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ORIGINAL ARTICLE

Government guarantees and the risk-taking of financial institutions: evidence from a regulatory experiment

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Abstract
The potential dark side of government guarantees, introduced to mitigate concerns about financial stability during economic downturns, is that they may create incentives for excessive risk-taking. In a low-interest rate environment, this effect may be even stronger as financial institutions try to "reach for yield". In this paper, we use the 2008 introduction of unlimited deposit insurance for all credit unions in the province of British Columbia, Canada, to examine the effect of government guarantees on financial institutions' earnings uncertainty. We find that the policy change resulted in an economically and statistically significant decrease in earnings uncertainty. In addition, although deposits grew following the policy change, lending did not increase and instead capitalization ratios improved. Overall, our results suggest that the provincial government guarantee boosted depositor confidence and increased the flow of funds to the insured financial institutions. We do not find support for the risk-taking hypothesis but instead show that risk management improved following the policy change. Finally, the effect of the policy change was stronger for smaller, more levered credit unions as well as those with fewer members and smaller market share.

Keywords Risk-taking · Deposit insurance · Financial cooperatives · Earnings volatility

JEL Classification G21 · G28 · L31 · G22

Introduction

The popularity of deposit insurance among regulators and policy makers worldwide is based on the widely held view that it increases financial stability. According to the International Association of Deposit Insurers, at the end of 2014, there were 113 countries with an explicit deposit insurance program in place and another 40 counties were either in the process of implementing deposit insurance measures or had some form of implicit guarantees. In addition, as a response to the financial crisis of 2007–2008, many countries such as Germany, Italy, and the USA introduced additional government guarantees to certain types of deposits in order to ensure depositors' confidence. In the countries without explicit deposit insurance, governments faced extreme political pressure to act as guarantors in bank insolvencies in the face of the widespread financial crisis and systemic instability. Demirguc-Kunt et al. (2008) argue that every country offers at least implicit deposit insurance, regardless of how strongly its top officials may deny it.[1] Table 1 shows the

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[1] Private deposit-issuance institutions face the risk of a run on their liquid assets. In times of financial instability, depositors may lose their confidence, so government guarantees can help prevent panic-based runs. Government guarantees, which were introduced in the wake of the financial crisis, still remain in effect in Germany, Italy and the USA. In other countries, such as Australia, Denmark, and Singapore, these guarantees were used as a temporary measure and were left to expire by the end of 2013.

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Table 1 Deposit insurance coverage in the G10 countries

Country	Statutory coverage	Change since 2008		Cooperatives
		Increased coverage	Government guarantee	
Belgium	EUR 100,000	y		*ND*
Canada	CAD 100,000			*D*
France	EUR 100,000	y		*ND*
Germany	EUR 100,000	y	y	*D*
Italy	EUR 100,000		y	*D*
Japan	JPY 10,000,000			*D*
Netherlands	EUR 100,000	y		*ND*
Sweden	EUR 100,000	y		*ND*
Switzerland	CHF 100,000	y		*ND*
UK	GBP 85,000	y		*ND*
USA	USD 250,000	y	y	*D*

The table outlines the explicit deposit insurance programs in the G10 countries for deposit-taking institutions—commercial banks and financial cooperatives (credit unions). The information is from Demirguc-Kunt et al. (2014). *D* (*ND*) indicates that the deposit insurance program for cooperatives is different (not different) from that for the banking system

deposit insurance provisions in the G10 countries for both commercial banks and financial cooperatives (credit unions) and the changes introduced since 2008.

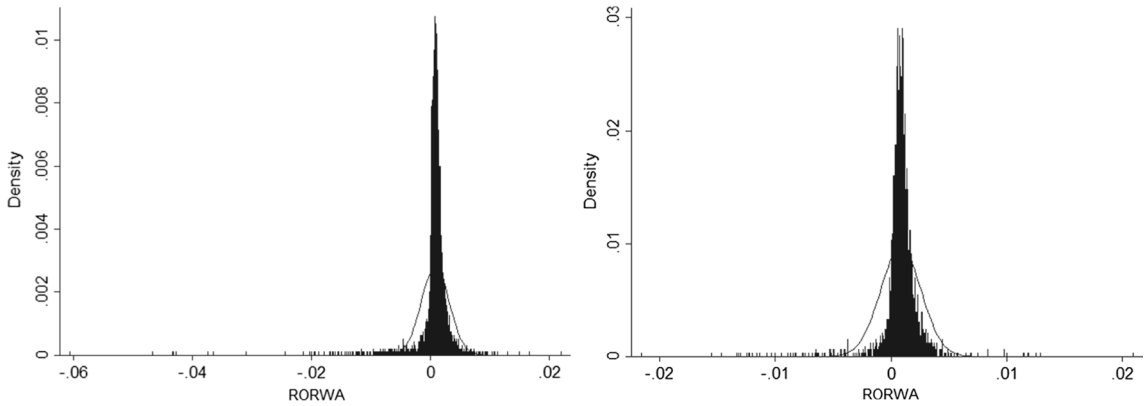
In this paper, we examine the impact of a government guarantee on the risk of financial institutions using a regulatory experiment that changed the deposit insurance design for credit unions incorporated in the Canadian province of British Columbia (BC) in 2008. Credit unions in Canada are provincially regulated cooperatives with deposit insurance schemes varying by province and type of deposit. We use a sample of 107 BC credit unions for the period April 1992 to December 2014. Specifically, we analyze the effect of a policy amendment introduced in November 2008 that offered unlimited protection to credit union depositors in response to the financial crisis.[2] The amendment introduced two key revisions. First, the maximum deposit coverage was increased from $100,000 to unlimited for all eligible deposits. Second, the insurance premium levied was changed from a flat rate to a charge based on the institution's risk ratings.

[2] The implementation of the unlimited deposit guarantee followed a concern that the volatile market conditions might result in some deposits being directed into neighboring provinces which offered unlimited deposit guarantees. There is also some evidence that the regulator responded to the funding constraints that credit unions faced during the 2007–2008 financial crisis. In 2007, Central 1, the entity acting as a clearing house and a lender of last resort for credit unions in BC, reported an increase in net borrowing of more than three times the amount in 2005.

The main rationale for introducing deposit insurance is to minimize the probability of bank runs and financial contagion by providing depositor protection. In addition, explicit deposit insurance can reduce the political pressure to bail out failed financial institutions (see Mortlock and Widdowson 2005). Whether deposit insurance indeed reduces the probability of bank runs and systemic contagion is theoretically ambiguous. In a seminal paper, Diamond and Dybvig (1983) present a model where banks extend long-term loans against demand deposits. In a "good" equilibrium, only depositors who had previously experienced a liquidity shock withdraw funds. In a "bad" equilibrium, however, there is a run on the bank. The authors show that deposit insurance puts an end to the bad equilibrium, since depositors no longer fear losing their money. Deposit insurance can, however, also decrease the incentives for depositors to actively monitor and discipline banks. Acharya et al. (2012) empirically examine deposit flows of distressed banks prior to their failure. Even though overall deposits declined, the failing banks were able to increase insured deposits. The authors conclude that such an increase in insured deposit flows provides evidence that deposit guarantees weaken depositor incentives to monitor.

A large number of papers, beginning with Merton (1977) and Kareken and Wallace (1978), have studied the theoretical moral hazard created by government guarantees and their policy implications. Several studies (for example, Demirguc-Kunt and Detragiache 2002; Wagster 2007; Anginer et al. 2014; Karas et al. 2019) have provided factual evidence of an increase in the propensity of financial institutions to undertake risk-taking activities following the introduction of deposit insurance. However, the overall empirical evidence on the impact of deposit insurance on risk-taking is mixed and varies across jurisdictions, time periods, and deposit insurance design. Demirguc-Kunt and Detragiache (2002) examine the effect of deposit insurance in 60 countries and conclude that explicit deposit insurance decreases bank stability and that the impact is stronger in countries with weak institutional infrastructure. Other papers have argued that deposit insurance does not necessarily lead to an increase in risk-taking behavior or financial instability. Anginer et al. (2014) provide evidence that while introducing deposit insurance leads to an increase in risk-taking activities during "normal" times, it had a strong "stabilizing" effect during the recent financial crisis. Allen et al. (2011) advocate several solutions to mitigate the distortions introduced by deposit insurance, for example risk-based insurance premium pricing, a strong regulatory environment, and various co-insurance mechanisms.

There are several channels through which the regulatory changes in the level of deposit protection and pricing of such protection may affect the uncertainty of financial institutions' earnings. On the one hand, unlimited deposit coverage may strengthen depositor confidence and reduce



(a) $RORWA$ distribution before the policy change **(b)** $RORWA$ distribution after the policy change

Fig. 1 Distribution of return on risk-weighted assets

the probability of panic-based withdrawals. On the other hand, the increase in coverage to unlimited deposit insurance may attract a new flow of funds predominantly from the wholesale market. These wholesale demand deposits may create additional liquidity risk for financial institutions if large withdrawals occur in the future. In addition, the new deposit inflows could result in excessive loan asset growth that could lead to deteriorating asset quality, and therefore to greater long-term earnings uncertainty (see Hess et al. 2009; Foos et al. 2010; Amador et al. 2013). Fully insured depositors may no longer have incentives to monitor and discipline credit unions, and as a result, these institutions may end up taking greater risks and/or investing less resources in improving operational efficiency. In contrast, the change from a flat to a risk-based insurance premium may mitigate these concerns and instead provide incentives for credit unions to adjust risk management practices to optimize the level of risk-taking.

In our empirical analysis, we follow Kuritzkes and Schuermann (2008) and convert credit union's earnings into a return-based measure by dividing (pre-tax) net earnings by risk-weighted assets.[3] We refer to this as the return on risk-weighted assets or RORWA. Figure 1 presents the empirical distribution of our return-based measure, RORWA, at the 99% confidence level before (Panel A) and after (Panel B) the policy change, whereas Figure 2 presents the conditional volatility of RORWA over the whole sample period (before and after the policy change). The figures illustrate the main point of our paper in a simple way. Figure 2 documents the sharp increase in volatility during the 2007–2008 financial crisis. However, both figures indicate that there was a decrease in credit union portfolio risk after the policy change to levels lower than the pre-policy as well as the pre-crisis levels.

Our formal analysis shows that the extreme loss, the left tail (1% or 0.5%) of the empirical distribution of RORWA, after the policy change was smaller than the extreme loss for the pre-policy period at conventional significance levels. Similarly, our regression results demonstrate that, following the changes to the deposit insurance design, there was economically and statistically significant decrease in credit unions' earnings uncertainty. For example, there was a 0.06% decrease in the annualized conditional volatility of RORWA following the introduction of the policy amendment. This change is economically important given that the average volatility over the sample period was 2.99%. In an ideal setting, we would be able to carry out a difference-in-difference estimation, matching credit unions in the province of British Columbia (treatment group) to credit unions headquartered in a province such as Ontario, where the deposit insurance regime remained unchanged (control group).

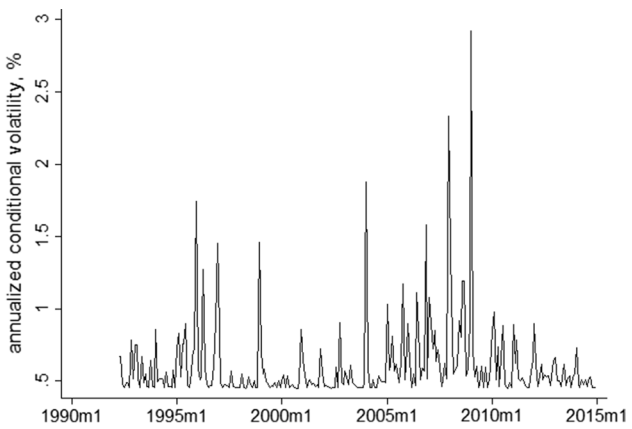


Fig. 2 Conditional volatility of return on risk-weighted assets

[3] Credit unions in BC calculate the risk-weighted assets according to the regulator's Capital Adequacy Return Completion Guide using Basel I risk weights.

Unfortunately, Canadian credit union data are not made public. Instead, we use publicly available data on Canadian commercial banks for which there were no changes in the deposit insurance scheme. Our regression results show that Canadian banks did not experience a decrease in earnings risk during the time period from the policy change to the end of our sample period. Consistent with the hypothesis that stronger deposit insurance provisions increase depositor confidence, we find that following the policy change, deposit and loan growth was stronger for credit unions and the increase was larger relative to the increase for Canadian banks. Similarly, in line with the risk management hypothesis we show that the capital-to-asset ratio of credit unions improved relative to the capitalization ratios of banks. We show that the impact of the policy change was stronger for smaller, less levered credit unions as well as for those with fewer members and smaller market shares.

The literature on the risk-taking of financial institutions focuses primarily on commercial banks and devotes little attention to financial cooperatives.[4] According to Hesse and Cihak (2007), only 0.1% of published research on financial institutions relates to cooperative banking. Our paper complements the existing literature by examining the impact of deposit insurance on the earnings uncertainty of credit unions. The paper closest to ours is Karels and McClatchey (1999), who show that US credit unions do not increase risk-taking behavior after the initial adoption of deposit insurance. Currently, discussions are being held on regulatory reforms to break provincial borders and bring Canadian credit unions under the federal charter.[5] The implementation of such a reform will likely lead to drastic shifts in the regulatory environment governing credit unions. Our paper contributes to this debate by shedding light on how a change in the deposit insurance regime may affect these financial institutions.

Our study examines the incentives created by government guarantees on the behavior of financial institutions. We use two types of measures of risk-taking activities: ex-post and ex-ante. We use conditional and historical volatility (ex-post) as well as the percentage of non-interest income, high-ratio mortgages and the capital-to-asset ratio (ex-ante) as proxies for risk-taking. Estimating default risk for credit unions is problematic as usually these financial institutions are not publicly traded and they resolve financial distress within their own organizations, which means that outsiders cannot observe defaults. Measure of default risk, such as the Merton distance to default, requires market price of equity. Measures such as default probabilities estimated from a statistical model (e.g., logistic regression) require that there are actual defaults.

The remainder of this paper is organized as follows. Section 2 presents the unique features of our setting and discusses the characteristics of the Canadian financial services industry and the regulatory reform used in our study. Section 3 describes the sample data and presents some summary statistics. Section 4 discusses the methodology, whereas the results are discussed in Sect. 5. Finally, Sect. 6 concludes.

Setting

Canadian financial institutions

The Canadian financial system is, in general, highly concentrated, very conservative and heavily regulated with more stringent rules governing leverage and capital ratios than the USA. The Canadian financial services industry has become more concentrated as a result of successive reforms in recent decades. Regular revisions of the Bank Act, coupled with significant changes in the Trust Companies Act and Insurance Companies Act, have accelerated the trend toward increased concentration. Although federal agencies control most of Canada's financial sector, credit unions and life insurance providers are governed by provincial regulations.[6]

In the province of British Columbia (BC), the Financial Institutions Act and the Credit Union Incorporation Act govern how credit unions are formed and operate. Credit unions are required to maintain adequate liquid assets and capital base in relation to their business operations. The Financial Institutions Commission (FICOM) is the governing body that regulates BC credit unions. A BC credit union is required to hold at least 8% of its deposit and other liabilities in an account with Central 1, the clearing house and lender of last resort. This reserve ratio of 8% has remained unchanged since the beginning of 2006. BC credit unions are also required to have a capital base that is at least 8% of their risk-weighted assets prior to any prescribed operational restrictions. In addition, FICOM sets a supervisory capital target of 10%, which has been effective since March 2013.[7]

[4] There is a well-established body of literature, both theoretical and empirical, that deals with bank risk-taking. For an extensive review, see Gorton and Winton (2003).

[5] Coast Capital Savings is the first credit union in BC, the second in Canada, to obtain a federal charter. It became a federal credit union in November 2018.

[6] The Office of the Superintendent of Financial Institutions Canada (OSFI) is the primary regulator and supervisor of federally regulated deposit-taking institutions, insurance companies, and federally regulated private pension plans.

[7] For Liquidity Requirement Regulation, see http://www.bclaws.ca/civix/document/id/loo93/loo93/332_90#section5. For Capital Requirements Regulation, see http://www.bclaws.ca/civix/document/id/loo88/loo88/315_90#section2. For FICOM's supervisory target, see http://www.fic.gov.bc.ca/index.aspx?p=fid/guidelines#cu.

Financial cooperatives differ from commercial banks in several important respects. First, commercial banks are owned by shareholders, who have voting rights based on the class and proportion of shares they hold. Cooperatives, on the other hand, are owned by their members, depositors and borrowers, who have equal voting rights under the one-member-one-vote principle. Unlike commercial banks, financial cooperatives often focus on different objectives and scope of operations and they are often motivated by ideals of solidarity. They operate in specific localities and primarily provide services to individuals and small businesses, and distribute earnings to their members in the forms of higher interest on deposits, lower interest on loans, and cash dividends. In contrast, commercial banks are for-profit entities. They are larger in size, have wider geographic and economic reach and provide services to large, often multinational, corporations as well as individuals and small businesses.[8] However, cooperative financial institutions are an important part of the financial system. They are the main alternative to commercial banks in providing financial services to consumers and small businesses. Currently, one in five Canadians belongs to a credit union. Credit unions fund 12.5% of the residential mortgages in Canada (see Crawford et al. 2013). Moore (2014) reports that the deposit market share of credit unions varies across provinces, from 4% in Ontario to over 30% in Quebec.

Credit unions have specific characteristics that make them highly complementary to the banking sector. For example, credit unions are more efficient than banks in assessing borrower creditworthiness, because they know their members well, and in some cases the members know each other fairly well due to "a common bond" (usually occupational, community or other associational bond) and can impose sanctions on delinquent payers. Unfortunately, evidence suggests that, generally speaking, members are unable to control and discipline credit unions. The one-member-one-vote rule means that the incentive and ability of members to generate sufficient voting power is limited. As a result, member participation in board elections and other key decisions is low (Hillier et al. 2008). This apparent lack of depositor supervision and discipline exacerbates moral hazard problems and increases the probability of runs on credit unions in the event of a loss of confidence among its members (Hessou and Lai 2016).

Credit unions follow a traditional, diversified banking model focused on personal, commercial and mortgage lending that is funded through deposits and retained earnings. This business model is based on the net interest margin between loan assets and deposits. The low-interest rates environment and the resulting decrease in the interest margin over the last 10 years have resulted in credit unions adjusting their balance sheet structure to increase interest earnings and reduce financing costs. Figure 3 shows that over the last 10 years, BC credit unions have reduced their holdings of liquid assets and have increased the proportion of high-ratio mortgages in their portfolios. In terms of sources of financing, credit unions have increased the use of demand deposits and decreased their reliance on term deposits.[9] The credit unions have also sought economies of scale through mergers and acquisitions. Between 1992 and 2014, over 60 consolidations among the credit unions were completed, of which over 40 took place between 1999 and 2005. Only 10% of the mergers were between credit unions of similar size, i.e., the target's total assets were over 60% of the assets of the acquirer. In 85% of the mergers, a smaller credit union was acquired by a much larger credit union, i.e., a credit union that had more than twice its level of total assets.

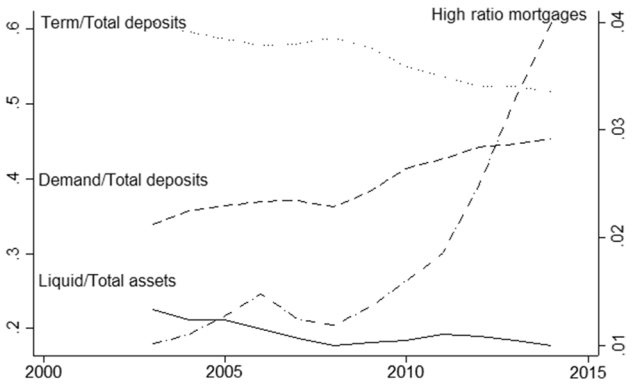


Fig. 3 Assets and liabilities

The regulatory experiment

In November 2008, the BC Provincial legislature passed amendments to the Financial Institutions Act to provide unlimited deposit insurance protection for all credit unions headquartered in British Columbia. The amendment introduced two key revisions. First, the amount of the deposit coverage was increased from $100,000 to unlimited deposit insurance protection for all for eligible deposits. The regulatory change placed the credit unions in BC on par with the credit unions in the province of Alberta. The deposit insurance limits, however, remained at a maximum of $100,000 in Ontario, and $250,000 in Quebec.

[8] The assets of the Royal Bank of Canada, the largest Canadian bank, are almost five times the assets of Desjardins, the largest federation of credit unions in Canada.

[9] Compared to banks, the credit unions are still more reliant on term deposits rather than demand deposits.

Table 2 Summary statistics

	Mean	Median	SD	1%	99%
Panel A: Assets					
Total assets ($millions)	477.50	95.97	1547.00	0.36	9485.34
Liquid assets	20.30%	17.39%	10.39%	8.32%	57.38%
Net loans	76.80%	79.48%	10.24%	40.89%	89.73%
High-ratio mortgages	1.32%	0.13%	2.85%	0.00%	14.94%
Nonperforming loans	0.98%	0.73%	0.95%	0.00%	4.46%
Panel B: Liabilities and capital ratio					
Total deposits ($millions)	425.37	89.48	1349.48	0.34	8371.78
Demand deposits	33.93%	33.35%	13.32%	0.00%	69.15%
Gap ratio: variable rate	48.27%	46.08%	29.91%	0.94%	100.00%
Gap ratio: fixed rate	40.57%	40.04%	23.28%	0.83%	90.25%
Capital-to-asset ratio	5.71%	5.55%	1.57%	2.68%	11.36%
Panel C: Incomes and returns					
Net income ($millions)	0.188	0.032	0.969	− 0.420	3.936
Non-interest income	12.22%	12.63%	37.46%	− 0.01%	34.52%
RORWA	0.88%	1.09%	8.93%	− 10.94%	6.96%
Volatility of RORWA	2.99%	0.64%	20.28%	0.18%	13.01%
Panel D: Governance indicators					
Membership	22,329	7381	56,356	246	372,613
Market share	1.46%	0.38%	3.78%	0.00%	23.35%
Score on senior management	3.058	3.000	0.589	2.000	4.000
Score on board oversight	2.785	3.000	0.502	1.000	4.000

The table presents summary statistics for 107 credit unions in BC, Canada for the period from April 1992 to December 2014. All balance sheet and income statement variables are monthly; returns (RORWA) and the volatility of returns are annualized. The variable definitions are in "Appendix 1"

The second amendment changed the pricing of insuring credit union deposits. Prior to the amendment, all credit unions were charged an insurance premium that was a flat rate on the insured deposits. The amendment imposed a variable insurance premium. The premium is now calculated based on the institution's risk rating, which is assigned by the regulator who takes into account the on-site supervisory examinations, as well as other quantitative risk factors. The objective of this second change to the legislation was to provide incentives for credit unions to manage their operations efficiently and avoid excessive risk-taking. In addition, the regulatory change aligned the same prudential, risk-based approach to determine insurance costs for all BC credit unions.

Data and summary statistics

Our sample contains proprietary financial information for 107 Canadian credit unions, incorporated in the province of British Columbia, for the period April 1992 to December 2014. The data include information from the monthly financial reports, including balance sheets and income statements as well as other statistics such as the amount of loans in arrears, unfunded loans and the number of depositor-members. Several data items are reported quarterly, e.g., variable- and fixed-rate assets and liabilities. The final sample consists of 18,682 credit union-month observations.

We also collect data for all Canadian banks from the Office of the Superintendent of Financial Institutions for the period January 1996–December 2014. Consolidated balance sheet statements are available monthly, and consolidated comprehensive income statements are available at quarterly frequency. Data for the daily stock returns for each bank for the sample period are from Bloomberg.[10] To measure banks' corporate governance provisions, we use an index produced by The Globe and Mail. The Globe and Mail conducts an annual corporate governance survey, the Report on

[10] Unfortunately, since the number of Canadian commercial banks is small and banks have very different characteristics from the credit unions, we are unable to match banks to credit unions. There are 21 publicly traded commercial backs in Canada. However, the six largest banks own 97% of total bank assets. Also, instead of earnings-based return volatility, we use the volatility of daily stock returns to measure bank's risk.

Business, and uses it as a ranking system of corporate governance effectiveness for publicly listed firms in Canada.[11]

Table 2 presents summary statistics for the credit unions in our sample.[12] The table shows that the credit unions in our sample are both small and have fairly low level of risk. The average (median) credit union has CAD$477.50 ($95.97) million in total assets. However, there is a wide variation in size with the bottom decile of credit union size of only CAD$12.29 million and the top decile of CAD$990.16 million. The average (median) credit union holds 20.30% (17.39%) of its total assets in cash or other liquid assets (*Liquid assets*), and 76.80% (79.48%) in loan assets (*Net loans*). Residential mortgages are the main category of loan assets for credit unions, representing 70.5% of all loan assets. A loan with a loan-to-value ratio above 75% is considered a high-ratio loan. Most of the high-ratio mortgages are insured. The uninsured high-ratio loans are on average 2.34% of total residential mortgages, or 1.32% of total assets. For the average (median) credit union, nonperforming loans, i.e., loans that are at least 30 days past due and are not yet written off as assets, are 0.98% (0.73%) of total assets. On the liability side, the average credit union holds CAD$425.37 million in deposits, 33.93% of which are demand deposits (*Demand deposits*). *Gap ratio* measures the balance sheet mismatch. For variable-rate assets and liabilities, the mean (median) gap ratio is 48.27% (46.08%). For fixed-rate assets and liabilities with 4–6 months to maturity, the mean (median) gap ratio is 40.57% (40.04%). The average (median) capital-to-asset ratio is 5.71% (5.55%).

In Panel C of Table 2, the average monthly net income is $0.188 million. Non-interest income is 12.22% of total net income. The annualized mean (median) monthly return on risk-weighted assets is 0.88% (1.09%), and the annualized volatility of the return on risk-weighted assets over the sample period has an average of 2.99%. In Panel D, the average credit union has 22,329 members, and 1.46% of the market share in terms of deposits. The scores on senior management and board oversight are ratings assigned to the credit unions by the regulators based on site visits and supervisory examinations. The highest score is 4; the lowest is 1. The average score is 3.058 for senior management, and 2.785 for board oversight.

Research design

As discussed in the previous section, we use the return on risk-weighted assets $RORWA_{i,t} = \frac{NI_{i,t}}{RWA_{i,t}}$ as a measure of credit union *i*'s earnings during time period *t*. *NI* is net income and *RWA* is the dollar value of the risk-weighted assets. We begin with a Value-at-Risk analysis and compare the left tail (1% and 0.5% of extreme negative values) of the empirical distribution of RORWA before and after the policy change. Then, we estimate linear regression models of measure of ex-post earnings uncertainty to examine the effect of the change in deposit insurance on credit union risk-taking.

We estimate the following model:

$$Risk_{i,t} = \alpha_i + \beta \times DI_t + \gamma \times Control\ variables_{i,t} + \theta \times Year_t + \epsilon_{i,t} \quad (1)$$

We use two measures for *Risk*. The first measure is the conditional volatility of RORWA derived from a GARCH(1,1) model. The second measure is the historical volatility of RORWA.[13] *DI* is a dummy variable that equals one for time periods after the change in the deposit insurance program and 0 otherwise. A positive β indicates that on average the change is associated with higher earnings uncertainty, whereas a negative β indicates that the change is associated with lower uncertainty. *Control variables* include credit union size (measured as the logarithm of total assets), liquid assets as a fraction of total assets, and net loans-to-asset ratio as a measure of credit unions' asset-liability structure (see Efing et al. 2015 for details). Additional control variables that capture size and governance are membership measured as the logarithm of the number of depositor-members, market share of total deposits, and the governance scores on senior management and board oversight. Equation (1) also controls for credit union and year fixed effects.

Next, we examine the possible channels through which the change in deposit insurance may have affected credit unions' earnings uncertainty. We hypothesize four channels: (1) depositor confidence: the increase in insurance coverage increases depositors' confidence and therefore prevents panic-driven deposit withdrawals; (2) risk-based premium: the risk-based insurance premiums may discourage excessive risk-taking; (3) moral hazard: in the absence of incentives, depositor-shareholders may be unwilling to monitor and discipline credit unions, and as a result increase risk-taking and/or decrease operating efficiency; (4) new deposit influx: a surge of new funds into the credit union system may create additional liquidity risk.

[11] The Globe and Mail rankings are based on four key factors that were considered to be critical to corporate governance effectiveness: board composition (out of 40), board compensation (out of 23), shareholder rights (out of 22), and public disclosure (out of 15). These scores are added to determine a total score.

[12] The variable definitions are in "Appendix 1" to this paper.

[13] The historical volatility for a given month is estimated as the volatility of the return on risk-weighted asset during the previous 36 months. We scale both the conditional and the historical volatility so that we can compare coefficients across regression specifications. Both the conditional and the historical volatility are estimated from monthly returns. In the regressions, they are annualized and are scaled by 100.

To examine the effect of these channels, we first compare the deposit and loan growth as well as the loan quality for the sample of credit unions versus a sample of Canadian commercial banks for the period before and after the deposit insurance policy change. Note that the deposit insurance policy change did not affect Canadian commercial banks. Then, we examine the effect of the policy change on alternative measures of ex-ante risk-taking as the dependent variable in Eq. (1). In particular, we use the proportion of non-interest to total income, the proportion of high-ratio to total mortgages, and the capital-to-asset ratio.

We also examine how the effect of the change in deposit insurance program varies across different financial cooperatives. First, we test whether the policy change had a different effect on large versus small credit unions. Previous studies have shown that, in the context of banks, size matters in terms of the effect of financial regulations on these institutions. We argue that large institutions have better access to resources and are more resilient to changes in the economic and regulatory environment. Also, the deposit insurance is more likely to improve depositors' confidence for smaller credit unions. As a result, the change would have a stronger effect for smaller institutions. However, from a market discipline point of view, larger institutions are monitored closely by the regulators, whose monitoring efforts would not change after the policy is implemented. This, to some degree, mitigates the moral hazard issues associated with deposit insurance. We estimate the following model:

$$Risk_{i,t} = \alpha_i + \beta \times DI_t + \delta \times DI_t \times \text{SMALL}_{i,t} + \gamma \times Control\ variables_{i,t} + \theta \times Year_t + \epsilon_{i,t} \quad (2)$$

where SMALL equals to 1 if the size (logarithm of total assets) of a credit union is below the sample median during a 3-year period before the policy change, and 0 otherwise. The rest of the variables are the same as in Eq. (1).

We examine whether credit unions with higher leverage reacted differently to the changes in the deposit insurance program. Le (2013) shows that after the introduction of deposit insurance, an increase in leverage drives an increase in risk-taking for banks. However, the banks that were highly levered before the deposit insurance adoption did not respond to the policy change. Highly levered institutions may not be able to further increase leverage (risk-taking), because regulators often monitor these financial institutions' capitalization very closely. However, new depositors/investors may still prefer well-capitalized credit unions even though their deposits are fully covered by the deposit insurance program. We estimate the following model:

$$Risk_{i,t} = \alpha_i + \beta \times DI_t + \delta \times DI_t \times \text{LOWLEV}_{i,t} + \gamma \times Control\ variables_{i,t} + \theta \times Year_t + \epsilon_{i,t} \quad (3)$$

Table 3 Left tail of the mean-adjusted return on risk-weighted assets

	1992–2014	Before	After
Panel A: All credit unions			
Number of observations	18,575	15,271	3,304
Confidence level			
99%	− 0.98%	− 1.02%	− 0.69%
99.5%	− 1.40%	− 1.56%	− 1.06%
99.9%	− 4.33%	− 4.41%	− 1.49%
Panel B: Subsample of credit unions			
Number of observations	12,808	9504	3304
Confidence level			
99%	− 0.82%	− 0.84%	− 0.69%
99.5%	− 1.18%	− 1.21%	− 1.06%
99.9%	− 2.23%	− 2.53%	− 1.49%

The table presents the quantiles representing extreme losses from the empirical distribution of the mean-adjusted return on risk-weighted assets. The values are constructed for three time periods. The 1992–2014 is the whole sample period—April 1992 to December 2014. Before includes the period before the change in deposit insurance—April 1992 to October 2008. After includes the period after the change—November 2008 to December 2014. In Panel A, the returns distributions are constructed using all credit unions, whereas Panel B uses a balanced subsample of credit unions that remain active after the policy change, i.e., after October 2008

where LOWLEV equals to 1 if the leverage ratio of a credit union is below the sample median during a 3-year period before the policy change, and 0 otherwise.[14] The rest of the variables are the same as in Eq. (1).

Finally, we examine whether credit unions' response to the policy change depends on their relative importance. Governments are often under pressure to bail out large financial institutions. The explicit deposit insurance should have a smaller effect for these credit unions. We use membership and market share in terms of deposits as two proxies of the importance of credit unions. The failure of a credit union will affect more people if it has a large member base. Similarly, a larger dollar amount deposits will be affected if a credit union with a larger share of the deposit market fails. To examine the impact of such importance on credit unions' response to the policy change, we augment Eq. (1) to include the interaction term between *DI* and membership or market share.

$$Risk_{i,t} = \alpha_i + \beta \times DI_t + \delta \times DI_t \times IMPORTANCE_{i,t} + \gamma \times Control\ variables_{i,t} + \theta \times Year_t + \epsilon_{i,t} \quad (4)$$

where *IMPORTANCE* is either the (logarithm of) number of depositor-members or the market share of the credit union.

[14] The leverage ratio is calculated as $1 - \frac{capital}{assets}$. For robustness check, we use risk-weighted assets in place of total assets and exclude other liabilities in the calculation. The results remain the same.

Table 4 Deposit insurance and credit union risk

	(1)	(2)	(3)	(4)	(5)
Panel A: Conditional volatility of RORWA					
DI	− 0.0553***	− 0.0539***	− 0.0553***	− 0.0564***	− 0.0583***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size		0.0450	0.0986*	0.1025***	0.1563**
		(0.185)	(0.096)	(0.005)	(0.037)
Liquid assets		1.8435*	1.6209	2.7429**	2.5431**
		(0.081)	(0.116)	(0.026)	(0.035)
Net loans		1.9464*	1.7340*	3.0952**	2.8907**
		(0.069)	(0.097)	(0.012)	(0.015)
Membership			− 0.0850		− 0.0424
			(0.218)		(0.653)
Market share			− 1.1874		− 3.0256***
			(0.103)		(0.001)
Governance score: management				− 0.0570***	− 0.0476**
				(0.001)	(0.036)
Governance score: board				− 0.0230	− 0.0278
				(0.299)	(0.255)
Number of observations	12,091	12,091	12,091	8,691	8,691
Adjusted R^2	0.450	0.450	0.450	0.362	0.362
Panel B: Historical volatility of RORWA					
DI	− 0.0016***	− 0.0078***	− 0.0084**	− 0.0040*	− 0.0024
	(0.000)	(0.003)	(0.012)	(0.054)	(0.380)
Size		0.0461	0.0700	− 0.0545*	− 0.1217
		(0.163)	(0.425)	(0.068)	(0.153)
Liquid assets		− 0.8228	− 0.8265	− 0.5179	− 0.4919
		(0.354)	(0.360)	(0.449)	(0.484)
Net loans/assets		− 1.4837	− 1.4844	− 1.0587	− 1.0387
		(0.131)	(0.135)	(0.168)	(0.182)
Membership			− 0.0275		0.0861
			(0.822)		(0.495)
Market share			− 0.2275		0.2182
			(0.733)		(0.769)
Governance score: management				− 0.1139**	− 0.1214**
				(0.024)	(0.013)
Governance score: board				0.0791***	0.0829***
				(0.007)	(0.003)
Number of observations	14,947	14,947	14,947	11,344	11,344
Adjusted R^2	0.680	0.683	0.683	0.563	0.563

The table presents the results from the estimation of regression Eq. (1). In Panel A, the dependent variable is the conditional volatility of the return on risk-weighted assets (RORWA) estimated from a GARCH(1,1) model. In Panel B, the dependent variable is the historical volatility of RORWA calculated using a 3-year rolling window. *DI* is a dummy variable that equals to 1 for time periods after the change in deposit insurance and 0 otherwise. The rest of the variables are defined in "Appendix 1". All regressions are estimated with credit union and year fixed effects. *p* values based on robust standard errors clustered by union are reported in brackets. *, **, and *** denote 10%, 5%, and 1% significance level, respectively

Table 5 Deposit insurance regression for Canadian banks

	(1)	(2)
DI	− 0.0278	0.0236
	(0.588)	(0.840)
Size		− 0.0046
		(0.971)
Liquid assets		− 0.0515
		(0.667)
Net loans		− 0.5573
		(0.137)
Market share		0.3997
		(0.662)
Governance score		− 0.6090**
		(0.038)
Number of observations	584	424
Adjusted R^2	0.020	0.107

The table presents the results from the estimation of regression Eq. (1) for the sample of Canadian banks. The data are quarterly from 1994 to 2014. The dependent variable is the conditional volatility of stock returns estimated from a GARCH(1,1) model. The variables definitions are the same as for the credit unions (see "Appendix 1"). The governance score is a governance index constructed by the Globe and Mail. All regressions are estimated with bank fixed effects. *p* values based on robust standard errors are reported in brackets. *, **, and *** denote 10%, 5%, and 1% significance level, respectively.

The rest of the variables are the same as in Eq. (1). The next section discusses the results from our empirical analysis.

Estimation results

Baseline model: the overall effect of the policy change

Table 3 presents the quantiles of the left tail of the empirical distribution of the mean-adjusted return on risk-weighted assets, RORWA. Panel A includes all credit unions, whereas Panel B only includes the credit unions remaining active after the change in the deposit insurance program.[15]

In Panel A, the 99 percentile of RORWA for the full sample is − 0.98%, i.e., 99% of the time, the monthly earnings did not fall below 0.98% of the average earning. The value is − 1.02% for the time period before the change, and − 0.69% after the change. The table shows that (for conventional confidence levels) RORWA quantiles for the time period after the change are much larger than the values for the time period before the policy change. In Panel B, the extreme loss after the change at each confidence level is again smaller than that before the change, although the difference between the two periods is smaller.

Table 4 presents the results from the estimation of Eq. (1). All specifications are estimated with credit union and year fixed effects and robust standard errors. In Panel A, the dependent variable is the annualized conditional volatility of RORWA derived from a GARCH(1,1). The coefficients for *DI* are negative and significant for all regression specifications. In column (5) (the complete specification) the policy change is associated with 0.0583% decrease in the annualized conditional volatility of RORWA. The coefficients are consistent across different specifications. In Panel B, the dependent variable is the historical volatility of RORWA calculated as the annualized standard deviation of monthly returns using a 3-year rolling window. The results are consistent with those in Panel A.

Next, we run the regression in Eq. (1) for the sample of Canadian banks instead of the credit unions. The definitions of all variables are the same as for the credit unions (see "Appendix 1"), except that there is no variable representing the membership and corporate governance provisions are measured by The Globe and Mail governance index. The dependent variable is the conditional volatility of daily stock returns estimated from a GARCH(1,1).[16] Table 5 presents the estimation results. The coefficient of the *DI* dummy is statistically insignificant. This is as expected. It suggests that the change in deposit insurance design had an effect on credit unions above the existing policy, and did not affect the Canadian commercial banks that are under a different federal deposit insurance regime.

Deposit insurance design: channels and credit union characteristics

Table 6 compares the deposit and loan asset growth and loan quality of the credit unions versus those of commercial banks. In Panel A, the total deposit growth rate for credit unions is on average 7.72% lower than the deposit growth rate for banks during the full sample period. In the time period after the policy change, both credit unions and banks exhibited slower deposit growth. This of course is due to the 2007–2008 financial crisis. However, deposit growth at credit unions was stronger when compared to the growth rate for banks. After controlling for the change in deposits growth rate at banks, the deposits growth rate at credit unions after the policy change is 14.81% higher than the

[15] Due to a sharp decline in the number of credit unions in recent years, we re-estimate all models with a balanced sample to control for possible attrition bias. The results remain the same.

[16] We use daily stock return to estimate daily conditional volatility, and take the average during a given quarter. Then we scale it to a monthly measure in order to align the measure with the measure for credit unions.

Table 6 Deposits and loans, before and after the policy change

	Deposits			Demand deposits		
	Cu	Bank	Cu–bank	Cu	Bank	Cu–bank
Panel A: Deposit growth						
All years	8.01%***	15.74%***	− 7.72%***	8.82%***	17.66%	− 8.84%***
Before the change	8.69%***	18.64%***	− 11.54***	8.59%***	17.53%***	− 8.94%***
After the change	5.02%***	7.11%***	− 2.09%	9.85%***	18.17%***	− 8.33%***
After–Before	− 3.67%***	− 11.53%***	14.81%***	1.26%	0.64%	7.45%***
	Loans			Loan commitments		
	Cu	Bank	Cu–bank	Cu	Bank	Cu–bank
Panel B: Loan growth						
All years	8.54%***	9.55%***	− 1.02%	14.62%***	8.36%***	6.26%***
Before the change	9.37%***	10.74%***	− 1.36%	16.82%***	7.32%***	9.50%***
After the change	4.83%***	5.82%***	− 0.99%	5.27%***	10.39%**	− 5.11%*
After–Before	− 4.55%***	− 4.92%**	4.49%*	− 11.55%***	3.07%	− 13.14%**
	Nonperforming loans					
	Cu		Bank	Cu–bank		
Panel C: Loan quality						
All years	0.98%***		1.75%***	− 0.76%***		
Before the change	1.01%***		2.08%***	− 1.07%***		
After the change	0.85%***		0.92%***	− 0.08%		
After–Before	− 0.08%		− 3.30%	3.22%		

The table compares the deposit growth, loan growth, and loan quality at credit unions and commercial banks for the period 1996–2014. Variables definitions are in "Appendix 1"

*, **, and *** denote 10%, 5%, and 1% significance level, respectively, and are based on *p* values from *t* tests for differences in means

Table 7 Alternative risk measures

	(1) Non-interest income	(2) High-ratio mortgage	(3) Capital-to-asset
DI	0.0135***	0.0001**	0.0006***
	(0.000)	(0.035)	(0.000)
Size	− 0.0530***	0.0040	− 0.0211***
	(0.000)	(0.173)	(0.000)
Liquid assets	− 0.6455***	− 0.0437	0.0820***
	(0.000)	(0.144)	(0.000)
Net loans	− 0.7355***	− 0.0345	0.0961***
	(0.000)	(0.248)	(0.000)
Membership	0.0546***	0.0074**	0.0190***
	(0.000)	(0.033)	(0.000)
Market share	− 0.0661	0.1614***	− 0.1217***
	(0.485)	(0.001)	(0.000)
Governance score: management	− 0.0010	− 0.0040**	− 0.0040***
	(0.830)	(0.019)	(0.000)
Governance score: board	0.0039	0.0027**	− 0.0033***
	(0.382)	(0.024)	(0.000)
Number of observations	13,094	13,144	13,144
Adjusted R^2	0.273	0.648	0.769

The table presents the results from the estimation of regression Eq. (1). Alternative risk measures are used as the dependent variable in each column. *DI* is a dummy variable that equals to 1 for time periods after the change in deposit insurance and 0 otherwise. The rest of the variables are defined in "Appendix 1". All regressions are estimated with credit union and year fixed effects. *p* values based on robust standard errors clustered by union are reported in brackets

*, **, and *** denote 10%, 5%, and 1% significance level, respectively

rate before the policy change. The pattern is similar for demand deposit growth. After controlling for the growth rate at banks, the credit unions' demand deposit growth rate after the policy change is 7.45% higher than the rate before the change.

In Panel B of Table 6, credit union loan growth rate after the policy change was 4.49% higher than the rate before the change when compared to the change in banks loan growth for the same two period. Taken together with the deposit growth results, this is consistent with the hypothesis that the increase in deposit insurance coverage enhanced depositors' confidence and attracted new flow of funds to credit unions, which then the unions used to increase lending. Also in Panel B, the credit unions have stronger growth in loan commitments than the banks do only in the time periods before the policy change. After the policy change, the control growth rate is 13.14% lower than the rate before the change, suggesting that credit unions slowed down in extending new credit lines. Loan commitment is a form of liquidity insurance. It imposes liquidity risk to the credit unions that provide cash on demand to customers. The slowed expansion of loan commitments can be an indication that credit unions have improved their risk management.

Panel C of Table 6 shows that on average credit unions have lower proportion of nonperforming loans when compared to banks. The ratio of nonperforming loans to total loans is 0.76% lower for credit unions. There is no significant shift in the ratio for both credit unions and banks after the policy change. Overall, our results suggest that credit unions experienced deposit influx as a result of the policy change. They transform the funds into loan assets. In addition, credit unions were exposed to lower liquidity risk in the form of loan commitments and they maintained the quality of their loan assets.

Table 7 reports the effect of the change in deposit insurance program on alternative measures of ex-ante risk-taking. In column (1), the *DI* dummy is associated with more income diversification at the credit unions. *Size* has a negative effect on non-interest income, which is the opposite of the expectation. Credit unions with more liquid assets and net loans have less non-interest income, whereas the credit unions with more members have more non-interest income. In column (2), the policy change is associated with more high-ratio mortgages. The effect of *DI* is statistically significant at the conventional level, but is not economically large. The change in deposit insurance program is associated with a 0.01% increase in the high-ratio mortgages, but this effect

Table 8 Impact of credit union characteristics

	(1)	(2)
Panel A: Conditional volatility of RORWA		
DI	− 0.0609***	− 0.1250***
	(0.000)	(0.000)
DI * SMALL	− 0.0047*	
	(0.068)	
DI * LOWLEV		0.1367***
		(0.000)
Size	0.1557**	0.1583**
	(0.039)	(0.034)
Liquid assets	2.6226**	2.8483**
	(0.034)	(0.023)
Net loans	2.9527**	3.2018***
	(0.016)	(0.010)
Membership	− 0.0357	− 0.0433
	(0.709)	(0.652)
Market share	− 3.0547***	− 1.8276**
	(0.001)	(0.026)
Governance score: management	− 0.0483**	− 0.0625***
	(0.038)	(0.010)
Governance score: board	− 0.0283	− 0.0287
	(0.282)	(0.215)
Number of observations	8,520	8,520
Adjusted R^2	0.361	0.362
Panel B: Historical volatility of RORWA		
DI	− 0.0229	− 0.0034
	(0.554)	(0.900)
DI * SMALL	− 0.0131	
	(0.605)	
DI * LOWLEV		0.0006
		(0.992)
Size	− 0.1115	− 0.1067
	(0.204)	(0.231)
Liquid assets	− 0.4068	− 0.3931
	(0.547)	(0.564)
Net loans/assets	− 0.9969	− 0.9813
	(0.186)	(0.190)
Membership	0.1010	0.1025
	(0.412)	(0.405)
Market share	− 0.0003	− 0.0073
	(1.000)	(0.992)
Governance score: management	− 0.1252***	− 0.1232**
	(0.009)	(0.011)
Governance score: board	0.0857***	0.0840***
	(0.003)	(0.004)
Number of observations	11,086	11,086
Adjusted R^2	0.573	0.573

The table examines the impact of credit union characteristics. SMALL is 1 for credit unions with average assets below the sample median during the 3-year period before the change in deposit insurance design, and 0 otherwise. LOWLEV is 1 for credit unions with average leverage ratio below the sample median. The rest of the variables are defined in "Appendix 1". All regressions are estimated with credit union and year fixed effects. *p* values based on robust standard errors clustered by union are reported in brackets

*, **, and *** denote 10%, 5%, and 1% significance level, respectively

is very small with only 0.003 standard-deviation increase. Finally in column (3), the policy change has a significantly positive effect on the capital-to-asset ratio. Taking together, the results suggest that the change in deposit insurance program increased credit unions' income diversification and capital ratio, both of which contributed to the lower overall risk at these financial institutions.

Next, we examine how the effect of deposit insurance varies with credit union characteristics. Column (1) of Table 8 presents the estimation results from regression equation (2). The coefficients of *DI* and the interaction term between *DI* and SMALL are both significantly negative. The policy change had a greater effect on smaller credit unions; the effect of *DI* on the annualized conditional volatility of RORWA for the small group is 0.0047% higher than the effect for the large group. This is consistent with our hypothesis that larger credit unions are more resilient to changing economic conditions and that depositors already have more confidence in these credit unions. As expected, the effect of the policy change for larger credit unions was smaller than for smaller credit unions. The coefficients of the control variables are consistent with those in Table 4.

Column (2) of Table 8 includes the estimation results from equation (3). The coefficient of *DI* is significantly negative, while the coefficient of the interaction term between *DI* and LOWLEV is significantly positive. For credit unions with higher ex-ante leverage, the policy change decreased the annualized conditional volatility by 0.125%. However, for credit unions with lower ex-ante leverage, the policy change increased the conditional volatility by 0.0117%. This is consistent with Le (2013) that following the introduction of deposit insurance, an increase in leverage is a main source of increase in banks' risk-taking. Credit unions with lower ex-ante leverage may be encouraged by the protection given by the unlimited deposit insurance and increase their risk-taking activities. Also, when we consider credit unions with larger membership base and larger deposit market share, the coefficient of *DI* in Table 9 is negative, while the coefficients of the interaction terms between *DI* and the proxies for importance are positive. It suggests that the policy change had a greater effect on credit unions with few members and smaller market share. This is consistent with the notion of implicit government guarantee on financial institutions. Larger credit unions are more likely to receive bail-out from the government, with or without an existing financial safety net or legislative mandate. If such implicit guarantee is perceived as possible, then an explicit insurance program would not have a significant impact on these credit unions. Our results support this conjecture.

Table 9 Credit union importance

	(1)	(2)
Panel A: Conditional volatility of RORWA		
DI	−0.2258*	−0.0516***
	(0.056)	(0.000)
DI * membership	0.0186*	
	(0.052)	
DI * market share		0.7542**
		(0.045)
Size	0.1455*	0.1554**
	(0.065)	(0.037)
Liquid assets	2.6417**	2.5308**
	(0.033)	(0.035)
Net loans	2.9871**	2.8781**
	(0.015)	(0.016)
Membership	− 0.0404	− 0.0448
	(0.669)	(0.639)
Market share	− 3.7456***	− 1.9038
	(0.002)	(0.174)
Governance score: management	− 0.0449**	− 0.0476**
	(0.037)	(0.037)
Governance score: board	− 0.0325	− 0.0280
	(0.180)	(0.251)
Number of observations	8,691	8,691
Adjusted R^2	0.362	0.362
Panel B: Historical volatility of RORWA		
DI	− 0.2383***	− 0.0003
	(0.008)	(0.959)
DI * membership	0.0250***	
	(0.007)	
DI * market share		− 0.0972
		(0.645)
Size	− 0.1388	− 0.1231
	(0.106)	(0.148)
Liquid assets	− 0.5423	− 0.4729
	(0.441)	(0.504)
Net loans/assets	− 1.0968	− 1.0208
	(0.160)	(0.192)
Membership	0.0760	0.0879
	(0.539)	(0.487)
Market share	− 0.0836	0.3251
	(0.920)	(0.667)
Governance score: management	− 0.1231**	− 0.1215**
	(0.012)	(0.014)
Governance score: board	0.0786***	0.0823***
	(0.005)	(0.003)
Number of observations	11,344	11,344
Adjusted R^2	0.564	0.563

The table examines the impact of credit union importance on the effect of deposit insurance. In equation (4), *IMPORTANCE* is proxied by either the membership or market share of the credit union. The rest of the variables are defined in "Appendix 1". All regressions are estimated with credit union and year fixed effects. *p* values based on robust standard errors clustered by union are reported in brackets. *, **, and *** denote 10%, 5%, and 1% significance level, respectively

Robustness test

In this section, we carry out several robustness tests to our main results. First, we filter the sample to include only credit unions that are active in the time period both before and after the policy change. Over the last two decades, the number of credit unions has been decreasing due to mergers and acquisitions. Most of these mergers happened during the early 2000's, and, based on anecdotal evidences, involved a poorly operated credit union being acquired. To address the attrition bias caused by the exit of poorly performing credit unions, we re-estimate Eq. (1) for the subsample of credit unions that remain active after the policy change. Table 10 column (1) presents the results. The results remain the same as those in Table 4 column (5).

Next, we test whether our results hold in a time window balanced around the policy change. Instead of all available years, we use a subsample ranging from January 2003 to December 2014. Column (2) of Table 10 includes all credit unions, while column (3) uses the subsample of active credit unions. We again obtain results that are consistent with Table 4. In addition, we find a negative relationship between credit union size and the conditional variance. Columns (4) to (6) in Table 10 estimate the effect of the policy change on alternative risk measures for the filtered subsample as in column (3). Similar to Table 7, there is a positive relationship between the policy change and non-interest income as well as the capital ratio, while the policy change does not have a significant effect on the holding of high-ratio mortgages.

Conclusions and discussion

In this paper, we examined the impact of an amendment in the deposit insurance program on the earnings uncertainty of credit unions. The amendment comprises two primary revisions: an increase in the insurance coverage to unlimited and the adoption of risk-based insurance premium. We find that these changes in the deposit insurance regime tended to decrease the conditional volatility of the returns on the credit unions' risk-weighted assets. The increase in insurance coverage is likely to enhance depositor confidence, as reflected in stronger deposit growth at the credit unions following the policy change. Our results also show that the policy change increased non-interest income and capital-to-asset ratio. These devices can be employed by the credit unions to reduce risk in response to the implementation of the risk-based insurance premium. In addition, we find that the effect of the policy change is larger for smaller credit unions, as well as those with fewer members and smaller market shares. In contrast, the policy change increased the conditional volatility of less leveraged credit unions.

Table 10 Robustness tests

	(1)	(2)	(3)	(4)	(5)	(6)
DI	− 0.0550***	− 0.0552***	− 0.0525***	0.0150***	0.0000	0.0007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.967)	(0.000)
Size	0.1671*	− 0.1698***	− 0.1940***	− 0.0596***	0.0145*	− 0.0261***
	(0.054)	(0.006)	(0.008)	(0.000)	(0.090)	(0.000)
Liquid assets	3.1657**	2.1336***	2.0950***	− 0.3693**	0.0040	0.0615**
	(0.028)	(0.000)	(0.001)	(0.020)	(0.943)	(0.030)
Net loans	3.5913**	1.5050***	1.4080***	− 0.3453*	0.0555	0.0694**
	(0.014)	(0.002)	(0.007)	(0.052)	(0.369)	(0.024)
Membership	− 0.0425	0.2774***	0.2846***	0.0283**	0.0206***	0.0177***
	(0.684)	(0.000)	(0.000)	(0.043)	(0.009)	(0.000)
Market share	− 3.3871***	− 3.8126***	− 3.5302***	− 0.4936**	0.1482	− 0.0079
	(0.000)	(0.003)	(0.006)	(0.018)	(0.159)	(0.843)
Governance score: management	− 0.0487**	− 0.0820***	− 0.0855***	0.0046	− 0.0044**	− 0.0021***
	(0.038)	(0.000)	(0.000)	(0.417)	(0.029)	(0.000)
Governance score: board	− 0.0292	0.0317	0.0347	− 0.0038	− 0.0007	− 0.0014*
	(0.233)	(0.163)	(0.138)	(0.406)	(0.648)	(0.070)
Number of observations	8,152	4,293	4,131	6,502	6,502	6,502
Adjusted R^2	0.351	0.426	0.417	0.165	0.758	0.892

The table reports results from the robustness checks. In columns (1)–(3), the dependent variable is the conditional volatility of the return on risk-weighted assets. Column (1) excludes the credit unions that are inactive after the policy change. Column (2) excludes the time period before 2003 to have a balanced time window around the policy change. Column (3) applies both of these two criteria. Columns (4)–(6) uses the filtered sample as in column (3), and non-interest income, high-ratio mortgages, and capital ratio as the dependent variable, respectively. The rest of the variables are defined in "Appendix 1". All regressions are estimated with credit union and year fixed effects. p values based on robust standard errors clustered by union are reported in brackets

*, **, and *** denote 10%, 5%, and 1% signficance level, respectively

Overall, our results support the hypotheses that an increase in deposit insurance coverage strengthens investor confidence and has a stabilizing effect, while the adoption of risk-based insurance premium helps alleviate moral hazard and reduces excessive risk-taking. The impact of the policy change has not been one-sided. Such changes may harbor unintended consequences. For example, the revision attracted deposit influx from the wholesale clients, which intensified credit union dependence on concentrated sources of funding. Wholesale depositors can be quick to undertake large withdrawals, and tend to be more volatile in their behavior when market conditions change. The increased reliance on wholesale deposits can expose credit unions to greater liquidity risk. In addition, the cost of complying to new regulations triggers complaints that regulatory change impinges on credit union profitability.

Canadian credit union legislation is unique, because these financial institutions are regulated at the provincial level. Several regulatory bodies and deposit insurance programs exist across provinces. It segments the credit union system, which is relatively small in size compared to the rest of the financial system. This may hinder the efficiency of operating a deposit insurance regime in an industry that assumes concentrated geographic and sectoral risks. We believe our study may have important implications for further regulatory measures.

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Appendix 1: Variable definitions

Variable	Definition
RORWA	Return on risk-weighted assets, calculated as monthly net income divided by risk-weighted assets.
Conditional variance of RORWA	Predicted variance of RORWA from a GARCH(1,1) model.
Historical volatility of RORWA	Standard deviation of RORWA in a 3-year rolling window.

Variable	Definition
DI	The dummy variable is 1 for time periods after the change in the deposit insurance program, and 0 otherwise.
Demand deposit	Demand deposits divided by total deposits.
High-ratio mortgage	Residential real estate backed loans divided by total assets; the loans are uninsured with a loan-to-value ratio greater than 75%.
Net loans	Loan assets net of allowance for impairment divided by total assets.
Nonperforming loans	Loans in arrears divided by total assets.
Gap ratio, variable rate	Absolute value of the difference between variable-rate assets and liabilities, divided by the greater of variable-rate assets and liabilities.
Gap ratio, fixed rate 4-6 months	Similar as above, except the assets and liabilities are fixed rate with 4-6 months to maturity.
Size	The natural logarithm of total assets.
Liquid assets	Cash and liquidity investments, divided by total assets.
Capital-to-asset ratio	Primary and secondary capital minus capital deductions, divided by total assets.
Non-interest income	Non-interest income divided by the sum of non-interest income and interest income.
Leverage ratio	One minus capital-to-asset ratio. Alternatively, total assets is replaced with risk-weighted assets and other liabilities are excluded in the calculation.
Membership	The number of members. In regressions, the variable is the natural logarithm of the number of members.
Market share	Deposits at a credit union divided by total deposits at all credit unions.
Score on senior management	Rating assigned by a credit union's supervisor based on the assessment of the ability of the credit union's management team. The lowest score is 1, and the highest is 4.
Score on board oversight	Rating assigned by a credit union's supervisor based on the assessment of the oversight and governance effort by the credit union's board of directors. The lowest score is 1, and the highest is 4.

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