

**Market Discipline of Canadian Banks' Letters of Credit Activities:
An Empirical Examination**

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Abstract

Although U.S. off-balance sheet (OBS) banking activities have been studied both theoretically and empirically, no paper studies Canadian OBS banking activities, which are growing larger each year. This paper supports the market discipline hypothesis of Canadian bank letters of credit (LC) activities by employing several market measures of risk from one-factor and multi-factor models, including an implied asset volatility from the option-pricing model. Furthermore, it examines both the price and quantity response of OBS activities in the Canadian banking market by using a Tobit analysis to assess the robustness of the conclusions about market discipline. The results indicate that the various market measures of risk and LC are negatively related. Moreover, banks with greater portfolio risk, measured in terms of equity and asset risk, as well as high leverage and interest rate risk, are less likely to issue LC.

Key Words: Off-Balance Sheet Activities, Letters of Credit, Four-factor Market Model, Implied Asset Risk, Market Discipline.

1. Introduction:

Off-balance sheet (OBS) banking refers to banking products and practices unrelated to on-balance sheet portfolio lending. Such OBS activities as letters of credit and guarantees are growing rapidly in Canada. The explosive growth of these activities has caused concern for regulators as they may threaten the stability of Canada's financial system (see Rose, 1990). For instance, in 1994 there was more than 800 billion of Canadian dollars of derivatives on the books of the Royal Bank and more than 600 billion on those of the Canadian Imperial Bank of Commerce. These amounts represented approximately six to eight times of the bank's equity capital.

A bank earns fee income for initiating and facilitating OBS transactions. These activities are not reported on the balance sheet, but are given in footnotes to the balance sheet. Until 1994, OBS activities in banks were not subject to direct regulatory control in Canada. The importance of Canadian banks' OBS activities is shown in Table 1. In 1994 Canadian banks started to comply with the (credit) risk-adjusted capital requirements from the Basel Accord (1988), which became effective at the end of 1992.

Traditional explanations of the existence of OBS activities have been analyzed in theoretical literature. These studies have focused on the various forms of regulatory tax effects such as capital and reserve requirements, as well as the moral hazard problem associated with deposit insurance.¹ This paper's objective is to examine empirically the motivation for Canadian banks to issue letters of credit (LC), and to examine the market discipline of Canadian banks' participation in the guarantee market.

Market discipline is said to exist if the market notices the relationship between bank risk and

¹Specifically, Greenbaum and Thakor (1987) focus on asymmetric information, Benveniste and Berger (1987) on the allocation of risk-sharing among debtholders and depositors, and James (1988, 1989) on the underinvestment problem arising from agency costs.

OBS activities and the market responds to this bank risk either by charging lower prices or reducing participation in these activities with riskier banks or both. LC amounts are comprised of financial guarantees, standby letters of credit (SLC), and commercial letters of credit (CLC). The total values of LC issued by Canadian banks increased by 2.5 fold to a peak of 45 billion of Canadian dollars in 1993 during the period of 1981-1994. The participation of various banks in LC is shown in Figure 1.

Extant empirical OBS activities literature is so far limited to U.S. banks only. This article is the first known attempt to investigate the riskiness of Canadian banks' OBS activities such as LC. Our investigation differs from the existing studies on U.S. banks' OBS activities in a number of ways. Specifically, this study is the first to employ a four-factor market model, in addition to a single-factor model, to calculate various measures of beta risk such as market, interest rate, credit risk and foreign exchange betas. In the absence of maturity gap data for Canadian banks, we employ an elasticity measure of interest rate risk. Second, this study provides an alternative measure of Canadian bank risk by incorporating the impact of bank regulation and deposit insurance in an option-pricing framework. In order to accomplish this, the research applies the Ronn and Verma (1986) method to calculate asset risk from market values of bank equity. The appeal of this measure is that it uses market information and incorporates a regulatory closure rule in determining asset risk. Third, we employ a Tobit method to take into account the qualitative (i.e., whether to issue a LC or not) and quantitative (i.e., how much LC to issue) nature of our data, and to investigate the market discipline of the LC market. Unlike previous research that provides only a price response in market discipline studies, we analyze both price and quantity responses by Canadian banks issuing LC. Finally, this study employs more recent panel data on Canadian banks ranging from 1981 to 1994.

Our paper continues in five sections. Section II describes the related literature on LC and other OBS activities. Section III provides background information on the data set. Section IV and V present and estimate the qualitative and quantitative relation between LC and various types of risk measures. Section VI draws conclusions.

II. A Brief Overview of the LC and OBS Activities Literature:

Letters of Credit (LC) are essentially contingent claims on banks' assets. The risk-based capital requirement of OBS activities mandates that standby letters of credit (SLC) and commercial letters of credit (CLC) be capitalized at 100% and 20% of loans respectively when calculating a bank's risk-weighted asset. The regulatory presumption for the additional capital requirement of LC is that LC is a risky banking activity.

The theoretical literature suggests different motivations for banks to enter into LC. Theories of financial intermediation suggest that credit enhancement services are natural banking activities. Banks issue LC so they can provide credit enhancement services to its customers. In order to minimize the cost of informational asymmetries between borrowers and lenders, the bank is induced to efficiently monitor its customers, to specialize in credit evaluation, to produce information, and to signal its own credibility. Bank LC may thus represent a substitute method of allocating credit with complementarities in bank production.

The risk-return trade-off between selling information services and warehousing assets induces a bank to divide its business between loans and LC. Therefore, a LC issuance does not affect the fundamental business risk of banking firms. Since part of the total risk is diversifiable, the remaining systematic risk is unaffected by a LC guarantee. The diversification hypothesis implies that banks engage in a LC guarantee in order to diversify their within-firm risk. According to this hypothesis, a bank's total risk may decrease, but systematic risk is unaffected by LC guarantees.

The leverage hypothesis or the moral hazard hypothesis states that fixed-rate deposit insurance together with capital requirements provide incentives for banks to increase financial leverage through LC guarantees because they are not subject to capital requirement. By increasing its financial leverage, a bank can enhance whatever subsidies it receives from deposit insurance. Therefore, LC may be associated with both a higher total and systematic risk of the bank (see Pyle, 1985, Benveniste and Berger, 1986, 1987).

Theory suggests four ways in which LC may be related to bank risk. First, a LC guarantee entails a bank customer's credit risk, because the bank has to make a payment or extend a loan in adverse circumstances. Second, overextension of LC creates a liquidity risk for the bank. Third, a LC is likely to signal a reduced risk of the bank customer. Fourth, a LC may signal a higher credit standing for the bank, and a reduced risk of the bank's portfolio. However, whether LC increases or decreases a bank's risk is an empirical question.

The extant empirical evidence on the risk-behavior of LC banking activities is inconclusive. Using a Logit analysis, Benveniste and Berger (1986, 1987) found a positive relationship between a bank's leverage and the probability of a bank issuing an SLC. They also found SLC and bank risk to be negatively correlated, which they interpreted to be supportive of the market discipline hypothesis. They tested the moral hazard hypothesis by examining whether failing banks tend to issue more SLC and found that failing banks tend to issue a decreasing amount of SLC as bank failure approached. These authors interpreted these results to be inconsistent with moral hazard, but consistent with the market discipline hypothesis.

Lynge and Lee (1987) found the coefficients of LC to be significantly negative in a model explaining equity risk, but insignificant in a model explaining systematic risk. Brewer, Koppenhaver and Wilson (1986) found that the coefficients of LC were insignificant in a model relating bank

excess returns to market and industry excess returns, where bank excess returns are interpreted as the risk premium. Goldberg and Lloyd-Davies (1985) found essentially no impact from banks issuing an SLC on their deposit costs.

Berger (1991) proposed a test of whether bank equity has the effect of disciplining a bank's risk-taking by examining actual bank performance instead of stock market prices. The evidence showed that higher capital ratios for large and small banks are associated with increased future earnings, lower probability of bank failure, and improved bank performance. Goldberg and Hudgins (1996) found that the ratio of uninsured liabilities to total liabilities declines with increases in thrift institution risk. This study of a quantity response, rather than a price response, provides a better picture for troubled institutions, which are in an extreme moral hazard position and may not respond significantly to deposit rates.

Pavel and Phillis (1987) examined the key determinants of commercial banks' loan sales activities. They found that diversification, capital, binding capital constraint, and reserve requirements all have an important impact on loan sales. Their results also suggest that banks start selling loans when capital ratios are low and charge-offs are high. Pavel and Phillis (1987) argued that OBS activities permit banks to invest in and diversify across a broader set of assets than they originate from and service. Pavel (1988) used a Ronn-Verma implied asset risk model to examine the riskiness of loan sales activities and found that loan sales are unrelated to bank risk.

James (1988) found a positive relationship between leverage and the probability of SLC issuance. Avery and Berger (1991b) used a number of risk measures and found that SLC were positively related to risk for small banks, but negatively related to risk for large banks. One explanation for these results is that the market discipline hypothesis dominates for large banks. Koppenhaver and Stover (1991) argued that the extant empirical literature on the relationship

between bank risk and SLC that uses contemporaneous data suffers from a simultaneous equation bias. Using Granger-causality tests, they found that bank leverage has a negative predictive effect on SLC, and SLC have a positive predictive effect on bank leverage. Hassan (1992) found that stockholders view CLC as reducing bank risk and that debtholders are indifferent about such CLC activities. A policy conclusion of his findings is that the additional capital requirements of some OBS activities for large commercial banks may be inappropriate. These results, in general, support the market discipline hypothesis for LC.

Berger and Udell (1990) found a negative relationship between used loan commitments and risk, where risk is measured by the premium of the loan rate over the Treasury rate of comparable duration. Avery and Berger (1991a) found that both used and unused commitments are moderately negatively related to the three measures of bank portfolio risk: nonperforming loans, loan charge-offs, and income. Avery and Berger (1991b) found that unused commitments are negatively related to several risk measures. Koppenhaver (1989) examined the determinants of banks' OBS loan commitments, SLC and CLC by using Logit models. He found that bank size, amount of reserves, and loan losses were important determinants of bank OBS activities. Capital and capital constraint variables were found to be insignificant in the decision to issue bank OBS activities. The research on loan commitment data generally supports the market discipline hypothesis, given that safer banks tend to issue more loan commitments.

Hassan, Karels and Peterson (1994) examined the market discipline hypothesis of OBS banking activities by employing contingent valuation techniques to derive implied asset risk from bank equity and risk-premia for bank-subordinated debt. They found that market discipline exists for most OBS banking activities because bank-subordinated debtholders and equityholders price such OBS activities as reducing bank risk. Table 2 provides a brief description of empirical

literature on OBS banking activities. This paper attempts to relate the extant empirical literature on U.S. OBS banking to Canadian banks and test the validity of the aforementioned hypotheses for Canadian LC activities.

III. Data and Background Information:

Data on the volumes of LC are only available for six large, chartered banks in footnotes and complementary notes of their annual reports. LC amounts are comprised of financial guarantees, standby LC, and commercial LC, all aggregated. Interim quarterly reports do not disclose information on the volumes of LC. Other bank-specific data for computing accounting ratios are taken from annual reports.

Our period of study extends from 1981-1994. Monthly market data, prices, and stock return of bank equity are extracted from the Toronto Stock Exchange TSE-Western database maintained by the University of Western Ontario. It is important to note that the monthly returns are compounded geometrically from daily returns by TSE-Western. Also found in the Bank of Canada Monthly Review is the data on interest rates, yields on bonds, and foreign exchanges.

The Canadian banking system is constituted mainly of six big institutions known as the chartered banks, the Bank of Montreal, the Bank of Nova Scotia, the Canadian Imperial Bank of Commerce, the National Bank, the Royal Bank, and the Toronto Dominion Bank. Their principal characteristics are briefly described below.

The Bank of Montreal (MO) is the only Canadian bank that offers a full range of service of importance in the U.S. via Harris Bancorp of Chicago. It is also the leader in areas such as community banking, development of new products, and activities with small businesses. The Bank of Nova Scotia (NS) is the Canadian bank that is the most diversified geographically. However, in the U.S., it is involved only with operations in swaps as well as corporate and syndicated loans. This

institution is very conservative in their credit granting, however, its revenue is volatile because of its aggressive interest rate exposures.

The Canadian Imperial Bank of Commerce (CIBC) is known for its unrelenting pursuit of offering full and complete services to its customers. It copes well to changes in banks' traditional role by offering specialized services more oriented towards consulting and risk management. It has begun to be recognized as a leader in banking services based on derivatives and investment. The National Bank (NA) has roughly two-thirds of its assets in Quebec and is the smallest of the six-chartered banks and is known for its regional focus in French Canada. Its level of profitability is below the average of the other banks.

The Royal Bank of Canada (RY) is the biggest bank in terms of assets in Canada, where it has invested the major part of its assets. RY offers almost a complete range of financial services to its customers. Outside Canada, the bank focuses on activities related to corporate treasury and investment. The Toronto Dominion Bank (TD) concentrates its operation in Ontario. This bank is special mainly because it prefers the strategy of partial participation in banking investment activities rather than solely acting in these activities. It has capital ratios that are the highest in the industry.

IV. Identifying Market Discipline of Canadian LC Activities: The Price Response

To detect the market discipline of Canadian LC activities, we first study the price response by investigating the link between the association of LC in Canadian banks and their various types of risk. We then examine the banks' quantity response with regards to their LC activities in the next section. We postulate the following behavioral model below with the expected signs for the explanatory variables.

$$\text{Market Measure of Risk} = f(\overset{?}{\text{LC}}, \overset{+}{\text{LEV}}, \overset{-}{\text{DIV}}, \overset{+}{\text{CD}}, \overset{+}{\text{INT}}, \overset{+}{\text{FX}}) \quad (1)$$

LC = LC and Guarantees / Total Assets;

LEV = Total Liabilities / Total Assets;

DIV = Diversification Index;

CD = Provision for Bad Debts/Total Assets;

INT = Elasticity of Interest Revenue to Interest Expenses;

FX = Absolute Value of Gain (Loss) of Foreign Exchange Position / Total Assets.

Accounting Measures of Risk:

The terms LEV, DIV, CD, INT, and FX are proxies for the leverage ratio, diversification index, credit risk, interest rate risk, and foreign exchange risk, respectively. The expected relationships between dependent and independent variables are summarized in Table 3, and rationalized in the following ways. First, banks use a high degree of financial leverage, which is directly related to financial risk. A highly leveraged bank is perceived to be riskier and LEV should positively relate to the market measure of risk.

Second, the diversification index (DIV) is a Herfindahl index calculated as:

$$DIV = \frac{1}{\sum_{i=1}^{10} L_i^2}$$

Where L_i are the loan-to-asset ratios for loan type i (Commercial Loan, Loan to Governments, Personal Loan, Residential Mortgages and Other Types of Loans) at the end of each year from 1981 through 1994. The Herfindahl index is not only popular in the industrial organization literature, but has also been adopted by the U.S. Department of Justice and Department of Commerce as an index to measure the degree of market concentration. We follow Hassan (1992, 1994), among others, and use the inverse value of the index to measure the diversification of a bank's loan

portfolios. The construction of a diversification index implies that the greater the diversification index, the higher the level of diversification in the loan portfolio. Therefore, a well-diversified bank is less risky and DIV is expected to be negatively related to the market measure of risk.

Third, the credit risk variable (CD) is defined as the provision for bad debts relative to total assets. CD represents the probability of future defaults that may reduce earnings and dividends. Other things being equal, a higher CD may reflect a higher degree of expected loss in the loan portfolio. Therefore, CD is expected to be positively related to the bank's market risk.

Fourth, the interest rate variable (INT) is an elasticity of interest revenue to interest expenses and is defined as

$$INT = \frac{(\Delta \text{Interest Revenue}) / (\text{Interest Revenue})}{(\Delta \text{Interest Expenses}) / (\text{Interest Expenses})}$$

Since to our knowledge, no maturity gap data is available (not reported) for Canadian banks, this is the first empirical study that employs this elasticity measure. The higher the elasticity of interest revenues with respect to interest cost changes, the less immune the bank is to fluctuations in interest rates, which makes the bank riskier. Therefore, INT is expected to be positively related to the market risk variable.

Fifth, the foreign exchange risk (FX) is defined as the non-realized capital gain (loss) from a foreign currency position scaled down by total assets. The more sensitive the bank is to changes in the foreign exchange rate, the more exposed it is to FX risk. Therefore, the absolute value of FX is expected to be positively related to the market measure of risk.

It is important to note that the first three risk proxies (ie. LEV, DIV, CD) have been used in previous studies, while the other three are unique to this study. This research employs these

accounting and market risk variables to explain the decision and amount of LC issuance by Canadian banks in order to examine the riskiness of LC and the existence of market discipline. All of these variables have been deflated by total assets so that heteroskedasticity is controlled in the regression analysis.

Market Measures of Risk:

1. Multi-Factor Market Model

We use the following four-factor model to estimate the market pricing of various types of risk. In addition to market risk, our model also accounts for interest rate risk, foreign exchange rate risk and credit risk.²

$$R_{it} = \alpha_i + \beta_{m,it} R_{mt} + \beta_{CT,it} R_{CTt} + \beta_{INT,it} R_{INTt} + \beta_{FX,it} R_{FXt} + e_{it}, \quad (2)$$

Where

R_{it} = Stock Return of Bank i, at time t,

R_{mt} = Market Return at time t,

$\beta_{m,it}$ = Systematic Risk of Bank i, at time t,

R_{CTt} = Return on Credit Risk Index at time t,

$\beta_{CT,it}$ = Coefficient of Sensitivity to Credit Risk of Bank i, at time t,

$R_{INT,it}$ = Return on Interest Rate Risk Index at time t,

$\beta_{INT,it}$ = Coefficient of Sensitivity to Interest Rate Risk of Bank i, at time t,

² See for instance, Flannery and James (1984) and Madura and Zarruk (1995) for interest sensitivity of U.S. bank stocks; Choi, Elysiani and Kopecky (1992) and Wetmore and Brick (1994) for interest rate and foreign exchange rate sensitivity of U.S. bank stocks.

R_{FXt} = Return on Foreign Exchange Index at time t,

$\beta_{FX, it}$ = Coefficient of Sensitivity to Foreign Exchange Risk of Bank i, at time t,

e_{it} = Error Term.

We proxy the credit, interest rate and foreign exchange indices in the following ways. The Credit Risk Index is proxied by the difference of the yield change of a Canadian corporate bond relative to a government bond and is defined as:

$$R_{CTt} = [(Y_{CB,t} - Y_{CB,t-1}) / (Y_{CB,t-1})] - [(Y_{GB,t} - Y_{GB,t-1}) / Y_{GB,t-1}],$$

Where

$Y_{CB,t}$ = Yield on a Pool of Medium-term Corporate Bonds,

$Y_{GB,t}$ = Yield on Medium-term Government Bonds.

The Interest Rate Risk Index is proxied by the percentage changes of the Canadian short-term rate and is defined as:

$$R_{INT,t} = (Y_{TB,t} - Y_{TB,t-1}) / (Y_{TB,t-1}),$$

Where $Y_{TB,t}$ = Return on a 6-month Canadian Treasury Bill.

The Foreign Exchange Index is proxied by the percentage change of the Special Drawings Right Index that is a money basket composed of the currencies of the G10 countries. The Foreign Exchange Index is defined as:

$$R_{FX,t} = (SDR_t - SDR_{t-1}) / (SDR_{t-1}),$$

Where SDR = market price of Special Drawings Right Index.

Following Saunders et al. (1990), we calculate a battery of measures of market-perceived risks such as σ_E (equity return risk or total risk), σ_R (residual risk), and σ_V (implied asset risk) and estimate β_m , β_{CT} , β_{INT} and β_{FX} by a rolling regression of equation (2).

2. Option-Based Model

Finally, this study uses the market equity data and contingent valuation approach developed by Ronn and Verma (1986) to measure asset risk. The Ronn and Verma method, which is extensively used in the banking literature, is an empirical approach for computing values of two unknown variables, the market value and the volatility of bank assets, in Merton's (1977) deposit insurance pricing model. Since a bank's equity can be viewed as a call option and its equity values can be observed, only one restriction is placed on the two unknown variables. By the same token, the equity volatility can be related to the two unknowns via a volatility formula and serves as the second restriction. Giammarino, Schwartz and Zechner (1989) is the only study so far which employs the Ronn and Verma (1986) method to examine the market valuation of Canadian bank assets.

The equity of a bank can be written as:

$$E = VN(x) - \rho BN(x - \sigma_v \sqrt{T}), \quad (3)$$

Where

$$x = \frac{[\ln(V/\rho B) + \sigma_v^2 T/2]}{\sigma_v \sqrt{T}}$$

$$\sigma_v = \sigma_E \frac{E}{VN(x)} \quad (4)$$

Where E = Market value of equity;

σ_E = Instantaneous standard deviation of equity return;

V = Unobserved post-insurance value of bank assets;

B = Book values of debt liabilities;

σ_V = Instantaneous standard deviation of asset return;

ρ = Regulator policy parameter;

T = Time until next audit of bank assets.

Equations (3) and (4) can be solved simultaneously for two unknowns, V and σ_V , for each observed E and σ_E . An exogenously determined closure rule is required to solve these simultaneous equations.

Banks are audited each year and at audit time a bank is closed if $V_T < \rho B$, where V_T is the terminal value of assets at time T and ρ is a policy parameter. The time to next audit and the maturity of debt are both assumed to be one year. As in the Ronn and Verma (1986) study on U.S. banks and the Giammarino et al. (1989) study on Canadian banks, we assume a ρ of 0.97. Once implied asset volatilities (σ_V) are calculated, they will be regressed over LC to test for the market discipline hypothesis. We summarize all variable definitions in Table 4.

Table 5 shows descriptive statistics of all dependent and independent variables used in this research while Table 6 presents correlation coefficients of all dependent and independent variables. The correlations among all independent variables are generally low, indicating that the multicollinearity problem is not serious and that these variables proxy for different aspects of a bank's balance-sheet risk. However, because σ_V is calculated from using σ_E as an input in the Ronn-Verma option pricing method, these two variables have a relatively high correlation (correlation coefficient=0.52). The simple correlations among the dependent variable LC and each

independent variable are of expected signs, supporting the hypothesized relationships. These correlation coefficients, however, indicate only bivariate relationships and do not account for the presence of other variables in the equation.

Table 7 presents the coefficient estimates of regression model (1) using total risk, residual risk from a one-factor market model, and implied asset volatility from Ronn-Verma (1986) as dependent variables. A pooled cross-section and time-series model was employed to perform an econometric analysis for two reasons. First, cross-section or time-series data alone (6 cross-sections and 14 time-periods) does not yield sufficient degrees of freedom in a regression analysis. Second, a regression based on cross-section data cannot be used to account for shifts in market measures of risk and accounting data through time. A time-series analysis alone cannot be easily used to conduct interbank relationships and comparisons, while a pooled cross-section and time-series analysis allows for simultaneous consideration of intertemporal movements and cross-sectional differences.

The coefficient of LC is negative and statistically significant in a model explaining total risk, residual risk and implied asset risk. Since LC reduce both types of risks from a market model and an option-based model, LC banking activities are potentially risk-reducing. In particular, such OBS activities reduce both systematic and non-systematic risk. These results appear to support the existence of market discipline in controlling LC banking activities, and further suggest market rewards to banks for diversifying with LC.

Table 8 provides regression results of the four-factor market models. The coefficients of LC are negative and statistically significant in explaining four various types of betas such as market beta, credit beta, interest rate beta and foreign exchange rate beta calculated from a four-factor market model using a rolling regression. The on-balance sheet measures of bank risk generally have their expected signs. The coefficients of the diversification index (DIV) and leverage ratio (LEV)

are statistically significant and retain their expected negative and positive signs respectively. The coefficient of credit risk (CD) is positive and significant for models explaining total risk and residual risk from a single-factor market model and four types of beta from a multi-factor market model. The coefficient of the interest rate risk variable (INT) is positive and significant for the implied asset risk and for almost all (except one) beta measures of risk calculated from both single-factor and multifactor market models. This suggests that both credit and interest rate risks are material in Canadian banks.

The foreign exchange rate risk variable (FX) has the expected positive signs and are statistically significant in explaining all measures of market risk. Therefore, Canadian banks are sensitive to foreign exchange risk. The relationship between the market measure of risk and on-balance-sheet measures of accounting risk variables are generally in agreement with earlier studies of Jahankhani and Lyng (1980), Lyng and Lee (1987), Lee and Brewer (1987), Avery and Berger (1991a), Hassan (1992) and Hassan et al (1994). Unlike the literature, we use a four-factor market model and an option-pricing framework to estimate risk of Canadian banks and incorporate OBS LC banking activities. A brief comparison of results is provided in Table 10. We turn next to the study of the quantity responses of Canadian LC.

V. Identifying Market Discipline of Canadian LC Activities: The Quantity Response

The link between the volume of LC in Canadian banks and their various types of market and accounting risk is studied using a Tobit regression technique to estimate the following behavioral model.

$$LC = f(\overset{-}{LEV}, \overset{+}{DIV}, \overset{-}{CD}, \overset{-}{INT}, \overset{-}{FX}, \overset{-}{\sigma_E} \text{ or } \overset{-}{\sigma_V}), \quad (5)$$

where the explanatory variables are explained in the previous section. Since empirical results in

Section IV indicate that the market perceives LC as risk-reducing activities, we presume that LC volume is negatively associated with bank risk. The theoretical relationship of LC and dependent variables are shown in equation (5).

A Tobit model is appropriate for estimation of a limited dependent variable. In OBS banking risk analysis, not only may a bank engage in OBS activities, but it also may also have a positive amount of OBS items outstanding. Thus, the dependent variable in this case is part qualitative (to issue or not to issue) and part quantitative (amount outstanding). The Tobit procedure estimates an equation where the dependent variable may be continuous or up to or beyond a single limiting value.

Use of OLS (Ordinary Least Squares) on a sample with limited observations implies that the limit and non-limit observations possess a distribution. However, this is clearly not the case. OLS gives equal weight to the limit observations. The Tobit procedure modifies the density function of the limit observations to reflect the greater probability of a limit observation occurring. Consequently, the Tobit procedure places less emphasis on the limit observations relative to the OLS procedure in the determination of the parameters. The linear, rather than non-linear, relationship used in the OLS procedure can thus result in large discrepancies outside the central range of the sample's values. The advantage of the Tobit procedure is then to give closer predictions throughout the sample's entire range.

Table 9 provides the Tobit and OLS regression results for major Canadian bank LC activities. The coefficients of all independent variables from both the Tobit and OLS models are of expected signs, but only a few, leverage (LEV), interest rate elasticity (INT) and two market measures of risk (σ_E and σ_V), are statistically significant at the 1% level. The negative and

significant coefficients of LEV, INT, σ_E , and σ_V are consistent with the market discipline hypothesis of Canadian bank LC activities, suggesting that more creditworthy or safer banks are likely to issue more LC or OBS items.

A bank's activity in the market for OBS credit enhancement is a function of its willingness to accommodate the need of its customers, the market's perception of the bank's quality as reflected in balance sheet decisions, and the incentives provided by the regulators. A bank may not be asked to issue LC unless the quality of its LC is made credible to the beneficiary. In this way, the market rations out those banks that are perceived as questionable quality guarantors; banks that can issue LC are perceived as superior quality institutions by the market. Bank lending, investment and credit analysis decisions will have an effect on the bank's ability to participate in the LC market. A bank may signal the quality of its information by increasing its capital ratio and loan diversification, as well as reducing its credit, interest and foreign exchange risk exposures.

The findings are consistent with those from the U.S. banking industry. For example, Hassan (1992) found that the relationships among the volume of commercial LC and equity risk, and implied asset risk are negative and significant. Hassan, Karels and Peterson (1994) found that market discipline exists for most OBS banking activities, because bank-subordinated debtholders and equityholders price such OBS activities as reducing bank risk. Berger and Udell (1990) found a negative relationship between used commitments and risk. Avery and Berger (1991a) found that both used and unused commitments are moderately negatively related to three measures of bank portfolio risk. Avery and Berger (1991b) found that unused commitments are negatively related to several risk measures.

VI. Summary and Conclusions:

The primary purpose of this research has been to examine the risk-exposure of Letters of Credit (LC) and the existence of market discipline in a country other than the U.S. This study is the first known attempt to understand the determinants of Canadian banks' engagement in off-balance sheet activities. The market discipline of LC banking activities has been examined for Canadian banks by using several measures of market risks calculated from single-factor and multi-factor market models, and the Ronn and Verma (1986) option-pricing model. Resulting from capital market tests of LC activities, it is found that LC reduces all types of market measures of risk. Several accounting bank risk variables also show statistically significant correlations with market measures of risk. These results lend support to the existence of market discipline of Canadian LC banking activities and are consistent with similar studies of U.S. banks' OBS activities. Market participants price LC as risk reducing. It appears that Letters of Credit (LC) contribute to the overall diversification of a bank's assets.

This research finds that leverage, equity risk, implied asset risk and interest rate elasticity are significant determinants of Canadian LC activities. Since Tobit regression considers both qualitative and quantitative aspects of LC activities, this estimation technique provides consistent and better parameter estimates as compared to the widely used OLS method. Unlike previous studies, which provide only a price response in market discipline studies, this study analyzes both price and quantity responses from Canadian banks issuing LC. This study shows that banks with greater portfolio risk measured in terms of equity and asset risk, high leverage and interest rate risk are more likely to issue less LC, which strongly supports the market discipline hypothesis.

Table 1

Derivatives in Canadian Chartered Banks (1993)

Name of Banks	Derivatives (in CDN Billion)	Market value of derivatives over book value of total assets	Market value of derivatives over book value of equity
Royal Bank	823	4.99	104.18
CIBC	692	4.91	86.5
National Bank	63	1.50	31.5
Toronto-Dominion Bank	319	3.75	63.8
Bank of Montreal	375	2.65	47.15
Bank of Nova Scotia	352	3.27	59.62

Source: Review of Accounting Information, Faculty of Administrative Science Press, Laval University, 1994.

Table 2

CHRONOLOGICAL SUMMARY OF EXTANT LITERATURE

Study, Year	Results	Support for Hypothesis
Benveniste & Berger, 1986	SLC issuance decreases as banks approach failure; SLC positively related to leverage	Market Discipline Regulatory Tax
Lynge and Lee, 1987	OBS activities reduce bank's total risk, but do not affect systematic risk	Market Discipline
Benveniste & Berger, 1987	SLC negatively related to bank risk	Market Discipline
Pavel & Phillis, 1987	Loan sales negatively related to diversification & capital	Regulatory Tax
James, 1988	SLC positively related to leverage	Collateralization
Avery & Berger, 1988	SLC positively related to bank risk	Moral Hazard
Pavel, 1988	Loan Sales unrelated to bank risk	Market Discipline
Koppenhaver, 1989	OBS activities positively related to size and reserves, and negatively related to loan losses	Market Discipline
. Pennacchi, 1988	Yield spread on loan sales positively related to perceived risk for selling bank	Market Discipline
Berger & Udell, 1990	Loan commitment negatively related to bank risk	Market Discipline
Avery & Berger, 1990a	Loan commitment negatively related to portfolio risk	Market Discipline
Avery & Berger, 1990b	SLC positively related to risk for small banks and negatively related to risk for large banks	Collateralization Market Discipline
Koppenhaver and Stover, 1991	SLC negatively related to leverage & Leverage positively related to SLC	Collateralization Market Discipline
Hassan, 1992	Commercial LCs reduce overall bank portfolio risk	Market Discipline
Brewer, Koppenhaver & Wilson (1992)	Market perceived SLCs as risk-reducing activities	Market Discipline
Hassan, Karels, & Peterson, 1994	Equityholders & subordinated debtholders view OBSA as risk-reducing	Market Discipline

Table 3

Theoretical Expected Signs in Empirical Models

Variable	Expected Signs in Price Equations	Expected Signs in Quantity Equations	Theoretical Relationship
Leverage effect	+	-	Increase in leverage (less capital) increases financial risk, hence market risks
Diversification index	-	+	The higher the index is the more the bank's loan portfolio is diversified. This variable negatively affects market-measured risks.
Credit risk	+	-	More provision for bad debts (relative to assets) indicates a higher credit risk. More provision for bad debts relative to total loan shows a "better" management of credit risk. Hence, their +/- signs.
Interest rate risk	+	-	The higher is the elasticity of interest revenues with respect to interest cost changes, the less the bank is immune to fluctuations in interest rates. Hence, the + sign.
Foreign exchange risk	+	-	The more the bank is exposed to foreign exchange risk, the more it is sensitive to changes in foreign exchange. Therefore, this variable is positively related to foreign exchange.

Table 4
Variable Definition

Variable Name	Definition
LC	Volume of LC/Total assets
LEV	Total liabilities/Total assets
DIV	A Herfindahl diversification index
CD	Provision for bad debt/Total assets
INT	Elasticity of interest revenue to interest expenses
FX	Non-realized capital gain (loss) from foreign currencies position / Total assets
β_m	Systematic risk sensitivity from four-factor market model
β_{CT}	Credit risk sensitivity from four-factor market model
β_{INT}	Interest rate risk sensitivity from four-factor market model
β_{FX}	Foreign exchange risk sensitivity from four-factor market model
σ_R	Residual risk from single factor market model
σ_E	Standard deviation of equity return or total risk
σ_V	Standard deviation of implied asset risk from RV model
R_{CT}	Monthly return from credit risk index
R_{INT}	Monthly return for interest rate index (G-10 countries)
R_{FX}	Monthly return for foreign exchange index (G-10 countries)

Table 5
Sample Summary Statistics (1981-1994)

Series	N	Mean	Std. Error	Minimum	Maximum
LC	84	0.0540	0.0158	0.0236	0.0977
LEV	84	0.9533	0.0094	0.9292	0.9733
DIV	84	3.7333	1.1043	2.3214	8.9793
CD	84	0.0059	0.0029	0.0017	0.0150
INT	84	0.5857	2.4343	-9.4588	17.9113
FX	84	-0.0001	0.0004	-0.0015	0.0006
σ_E	84	0.2126	0.0831	0.0196	0.4695
σ_V	84	0.0861	0.0257	0.0351	0.2175
β_M	84	0.8795	0.2476	0.2892	1.5332
β_{CT}	84	0.1995	1.0145	-0.8661	4.8916
β_{INT}	84	-0.1095	0.1459	-0.5212	0.3309
β_{FX}	84	0.0572	0.5168	-1.5333	1.5727

Table 6

Correlation Matrix of Dependent and Independent Variables

	LC	LEV	DIV	CD	INT	FX	σ_E	σ_V
LC	1.00	-0.64	0.06	0.11	-0.21	-0.28	-0.14	-0.38
LEV		1.00	-0.20	-0.21	-0.02	-0.38	0.23	-0.55
DIV			1.00	0.10	0.08	0.36	-0.51	-0.22
CD				1.00	-0.03	0.03	-0.08	0.03
INT					1.00	-0.04	-0.16	-0.18
FX						1.00	-0.29	0.04
σ_E							1.00	0.52
σ_V								1.00

Notes:

The pairwise correlation coefficients range from 3% to 20%, implying that multicollinearity is not a problem in the data set. Because σ_E and σ_V are highly correlated, these two explanatory variables are used separately in the regression analyses.

Table 7

Pooling Regression Results (1981-94)
 Model: Market Measures of Risk = f(LC, LEV, DIV, CD, INT, FX).

Independent Variables (On- & Off-balance Measures of Risk)	Dependent Variables		
	Market Measures of Risk (Single-Index Market Model)		Implied Asset Volatility (σ_V)
	Total Risk (σ_E)	Residual Risk (σ_R)	
LC	-0.53 (-1.97)**	-.10 (-2.10)**	-.098 (-2.37)*
LEV	0.30 (2.25)**	.16 (2.39)**	.145 (2.89)***
DIV	-.03 (-4.38)***	-.001 (-3.10)***	-.037 (-2.96)***
CD	.62 (2.10)**	.002 (2.19)**	-.046 (-1.07)
INT	.005 (1.96)**	.0023 (2.22)**	.003 (2.17)**
FX	19.40 (1.99)**	5.9 (1.96)**	.005 (1.98)**
CONSTANT	-0.89 (-1.63)	-.18 (-1.61)	-1.92 (-2.32)**
R ²	.25	.12	.43
F(6,77)	5.62***	2.80**	5.23***

Notes:

- (1) Two-tail t-tests are reported for LC, LEV, DIV, CD, INT, and FX.
- (2) Numbers in parentheses are t-statistics.
- (3) Significance levels: * = 10%; ** = 5%; *** = 1%.
- (4) Estimation method is "fixed effects" panel estimation, in which each bank is permitted to have its own (unreported) intercept term.
- (5) Estimated standard errors are computed using White's method. Heteroskedasticity-consistent t-statistics are reported in parentheses below each coefficient estimate.

Table 8

Pooling Regression Results (1981-94)
Market Measures of Risk = f(LC, LEV, DIV, CD, INT, FX)

Independent Variables (On- & Off-Balance Sheet Items)	Dependent Variables (Market Measures of Risk) (Four-Factor Model)			
	Market Beta	Credit Beta	Interest Rate Beta	Foreign Exchange Rate Beta
LC	-4.04 (-1.96)*	-17.92 (-2.64)**	-1.31 (-2.72)**	-2.06 (-2.78)**
LEV	6.88 (2.15)*	83.08 (6.19)***	10.62 (3.47)***	.93 (2.18)*
DIV	-0.01 (-1.81)*	-0.06 (-2.37)*	-.001 (-1.86)*	-.15 (-5.00)***
CD	10.49 (2.00)*	6.08 (2.21)*	4.05 (1.84)*	.82 (2.07)*
INT	0.01 (2.73)**	0.37 (1.95)*	.012 (1.35)	0.02 (1.92)*
FX	90.63 (1.77)*	188.66 (1.73)*	44.48 (2.15)*	220.73 (2.20)*
CONSTANT	-5.55 (-1.84)*	-79.89 (-6.20)***	-10.37 (-3.11)***	-.025 (-2.05)*
R ²	.23	.38	.11	.28
F(7, 143)	4.00***	6.98***	2.21**	4.85***

Notes:

- (1) Two-tail t-tests are reported for LC, LEV, DIV, CD, INT, and FX.
- (2) Numbers in parentheses are t-statistics.
- (3) Significance levels: * = 10%; ** = 5%; *** = 1%.
- (4) Estimation method is "fixed effects" panel estimation, in which each bank is permitted to have its own (unreported) intercept term.
- (5) Estimated standard errors are computed using White's method. Heteroskedasticity-consistent t-statistics are reported in parentheses below each coefficient estimate.

Table 9
Tobit and OLS Regression Analysis

Model : $LC = f(LEV, DIV, CD, INT, FX, \sigma_E \text{ or } \sigma_V)$

Independent Variables	Tobit		Ordinary Least Squares	
	CONSTANT	1.09 (7.35)*	1.09 (7.35)*	.97 (3.72)*
LEV	-1.07 (-6.92)*	-1.07 (-6.92)*	-1.27 (4.23)*	1.23 (-3.80)*
DIV	0.002 (1.05)	0.002 (1.05)	.003 (1.23)	.004 (1.07)
CD	-0.18 (-0.38)	-0.18 (-0.38)	-.09 (-1.28)	-.03 (-.97)
INT	-0.001 (-2.70)*	-0.001 (-2.70)*	-.023 (3.12)*	-.02 (-2.37)*
FX	-2.03 (-0.49)	-2.03 (-0.49)	-1.97 (-.86)	-2.32 (-1.50)
σ_E	-0.01 (-2.78)*	-----	-.003 (2.56)*	-----
σ_V	-----	-0.04 (-2.52)*	-----	-.037 (-2.90)*
\bar{R}^2	.76	.82	.69	.73
F(6,77)	14.09*	16.31	12.10*	14.02*

Notes:

- (1) * indicates that these variables are significant at the 1% level.
- (2) t-statistics are computed using White's method of heteroskedasticity-consistent covariance matrix.
- (3) Tobit is a non-linear estimation method. Therefore, it is not possible to directly interpret the estimated coefficients as the marginal effects of independent variables on LC as it can be done in Ordinary Least Squares. Tobit estimated coefficients must be multiplied by the cumulative standard normal distribution function evaluated at a given probability level.

Table 10

Comparison of Results of Canadian LC with those of U.S. LC

Authors	Sample	Results
Lynge and Lee (1987)	U.S. banks (1985-1986)	Off-balance sheet activities reduce banks' total risk, but do not affect systematic risk.
Brewer, Koppenhaver and Wilson (1992)	U.S. banks (1979-86)	SLC "contribute" to the decrease of both total risk and systematic risk.
Hassan (1992)	U.S. banks (1984-1988)	CLC are significant and negatively related to equity risk and implied asset risk.
Hassan, Karels and Peterson (1994)	U.S. banks (1984-1988)	SLC decrease systematic risk and equity risk.
This Paper	Canadian chartered banks (1981-1994)	LC reduces all market measures of risk from the single-factor market model, four-factor market model, and option-based model.

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