscathed. We examine the risk taking behavior of banks in the US and Canada prior to the recent financial crisis and find that Canadian banks had lower risk than their US counterparts over the study period. Further analysis shows that entry restrictions, which create concentrated banking structure, restrictions relating to capital, liquidity and activities, and strong supervisory power and discipline positively related to the z-score, suggesting that these factors constrain excessive risk taking by Canadian banks. We also decompose the z-score into its components and re-estimate our baseline regression with the view to identifying the source of the risk. We find that entry restrictions (and higher concentration) generate higher profits and lower variability of asset returns for Canadian bank while restrictions on activities reduce profitability and increases variability in asset return; however, the former seems to overwhelm the effect of asset restriction, given the lower risk that we observe for the Canadian banks. The less concentrated but competitive banking structure in the US is associated with higher bank risk taking.

**Keywords** Banks regulations · risk-taking · z-score

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**Riassunto** *La struttura del settore bancario negli Stati Uniti d'America è meno concentrata, più competitiva e meno restrittiva rispetto al medesimo settore in Canada. La maggior parte degli istituti creditizi statunitensi ha avuto bisogno di un piano di salvataggio sostenuto dal Governo per superare la crisi finanziaria del 2008, mentre le banche canadesi hanno superato la crisi finanziaria internazionale relativamente illesi. In questo lavoro analizziamo la tendenza all'assunzione di rischi da parte degli istituti creditizi statunitensi e canadesi precedentemente alla crisi del 2008. I risultati mostrano che le banche canadesi mostravano livelli di assunzione di rischi inferiori a quelli delle loro controparti statunitensi nel periodo indagato. Ulteriore analisi mostrano come restrizioni all'entrata nel settore, che hanno contribuito alla concentrazione elevata del settore, restrizioni in merito al capitale, alla liquidità e alle attività bancarie, assieme ad un forte poter di controllo e disciplina del settore sono correlate positivamente al valore dell'indicatore "z" (z-score), suggerendo che questi fattori limitano l'assunzione eccessiva di rischi da parte degli istituti creditizi canadesi. Al fine di individuare le singole fonti di rischio bancario, decomponiamo l'indicatore "z" e procediamo a calcolare regressioni partitamene per le singole variabili ad esso sottese. Troviamo che le restrizioni all'entrata nel settore (e alti livelli di concentrazione) contribuiscono a generare elevati tassi di profitto e ridotti gradi di variabilità del ROA degli istituti di credito, mentre le restrizioni sulle attività esercitate riducono i livelli di profitto e incrementano la variabilità del ROA degli stessi. Tuttavia, l'effetto della prima restrizione appare più significativa della seconda, dato il livello di rischi ridotto che caratterizza il sistema bancario canadese. In contrasto, la struttura meno concentrata e più competitiva del sistema bancario statunitense è associato ad un tasso di assunzione di rischi più elevato.*

**Parole chiave** *Regolamenti delle banche - assunzione di rischio - Score z*

## 1 Introduction

During the recent financial crisis, the Canadian banking system was described as resilient, healthy, and prudent; and was publicized as the soundest banking system in the world which enabled it to weather the global financial crisis well, and unlike many banks in the U.S and Europe, required no public funds injection. In fact, 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. Since the 2008 financial crisis, financial commentators and policy analysts have probed at the sources of the resilience of the financial system by posing and analyzing questions such as: 'Why banking crises happen in America but not in Canada?' (John Kay, *Financial Times*, June 4, 2014), 'How Canadian bank defied the financial crisis' (Constantine Passaris and Peter Bessey, *The Daily Gleaner*, March 2012) and 'Why was Canada exempt from the financial crisis?' (Renee Haltom, *Econ Focus*, 2013). Answers to these questions boil down primarily to the different regulatory regimes in the US and Canada.

While several factors account for such stability and resilience, but most relate to the difference in regulations. The Canadian financial system is characterized by a high degree of

concentration and consequently, a conservative and entrenched regulatory structure. Specifically, strong regulatory regime, stringent capital requirements for banks, federal supervision, strict mortgage market regulations, and a conservative appetite for risk are hallmarks of the Canadian financial system. Historically, the financial services sector has been strong in Canada. No banks 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). For instance, compared to the US, the banking system in Canada is more concentrated and more tightly regulated, have higher capital requirements, greater leverage restrictions, and fewer off-balance sheet activities. To minimize competing regulatory objectives, there is only one prudential (federal) regulator for both banks and insurance. Unlike the Canadian system, the US banking system is comprised of a very large number of small financial institutions and hence is much more fragmented. Unlike the US where each subsidiary of a banking conglomerate might be subject to a different regulatory authority (according to whether it was classed as an insurance company, investment bank, or commercial bank), in Canada, there is only one regulatory authority.

Another area where there is a sharp contrast between the regulatory regimes in Canada and the US is home ownership and mortgage practices. In Canada, mortgage interest is not tax deductible. The effect of these features of the mortgage market is that Canada has not seen a tax-driven distortion in the level of housing debt (Bones, 2009). It is a common practice for Canadian banks to hold mortgage on their balance sheets, which resulted in the application of high level of due diligence in the underwriting of bank loans. This has contributed to the fact that Canada did not experience the same degree of housing boom and bust that occurred in many other countries in the aftermath of the financial crisis. In contrast, there is mortgage interest deductibility for tax purposes in the U.S. (which encourages people to take on higher mortgages sometimes to fund purchases of consumer products), and longer mortgage amortization period. In addition, the implicit policy of financial access to the poor compelled banks in the US to relax their lending rules and in some cases engaged in what is now known as ‘low document’ mortgage lending where mortgage applicant’s statement of their income level and job history were accepted without direct verification. This deviation from the traditional and prudential financial management practices in part triggered the financial crisis whose epicenter was the housing sector. This was in sharp contrast to the Canadian banks, which were not lured into the hype of risky investments that had the potential for high returns but carried excessive financial risk. Rather, they remained focused, exercising sound financial practices, holding adequate capital reserves as a buffer against financial emergencies (Passaris and Bessey, 2012).

Extant literature provides inconsistent results on the effect of regulation on risk taking. For instance, Gonzalez (2005) finds that banks in countries with stricter regulation have a lower charter value, which increases their incentive to follow risky policies. By contrast, Jin et al. (2013) find that banks that are required to comply with the FDICIA internal control requirements had lower risk taking in the pre-crisis period and are less likely to experience failure and financial trouble during the crisis period. Guyie and Lai (2003) test the presence of moral hazard in Canadian banks by analyzing the risk-taking behavior of Canadian commercial

banks following the introduction of flat rate deposit insurance in 1976. Their results show no evidence of an increase in moral hazard among Canadian commercial banks. Schawrtz and Zechner (1989) find that flat-rate deposit insurance system has resulted in cross-subsidization among Canadian commercial banks during 1980-1985. These results are not always consistent with studies that examine bank risk taking in the US market. For instance, Duan, Moreau and Sealey (1992) find that one fifth of the banks in their US sample of commercial banks succeed to transfer risk to the FDIC.

Barth et al. (2004) assess the relationship between specific regulatory and supervisory practices and banking-sector development, efficiency, and fragility. The paper examines: (i) regulatory restrictions on bank activities and the mixing of banking and commerce; (ii) regulations on domestic and foreign bank entry; (iii) regulations on capital adequacy; (iv) deposit insurance system design features; (v) supervisory power, independence, and resources; (vi) loan classification stringency, provisioning standards, and diversification guidelines; (vii) regulations fostering information disclosure and private-sector monitoring of banks; and (viii) government ownership. The results raise a cautionary flag regarding government policies that rely excessively on direct government supervision and regulation of bank activities. The findings instead suggest that policies that rely on guidelines that (1) force accurate information disclosure (2) empower private-sector corporate control of banks, and (3) foster incentives for private agents to exert corporate control work best to promote bank development, performance and stability. Saunder and Wilson (1999) investigate bank consolidation and safety-net support provision in Canada, the UK and the US over a 100-year historical period, and the impact of these policy variables on bank capital and risk-taking choices. They find among others that despite strengthened safety-net guarantees, bank capital ratios and bank asset-risk choices in the 1980s are comparable to those observed in the 1890s, while bank equity volatilities have shown approximately a 10-fold increase over this period. Kane and Wilson (2002) construct a synthetic time-series for banks safety-net capital in Canada and the U.S. and show that even in the absence of formal government guarantees, country safety nets sometimes enhanced substantially the value of each country's major banks.

Unlike the US where many banks collapsed and/or had to be bailed-out during the recent financial crisis, Canada did not experience any bank collapse. In this paper, we conduct a comparative analysis of the impact of the regulatory regimes on banks' risk taking by banks in the US and Canada to ascertain whether as a result of the more conservative and stringent regulatory regime the Canadian banks take on less risk in the pre-crisis period than the US banks. The objective of the paper is to analyze the effects of national regulation on risk taking of Canadian and US banks leading up to the financial crisis. The more conservative regulatory regime in Canada compared to the US suggests that risk taking by banks in Canada will be lower than that in the US. Although there appears to be anecdotal evidence to that effect, there has not been any systematic analysis of whether the conservative and strict regulatory regime in Canada made them take less risk than the US banks. The results of such analysis will be relevant to policy makers around the world.

We find that Canadian banks had higher z-score and therefore lower risk than their US counterparts did over the study period. Our results based on a composite index created using World Bank survey results indicate that higher regulation and supervisory power leads to an increase in z-score (decrease in risk), however, an interaction of the country dummy and the composite regulatory index overall the Canadian regulatory index, as constructed using the World Bank survey, is less stringent than its US counterpart and produces results inconsistent with our earlier findings. The composite index could generate misleading or inconclusive results regarding the effects of regulations on bank risk taking as the different aspects of a country's regulatory system may be subsumed by responses to other survey questions that may have opposing effect. In view of this shortcoming, we use such sub indexes reflecting the different aspects of regulations. Our results show that entry restrictions which create concentrated banking structure, restrictions relating to capital, liquidity and activities, and strong supervisory power and discipline are positively related to the z-score, suggesting that these factors constrain excessive risk taking by Canadian banks. This effect is however, attenuated by the restrictions on banking activities, which lead to increase in risk. Combining these effects in a composite index could make the effects of regulations on risk taking ambiguous, which can explain the inconsistent results in the literature concerning the effects of regulations on risk taking.

We also decompose the z-score into its components and re-estimate our baseline regression with the view to identifying the source of the risk. We observe that ROA and the volatility of ROA are the channels through which the different aspects of a regulatory regime affect risk. We find that entry restrictions (and higher concentration) generate higher profits and lower variability of asset returns for Canadian bank whiles restrictions on activities reduce profitability and increase variability in asset return; however, the former seems to overwhelm the effect of asset restriction, given the lower risk that we observe for the Canadian banks. These results show that the lower risk and the stability experienced by the Canadian banks regime emanate from high profitability and lower profit variability- product of the concentrated nature of the banking industry, which seems to emphasize scale instead of competition.

Our study contributes to the literature in an important way. While the relationship between regulation and bank risk taking has been examined for other countries, the 2007-09 global financial crisis underscored the importance of financial regulation and surveillance, not only for the soundness of individual financial institutions, but also for the stability of the financial system as a whole. In the aftermath of one of the worst financial crises, there has not been any analysis of the impact of the regulatory regime type on risk taking behavior of banks in these countries with completely different regulatory regimes and experiences - where in one country the banks caused the financial crisis and in the other, the banks were resilient and sailed through the period relatively unscathed. Examining the risk taking behavior of banks that operate in a concentrated banking market with strong regulatory regime and those in a less concentrated less stringent regime with completely different outcome during the recent financial crisis adds to the regulation and risk taking literature.

The rest of the paper is organized as follows. The regulatory regimes in Canada and the United States and the hypotheses are discussed in Section 2. Section 3 deals with data and methodology. The analyses are presented in Section 4, and conclusion and policy implications are presented in Section 5.

## 2 Overview of Banking Regulations in the U.S. and Canada and hypothesis development

### 2.1 Differences in the US and Canadian Banking Systems

Some researchers argue that the reason why the Canadian banking system is resilient is more fundamental and that the Canadian banks stability and their stronger regulatory system compared to the United States are the result of divergent political systems and has deep historical roots. Calomiris and Haber in their 2014 book *Fragile by Design* argue that the structure of the U.S. political system allows popular interests to influence policy and regulations, which ultimately affect the risk taking behavior of the banks. In this section, we outline some of the more important differences between the U.S. and Canadian regulatory capital regimes, which will inform our hypothesis.

#### *Structure:*

The structure of the Canadian financial system (including the mortgage and housing markets) is different from what exists in the United States. The banking system in Canada consists of a small set of large and tightly regulated financial institutions defined by ownership, namely Canadian-owned banks, foreign banks with Canadian operations, cooperative banks, etc. These institutions of chartered banks offer financial stability in exchange for the Canadian government limiting entry to the industry. However, there are six major Canadian banks, namely Bank of Montreal, Scotiabank, TD Bank Financial Group, Royal Bank CIBC and the National Bank. These banks account for approximately 92.7% of the total assets and contributed almost 92% of the credit to loan markets (Office of the Superintendent of Financial Institutions Canada (2014). The concentration ratio was 92.7 % and the Herfindahl Index was 1679, which is considered to be a moderately concentrated market structure (Wu, 2015). Given the highly concentrated structure of the banking system where the six largest banks hold over 90 percent of total bank assets and since these banks perform key economic functions, the way they borrow funds, combined with the risks involved in their lending activities could in some circumstances threaten their solvency and can cause systemic problems; therefore, they need to be strictly regulated and supervised in order to ensure the stability and efficiency of the financial system.<sup>1</sup> Consequently, the Canadian financial system has been characterized by a strong regulatory regime.

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<sup>1</sup> Systemic risk may arise if banks in the normal course of business take excessive risks that result in their failing, other banks may fail or be threatened with insolvency because of their connections with this failed bank. This could threaten the broader financial system and the performance of the economy.

In contrast, the US banking system is comprised of a very large number of small financial institutions and hence much more fragmented than its Canadian counterpart. According to the Conference of State Bank Supervisors (CSBS) in 2013, there were 6821 domestic and foreign institutions (CSBS, 2013). The six largest bank holding companies in U.S. account for almost 58.5% of total industry assets on June 30, 2014. The concentration ratio of largest six bank holding companies in U.S. was almost 58% and the Herfindahl Index is 705, which is considered a low level of concentration (Wu, 2015).

### *Supervisory responsibility*

In Canada, 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). However, to ensure consistency and to minimize competing regulatory objectives, the administration of the prudential regulation of Canadian financial institutions (banks and insurance companies alike) is under the jurisdiction of only one prudential regulator - The Office of the Superintendent of Financial Institutions (OSFI). Major structural reforms to banking sector regulations in the late 1980s also set the Canadian financial system apart from what exists in the US. Following the Canadian Government's 1987 deregulation bill, most of the country's large investment houses were bought by the big five commercial banks. The single regulator is empowered to regulate the whole entity. Consequently, the investment dealers have been subject to the same stringent rules as the commercial banks.

Banking is regulated at both the federal and state levels in the U.S. State-chartered banks are subject to the regulation of the state in which they are chartered. Thus, a bank's primary federal regulator could be the Federal Deposit Insurance Corporation, the Federal Reserve Board, or the Office of the Comptroller of the Currency. Thus, each subsidiary of a banking conglomerate might be subject to a different regulatory authority according to whether it was classed as an insurance company, investment bank, or commercial bank. Apart from the bank regulatory agencies, the US maintains separate securities, commodities, and insurance regulatory agencies at the federal and state level. This can create competing regulatory objectives.

### *Mortgage market*

Nowhere does the regulatory differences manifest themselves more clearly than in mortgage finance markets. In Canada, banks cannot offer loans with less than 5 percent down payment, and the mortgage must be insured if the borrower puts less than 20 percent down. The legislation relating to mortgages requires that all high-ratio residential mortgages (currently defined as those having an initial down payment of less than 20% of the value of the property) made by banks be insured against default by either the government-owned Canada Mortgage and Housing Corporation (CMHC) or private insurers. Mortgage insurance is available, moreover, only if the household's total debt service is less than 40 percent of gross household income. These mortgage insurance providers are backed by the federal government, and are required to use conservative underwriting criteria.

Canadian banks also tend to hold on to mortgages rather than selling them to investors. Less than a third of Canadian mortgages were securitized before the financial crisis, compared to almost two-thirds of mortgages in the US. This feature of the Canadian financial system, combined with tight regulatory standards, gives Canadian banks stronger incentive to make those mortgages safe. The consequence was that prior to the recent financial crisis, not only did Canada have a much smaller housing boom than the U.S., but its mortgage delinquencies barely rose above the historical average of less than 1 percent. At its peak, 11 percent of American mortgages were more than 30 days overdue. These regulatory requirements curtailed the flourishing of the sub-prime market in Canada. Fewer than 3 percent of Canadian mortgages were classified as subprime before the crisis, compared to 15 percent in the U.S (Coyne, 2009). In addition, unlike in the United States, homeowners in Canada cannot reduce their federal or provincial taxes by the mortgage interest, as mortgage interest on residential properties is not deductible for tax purposes. The effect of these features of the mortgage market is that Canada has not seen a tax-driven distortion in the level of housing debt (Bones, 2009). This has contributed to the fact that Canada did not experience the same degree of housing boom and bust that occurred in many other countries in the aftermath of the financial crisis.

#### ***Regulatory capital requirements and leverage restrictions***

While both US and Canadian banks adhere to Basel II requirement 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. Nevertheless, Canadian banks tend to hold substantially more capital above these minimum requirements as buffers. In fact, the average capital reserves (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. Another very important regulatory factor supporting 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 Canadian banks is capped at no more than 20x capital. While the leverage ratios at major Canadian banks have risen steadily in recent years, the ceiling has ensured that average 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 had an average leverage ratio of over 25x and European banks with an average ratio of over 30x prior to the financial crisis (Bones, 2009).

In summary, the Canadian financial system is characterized by a high degree of concentration, a strong regulatory regime, stringent capital requirements for banks, federal supervision, strict mortgage market regulations, and a conservative appetite for risk. The conservative and entrenched regulatory structure helped the Canadian banks in weathering the recent financial crisis relatively well. It is in light of this resilience that the World Economic Forum in its annual Global Competitiveness Report, ranks Canada banking system as the soundest in the world.<sup>2</sup>

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<sup>2</sup> The U.S. came in at No. 40, Switzerland was No. 16, and Germany and Britain ranked 39 and 44 respectively.



Unlike the US where many banks collapsed and/or had to be bailed out during the recent financial crisis, there was no bank collapse in Canada. In fact, the value of the Canadian banks has actually risen in relative terms since the financial crisis. 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). Financial commentators and policy analysts have probed at the sources of the resilience of the financial system by posing questions such as: ‘Why banking crises happen in America but not in Canada?’ (John Kay, *Financial Times*, June 4, 2014), ‘How Canadian bank defied the financial crisis’ (Constantine Passaris and Peter Bessey, *The Daily Gleaner*, March 2012) and ‘Why was Canada exempt from the financial crisis?’ (Renee Haltom, *Econ Focus*, 2013) could be found in the regulatory regime. The stronger supervision and stronger bank capital oversight might have been effective at preventing banks from taking excessive risks before the crisis.

## 2.2 Hypothesis Development

There are, at least, three channels for market regulations affect bank risk taking. First, regulations may explicitly mandate the level of leverage a bank can have. Second, entry barriers resulting from regulations may directly or indirectly determine the number of banks and the level of competition or concentration in the industry. This in turn can affect the margins and charter value of banks and therefore their risk taking incentives. Third, it explicitly restricts the operations of banks in certain segments of the market (e.g. investment banking, insurance, leverage, and the mortgage market) and this regulatory restrictions can affect the risk taking behavior of the banks. Regulations influence bank risk taking through their potential effect on bank charter value (Gonzales, 2005). Regulatory regime determines the structure of the banking system (concentrated or not) which in turn can affect the level of competition and the charter value. A regulatory regime that leads to a more concentrated banking structure and a positive effect on bank charter value will provide incentives for banks to institute conservative investment policies. On the other hand, a regulatory regime that creates less concentrated banking system with lower charter value will induce banks to take higher risk. In fact, prior studies indicate an inverse relationship between bank charter value (which itself is affected by the level of competition) and risk taking. Keeley (1990), Demsetz et al. (1996) and Anderson and Frazer (2000) show that high charter value reduces bank risk taking incentives and vice versa. Gropp and Vesala (2001) also document a negative relationship between charter value and bank risk taking for EU banks and by Konishi and Yasuda (2004) for Japanese banks. A bank with a high charter value has strong incentive to avoid high-risk choices that may trigger a drop in its charter value.

The comparative review of the banking regulations of the U.S. and Canada have over the years adopted different regulatory systems have an important influence on banks’ risk taking behavior and produce a testable hypothesis about risk taking by banks in the two countries. To reiterate, the banking structures in the US can be described as less concentrated (more

competitive) and less restrictive banking in the US whereas that of Canada can be characterized as being more concentrated (less competitive) and more restrictive banking system. The differences between the U.S. and Canadian banking regulations (reflected in lower market concentration and less market power, which leads to higher level of competition among US banks and one that emphasizes economic scale and concentrated banking system in Canada) generate different expectations concerning risk taking of banks that operate in these regimes, and the differences produce a testable hypothesis about risk taking by banks in the two countries. The lower bank concentration and higher level of competition in the US can affect the charter value of the banks, which in turn can induce higher risk taking. On the other hand, banks in the highly concentrated Canadian market would command more market power, earn more revenues and as a result, they would have limited incentives to pursue more profits. This will reduce the incentives to take higher risks in Canada.

Also, Flannery (1998) and Hovakimian and Kane (2000) note that restrictions on bank activities are tools for reducing bank risk. Given the institutional features of the banking sector in the US and Canada, regulatory restrictions exist more in Canada and will affect incentives banks have to take on risk. Actually, regulatory restrictions can either reduce or increase risk. On the one hand, the greater banking freedom (as it exists) in the US can enable banks with low charter value (because of increased competition) to respond more to their high risk taking incentives and allow those banks to broaden diversification opportunities, which in turn can lead to a reduction in risk. On the other hand, the greater banking freedom, which can induce banks' entry into non-traditional areas, can increase the volatility of asset returns. Stronger regulatory restriction in Canada should affect the investment opportunity set of the banks and therefore risk-reducing effects from diversification of banks' asset portfolio will be limited. On the other hand, less banking freedom can curb banks' efforts to diversify into *non-traditional* areas, which in turn can limit the volatility of asset returns. The foregoing discussion suggests that the effects of regulation on bank risk taking can be ambiguous. A less concentrated and more competitive banking system, as exists in the US, would encourage greater risk taking (thus suggesting a negative relationship between degree of regulation and bank risk taking), but at the same time, the less restrictive nature of the regime will allow banks to diversify their asset portfolios and experience lower asset return volatility (thus suggesting a positive relationship between the degree of regulatory restriction and bank risk taking). In this study, we compare the risk taking behavior of Canadian and U.S. banks to investigate how these two factors affected the banking industry during the period leading up to the 2007-08 financial crisis.

### 3 DATA AND METHODOLOGY

#### 3.1 Data

Our sample consists of the six major Canadian banks and a sample of eighteen US banks. The Canadian sample is comprised of Bank of Montreal (BMO), Canadian Imperial Bank of Commerce (CIBC), TD Bank Financial Services (TD), Royal Bank of Canada (RBC), Scotiabank,

and National Bank. This sample represents about 85 percent of bank assets and deposits in Canada. 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 US sample is comprised of 18 banks with assets between \$100 billion and \$800 billion and a diversified range of activities including commercial banking.<sup>3</sup> A list of sample banks is shown in the Appendix. Our sample period ranges from 1995 to 2008. This sample period allows us to examine the risk taking behavior of banks before the financial crisis. Bank specific data is obtained from Bankscope. Bank regulation and supervision survey data, as well as country wide macroeconomic variables from the World Bank. We employ accounting data and bank-specific data to measure risk. Our main measure of risk is the z-score, which we calculated using a five-year rolling window.

### 3.2 Measures of risk taking

We use both bank-specific and accounting-based measures of risk to examine the impact of regulatory regimes on risk-taking by Canadian and US banks. Our accounting-based measures are the z-score, ROA volatility, ROE volatility, the ratio of non-performing loans to gross loans, and solvency ratio. We use the z-score as our main measure of accounting-based risk and the other measures are used for robustness checks. The z-score is defined as the inverse of the probability of insolvency and is estimated as the return on assets plus the capital-to-asset ratio, divided by the standard deviation of return on assets. It measures the distance from insolvency (Roy, 1952). Following Laeven and Levine (2009), we define insolvency as a state where losses surmount equity ( $E < -\pi$ ) (where  $E$  is equity and  $\pi$  is profits), ROA ( $=\pi/A$ ) as return on assets, i.e net income divided by total assets, where  $A$  is total assets,  $\sigma(\text{ROA})$  as the standard deviation of ROA, and CAR ( $= E/A$ ) as the capital-asset ratio. The probability of insolvency can be expressed as  $\text{prob}(-\text{ROA} < \text{CAR})$ . If profits are normally distributed, then  $z$  equals  $(\text{ROA} + \text{CAR})/\sigma(\text{ROA})$ , which is the inverse of the probability of insolvency. Thus,  $z$  indicates the number of standard deviations that a bank's ROA has to drop below its expected value before equity is depleted. A higher z-score indicates that the bank is more stable. For our analysis, we use the natural logarithm of the z-score, which is less skewed and follows the normal distribution.

We use a five-year moving window to calculate the volatility of ROA. 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 calculate ROE as net income divided by the book value of equity. Similar to ROA, the ROE series are winsorized at -100% and +100%, and we use a five-year moving window to calculate the volatility of ROE. The *ratio of non-performing loans* is the ratio of non-performing loans to gross loans. This ratio approximates a bank's exposure to credit risk. Barth et al. (2004) and Gonzalez (2005) use similar ratios to measure bank risk. A

<sup>3</sup> Our sample does not include investment banks such as Goldman Sachs, Merrill Lynch and Morgan Stanley since commercial banking does not constitute their main business activity.

higher ratio indicates a higher exposure to credit risk. *Solvency ratio* is defined as the ratio of shareholders' equity divided by total assets. A higher ratio indicates a decrease in the exposure to credit risk.

### 3.3 Measures of banking systems

We use several variables to capture the basic regulatory differences between the Canadian and the US banking systems as they relate to *structure*, *supervisory responsibility*, *mortgage market*, and *regulatory capital requirements and leverage restrictions*. We use the banking industry concentration ratio, which is available from the World Bank database, as a proxy for the difference in *structure* between the two countries. We use the number of regulators, which is 1 for Canada and 2 for the US as a proxy for the difference in *supervisory responsibility*. To capture differences in the *mortgage market* we use the ratio of non-performing loans over total loans. Our rationale is that more lenient mortgage requirements and higher incentives, through tax deductions for instance to increase mortgages would lead to higher delinquency rates and more non-performing loans. To proxy for differences in *regulatory capital requirements and leverage restrictions*, we use a ratio of debt multiplier as measured by long-term debt over capital.

### 3.4 Survey-based Measures of Financial regulation and supervision

To provide further insight into the differences between the Canadian and the US banking regulatory regime, we use data compiled by Barth, Caprio, and Levine (2001b) and updated by Barth, Caprio and Levine (2006, 2007) and currently available as part of the World Bank databases. The data represents a survey on how banks are regulated and supervised around the world, which is conducted and updated at several points in time for all countries subscribing to the Basel Accords. We use 2001, 2003, and 2007 surveys to construct indices on bank supervision and regulation for the US and Canada. First, we construct a comprehensive index (*Reg\_Index*) that evaluates the regulatory regime by assessing the stringency of the country's bank regulatory and supervisory authorities. We also construct three sub-indices that assess different aspects of the quality of bank regulation and supervision, namely, *Act\_Cap* the index of activities' restrictions, and capital and liquidity requirements; *Ent\_Mkt* the index of entry, market and ownership; and *Super* the index of supervisory power, all of which are expected to have an impact on banks' risk taking.

Most of the survey questions, which cover various aspects of regulation and supervision, require "yes" or "no" answers. Following Delis et al. (2011) and Kodongo (2016), for most questions, we assign a value of "1" for "yes" responses and a value of "0" for "no" responses and sum the values for each regulatory and supervisory aspect. Higher scores indicate higher regulatory stringency. Intuitively, more restrictive entry requirements, higher liquidity and capital requirements, higher supervisory and market powers, and higher restrictions on banks'

activities are expected to reduce banks' incentive to take on high risks. Our empirical framework allows us to test the effect of each of these aspects regulation on risk taking. The questions that are used to construct the composite index and each sub-index are shown in the Appendix.

### 3.5 Methodology

To understand the effects of the main features of banking system in the US and Canada (concentration, supervisory bodies and mortgage features on bank risk taking, we test our preliminary hypotheses by running the following regression:

$$Risk_{i,j,k} = \alpha_0 + \alpha_1 Con\_Ratio_{j,k} + \alpha_2 Numb\_Reg_k + \alpha_3 NonPerfLoans_{i,j,k} + \alpha_4 DebtM_{i,j,k} + u_{i,j,k} \quad (1)$$

where  $Risk_{i,j,k}$  is the *z-score* for bank  $i$  in year  $j$  and country  $k$ ;  $Con\_Ratio_{j,k}$  is the banking industry concentration ratio in year  $j$  and country  $k$ ;  $Numb\_Reg_k$  is the number of prudential regulators of country  $k$ ;  $NonPerfLoans_{i,j,k}$  is the ratio of non-performing loans over gross loans for bank  $i$  in year  $j$  and country  $k$ ;  $DebtM_{i,j,k}$  is the ratio of long-term debt over capital. This regression would allow us to test how the general characteristics of the banking system affect banks' risk-taking.

In order to understand how specific aspects of regulation affect banks' risk-taking, we use the World Bank survey on bank regulation and supervision, to conduct a pooled cross-sectional time series regression analysis on banks' risk-taking. Using individual bank's data and the least squares estimation technique, we estimate the following model for the sample firms:

$$Risk_{i,j,k} = \alpha_0 + \alpha_1 Reg_k + \alpha_2 Reg\_Index_{j,k} + \alpha_3 Reg_k * Reg\_Index_{j,k} + \alpha_4 Size_{i,j,k} + \alpha_5 Leverage_{i,j,k} + \alpha_6 ROA_{i,j,k} + \alpha_7 Int\_Rate_{j,k} + \alpha_8 Risk\_Prem_{j,k} + \alpha_9 GDPG_{j,k} + u_{i,j,k} \quad (2)$$

where  $Risk_{i,j,k}$  is the *z-score* for bank  $i$  in year  $j$  and country  $k$ .  $Reg_k$  is country dummy variable equal to 1 for Canada ( $k=1$ ) and 0 for the US ( $k=0$ ). The inclusion of this variable allows us to capture differences in bank risk-taking by country.  $Reg\_Index$  is a composite index that summarizes regulatory restrictions and requirements in each country. The ratio helps us ascertain whether risk taking depends specifically on the country's regulatory environment. We also control for the impact of bank characteristics that might affect risk taking. These are *Size*, measured as the natural logarithm of the book value of bank assets; *Leverage*, is measured as the ratio of deposit and non-deposit liabilities to total assets; and profitability (*ROA*) is measured as return on assets. Bank stability is also affected by macroeconomic variables such as output growth, inflation, currency, real interest rates, and credit expansion (see for instance, Demirguc-Kunt and Detragiache, 1998). We control for three main macroeconomic variables, namely the equity risk premium, which is defined as the lending rate minus the Treasury bill rate, the real interest rate, and GDP growth rate. Robust standard errors are estimated using Petersen (2009) correction for firm clustering.

## 4 RESULTS

### 4.1 Preliminary results: Univariate analysis

	Canada			USA		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation
<i>Return on Assets (%)</i>	0.639	0.684	0.129	1.154	1.131	1.722
<i>Return on Equity (%)</i>	13.419	13.708	2.513	14.502	15.121	5.080
<i>Solvency Ratio (%)</i>	4.762	4.728	0.225	8.083	8.364	3.440
<i>Loan Loss Reserve over Gross Loans (%)</i>	1.354	1.257	0.291	1.440	1.456	0.979
<i>Non-Performing Loans over Gross Loans (%)</i>	1.333	1.174	0.422	2.198	1.035	3.512
<i>Loan Loss Provision over Interest Revenue (%)</i>	13.285	12.467	0.341	17.268	16.479	9.321
<i>Net Interest Margin (%)</i>	2.066	2.049	0.102	3.341	3.527	2.010
<i>Standard Deviation ROA (%)</i>	0.147	0.120	0.081	0.701	0.367	1.115
<i>Standard Deviation ROE (%)</i>	3.157	2.469	1.698	6.085	4.136	5.574
<i>Total Assets (<math>10^8</math>)</i>	2.08	2.53	1.18	2.45	1.00	3.23
<i>Z-Score</i>	3.983	3.777	0.285	3.515	3.523	0.715
<i>N</i>	84	84	84	252	252	252

**Table 1** Descriptive Statistics. This table shows descriptive statistics of the main variables over the sample period 1995-2008. Statistics are measured using annual data on the six major Canadian banks and eighteen US banks matched by size.

We estimate the mean (median) and difference in mean (median) of five risk measures for Canadian and US banks over our sample period and present the results in Table 2. The results show that the mean (median) *solvency ratio* and *non-performing loans over gross loans* are significantly lower for Canadian banks compared to US banks. We also observe that the mean (median) *standard deviation of ROE* and *standard deviation of ROA* are significantly lower for Canadian banks compared to US banks, which indicates that Canadian banks have lower volatility of returns compared to their US counterparts. The mean (median) *z-score* of Canadian banks is significantly higher than that of US banks, which indicates that Canadian banks are less risky than US banks.

	Canada		USA		Difference in Mean	Difference in Median
	Mean	Median	Mean	Median		
<i>Solvency Ratio (%)</i>	4.762	4.728	8.083	8.364	-3.321*** (4.074)	-3.636** [2.088]
<i>Non-Performing Loans over Gross Loans (%)</i>	1.333	1.174	2.198	1.035	-0.865* (0.907)	0.139*** [0.410]
<i>Standard Deviation ROA (%)</i>	0.147	0.120	0.701	0.367	-0.554** (-2.093)	-0.247*** [2.814]
<i>Standard Deviation ROE (%)</i>	3.157	2.469	6.085	4.136	-2.928** (2.002)	-1.667* [1.724]
<i>Z-Score</i>	3.983	3.777	3.515	3.523	0.468* (1.780)	0.254* [1.722]

**Table 2** Difference in mean (median) tests. This table shows difference in mean (median) tests for Solvency ratio, non-performing loans over gross loans, standard deviation of ROA, standard deviation of ROE, and Z score over the sample period 1995-2008. Differences in mean (median) tests compare the Canadian banks mean (median) statistic to the US banks mean (median) statistic. Satterthwaite-Welch t-test 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.

In summary, the preliminary analysis indicates lower capitalization of Canadian banks compared to US banks, but also lower risk as measured by *standard deviation of ROE*, *standard deviation of ROA*, and *z-score*. Since univariate tests are only suggestive and have no explanatory power, we use multivariate cross-sectional analysis to examine the difference in risk between Canadian and US banks and study the impact of the regulatory regime on bank's risk. The results of the multivariate cross-sectional analysis are presented in the next section.

## 4.2 Multivariate analysis

In this section, we run multivariate cross-sectional regressions using *z-score*, which is our main measure of risk, to examine the difference in risk between Canadian and US banks and how such difference relates to the country's regulatory regime. In order to avoid spurious associations and to better gauge the drivers of banks risk-taking, we conduct the analysis using different specifications.

Table 3 reports regression results of the first regression (1) which represents a preliminary test of the difference in banking system between the US and Canada and its impact on banks' risk-taking. Consistent with our expectations, the univariate regression results indicate that higher industry concentration, a lower number of regulators, and lower ratios of non-performing loans lead to lower bank risk-taking as measured by the z-score. The debt multiplier, however, does not have a significant impact on risk taking. Results of the multivariate specifications (except model (6)) are consistent with the univariate results and indicate that a regulatory

regime characterized by high concentration, a low number of regulators, and restrictions on the mortgage market activities leads to more stable and less risky banks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>c</i>	3.545*** (8.087)	4.545** (2.396)	3.983*** (3.375)	3.952*** (8.333)	4.458*** (8.005)	4.045*** (2.789)	5.719*** (6.954)
<i>Con_Ratio</i>	0.533*** (2.880)					0.145*** (2.672)	-0.668*** (-5.025)
<i>Numb_Reg</i>		-0.461*** (-4.894)			-0.213** (-1.961)		-0.467*** (-5.271)
<i>NonPerfLoans</i>			-0.077*** (-3.287)		-0.091*** (-6.447)	-0.092*** (-6.507)	-0.077*** (-6.053)
<i>DebtM</i>				-0.153 (-0.983)	-0.047 (-0.300)	-0.021 (-0.136)	0.002 (0.224)
<i>R_squared</i>	0.04	0.06	0.05	0.01	0.11	0.12	0.18
<i>N</i>	255	255	255	204	183	183	183

**Table 3** Banking structure and risk taking: This table presents regression results of z-score on the banking industry concentration ratio (*Con\_Ratio*), the number of prudential regulators (*Numb\_Reg*), the ratio of non-performing loans over gross loans (*NonPerfLoans*), and the debt multiplier (*DebtM*). T-statistics appear in parentheses. The symbols \*, \*\* and \*\*\* indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

To better understand how the regulatory regime affects banks' risk taking we use the World Bank survey on banking regulation and supervision to build different indices that would inform us on how different aspects of regulations might affect risk taking. We also use a dummy variable, *Reg*, which is equal to 1 for Canada and 0 for the US to capture the country regulatory regime effect. In the first specification, we examine whether risk-taking is affected by the country dummy variable, *Reg*. In the second regression we explicitly use a composite regulation index, *Reg\_Ind*, constructed using the bank regulation and supervision survey from the World Bank. This composite index illustrates the difference in bank regulatory and supervisory power between Canada and the US based on the World Bank survey. In order to better gauge the impact of the country's regulatory regime on banks' risk, an interaction term *Reg\*Reg\_Ind* is introduced in regression (3). Firm characteristics and macroeconomic variables are added in regressions (4) and (5) to control for other drivers of banks' risk.



	(1)	(2)	(3)	(4)	(5)
<i>c</i>	3.622*** (3.651)	5.567*** (5.811)	-3.988*** (-2.572)	-2.058** (-2.283)	-2.277 (-1.616)
<i>Reg</i>	0.461*** (4.894)	0.215 (1.481)	3.900*** (3.062)	3.737*** (3.456)	2.406*** (2.662)
<i>Reg_Index</i>		-0.069** (-2.045)	1.309*** (2.854)	0.991*** (3.196)	0.574** (2.409)
<i>Reg*Reg_Index</i>			-1.388*** (-3.047)	-1.064** (-3.450)	-0.595*** (-2.605)
<i>Size</i>				-0.209** (-3.804)	-0.135*** (-4.167)
<i>Leverage</i>				0.455 (1.184)	0.421 (0.930)
<i>ROA</i>				-0.300 (-0.223)	0.421 (1.338)
<i>Int_Rate</i>					0.160** (2.018)
<i>Risk_Prem</i>					0.143*** (4.043)
<i>GDPG</i>					0.090** (2.166)
<i>R_squared</i>	0.05	0.07	0.13	0.12	0.24
<i>N</i>	275	255	255	204	204

**Table 4** Effects of the regulatory regime on banks' risk This table presents regression results of z-score on the country dummy (*Reg*), the regulatory composite index (*Reg\_Index*), bank characteristics (size, leverage, *ROA*), and macroeconomic variables (interest rate, risk premium, and *GDP* growth). T-statistics appear in parentheses. The symbols \*, \*\* and \*\*\* indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

When the *z-score* is regressed on the *Reg* dummy (regression 1), we observe that consistent with the univariate test *Reg* is positive and statistically significant, which indicates that Canadian banks are characterized by a higher z-score and therefore lower risk than their US counterparts. When *Reg\_Index* is included in the regression (regression 2) *Reg* coefficient loses its significance, however *Reg\_Index* coefficient is negative and statistically significant. This result seems to be puzzling but is better understood when the interaction variable, *Reg\*Reg\_Ind* is introduced in regression (3). Results of regression (3) indicate that the country's impact as measured by *Reg* is positive, which indicates that Canadian banks are less risky than US banks. The regulatory index, *Reg\_Index*, impact is also positive, which indicates that higher regulation and supervisory power leads to an increase in z-score (decrease in risk). The interaction term, *Reg\*Reg\_Ind*, is negative and statistically significant, which indicates that overall the Canadian regulatory index, as constructed using the World Bank survey, is less stringent than its US counterpart. Our results remain qualitatively the same when firm specific and country-wide control variables are added in regressions (4) and (5).

### 4.3 Regulatory regime and risk: Index decomposition

To better gauge the relationship between banks' risk and the country's regulatory regime, we decompose the index, *Reg\_Index*, into three sub-indices that assess different aspects of the quality of banks' regulation and supervision, namely, *Act\_Cap*, an index that assesses banks' activity restrictions, and capital and liquidity requirements; *Ent\_Mkt*, an index that assesses ease of entry

into the banking market, market power and ownership; and *Super*, an index that measures supervisory power and discipline.

$$\begin{aligned}
 Risk_{i,j,k} = & \alpha_0 + \alpha_1 Reg_k + \alpha_2 Ent\_Mkt_{j,k} + \alpha_3 Act\_Cap_{j,k} + \alpha_4 Super_{j,k} + \alpha_5 Reg_k * Ent\_Mkt_{j,k} \\
 & + \alpha_6 Reg_k * Act\_Cap_{j,k} + \alpha_7 Reg_k * Super_{j,k} + \alpha_8 Size_{i,j,k} + \alpha_9 Leverage_{i,j,k} + \alpha_{10} Int\_Rate_{j,k} \\
 & + \alpha_{11} Risk\_Prem_{j,k} + \alpha_{12} GDPG_{j,k} + u_{i,j,k}
 \end{aligned} \tag{2}$$

Panel A of Table 5 presents descriptive statistics and difference in mean (median) tests between the US and Canada for each sub-index. John et al. (2000) illustrate that if bank regulation concentrates on bank capital ratios then it may be ineffective in controlling risk-taking if banks have high leverage ratios. Higher leverage combined with high asset risk indicates higher moral hazard. Flat deposit insurance system encourages excessive risk taking since premiums are not adjusted (see Merton, 1977). Risk transfer to the insurer occurs when banks exhibit higher risk exposures than the risk category on which the flat rate is based. The lower capital ratios for Canadian banks is consistent with Saunders and Wilson (1999) suggestion that high bank capital levels have been supplanted by increased bank consolidation and safety-net provisions. Size, as a measure of diversification (see Brewer, 1989, among others), is expected to be negatively related to risk.

Panel B of Table 5 presents the results of different specifications that examine the impact of each of these sub-indices on banks' risk taking. Regression (1) results indicate that, in general, higher market power, stringent entry regulations, and higher supervisory power do not necessarily lead to a reduction in risk as measured by z-score, whereas higher restrictions on banks' activity and capital requirements lead to a reduction in risk-taking. These somehow unexpected results can be better gauged when interaction variables are added in regressions (2), (3), and (4). The results of such interactions indicate that the regulatory characteristics of the Canadian banking sector lead to a reduction in risk taking by Canadian banks as shown by the positive and statistically significant coefficient on *Reg\*Ent\_Mkt* and *Reg\_Super*. The negative coefficient on *Reg\*Act\_Cap* interaction indicates that restrictions on bank activities relating to their involvement in securities, insurance, and real estate, and regulatory requirements on capital do not necessarily lead to lower bank risk. On the contrary, these restrictions lead to increase in risk, as they do not allow the banks to enjoy diversification benefits. Consistent with the caution made earlier concerning the results of the interaction of the composite regulatory index and the country dummy the strongly positive effect of the activity restriction sub-index could be driving the positive effect of the composite index in the z-score regression reported in Table 3. This might indicate that regulatory measures have little effect when capital is above

the regulatory minimum. The results remain qualitatively the same when control variables are added in regression 5-7.

Consistent with Barth et al. (2008) restricting bank activities does not reduce risk taking. Banks that are involved in a broad range of activities should find it easier to diversify their income and hence reduce their risk. Besides, fewer regulatory restrictions can increase the franchise value of banks and therefore increase incentives for more prudent behavior.

Panel A							
	Canada		USA		Difference in Mean	Difference in Median	
	Mean	Median	Mean	Median			
<i>Ent_Mkt</i>	10.208	10	7.083	7	3.125*** (9.508)	3*** (8.763)	
<i>Act_Cap</i>	4.333	4	8.625	9	-4.291*** (-8.737)	-5*** (7.549)	
<i>Super</i>	8.833	8	12.208	12	-3.375*** (-9.666)	-4*** (5.037)	
Leverage	0.240	0.265	0.291	0.290	-0.051*** (-3.094)	-0.025** (2.065)	
Panel B							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>c</i>	7.127*** (5.730)	2.842*** (3.966)	2.615** (2.299)	10.747*** (4.570)	5.216*** (3.825)	1.237* (1.847)	7.997*** (3.544)
<i>Reg</i>	3.986*** (3.104)	2.460* (1.857)	7.656*** (5.777)	5.226*** (2.567)	1.581** (2.132)	4.013*** (3.237)	2.447 (1.256)
<i>Ent_Mkt</i>	-0.691** (-2.336)	-1.309*** (-2.854)			-0.575* (-1.796)		
<i>Act_Cap</i>	0.518*** (5.422)		0.735*** (5.522)			0.387*** (2.834)	
<i>Super</i>	-0.242*** (-2.576)			-0.572*** (-3.008)			- 0.275* (- 1.728)
<i>Reg*Ent_Mkt</i>		0.701* (1.820)			0.401 (1.089)		
<i>Reg*Act_Cap</i>			-0.941*** (-4.980)			-0.436*** (-2.498)	
<i>Reg*Super</i>				0.420*** (2.656)			0.230* (1.688)
<i>size</i>					-0.135*** (-2.803)	-0.110*** (-2.429)	0.117*** (- 2.518)

<i>Leverage</i>					0.421* (1.701)	0.442 (1.298)	0.360 (1.015)
<i>ROA</i>					2.018 (1.528)	2.051 (1.631)	2.615* (1.771)
<i>Int_Rate</i>					0.155*** (2.688)	0.170*** (3.227)	0.146** (2.504)
<i>Risk_Prem</i>					0.146*** (3.806)	0.083* (1.895)	0.107** (2.407)
<i>GDPG</i>					0.089* (1.677)	0.105** (2.156)	0.126** (2.401)
<i>R squared</i>	0.23	0.13	0.20	0.17	0.24	0.25	0.24
<i>N</i>	255	255	255	255	204	204	204

**Table 5** Bank regulation and supervision indices and banks' risk. This table presents regression results of z-score on the country dummy (*Reg*), the entry restrictions and market discipline variable (*Entry\_Market*), the activities restrictions and capital requirements variable (*Act\_Cap*), the supervisory power variable (*Super*), bank characteristics (size, leverage), and macroeconomic variables (interest rate, risk premium, and GDP growth). T-statistics appear in parentheses. The symbols \*, \*\* and \*\*\* indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

#### 4.4 Regulatory regime and risk: Sources of risk and z-score decomposition

Our multivariate regression results indicate that a country's regulatory regime has an impact on its banks risk taking as measured by the *z-score*. An improvement in the *z-score*, and thus a reduction in risk, 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 risk we examine how the components of the z-score are affected by the regulatory regime by re-estimating some specifications of Model (3) using ROA, volatility of ROA, and CAR as dependent 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 is calculated as total equity divided by total assets. The results, reported in Table 5, indicate that ROA and the volatility of ROA are the channels through which the different aspects of regulation as measured by the three sub-indices affect risk. Specifically, the results show that the lower risk and the stability experienced by the Canadian regulatory regime emanate from increase in profitability and lower profit variability- product of the concentrated nature of the banking industry, which seems to emphasize scale instead of competition. This effect is however, attenuated by the restrictions on banking activities.

	ROA				CAR				Standard deviation ROA			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>c</i>	0.135*** (3.939)	0.321*** (4.031)	-0.060 (-1.462)	-0.051 (-0.776)	0.152 (1.668)	0.146 (0.804)	0.123* (1.738)	-0.022 (-0.194)	0.021** (-2.528)	0.081*** (-4.286)	0.055*** (5.169)	0.015 (0.515)
<i>Reg</i>	0.139*** (3.606)	0.334*** (4.168)	0.062 (1.523)	0.054 (0.823)	-0.001 (-0.177)	-0.101 (-0.553)	-0.077 (-1.086)	0.068 (0.605)	0.041*** (-4.726)	0.079*** (4.054)	0.054*** (-5.113)	-0.014 (-0.509)
<i>Ent_Mkt</i>	0.034*** (-3.761)	0.043*** (-3.820)			0.013*** (-5.904)	-0.008 (-0.301)			0.008*** (3.587)	0.012*** (4.568)		
<i>Act_Cap</i>	0.004* (1.909)		0.009* (1.897)		-0.005 (-1.311)		-0.004 (-0.432)		0.003*** (-3.998)		0.006*** (-4.688)	
<i>Super</i>	0.007*** (3.007)			0.005 (1.009)	0.006** (2.418)			0.009 (1.011)	0.000 (-0.170)			-0.001 (-0.290)
<i>Reg*Ent_Mkt</i>		0.045*** (3.973)				0.008 (0.308)				0.012*** (-4.371)		
<i>Reg*Act_Cap</i>			-0.008* (-1.700)				0.004 (0.457)				0.006*** (4.775)	
<i>Reg*Super</i>				-0.005 (-0.938)				-0.009 (-1.011)				0.001 (0.339)
<i>R_squared</i>	0.10	0.08	0.11	0.05	0.05	0.02	0.05	0.07	0.17	0.16	0.18	0.17
<i>N</i>	268	268	268	268	268	268	268	268	268	268	268	268

**Table 6** Bank regulation and supervision and sources of risk: z-score components. This table presents regression results of the components of the Z-score for the sample banks using ROA, CAR and Volatility of ROA as the dependent variables. Each dependent variable is regressed on the country dummy (Reg), the entry restrictions and market discipline variable (*Entry\_Market*), the activities restrictions and capital requirements variable (*Act\_Cap*), and the supervisory power variable (Super). T-statistics appear in parentheses. The symbols \*, \*\* and \*\*\* indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

## 4.5 Further Analysis

### 4.5.1 Autocorrelation

By construction, the volatility of ROA and the volatility of ROE suffer from autocorrelation as we use a moving average to estimate the volatility. To reduce the impact of autocorrelation, we restrict our analysis to observations, which are two years apart and hence are less affected by the issue of autocorrelation. The results of this restricted regression are presented in Table 7. The results are consistent with our earlier findings and indicate that higher market power, stringent entry regulations, and higher supervisory power do not necessarily lead to a reduction in risk. The interaction effects and the control variables results are also consistent with earlier findings.

	(1)	(2)	(3)	(4)
<i>c</i>	4.703 <sup>***</sup> (4.822)	2.828 (0.752)	1.704 (1.054)	3.874 <sup>***</sup> (6.515)
<i>Reg</i>	1.819 <sup>***</sup> (3.325)	3.902 <sup>*</sup> (1.803)	5.864 <sup>***</sup> (4.214)	9.925 (1.344)
<i>Ent_Mkt</i>	-0.164 (-1.111)	0.126 (1.239)		
<i>Act_Cap</i>	0.491 <sup>***</sup> (6.652)		0.625 <sup>***</sup> (3.975)	
<i>Super</i>	-0.310 <sup>***</sup> (-4.815)			-0.863 <sup>***</sup> (-5.573)
<i>Reg*Ent_Mkt</i>		-0.363 (-0.587)		
<i>Reg*Act_Cap</i>			-0.625 <sup>***</sup> (-3.975)	
<i>Reg*Super</i>				0.801 <sup>***</sup> (5.591)
<i>size</i>		-0.058 (-1.213)	-0.028 (-0.628)	-0.003 (-0.072)
<i>Leverage</i>		0.716 <sup>**</sup> (2.044)	0.969 <sup>***</sup> (3.089)	0.714 <sup>**</sup> (2.212)
<i>ROA</i>		1.375 (0.613)	0.396 (0.176)	4.334 <sup>*</sup> (1.876)
<i>Int_Rate</i>		0.029 (0.394)	0.075 (1.124)	0.022 (0.319)
<i>Risk_Prem</i>		0.145 <sup>***</sup> (2.747)	0.036 (0.748)	0.017 (0.414)
<i>GDPG</i>		0.153 <sup>**</sup> (2.228)	0.113 <sup>**</sup> (2.160)	0.188 <sup>***</sup> (3.670)
<i>R_squared</i>	0.23	0.15	0.22	0.25
<i>N</i>	255	182	182	182

**Table 7** Autocorrelation and robustness check. This table presents regression results of z-score on the country dummy (*Reg*), the entry restrictions and market discipline variable (*Entry\_Market*), the activities restrictions and capital requirements variable (*Act\_Cap*), the supervisory power variable (*Super*), bank characteristics (*size*, *leverage*), and macroeconomic variables (*interest rate*, *risk premium*, and *GDP growth*). T-statistics appear in parentheses. The symbols \*, \*\* and \*\*\* indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

#### 4.5.2 Aggregate Analysis

To check the robustness of our results, we rerun some of the regressions using a country wide aggregate measure of the z-score. The results are reported in Table 8 and are consistent with the individual firms' results. They indicate that on aggregate the regulatory system has an impact on banks' risk taking behavior and that more stringent regulation on industry entry, stronger market power, and higher supervisory authority lead to lower risk taking by banks.

As a last robustness check, we use standard deviation of ROE as our measure of risk and the results remain qualitatively the same.

	Aggregate Z-score								Standard deviation ROE			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)				
<i>c</i>	35.223** (-2.415)	5.615 (0.923)	-2.061 (-0.465)	13.613*** (3.808)	-3.279*** (-3.126)	10.928*** (2.904)	17.169*** (6.105)	11.284*** (4.727)	15.644*** (6.938)	0.046*** (9.691)	1.558*** (2.683)	0.073*** (-3.447)
<i>Reg</i>	41.911*** (2.964)	9.599** (2.392)	3.769*** (3.628)	3.231 (0.709)	8.320*** (6.424)	5.411 (1.554)	0.703 (0.384)	2.458*** (3.208)	1.396 (0.861)	0.020*** (-4.966)	-1.556 (-2.703)***	0.171*** (-13.191)
<i>Reg_Index</i>	1.409*** (2.782)	0.360** (2.217)									0.054*** (-2.607)	0.030*** (6.796)
<i>Reg*Reg_Index</i>	1.484*** (-2.957)	0.382** (-2.388)									0.055 (2.680)	0.017*** (-6.856)
<i>Ent_Mkt</i>			0.443** (-2.344)	1.405*** (-2.782)			-0.251 (-1.665)					0.004 (1.608)
<i>Act_Cap</i>			1.113*** (3.200)		0.817*** (6.646)			0.237*** (2.674)				
<i>Super</i>			0.628*** (-3.312)			0.587* (-1.930)			-0.152 (-1.143)			
<i>Reg*Ent_Mkt</i>				0.797* (1.875)			0.187*** (1.812)					
<i>Reg*Act_Cap</i>					-1.024*** (-5.349)			0.263*** (-2.626)				
<i>Reg*Super</i>						0.435* (1.721)			0.137* (1.910)			
<i>Size</i>		0.571*** (-4.187)					0.570*** (-4.581)	0.450*** (-4.169)	0.464*** (-3.227)			
<i>Leverage</i>		5.018*** (-2.549)					5.011*** (-3.452)	5.515*** (-4.590)	6.460*** (-4.390)			

<i>ROA</i>		4.391* (1.970)					4.713* (1.863)	3.268 (1.028)	4.974 (0.717)			
<i>Int_Rate</i>		0.091*** (3.290)					0.090*** (3.233)	0.101*** (3.788)	0.083*** (2.987)			
<i>Risk_Prem</i>		0.058** (1.815)					0.057* (1.842)	0.031* (1.888)	0.051 (1.640)			
<i>GDPG</i>		0.036 (1.384)					0.039 (1.410)	0.045* (1.908)	0.062** (2.285)			
<i>R Squared</i>	0.36	0.63	0.71	0.38	0.53	0.29	0.63	0.64	0.62	0.03	0.14	0.20
<i>N</i>	28	28	28	28	28	28	28	28	28	275	275	275

**Table 8** Aggregate analysis and robustness check. This table presents regression results of the aggregate z-score and standard deviation of ROE on the country dummy (*Reg*), the entry restrictions and market discipline variable (*Entry\_Market*), the activities restrictions and capital requirements variable (*Act\_Cap*), the supervisory power variable (*Super*), bank characteristics (size, leverage), and macroeconomic variables (interest rate, risk premium, and GDP growth). T-statistics appear in parentheses. The symbols \*, \*\* and \*\*\* indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

## 5 Conclusion

Over the years, the U.S. and Canada have adopted different regulatory systems. The banking structures in the US can be described as less concentrated (more competitive) and less restrictive banking in the US whereas that of Canada can be characterized as being more concentrated (less competitive) and more restrictive banking system. In the wake of the worst financial crisis, the Canadian banking system was resilient and went through the crisis relatively unscathed. We examine the risk taking behavior of banks in the US and Canada prior to the recent financial crisis. We find that Canadian banks had higher z-score and therefore lower risk than their US counterparts did over the study period. Further analysis shows that entry restrictions, which create concentrated banking, structure, restrictions relating to capital, liquidity and activities, and strong supervisory power and discipline positively influence the z-score, suggesting that these factors constrain excessive risk taking by Canadian banks. We also decompose the z-score into its components and re-estimate our baseline regression with the view to identifying the source of the risk. We find that entry restrictions generate (and higher concentration generate higher profits and lower variability of asset returns for Canadian bank whiles restrictions on activities reduce profitability and increases variability in asset return; however, the former seems to overwhelm the effect of asset restriction, given the lower risk that we observe for the Canadian banks.

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## APPENDIX A: Regulatory Sub-indices

	Variable	Description and Sources
	Regulatory variables	
<b>Act_Cap</b>	Capital and Liquidity Requirements	<p>This index is determined by adding 1 if the answer is yes to questions 1-6 (i.e., yes=1, no=0). The questions are:</p> <ol style="list-style-type: none"> <li>1. Is the minimum capital-asset ratio requirement risk-weighted in line with Basel guidelines?</li> <li>2. Does the ratio vary with a bank's credit risk?</li> <li>3. Does the ratio vary with market risk?</li> <li>4. Before minimum capital adequacy is determined, are these items deducted from the book value of capital? (a) market value of loan losses (b) unrealized securities losses (c) unrealized foreign exchange losses.</li> <li>5. Are there guidelines for asset diversification?</li> <li>6. Are the sources of funds to be used as capital verified by authorities?</li> </ol>
	Activity Restrictions	<p>This index is determined by adding 1 if the answer is yes to the following questions (i.e., yes=1, no=0):</p> <ol style="list-style-type: none"> <li>1. Is the level of such activities restricted: (a) securities activities (b) insurance activities (c) real estate activities (d) bank ownership of nonfinancial firms</li> <li>2. Are banks required to hold either liquidity reserves or any deposits at the central bank</li> </ol>
<b>Ent_Mkt</b>	Entry and Ownership	<p>This index is determined by adding 1 if the answer is yes to questions 1-3 (i.e., yes=1, no=0), and adding 1 if the answer is no for question 4 (i.e., yes=0, no=1). The questions are:</p> <ol style="list-style-type: none"> <li>1. Is there a minimum capital entry requirement?</li> <li>2. Is information on source of funds for capital required?</li> <li>3. Is there a maximum percentage of capital that can be owned by single owner?</li> <li>4. Can borrowed funds be used?</li> </ol>
	Market Discipline	<p>This index is determined by adding 1 if the answer is yes to questions 1-9 (i.e., yes=1, no=0). The questions are:</p> <ol style="list-style-type: none"> <li>1. Does income statement contain accrued but unpaid interest/principal while loan is non-performing?</li> <li>2. Are consolidated accounts covering bank and any non-bank financial subsidiaries required?</li> <li>3. Are off-balance sheet items disclosed to public?</li> <li>4. Must banks disclose risk management procedures to public?</li> <li>5. Are directors legally liable for erroneous/misleading information?</li> <li>6. Do regulations require credit ratings for commercial banks?</li> <li>7. Is there an explicit deposit insurance scheme?</li> <li>8. Is subordinated debt allowable (required) as part of capital?</li> <li>9. Is an external audit compulsory?</li> </ol>

<p style="text-align: center;"><b>Super</b></p>	<p style="text-align: center;">Supervisory Power</p>	<p>This index is determined by adding 1 if the answer is yes to questions 2-12 (i.e., yes=1, no=0), and adding 1 if the answer is no for question 1 (i.e., yes=0, no=1). The questions are:</p> <ol style="list-style-type: none"> <li>1. Is there more than one supervisory body?</li> <li>2. Are auditors legally required to report misconduct by managers/directors to supervisory agency?</li> <li>3. Can legal action against external auditors be taken by supervisor for negligence?</li> <li>4. Are off-balance sheet items disclosed to supervisors?</li> <li>5. The number of onsite visits per year is at least one?</li> <li>6. Is the supervisory agency head appointed by the Ministry of Finance?</li> <li>7. Can the supervisory agency order directors/management to constitute provisions to cover actual/potential losses?</li> <li>8. Can the supervisory agency suspend director's decision to distribute: (a) dividends (b) bonuses (c) management fees</li> <li>9. Can the supervisory agency supercede bank shareholder rights and declare bank insolvent?</li> <li>10. Does banking law allow supervisory agency to suspend some or all ownership rights of a problem bank?</li> <li>11. Does the law establish pre-determined levels of solvency deterioration which forces automatic actions such as intervention?</li> <li>12. Regarding bank restructuring &amp; reorganization, can supervisory agency or any other govt. agency do the following: (a) supercede shareholder rights (b) remove and replace management (c) remove and replace directors</li> </ol>
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**Appendix B: List of Banks**

Canada	USA
<p style="text-align: center;">           Royal Bank of Canada            Toronto-Dominion Bank            Bank of Nova Scotia            Bank of Montreal            Canadian Imperial Bank of Commerce            National Bank of Canada         </p>	<p style="text-align: center;">           Bank of New York Mellon Corporation            Wells Fargo &amp; Company            SunTrust Banks, inc.            PNC Financial Services Group, Inc.            Bank of New York Company, Inc.            Wachovia Corporation            National City Corporation            KeyCorp            FleetBoston Financial Corporation            State Street Corporation            Fifth Third Bancorp            Bank of America Corporation            Washington Mutual Inc.            Citigroup Inc.            Capital One Financial Corporation            US Bancorp            BB&amp;T Corporation            Regions Financial Corporation         </p>