Bank Capital, Securitization and Credit Risk: an Empirical Evidence

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Bank Capital, Securitization and Credit Risk: An Empirical Evidence†

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Abstract

This paper is one of the first attempts to conduct an empirical investigation of the relationship between bank capital, securitization and bank risk-taking in a context of the rapid growth in off-balance-sheet activities. The data come from the Canadian financial sector. Evidence from the 1988-1998 period indicates that: (a) securitization has a negative statistical link with both current Tier 1 and Total risk-based capital ratios, and (b) there exists a positive statistical link between securitization and bank risk-taking. Profit-risk measure is more sensitive than loss-risk measure to the variation in securitization activity. These results seem to agree, during the studied period, with models indicating that banks might be induced to shift to more risky assets under the current capital requirements for credit risk because the regulatory capital levels are considered too high.

Keywords: Securitization, credit risk, capital regulation, Canadian financial sector, bank regulation.

JEL classification: G18, G21, G28.

Résumé

La croissance rapide des activités hors bilan soulève un nombre intéressant de questions au sujet de la relation entre le capital des banques, la titrisation et le risque. Cet article est le premier qui étudie cette relation empiriquement. Les résultats pour le Canada durant la période 1988–1998 montrent que : a) la titrisation a des effets négatifs sur les ratios de capital, et b) il existe un lien statistique positif entre la titrisation et le risque des banques. Ces résultats semblent confirmer, pour la période étudiée, les prédictions des modèles indiquant que les banques semblent être motivées à conserver des actifs plus risqués sous la réglementation du risque de crédit parce que les niveaux de capital exigés sont considérés trop élevés.

Mots clés : Titrisation, risque de crédit, réglementation du capital, Comité de Bâle, réglementation des banques.

Classification JEL : G18, G21, G28.

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Introduction

In the late 1980s, the Canadian bank regulatory agency, as part of the international Basel Committee on Banking Regulation and Supervisory Practices, adopted minimum capital requirements. One of the primary purposes of the regulation was to incorporate off-balance-sheet activities into assessments of bank capital. Prior to the regulation risk-based capital, banks were subject to a leverage ratio requiring them to hold, at minimum, capital equal to a fixed percentage of their total on-balance-sheet assets. But the leverage ratio did not adequately reflect risk variations in on-balance-sheet assets nor did it account for the risk posed by off-balance-sheet activities. Moreover, it failed create enough incentives to push banks to hold low-risk assets.

With the rapid growth of off-balance-sheet activities in the 1980s and the adoption of risk-based capital standards in the later part of that decade, a number of interesting issues have been raised regarding the relationship between capital, off-balance-sheet activities, and risk. These issues include questions about how securitization activity relates to capital in general and to risk-based capital ratios, in particular. Another question of interest asks how changes in securitization affect bank risk-taking. None of these aspects has been addressed in the existing literature.

This study makes several original contributions to the literature. First, we examine the relationship between risk-based capital ratios and securitization. Then, using an instrumental variable model, we not only examine the impact of total risk-based capital ratio on securitization activity but also look to see how the predicted level of securitization influences bank risk-taking. As a by-product we propose a description of the evolution of the Canadian securitization market during the 1987-1998 period. In light of current efforts to revise credit risk regulation, this study has potentially important implications for the reform of regulatory capital standards currently underway.

The remainder of the paper is organized as follows. Section 1 reviews the theoretical links between bank regulation and securitization activity. Then, Section 2 documents different aspects of securitization for Canada during the 1987-1998 period. Section 3 proposes a basic model that establishes a statistical relationship between securitization activity and both Tier 1 and Total capital ratios. Finally,

Section 4 uses an instrumental variable estimation model to ascertain the relationship between securitization and risk. A conclusion summarizes the results and discusses their implications in terms of capital regulation.

1. Bank Regulation and Securitization

The remarkable feature of banks is that their balance sheet combines liabilities, which can be withdrawn at any time (deposits), and many assets that are not highly marketable (corporate loans). This situation makes these institutions – even solvent banks – quite vulnerable to depositor confidence. Maintaining sufficient solvency is one way for banks to deal with this problem, as this may generate confidence in the banking sector as a whole.

However, theory suggests that, owing to asymmetric-information problems, partly generated by a non-optimal deposit insurance system, limited liability banks tend to take on too much risk. In a perfect-information scenario, market discipline would ensure that a bank engaging in riskier behavior would have to compensate its stockholders and depositors with a higher rate of return (Rochet, 1992). But small depositors are unable to monitor banks and there is a free-rider obstacle to acquiring information. Also, full deposit insurance lowers the incentive for depositors with $60,000 or less in their account (during the studied period) in Canada to monitor their bank.

Regulatory capital requirements are regarded as one of the solutions to this problem. It is important for governments to prevent bank failures, because the burdens of such failures will fall on them. Moreover, bank failures tend to spread contagiously through the financial services sector (Crouhy et al. 2001). In order to ensure sufficient solvency, banks are asked to hold an amount of capital prescribed in proportion to their asset portfolio. This may also lead depositors to have more confidence in the banking system.

The primary objective of regulators in adopting the 1988 Basel Accord was to reinforce financial stability.[1] Secondly, there was a need to establish a level playing field for banks from different countries and, in the case of some countries, to reduce the explicit or implicit costs of government-backed deposit

guarantees. In other words, regulation privatizes part of the burden by asking banks to retain regulatory capital. But, when bank supervisors rely extensively on capital requirements and discretionary rules that may be at odds with economic (or optimal) capital, this may inevitably beg the question about the possible distortions such arrangements may cause in bank behavior, particularly in the management of credit risk (Allen and Gale, 2003; Dionne, 2004).

One of the possible impacts of risk-weighted capital requirements on bank behavior is this: If the weights applied to risk categories of assets differ too widely, banks might be induced to shy away from highly risk-weighted assets. In the early 1990s, U.S. banks shifted sharply from corporate lending to investing in government securities, and many commentators and researchers have attributed this shift to the post–Basel Accord system of capital requirements.

While papers such as those by Hall (1993), Haubrich and Wachtel (1993), and by Calem and Rob (1996), and Thakor (1996) have made a persuasive case for the role played by capital requirements in this switch, their conclusion has been challenged. Hancock and Wilcox (1997), for example, have presented evidence that the decline in private sector lending is better explained by U.S. banks' own internal capital targets than by the capital requirements imposed by regulators. Furthermore, the fact that capital requirements affect bank behavior does not in any way imply that their impact is undesirable. Bank supervisors must judge whether or not the levels of capital induced are adequate, given the broad goals of regulation.

Another potential impact on banks comes from risk-weighted capital requirements of the Basel-Accord type: They may prompt banks to shift towards riskier assets within each asset category whenever there is a gap between regulated capital and economic capital. Imposing equal-risk weights on different private sector loans may make safer, lower- yielding assets look less attractive and prompt substitution toward higher risk investments. Kim and Santomero (1988) show formally how a bank maximizing mean-variance preferences and facing uniform proportional capital requirements may substitute toward riskier assets.

For example, banks can use securitization for regulatory capital arbitrage (cherry-picking and securitization with partial recourse; see Jackson, 1999; Jones, 2000). Capital arbitrage may help banks keep their funding costs as low as possible. It may also affect bank risk-taking: Cherry-picking may stabilize banks' regulatory capital ratios (substitution among different private loans with different ratings) but increase its overall riskiness. Jackson et al. (1999) show how securitization with partial recourse may be interpreted as cherry-picking. Jones (2000) presents examples where securitization can reduce banks' risk-based capital ratio. More generally, he shows how divergences between economic risk and regulated capital ratios may create opportunities to repackage portfolio risks in order to reduce effective capital requirement per dollar of economic risk. Another form of substitution occurs between long-term and short-term issues (less than one year), since the latter category needs no corresponding capital. Finally, securitization may also make highly risk-weighted assets seem more attractive because of the better balance between return and protection they offer. As a result, when banks are active in securitization, reported capital ratios may not represent their true risk.

Theoretical contributions by Keeley and Furlong (1989, 1990) and Rochet (1992) suggest, however, that such substitution effects are sensitive to assumptions about banks' objective functions and depend on whether or not asset markets are complete. The extent to which banks are affected by this kind of distortion therefore remains an empirical question. Several recent econometric studies have used data on U.S. banks to look for substitution effects attributable to capital requirements. See, for example, Shrieves and Dahl (1992), Haubrich and Wachtel (1993), Jacques and Nigro (1997), and Aggarwal and Jacques (2001). Blum (1999) presents results that suggest a positive link between regulatory capital standards for banks and a bank's decision to engage in more risky activities.[2] More recently, however, Aggarwal and Jacques (2001), using a simultaneous equations model, have shown that the Federal Deposit Corporation Improvement Act (US Congress, 1991) raised capital ratios and reduced credit risk for banks. In this article, because our data come from a time period reporting no significant change in Canadian regulation, we are not concerned with the direct impact of regulation change on banks' behavior. We are, rather, interested in studying how securitization activity affects banks' capital ratios and their level of risk.

All the empirical literature we referred to above draws on the U.S. experience. U.S. data offer many advantages, most notably the very large number of banks for which data are available and the detailed information one may obtain on individual institutions. Nevertheless, it is important to examine the impact of capital requirement systems operating in other countries. Although the Basel approach provides a basic framework of minimum capital standards, regulators in different countries have supplemented it with a range of other requirements that deserve empirical investigation (see Rime, 2001 for Swiss banks; Ediz, Michael and Perraudin, 1998, for UK banks).

Furthermore, data from other (that is, non-U.S.) banking markets may shed interesting light on the effects of capital requirements, simply because they constitute a largely independent sample. Since U.S. banks are inevitably subject to large common shocks, banking industries in other countries provide a valuable source of additional evidence. This is precisely one of the purposes of our paper.

2. Trends and Developments of Securitization in Canada (1987-1998)

2.1 Overview of the Market

Securitization is one of the more prominent developments to emerge in Canadian financial markets over the nineties. The term securitization has been used to describe any issue of fixed-income securities whose payments are linked to a specific pool of financial assets. This definition included: (i) on-balance-sheet securitization, where the securitized assets are retained on the original lender's balance sheet; and (ii) off-balance-sheet securitization, where the assets are segregated and removed from, or in some cases never appear on, the lender's balance sheet. There appears to be a growing trend towards narrowing this definition to refer only to the dominant off-balance-sheet variety. It is this type of activity that impacts credit-market estimates. Unless otherwise specified, this paper refers to securitization in this second sense.

A securitized asset can be any form of receivable with a predictable cash flow, such as a loan, lease or a mortgage.[3] Due to the nature of these receivables, the original lenders are typically financial institutions, such as banks, near-banks, sales financing and consumer loan companies, and other types of financial

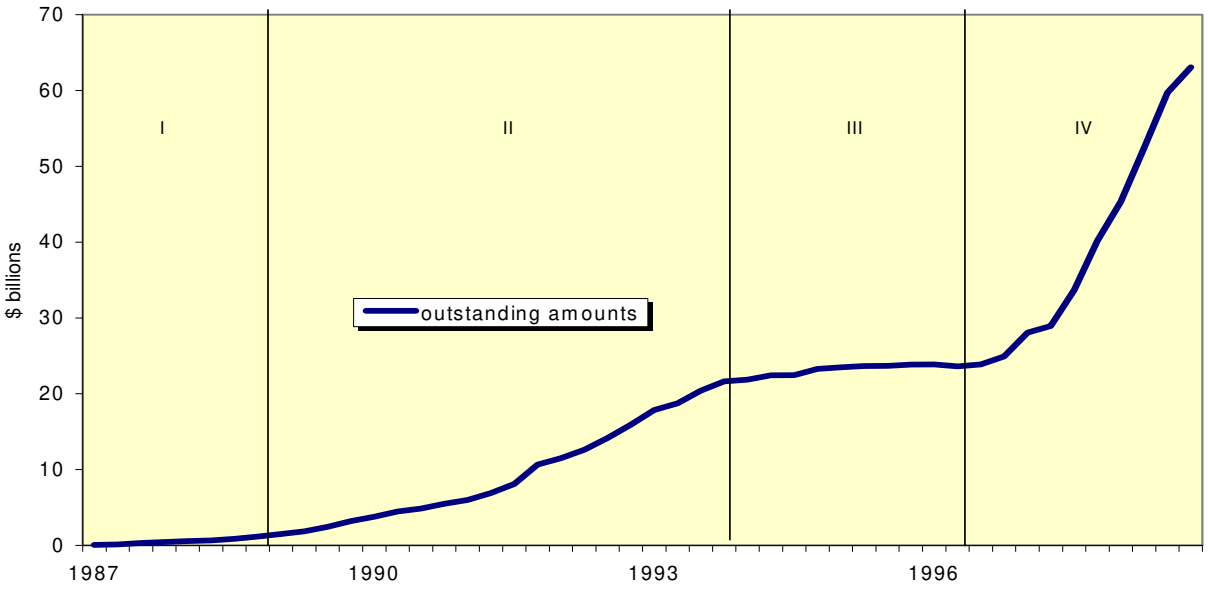
intermediaries. The fixed-income securities that arise from the pooling of these receivables are called asset-backed securities. The return on these instruments is collateralized by the expected cash flows on the securitized assets rather than by the obligation of the lending institution. While these securities resemble conventional corporate debt, they do not carry legal title to the lender's assets should these cash flows weaken. Therefore, the investors may bear some degree of credit risk. In addition, they may be subject to market and prepayment risks but may be compensated with an appropriate rate of expected return.

There exist two broad classes of asset-backed securities in Canada: (i) National Housing Act-insured Mortgage-Backed Securities (NHA-MBS); and (ii) securities backed by other types of assets, broadly referred to as other Asset-Backed Securities (ABS). Each is structured uniquely and is host to a different range of investors.

Securitization in Canada can be traced back to a federal policy initiative during the mid-eighties. In December 1986, the Government of Canada instituted a mortgage-backed securities program[4] similar to an existing federally sponsored plan in the United States. The purpose of this program is to provide additional sources of funds for residential mortgage financing (including social housing), while encouraging lower interest rates and longer-term mortgage financing.[5]

The Canadian market for securitization experienced significant growth. Correspondingly, outstanding securitized assets in Canada rose from under half a billion dollars in 1987 to over $63 billion by year-end 1998 (Chart 1). This can be depicted in terms of four development phases. The first phase from 1987-89 represented the initiation of the securitization market with the introduction of National Housing Act Mortgage-Backed Securities (NHA-MBSs). The second phase from 1989-94 was marked by the continued growth of NHA-MBSs and the introduction of other asset-backed securities. The acceleration in 1992 largely reflected a pick-up in the issuance of mortgage-backed securities. The third phase, in which activity seemed to come to a halt from 1994-96, was marked by a decline in the issuance of NHA mortgage-backed securities, which was offset by continued growth in other Asset Backed Securities (ABSs). In contrast, the boom in the final phase in 1997 and 1998 was led by securitizations of loans, credit-card receivables, and conventional residential mortgages, and saw a modest recovery for NHA mortgage-backed securities.

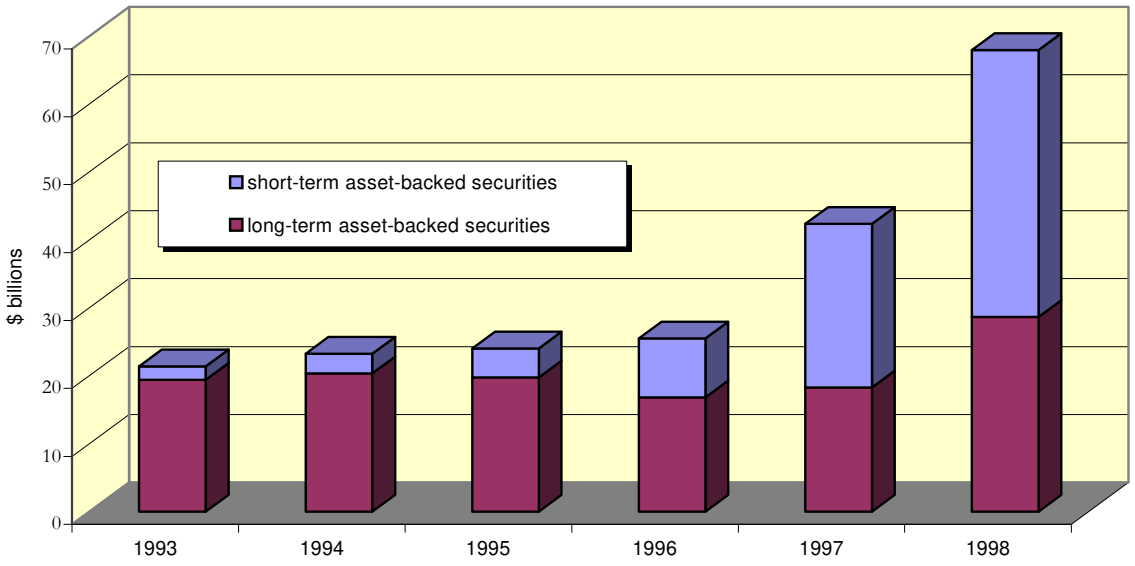
Chart 1. Securitized Receivables in Canada



Source: Financial and Wealth Accounts, Statistics Canada

A notable trend in these securities has been the move towards shorter-term issues (Chart 2), with maturities of less than one year. Originally, a tendency existed for financial institutions to shape the maturity and payments of the security to that of the underlying pool of assets. Since most types of securitized receivables do not expire within the time frame of a year, asset-backed securities were generally structured as medium-and longer-term investments. By the end of 1994, longer-term ABSs stood at $20.3 billion, accounting for over ninety percent of the Canadian market for these instruments.

Chart 2. Short- Versus Long-term Asset-Backed Securities



Source: Financial and Wealth Accounts, Statistics Canada.

By the mid-nineties, financial institutions began shifting toward shorter-term, asset-backed securities. This phenomenon stemmed in part from recognition of investor demand for money-market instruments, given the reduction in the amount of Government of Canada Treasury bills outstanding. Another contributing factor was the robust growth in non-mortgage loan activity over this period. By year-end 1998, short-term ABSs amounted to $39.3 billion, almost one-and-a-half times that of their longer-term counterparts. It should be mentioned that the conversion factor for off-balance-sheet exposure is nil for commitments with an original maturity of one year or less. In other words, capital requirement is nil for these exposures (Crouhy et al., 2001; Aqdim et al., 2003).

2.2 National Housing Act Mortgage-Backed Securities, 1987-1998

During its first year of operation, the NHA-MBS program involved the participation of fourteen financial institutions. The majority of these participants were trust companies, followed by chartered banks. By 1998, the number of approved issuers had risen to over 65, including a wide selection of credit unions and life insurance companies. However, with the bank acquisition of various trust companies during the early nineties, most of this activity shifted to the banking sector.

The outstanding amount of securitized NHA-insured mortgages grew steadily up to 1993 and peaked by year-end 1994 at $17.5 billion. Over the period of 1994 to 1996, the market declined by over 20 percent, coinciding with a slowdown in mortgage lending activity and reduced investor demand for these securities.[6] Since the first quarter of 1997, this market has recovered due to a succession of NHA-MBS deals by chartered banks and trust companies, in line with improvements in the housing market. By year-end 1998, the value of outstanding securitized NHA-insured mortgages amounted to $19.1 billion. Still, relative to the overall asset-backed securities market, these instruments have lost considerable ground, particularly since 1996-97. This may have reflected a growing preference by lending institutions to securitize other assets.

2.3 Other Asset-Backed Securities, 1989-1998

The first non-NHA-MBS securitization was performed in 1989 by a major bank. This transaction involved the creation of a trust, which offered other financial institutions the opportunity to securitize their commercial loans. The success of this multi-seller vehicle set off a wave of similar securitization programs by other financial institutions. To date, securitizations have been performed by over ninety different vehicles and have involved an extensive range of assets, including: agricultural and equipment retail sales contracts; inventory credit; franchise loans; heavy equipment leases; office equipment leases; automobile leases; credit card balances; non-NHA-insured residential and commercial mortgages; and other miscellaneous receivables.

In recent years, these other asset-backed securities have overtaken NHA-MBSs to account for over 60 percent of the overall securitization market in Canada. By year-end 1998, the amount of other securitized assets reached almost $44 billion, led by commercial loans and leases in 1996 and consumer credit and conventional residential mortgages in 1997 and 1998. These assets-backed securities may offer more flexibility for risk substitution than MBS.

3. Effect of Securitization on Capital Ratios

3.1 Basic Model

The nature of efficient bank regulation is still an open question in the literature. A bank may take various discretionary measures to change its capital ratios, whether or not in response to regulatory prescriptions or market discipline. It may wish to change its capital ratios because they deviate from the bank's own target – a target which may of course be affected by regulation (in practice banks are capitalized well above the minimum requirements) – or because they come too close to minimum regulatory standards. As already indicated, this study does not examine how a direct exogenous change in regulation will affect bank behavior, but rather how securitization affects capital ratios and, in turn, how securitization impacts on banks' risk-taking. Let us begin by the effect of securitization on capital ratios.

The ratio C/RWA (where C and RWA represent, respectively, capital and risk-weighted assets) can be regarded as the bank's own capital-ratio target or, when capital requirements are binding, as the regulatory requirements. The variable RWA can be interpreted as that defined by regulatory standards or as the one chosen by the bank itself, for example based on its internal risk model. Given the data available, we shall use the risk weighting implied by the Basel Capital accord to define RWAs in our analysis.

Whether it is a matter of increasing capitalization relative to risk-weighted assets (C/RWA) in compliance with regulatory standards or in response to the bank's own preferred risk/return profile, this can be achieved by increasing capital, by reducing the risky assets in proportion to total assets or by reducing total assets.

As for changes in the bank's risk profile, it is important to distinguish between shifts related to the bank's own capital target and those induced by regulatory requirements. In the latter case, banks may be forced to take on less risk than they would have chosen themselves. Depending on its shareholders' risk/return appetite, the bank may comply with minimum solvency requirements by reducing the size of its risky portfolio (size effect) or by refusing to reduce (and perhaps even increasing) its risk-taking activities (reshuffling effect).

The capital adequacy requirements set by the Basel Agreement of 1988 for credit risk imply that banks must possess funds (capital) amounting to at least 8% of a weighted sum of their risky assets and their OBS (Off-Balance-Sheet) activities. The purpose of the Accord was to standardize capital requirements internationally, in order to create a level playing field for banks. Bank's assets and OBS activities are assigned to four different risk categories, according to their credit risk (or default risk). The weighted-asset portfolio for application of the capital/asset ratio is computed according to the formula:

$$\text{RWA} = 0 \cdot (\text{category 1}) + 0.2 \cdot (\text{category 2}) + 0.5 \cdot (\text{category 3}) + 1.0 \cdot (\text{category 4}) \quad (1)$$

and the bank has to meet two capital requirements, namely:

Tier 1:

$$\text{Stockholder equity capital (Tier 1)} = 0.04 \cdot \text{RWA} \quad (2)$$

and

Total risk-based capital:

$$\text{Stockholder equity capital + loan loss reserves + subordinated debt} = 0.08 \cdot \text{RWA}. \quad (3)$$

Category 1 consists of assets with zero-default risk (government securities, reserves), category 2 of assets with a low-default risk (e.g. interbank deposits), category 3 of medium-risk assets (mortgage loans), and all remaining assets fall into category 4 (commercial loans). OBS activities are also assigned to one of these categories, depending on their risk. It is important to repeat that these categories are not homogeneous. For example, commercial loans can be attributed to firms with different default risks and be in the same category. The same comment applies to mortgage loans.

The minimum requirements of the Basel Accord (4% for Tier 1 and 8% for total capital) are usually not binding, i.e. most banks are more capitalized than is required. Some authors therefore argue that the requirements are ineffective. Still, lower requirements might induce banks to hold less capital, i.e. under current conditions, banks may be applying a standard mark-up to the minimum requirements (to maintain their image, for example). Banks can also be officially classified as well-capitalized, providing its stockholder equity capital ratio (Tier 1) stands at 6%, and its total capital ratio at 10%. Furthermore, it should be kept in mind that in some countries the Basel requirements are complemented with additional

regulatory standards. (See Aggarwal and Jacques, 2001, on US regulations, and Rime, 2001, on Swiss regulations.)

In light of the above discussion, it is clear that capital requirements based on credit-risk weights may produce a variety of reaction patterns in bank behavior. The theory is not conclusive, empirical studies deliver mixed results and, for many countries, no empirical evidence has been presented thus far. The previous literature has reviewed what banking theory considers as determinants of bank-capital variations. This section of the article examines the extent to which securitization is statistically related to the risk-adjusted capital ratios (RACRs) developed by the BIS (Bank of International Settlements).

3.2 The econometric implementation

The RACRs analyzed are the Tier 1 ratio and the Total risk-based capital ratio, as described above. We assume that the unobservable bank-specific effects are fixed and that they capture all factors—such as management philosophy, autonomous changes in risk aversion and capital preference—which are not taken into account explicitly. The other explanatory variables include: bank-specific factors, banking industry factors, a time trend, and a capitalization dummy.

The explanatory variables used in our econometric model (see equation (4) below), their definitions and economic rationale are presented in detail. The first bank-specific characteristic focuses on changes in capital, mainly determined by its cost. The Cost of Capital is captured by the return on equity. In theory, the higher the cost of core capital (equity), the more expensive capital increase becomes and, ceteris paribus, the lower the change in RACRs (negative coefficient). The next two bank-specific variables focus on the riskiness of bank assets, namely on-balance-sheet and OBS riskiness. Both variables certainly influence the RWA, but banks may also modify their capitalization in reaction to changes in their risk profile.

The Loan Ratio, defined as loans divided by total assets, takes into account the bank's major high-risk assets. An increase in the Loan Ratio may imply a higher risk profile for the bank's balance sheet, a subsequent rise in RWAs and, if bank capital remains unchanged, a decline in RACRs. However, if bank managers increase bank capital more than strictly required by the BIS-weighting scheme, RACRs will

rise. In other words, a positive relationship between the RACR and the loan ratio implies that the bank portfolio's credit risk is estimated higher by bank managers than by BIS-standards.

In addition, banks involved in securitization activities are affected by the same arguments as those applying to the bank's most important assets–loans. An increase in the Securitization Ratio may imply a rise in RWAs (arbitrage) and therefore, given the level of capitalization, a decline in RACRs (see Jones, 2000, for examples where securitization of high-quality commercial loans can reduce RACRs). However, when securitization is taken into account by risk-adjusted BIS capital ratios, an increase in securitization risk may make the RACR ratio increases or remains constant.

The fourth and final bank-specific variable considered is Asset Growth: the percentage change in total assets held by banks. We take this variable into account to investigate how RACRs are changed by the direction of growth in on-balance-sheet activities (in contrast to the former bank-specific variable that measures the growth of OBS activities relative to on-balance-sheet activities). Asset growth may imply an increase in RWAs and, ceteris paribus, a decline in the RACR, much like the two bank-risk proxies. Asset growth may also change bank capital. Both capital increase and decline are possible. Capital ratios are influences by market forces at the bank level and by prevailing conditions in the banking industry (market discipline) as a whole.

Of course, developments within the banking industry (interest rate movements, for example), monetary policy, and the business cycle, which may all have an impact on bank capital, are also (partially) reflected in bank-specific variables such as the cost of capital. The banking-industry variable included in our empirical analysis reflects increasing competition that forces banks to use their capital more efficiently, leading to a decrease in RACR. This effect is captured by a linear time trend (Trend).

We also considered a Bank Relative Performance variable in the capital ratios regression. This variable takes into account the banking perception of macroeconomic activity. For example, banks may adjust their capital in response to anticipated changes in interest rates, monetary policy, and even business cycles. This variable is measured by the difference between the returns on capital observed for banks and those observed for the whole corporate sector. The more optimistic the banks, the more risks they take

(RWAs increase) and the more they invest (reduction of capital). So, we anticipate a negative relationship between the variable Bank Relative Performance and capital ratios.

The seventh and last factor taken into account is the fact that banks' capital is regulated. One may therefore suspect that relatively undercapitalized banks, whether in response to regulators or voluntarily, will try harder to increase their capital (Jackson et al., 1999). This effect is taken into account by a Capitalization Dummy which is 1 if the RACR drops below the banking sector's 'normal' level (proxied by the overall median) and otherwise 0. The use of the median as the threshold value is somewhat arbitrary, but, unfortunately, there is no information about the threshold values used by the banks, and the BIS threshold values of 4% and 8% are rarely binding. Finally, dummy variables were introduced in the regression in order to take into account the firm-specific effects.

The estimated equation for capital ratios can then be written as:

$$RACR_{it} = \beta_0 + \beta_1 B_t + \beta_2 \text{ Cost of Capital}_{it} + \beta_3 \text{ Loan Ratio}_{it} + \beta_4 \text{ Securitization Ratio}_{it} + \beta_5 \text{ Asset Growth}_{it} + \beta_6 \text{ Bank Relative Performance}_{it} + \beta_7 \text{ Trend}_{it} + \beta_8 \text{ Capitalization Dummy}_{it} + \varepsilon_{it} \quad (4)$$

where β_1 is a vector of coefficients for banks' fixed effects and B_t is a vector of banks' identification dummies.

3.3 Data and Results

Bank-specific data are obtained from the Canadian Banking Association. If both consolidated and unconsolidated account data are available, consolidated figures are used because we want to study the capital behavior of the parent company. Movements within a year are not analyzed. We focus on annual data, as we are interested in long-term trends in bank capital rather than short-run fluctuations in capital ratios. In other words, by using annual data, we capture more discretionary than autonomous behavior. Since we wanted to use data from small banks that do not have publicly traded stock, we used accounting measures of risk.

A panel data set is constructed, consisting of individual commercial bank data for the years 1988–1998. The main benefit of considering foreign and national commercial banks within the same country is that they face more or less the same accounting standards and national regulatory conditions. We analyzed

commercial banks, the most common banks in Canada. In addition, issues on capital behavior are more interesting to study for these sorts of banks. Banks that did not report both the Tier 1 ratio and the Total risk-based, capital-adequacy ratio for three consecutive years are omitted from the data set. Also, capital ratios above 50% are deleted from the sample. Mergers and acquisitions in the 1990s cause some imbalances in our panel. Banks that disappeared through mergers or takeovers do, however, remain part of the sample, because their assets and liabilities appear on the balance sheet of the acquiring bank.

Table 1 lists the median of the Tier 1 ratio and Total risk-based capital-adequacy ratio for 1988–1998.[7] The median of the RACR is far above the minimum required level of 4% and 8%, respectively.

Table 1. Median Tier 1 and Total Capital Ratio Across Years

1988-98	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Tier 1 Ratio											
7.75	5.3	6.1	7.5	7.9	8.0	8.2	8.4	8.6	8.9	8.4	8.0
Total Capital Ratio											
9.64	8.3	8.4	8.6	8.8	9.3	9.6	9.9	10.2	11.3	10.6	11.0

Looking at the distribution across years, it becomes clear that capital ratios are not constant over time. The median in the late 1980s is lower than the overall median, and we observe a constant increase during the 1988-1996 period, followed by a decline during the last two periods.

Table 2. Median Bank-Specific Model Variables

Tier 1 Ratio	Total Capital Adequacy Ratio	Cost of Capital	Loan Ratio	Securitization Ratio	Asset Growth	Bank Relative Performance
7.75	9.64	16.9	69.6	7.9	7.9	6.32

Table 2 presents the median of the bank-specific model variables. The capital ratios are already described above. The median of the cost of capital indicates a relatively high return on equity. Loans account for close to 70% of total assets. The median of securitization items is about 8% of total assets.

What is observed as most striking about the banks' relative performance is that they outperform all sectors. This suggests that banks are engaged in risky activities and, accordingly, are compensated with higher returns. Moreover, the high riskiness of commercial banking activities, together with their high total capital-adequacy ratio, suggests that bank risk-taking may be inadequately captured by the BIS-risk weights. We now turn to the econometric results.

Table 3 shows the ordinary least squares estimation results for both Tier 1 Ratio and Total risk-based capital ratio as dependent variables. Bank-specific parameters are not reported. The model equation explains about 85% of the variation in both ratios. Many bank-specific factors significantly explain bank-capital behavior. The impact of the cost of capital on both ratios is significantly negative: an increase in the cost of capital lowers capital itself. The loan ratio has a significant positive impact on the ratios. For example, increasing the loan ratio by 1 percentage point results in a 0.05 percentage point rise in the Total risk-based capital ratio. This may imply that banks themselves view the BIS risk-weights as inadequate, since they raise the two ratios when the loan ratio increases. Any increase in securitization activities relative to on-balance-sheet activities causes a decline in both ratios. This suggests two possible conclusions. Either banks that securitize represent lower risk and need lower capital because of the credit enhancements of the securitization process or banks that securitize represent higher risk because they use the option of capital arbitrage. The analysis in the next section shall separate the two interpretations by linking securitization to banks risk. Bank's Relative Performance does not have a significant effect (at 5%) nor does the trend variable.

Table 3. Determinants of Capital Ratio*

	Tier 1 Ratio	Total Capital Ratio
Intercept	0.171 (2.016)	0.91 (0.313)
Cost of Capital	-0.0201 (-3.114)	-0.0121 (-2.342)
Loan Ratio	0.0331 (4.133)	0.0551 (2.116)
Securitization Ratio	-0.0128 (-2.016)	-0.0111 (-2.004)
Asset Growth	0.0039 (3.017)	0.0051 (1.514)
Bank Relative Performance	-0.0025 (-1.954)	-0.0031 (-1.521)
Trend	-0.0016 (-1.881)	-0.0022 (-1.897)
Capitalization Dummy	1.324 (2.605)	2.117 (2.116)
R^2	0.84	0.86
R^2 Adjusted	0.81	0.83
SE	0.52	0.42
Number of observations	450	450

* T-statistics in parentheses; not shown but included in the regressions are dummy variables to control for banks fixed effects. A coefficient is statistically significant at 5% (10%) when the T-statistics is greater than 1.965 (1.65) in absolute value.

The impact of the last bank-specific variable considered, asset growth, is positive for the Tier 1 ratio and not significant for the Total risk-based ratio. Finally, there is a positive relationship between the capitalization dummy and the change in the capital ratios. Based on our data, it is, however, unclear whether this is dictated by (inter)national regulators or voluntarily implemented for market discipline reasons. This positive relationship indicates that if the Tier 1 ratio drops below the banking industry's 'normal' level it will trigger a rise of 1.3 percentage points. The corresponding increase in the total capital ratio is much higher (2.18). The next questions are: "How do these capital ratios adjust to securitization? Does securitization introduce more risks?" Since both ratios show somewhat similar results in Table 3, we shall now concentrate the analysis on Total risk-based ratio.

4. Securitization and Risk

The previous section suggests that banks use of securitization activity affects their risk-adjusted capital ratios. However, this analysis does not allow us to draw any conclusions on the extent to which securitization affects banks risk. In recent years, a number of studies, including those of Shrieves and Dahl (1992) and Aggarwal and Jacques (2001), have modeled the response of banks to regulatory capital standards by using simultaneous equation models that allow bank-risk levels to be influenced both directly and indirectly by regulatory capital requirements.

Building on these studies, the system of equations developed reflects not only the indirect regulatory pressure exerted by risk-based capital standards but also the fact that both securitization and credit risk may be influenced by these same risk-based capital ratios. Moreover, since we are interested in the direct relationship between two endogenous variables, we first estimate the securitization equation and then use the predicted level of securitization to estimate the risk equation. Specifically, the model is of the form:

$$\Delta SEC_{it} = b_0 + b_1\, SIZE_{it} + b_2\, CAP_{it-1} + b_3\, CAP_{it} + b_4\, TREND_{it} + b_5\, RBCC_{it} + b_6\, LEVC_{it} + b_7\, CC_{it} + \beta_1 B_t + \mu_{it} \quad (5)$$

$$\Delta RISK_{it} = a_0 + a_1\, SIZE_{it} + a_2\, CAP_{it-1} + a_3\, CAP_{it} + a_4\, TREND_{it} + a_5\, RBCC_{it} + a_6\, LEVC_{it} + a_7\, CC_{it} + a_8\, \overline{\Delta SEC}_{it} + \beta_1 B_t + \eta_{it} \quad (6)$$

where

$\Delta RISK_{it}$ = Change in credit risk. Credit risk is measured by five alternative variables. In a first step we consider the provisions for banks uncoverable loans ($\Delta RISK_1$) to total assets and the total of risk-weighted assets to total assets ($\Delta RISK_2$). Three other measures of risk defined in terms of standard derivation are considered below: standard derivation of return on equity, standard derivation of return on assets, and standard derivation of loan loss provision to total loans.[8]

$SIZE_{it}$ = Log of total assets.

ΔSEC_{it} = Change in securitization activity. Securitization activity is measured by the ratio of securitized assets to total assets. $\overline{\Delta SEC}_{it}$ in (6) is the predicted level of securitization obtained from Equation (5).

CAP_{it} = Banks' Total risk-based capital ratio as defined in Section 4.

CAP_{it-1} = Lagged banks' Total risk-based capital ratio.

CC_{it} = Cost of capital as defined in Section 4.

TREND = Time trend

$LEVC_{it}$ = Regulatory pressure variable =1 if a bank failed to meet the minimum leverage ratio, 0 otherwise

$RBCC_{it}$ = Regulatory pressure variable = 1 if a bank failed to meet either the Tier 1 risk-based capital ratio or the Total risk-based capital ratio, 0 otherwise

B_t = Vector of banks participation dummies as defined in (4).

In the system of equations corresponding to an instrumental variable model, SIZE is used to take into account the greater diversification possibilities enjoyed by larger banks. So, larger banks must make more frequent use of the securitization instrument and must bear larger risks. Banks' Total risk-based capital ratios are control variables for the effects of capital on decisions to securitize and to take risky positions. As measured in the previous section, banks with large securitization activities have less capital. Here, we consider both capital in the current and in the previous period as explanatory variables of both securitization and risk. To be consistent with, let's say, a positive relationship between securitization and risk, we must expect that banks with, higher capital ratios should have lower securitization activities and lower risk (via the predicted securitization variable). However, the direct effect of a higher capital ratio may itself have a positive effect on risk, when we control for securitization.

The two regulatory dummy variables that account for regulatory constraints should be binding for more risky banks with higher levels of securitization. The cost of capital (CC) variable is an opportunity cost variable and should have a positive effect on both variables.

Finally, for the purpose of this paper, we did instrument the predicted level of securitization to explain the risk levels of banks. The coefficient of $\overline{\Delta SEC}$ on $\Delta RISK$ will be positive if the securitization activity generates more risk. Such a positive relationship can be interpreted in the following way: Because the current regulatory measures of risk do not correspond to the optimal economic risk that internal models of credit risk may measure (we do not have access to this information), the current credit-risk regulation may not be appropriate. For example, the current regulation may be too costly in terms of capital for well diversified banks (particularly larger banks) and securitization activity may therefore be used to reduce this cost. In other words, a positive coefficient would ask the following question: "Is the current model of regulation for credit risk conceptually sound enough to introduce the appropriate incentives for credit-risk management?" Another related question would be: "Is the observed positive link between securitization and risk due to inappropriate measurement of credit risk by current regulatory ratios or to an appropriate measurement of off-setting behavior by banks?" Unfortunately, our data cannot separate the two effects.

Table 4. Estimation of Securitization and Risk*

	ΔSEC	ΔRISK$_1$	ΔRISK$_2$
Intercept	-1.302 (-1.737)	0.114 (1.905)	-0.521 (-1.639)
SIZE	0.014 (2.714)	0.008 (2.109)	0.013 (1.921)
CAP	-0.021 (-2.108)	0.016 (2.014)	0.009 (2.107)
CAP$_{-1}$	0.008 (1.904)	0.010 (1.998)	-0.004 (-1.301)
TREND	0.0007 (1.707)	0.005 (1.982)	0.11(1.5205)
RBCC	0.019 (2.127)	0.011 (2.103)	0.023 (1.824)
LEVC	0.005 (1.973)	0.007 (1.917)	0.009 (1.704)
CC	0.012 (1.510)	0.001 (1.200)	0.019 (2.821)
$\overline{\Delta SEC}$		0.171 (2.334)	0.0054 (1.732)
R^2	0.32	0.61	0.55
Number of observations	449	449	449

* T-statistics in parentheses; not shown but included in the regressions are dummy variables to control for banks fixed effects. The coefficient is statistically significant at 5% (10%) when the T-statistics is greater than 1.965 (1.65) in absolute value.

The system of equations is estimated using the instrumental variable method. The results are presented in Table 4. An examination of the results reveals that most of the variables that are considered to explain variations in securitization activity or credit risk (particularly $\Delta RISK_1$) are statistically significant. SIZE and CAP have a positive impact on risk. Examining the impact of regulatory capital constraints on bank-credit risk, the parameter estimates in the risk equation ($\Delta RISK_1$) are positive and significant both for banks constrained by the leverage ratio (LEVC) and for those constrained by the risk-based capital ratio (RBCC). This result is consistent with Aggarwal and Jacques (1998) who found that banks operating under risk-based capital constraints tend to take on more risk. The results also suggest that securitization activity has a positive impact on banks' credit risk. The parameter estimate of $\overline{\Delta SEC}$ in the credit-risk equation is significant (at 5% in $\Delta RISK_1$ and 10% in $\Delta RISK_2$), suggesting that banks active in the securitization market tend to be more risky.

The results in the ΔSEC equation provide estimates of the impact of regulatory pressures on banks' securitization activities. The parameter estimate of banks constrained by the leverage ratio (LEVC)

is positive and significant in the ΔSEC equation, a finding that is also consistent with the literature which reports that banks constrained by the leverage ratio tend to increase their use of off-balance-sheet activities.

With respect to banks constrained by risk-based capital standards (RBCC), the results also suggest that these banks tend to increase their use of securitization activity. One possible explanation is that in cases where banks are constrained by risk-based capital standards, the positive parameter estimate may then show that the absolute risk weights are too low compared to the risk weights on other assets or activities, thereby creating an incentive for banks to engage in regulatory capital arbitrage and to increase their use of securitization, despite the existence of risk-based standards. Tables 5 and 6 indicate that the results of Table 4 are robust to the use of either short-term or long-term asset-backed securities for both equations. They indicate that the effect of securitization on credit risk is much stronger for Short-term Asset-backed securities a result which confirms the predictions made by Crouhy et al. (2001).

Table 5. Short-term Asset-backed Securities*

	ΔSEC	**$\Delta RISK_1$**
Intercept	0.114 (1.987)	0.074 (1.811)
SIZE	0.019 (2.506)	0.021 (2.147)
CAP	-0.033 (-2.914)	0.036 (2.109)
CAP (-1)	0.014 (2.308)	0.010 (1.952)
TREND	0.0018 (2.221)	0.005 (2.004)
RBCC	0.024 (2.514)	0.009 (2.308)
LEVC	0.011 (2.841)	0.017 (2.106)
CC	0.018 (1.410)	0.012 (1.807)
$\overline{\Delta SEC}$		0.214 (3.001)
R^2	0.65	0.81
Number of observations	449	449

* T-statistics in parentheses; not shown but included in the regressions are dummy variables to control for banks fixed effects. A coefficient is statistically significant at 5% (10%) when the T-statistics is greater than 1.965 (1.65) in absolute value.

Table 6. Long-term Asset-backed Securities*

	ΔSEC	$\Delta RISK_1$
Intercept	-1.022 (1.601)	0.0501 (2.001)
SIZE	0.010 (1.914)	0.005 (2.114)
CAP	-0.015 (1.982)	0.016 (2.007)
CAP (-1)	0.004 (1.836)	0.011 (2.164)
TREND	0.0003 (1.923)	0.003 (1.704)
RBCC	0.011 (1.869)	0.002 (1.807)
LEVC	0.002 (1.765)	0.001 (1.739)
CC	0.009 (1.662)	0.005 (1.336)
$\overline{\Delta SEC}$		0.116 (2.306)
R^2	0.29	0.69
Number of observations	419	419

* T-statistics in parentheses; not shown but included in the regressions are dummy variables to control for banks fixed effects. A coefficient is statistically significant at 5% (10%) when the T-statistics is greater than 1.965 (1.65) in absolute value.Here, a careful examination is required. The results contain an apparent contradiction, since the CAP variable coefficient has a negative sign in the ΔSEC equation and a positive one in ΔRISK equations. Just as with the capital-ratio equation in Section 4, the ΔSEC equation does not control for bank risk. So, a negative sign for CAP in the ΔSEC equation may simply mean that banks with high securitization are banks with high levels of risky assets in the CAP denominator. In the ΔRISK equations, the risky assets variable is now part of the dependent variable. So, the more risky banks also have more capital than the other banks when securitization is controlled. Therefore, our results seem to support the prediction that strong capital restrictions on credit risk in models that do not choose capital at its economic (or optimal) value may cause banks to increase their level of risk by using securitization.

Much like the one used by Aggrawal and Jacques (2001), our methodology considers that both securitization activity and risk level as endogenous variables for banks. Moreover, ours makes it possible to isolate the effect of the predicted level of securitization activity on the level of risk. We should mention that identical results (available on request) were obtained with a simultaneous equation model and three-stage least squares.

The first two measures of bank risk-taking we used are not without their critics (Evanoff and Wall, 2001). In order to verify the robustness of our results, we also repeated the analysis with the use of volatility-of-accounting measures, as suggested by Cebenoyan and Stranhan (2004). Three supplementary measures of risk were tested:

$\Delta RISK_3$: Standard deviation of loan loss provision to total loans (median = 4.8%).

$\Delta RISK_4$: Standard deviation of ROA (earnings to assets) (median = 3.3%).

$\Delta RISK_5$: Standard deviation of ROE (earnings to book value of equity) (median = 2.9%).

We did not consider the volatility of non-performing loan/total loans because the information was not available.

The supplementary results for the three risk equations are presented in Table 7. Results for the ΔSEC equation are available upon request. We obtain similar results to those in Table 4 for $\Delta RISK_4$ and $\Delta RISK_5$ while $\overline{\Delta SEC}$ is not significant (at 10%) in explaining $\Delta RISK_3$. It seems that standard deviation of the loan-loss provisions to total loss ratio is not affected by the variation in securitization activity. Overall, the results indicate that the profit-risk measure (volatility of ROA or ROE) is more sensitive to variations in securitization activity than is the loss-risk measure ($\Delta RISK_3$).

Table 7. Estimation of Securitization and Risk*

	Δ**RISK**$_3$	Δ**RISK**$_4$	Δ**RISK**$_5$
Intercept	0.0123 (1.221)	0.0334 (2.113)	0.0917 (1.923)
SIZE	0.0249 (1.675)	0.0132 (2.873)	0.0112 (2.013)
CAP	0.0154 (1.666)	0.0234 (2.563)	0.0156 (2.421)
CAP_{-1}	0.0398 (1.554)	0.0107 (2.643)	0.0095 (2.121)
TREND	0.0296 (1.012)	0.0564 (2.019)	0.0658 (1.936)
RBCC	0.0121 (1.089)	0.0031 (2.139)	0.0125 (2.315)
LEVC	0.0986 (1.675)	0.0213 (3.723)	0.0103 (3.016)
CC	0.0258 (1.521)	0.0106 (1.997)	0.0093 (1.896)
$\overline{\Delta SEC}$	0.0354 (1.476)	0.2675 (3.986)	0.2231 (3.741)
R^2	0.56	0.78	0.75
Number of observations	449	449	449

* T-statistics in parentheses; not shown but included in the regressions are dummy variables to control for banks fixed effects. The coefficient is statistically significant at 5% (10%) when the T-statistics is greater than 1.965 (1.65) in absolute value.

5. Concluding Remarks

This paper studies the capital behavior of commercial banks. To the best of our knowledge, this study is one of the first attempts to report on empirical investigation of the relationship between securitization, capital regulation, and bank risk-taking. The results suggest that securitization activities in Canada had significant positive impacts on bank risk-taking during the period studied (1988-1998).

An empirical model of the change in the Tier 1 and Total risk-based capital adequacy ratios is presented and reveals that both levels of capital ratios are negatively affected by securitization activities. This first result was strong enough to motivate a more detailed analysis of the relationship between securitization and bank risk-taking. The results in Section 4 clearly indicate that higher levels of securitization correspond to higher levels of risk.

These results challenge the nature of efficient credit-risk regulation. Some have argued that the current regulation forces well diversified banks (strong risk management activity) to hold too much capital which, in turn, allows them to take on riskier activities. There is also evidence that securitization might be a market activity making it possible to obtain a better balance between regulated capital and economic capital. Our results indicate clearly that securitization is negatively related to capital ratios and positively related to bank risk-taking in Canada. They also indicate that, once we control for securitization, banks with higher capital ratios are the more risky banks.

During recent years, securitization has provided opportunities for banks to increase their regulated capital ratios with a direct corresponding increase in overall economic risk. So, reported regulated capital ratios may not represent the true financial conditions of banks. The current regulatory system seems to encourage banks to securitize their low-risk assets. Therefore, one may ask whether current regulatory capital ratios are set high enough to take securitization activity into account.

The New Basel Capital Accord (to be implemented in 2007) proposes a new framework for bank securitization. There is nothing to say that the new structure may not also encourage banks to seek other financial innovations allowing them to manage their risk in an optimal economic framework.

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Notes

[1] Since our data set is for the period 1988-1998, we do not discuss here the 1996 amendment which became mandatory in 1998 and concerns mainly market risk.

[2] See also Jacques, Aggarwal and Rice (1998) who found for the US that capital constrained banks increase their use of stand by letters of credit and loan commitments and that these activities increase credit risk, but they mention other research coming to different conclusions. See also Ambrose et al. (2004); they obtained a similar conclusion as in this study but with a different methodology.

[3] These receivables originate in Canada. The securitization of foreign assets in Canada or Canadian assets abroad has been hindered by a number of factors, including the withholding taxes associated with cross-border transfers of property, (the hedging costs associated with the reduction of) currency risk and international differences in issue and rating expenses.

[4] The first NHA-MBS were issued in January 1987.

[5] See the Canada Mortgage and Housing Corporation, NHA Mortgage-backed Securities: Your questions answered, 1990 and Strategic Plan 1992 – 1996, Ottawa: CMHC, 1991.

[6] See CMHC, Market Trends, third quarter 1994.

[7] We do not consider the year 1987 in the econometric analysis in order to eliminate the 1988 regulatory change from the data.

[8] The median of $\Delta RISK_1$ is 11.6 and that of $\Delta RISK_2$ is 9.3.