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Market valuation of bank assets and deposit insurance in Canada

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Abstract. We examine a sample of Canadian banks and use option pricing theory to infer the market value of a bank's assets from the observed market value and volatility of its equity. We find that market value estimates are significantly different from corresponding book values. These differences vary significantly across banks, suggesting that market values provide bank-specific information not found in book values. We also derive that risk-adjusted deposit insurance premia for these banks. Our results suggest that the current fixed rate deposit insurance premium system has resulted in significant cross-subsidization among banks.

La valeur au marché des actifs des banques et l'assurance-dépôts au Canada. Les auteurs utilisent la théorie du prix des options pour inférer la valeur au marché des actifs d'un échantillon de banques canadiennes à partir de la valeur au marché observée et de la volatilité du prix de leur capital-action. Il appert que les estimés de la valeur au marché diffèrent de manière significative des valeurs aux livres correspondantes. Ces différences varient de manière significative d'une banque à l'autre, ce qui suggère que la valeur au marché contient de l'information spécifique sur la banque qu'on ne trouve pas dans la valeur aux livres. Les primes d'assurance-dépôts ajustées pour le risque sont définies pour ces banques. Les résultats suggèrent que le système de primes à taux fixe qui est en vigueur a entraîné des subventions croisées entre banques.

INTRODUCTION

Deposit-taking institutions, particularly chartered banks, play a role in financial markets that is comparable to that of the stock and bond market. For

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instance, of the \$86.2 billion raised by major non-financial borrowers in 1986, \$11.9 billion was provided by the banking sector, compared with \$7.8 billion raised in the stock market and \$18.3 billion raised through the sale of bonds. In the light of the importance of this sector to economic activity in general, there is, not surprisingly, great concern for its efficiency and stability. However, the appropriate mix of regulatory policies has long been a subject of debate in Canada. In this context, the recent collapse of two regional and relatively young banks, the Canadian Commercial Bank and the Northland Bank, raises the important question of whether or not the regulation and monitoring of deposit taking financial institutions is adequate.

This issue has been addressed by the inquiry into the collapse of the CCB and the Northland Bank (Estey, 1986), also referred to as the Estey Commission. The commission report highlights the fact that, although the Office of the Inspector General of Banks (OIGB) has traditionally depended heavily on external auditors, the auditors were, in the case of the Northland Bank and the CCB, persuaded by management to accept accounting statements about which they had serious concerns. According to the commission, this allowed management to disguise the true state of the firm from the financial market. The commission further states that, in the case of the Northland Bank, 'All this is remarkable considering that the directors of the bank received in late 1982 an analysis of the bank which accurately described the bank's condition and foretold its fate. What makes this analysis the more remarkable is that the analyst produced his study from published bank statements and from discussions with persons in the financial market in Calgary, where the bank had its executive offices.'

When placed in the context of accepted financial theory, these conclusions raise two important and related issues. First, the claim that the banks' managers and accountants were able to disguise publicly available information from financial markets flies in the face of the semi-strong form of the efficient markets hypothesis and therefore must be examined carefully. Second, if, contrary to the statement, the market is in fact relatively efficient in assessing the status of the banks, then regulators should be less concerned with reported book values and more concerned with market values than seems to be the case currently.

Obtaining market values for use in the regulatory process is, however, difficult. One cannot infer the market value of a bank by adding up the market values of the assets since the bulk of these assets are loans which are not actively traded. This would not be a problem if the majority of the banks' debt and equity securities were traded in financial markets, since one could then infer the value of the bank's assets from the value of its traded securities. However, although most equity securities do trade in a well-established market, banks are primarily financed by deposits that are not traded.

In this paper we take an alternative approach to this problem, and derive market-based measures of a bank's total value and risk. We follow Ronn and

Verma (1987) in using an option-pricing framework and view a bank's equity as an option on the value of its assets. Exploiting the equilibrium relationship between an option and the underlying assets as well as the informational efficiency of financial markets, we can derive the asset value from the market value of equity and estimates of the variance of the rate of return on equity. We find evidence to suggest that, in the specific case of the Northland Bank, the market at large was *not* fooled by the 'survival tactics' adopted by management, and that, more generally, the market provided valuable information not reflected in accounting statements.

In addition to their value as market-based performance measures, our estimates of the market value of banks' assets can also be used to calculate risk adjusted prices for deposit insurance. Currently, all financial institutions in Canada pay the same per dollar premium for insurance. This fixed-rate schedule is appropriate if it is possible to constrain the activities of different institutions so that they all have assets of equal risk. However, while all insured banks are inspected from time to time, informational problems make it virtually impossible to impose such a constraint. In addition, even if such an imposition were possible, it would be allocatively inefficient. An alternative is to allow banks more freedom in their portfolio choices but to charge a risk-adjusted insurance rate so as to confront management with the true cost of their decisions.

Risk-adjusted deposit insurance has been advocated both in Canada and in the United States as an alternative to the flat fee system. The Working Group for the Cabinet Council on Economic Affairs in the United States (1985) has recommended the implementation of such insurance. However, while recognizing the desirability of its implementation in Canada, the Working Committee on the Canada Deposit Insurance Corporation (1985) expressed the opinion that it is not possible to establish a system of this sort at the present time, but that such action should be pursued in the future.

We estimate the risk-adjusted premia that various financial institutions should have paid during the 1980-5 period and compare these with an estimate of the amount charged. Based on this comparison we determine whether or not the flat fee system resulted in cross-subsidization within the banking industry. We conclude that flat fees led to considerable cross-subsidization among banks. The hypothesis that the average amount that should have been paid by each bank is indistinguishable from an industry average is strongly rejected.

The remainder of this paper is organized as follows. In the next section we estimate and analyse market values of banks' assets. Based on these results we calculate risk adjusted deposit insurance premia in the third section. The fourth section summarizes our findings.

OPTION PRICING AND THE VALUE OF A BANK'S ASSETS

One of the most important innovations in finance occurred in the valuation of

options. Black and Scholes (1973) and Merton (1973) have developed models that link the value of a stock option to the value of the underlying stock and its variance. A call option (put option) is a contract that gives to its holder the right to purchase from (sell to) the writer a specified stock at a designated price – the exercise price – within a given period of time. Thus, the value of the call option at maturity is equal to

$$C = \max(0, S - X), \quad (1)$$

where C refers to the value of the call option, S refers to the share price, and X refers to the exercise price.

As Black and Scholes (1973) point out (see also Galais and Masulis, 1976), it is possible to view almost any asset in an option pricing framework. In this section we shall interpret a bank's equity as a call option on the bank's assets. Shareholders of a levered bank can, at the maturity of the outstanding debt, either 'repurchase' the firm from depositors by making the required interest payments and principal repayments or walk away from their liability and thus relinquish ownership of the bank to the depositors and other creditors. Thus, when the option expires, either at the maturity of the debt or when the bank is audited, the value of equity is given by

$$E = \max(0, V - B), \quad (2)$$

where V is to the total value of a bank's assets and B is the face value of total debt liabilities including deposits plus preferred shares.¹ Comparison of equations (1) and (2) shows that the pay-off structure of equity is identical to the pay-off structure of a call option. B should be interpreted as the exercise price, whereas the value of the bank's assets replaces the stock price in equation (2).

A bank's equity, for which a market value often exists, can thus be viewed as a derived asset whose value depends upon the value of the bank's assets – primarily its loan portfolio – for which there is usually no observable market value, as well as the variance of the asset value. By exploiting the relationship between the value of a derived asset (the option) and the value of the asset on which it is based we can estimate the implicit market valuation of the bank as a whole and, consequently, the value of the bank's non-traded assets. Given the standard assumptions of the Black and Scholes option pricing model, a formula for the equity viewed as a call option on the assets of the bank can be derived:

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

1 In our simple framework we assume that the entire firm is liquidated when the option expires, and it is then refinanced. This implies that the striking price of the option includes preferred equity. The common equityholders' residual claim has positive value only if the total asset value is sufficient to repay the preferred shareholders as well as all depositors. This approach abstracts from the complex role of preferreds in a model where common equity is interpreted as a compound option on the assets (see Geske, 1976).

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

where N refers to the cumulative standard normal distribution function, T refers to the time to the next audit of the bank, and σ_v refers to the instantaneous standard deviation of the process² dV/V .

The simple form of the boundary condition (2) that leads to the solution in equation (3) requires that all liabilities have the same maturity corresponding to the expiration date of the option. This assumption does not hold for a bank issuing mostly deposits. However, it has been argued by Merton (1977) that in the case of a bank, the maturity of debt can be interpreted as the length of time until the next audit of the bank's assets: If auditors find that the value of the bank's assets is less than the liabilities, they declare the bank bankrupt and extinguish the equityholders' claims.³ Auditors would therefore enforce the boundary condition (2) at the time of the audit. There are, however, two problems with this interpretation. First, if the audit does not result in bankruptcy, the banks will continue to operate and the value of equity claims can be interpreted as a renewed option on the bank's assets. Thus, more realistically, equity should be modelled as a compound option. While theoretical solutions for the value of compound options exist (see Geske, 1976, 1979), the solutions cannot be used readily for numerical calculations of option values. Secondly, it can be argued that auditors will not immediately force a bank into bankruptcy when its asset value reaches the value of the liabilities. In the presence of bankruptcy costs it might be optimal for the deposit insurer to allow a bank to continue operations even if the value of the assets does not fully cover the deposits and thereby avoid costly bankruptcy. We account for this by adjusting the exercise price of the equity option B to ρB , where $\rho < 1$. Thus ρB represents the critical asset value below which the auditor finds it optimal to force bankruptcy. With this adjusted exercise price the equity value is given by⁴

$$E = VN(x) - \rho BN(x - \sigma_v \sqrt{T}) \quad (3')$$

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

- 2 Note that Black and Scholes assume that the variance of the process is constant. Hull and White (1987) and Shanno and Johnson (1985) extend the option pricing result to the case where the variance is stochastic. Hull and White show that the impact on the estimated option values is in fact small.
- 3 Ronn and Verma (1986) argue that 'At the time of the audit, therefore, if the FDIC decides to dissolve the bank, all depositors are paid off, and it is therefore at the time of the audit that the boundary value assumed by the total assets of the bank impinges on the value of the stockholders' investment. In other words, the boundary condition for the value of the equity as a call, i.e., $\text{Max}(0, V - B)$ comes into effect at the time of the audit.'
- 4 In the absence of transactions or bankruptcy costs, it would be optimal for the deposit insurer to trigger bankruptcy as soon as the asset value reaches the face value of the liabilities. However, it may be the case that, as the Estey Commission suggests, auditors are persuaded 'not [to] blow the whistle' at the appropriate time. In this case ρ can be thought of as an adjustment for such imperfections.

From Ito's lemma it follows that the standard deviation of the process dE/E , σ_E , is given by

$$\sigma_E = (V/E)(\partial E/\partial V)\sigma_V. \quad (4)$$

We now have one equation for the bank's equity and one equation for the standard deviation of the return on the equity. Both the market value of equity and the standard deviation of past equity returns can be observed. We can therefore solve for the only two unknowns in the above two equations: the total value of the firm, V , and the standard deviation of the rate of change of V , σ_V .

Empirical market value estimates

In our study we focus on Schedule A banks and include those for which share price data were available from the Financial Research Foundation Daily Price Tape. The banks in this sample account for approximately 90 per cent of the assets held by the Canadian banking industry. This resulted in the following sample of nine banks: the Bank of British Columbia; the Canadian Imperial Bank of Commerce; the Mercantile Bank; the Bank of Montreal; the National Bank; the Northland Bank; the Bank of Nova Scotia; the Royal Bank; and the Toronto Dominion Bank.

In order to solve for the value of the banks' assets, we require as input the equity value, the variance of the equity value, the striking price of the option and the time to maturity. This translates into a need for daily stock price returns from which the variance is estimated, the total market value of the equity (the value of the option), and the outstanding debt and deposits (the exercise price).⁵

We collected daily stock price data for the period January 1980 to December 1985. Our initial data source was the daily stock price tape provided by the Financial Research Foundation. The time series of equity values of the Northland Bank is incomplete, because price data were not available for periods prior to December 1980 and trading was halted in 1985 prior to bankruptcy. Since the tape does not include data beyond 1983, the additional data required were collected from the *Globe and Mail*.

Based on the stock prices, dividend record, and stock split data, we computed daily stock returns. The variance of the rate of return on equity, σ_E , has been estimated from the daily return data over a twelve-month period prior to the evaluation date, which is the end of each month.⁶ According to the assumptions of the option pricing model, V follows a geometric Wiener process

5 While we were able to obtain the required data for a good sample of banks, we could not obtain price data for the Canadian Commercial Bank. This is unfortunate, since the ccb is one of the banks that failed during the sample period.

6 An alternative measure of the equity variance is the variance implied by the price of traded stock options. However, such estimates could not be used, because some of the banks did not have traded options.

TABLE I
Market value estimates and book values^a of bank assets (\$ billions)

Bank	Oct. 81		Oct. 82		Oct. 83		Oct. 84		Oct. 85	
	MV	BV	MV	BV	MV	BV	MV	BV	MV	BV
Northland	-	0.5	0.6	0.7	0.7	0.7	1.0	1.1	-	1.4
Bank BC	2.9	3.0	3.1	3.3	2.9	3.1	3.0	3.1	3.1	3.3
Mercantile	4.0	4.1	4.2	4.4	4.0	4.1	4.7	4.9	3.8	3.9
National	18.4	19.2	18.0	18.8	17.1	17.8	18.5	19.3	22.7	23.3
BNS	48.6	50.1	52.1	53.6	53.6	54.8	57.5	59.1	59.3	61.1
TD	44.3	44.8	43.5	45.0	41.8	42.5	45.4	46.6	49.5	50.2
Royal	85.2	87.5	85.4	88.5	82.7	84.7	85.6	88.0	93.4	96.0
BMO	61.7	63.8	60.1	62.0	61.4	63.2	74.0	76.5	80.0	82.4
CIBC	64.3	66.8	65.9	68.4	65.8	68.1	65.6	68.1	73.5	75.8

^a Book Values are as of 31 October.

with constant variance. The variance of the process dE/E , σ_E , is therefore non-stationary. Thus, using the time series of past equity values to estimate σ_E is an empirical approximation. However, Ronn and Verma (1986) present evidence that the associated error in valuation is small. We have also performed a sensitivity analysis with respect to our estimates of σ_E and found that the market value estimates are not sensitive to changes in σ_E .⁷

The monthly balance sheets of the banks were taken from the *Canada Gazette*. From this source we obtained the total liability figures required to solve equations (3') and (4).

As in Marcus and Shaked (1984) and Ronn and Verma (1986), the maturity of the debt liabilities was assumed to be equal to the approximate periodicity of audits and was set equal to one year. Empirically it is difficult to estimate the periodicity of audits, and in fact the assumption that it is one year is somewhat arbitrary. However, while increasing the time to maturity will increase the estimated option values, the cross-sectional comparison of bank performance is robust to changes in the maturity, T .

Estimates of the market value of the banks' assets as of the end of each month were computed for each bank. These estimates were obtained by simultaneously solving equations (3') and (4) for V and σ_V , using the ZCNT subroutine of the International Statistical Library. The known parameters in equations (3') and (4) are the market value of the bank's common shares at the end of each month, the estimate of the standard deviation of the rate of return on equity, σ_E , and the exercise price of the option, ρB .⁸

⁷ For example, the estimated total asset value for the Canadian Imperial Bank, January 1983 decreases by only \$114,740 if we increase the equity variance from our estimated value of 5.26 to 30 per cent.

⁸ We set ρB at 97 per cent of the value of liabilities plus preferred shares. While our numerical estimates are sensitive to the actual adjustment made, the ranking of banks and the conclusions we draw from the analysis is unaffected.

TABLE 2
Market value of loan portfolio over book value of loan portfolio significance of differences in means and Wilcoxon rank sum test

Bank	1981			1982			1983			1984			1985		
	Per cent mean ratio	t	A/B	Per cent mean ratio	t	A/B	Per cent mean ratio	t	A/B	Per cent mean ratio	t	A/B	Per cent mean ratio	t	A/B
Northland	*	*	*	0.906	6.1	B	0.913	3.7	B	0.891	12.4	B	0.893	5.4	B
Bank BC	0.969	0.3	-	0.962	4.2	-	0.963	3.6	-	0.951	3.5	B	0.940	8.8	B
Mercantile	0.986	6.8	A	0.963	7.9	A	0.975	11.1	A	0.964	1.3	-	0.962	3.3	B
National	0.954	8.8	B	0.954	4.8	B	0.961	9.4	B	0.956	6.3	B	0.971	5.0	A
BNS	0.967	1.2	-	0.955	3.4	-	0.972	5.4	A	0.964	1.8	-	0.966	2.0	-
TD	0.972	0.7	-	0.965	10.7	A	0.981	10.7	A	0.973	8.3	A	0.988	20.2	A
Royal	0.974	1.1	-	0.958	0.1	-	0.969	1.1	-	0.965	5.2	A	0.965	4.5	-
BMO	0.976	1.1	-	0.958	1.5	-	0.967	2.2	-	0.959	7.6	B	0.964	10.7	B
CIBC	0.962	3.5	B	0.956	7.1	B	0.961	12.4	B	0.956	13.9	B	0.962	16.4	B
All banks*	0.970			0.958			0.968			0.962			0.967		

NOTES

* Omitted due to insufficient observations.
t-statistic is pairwise t; Bank's mean ratio = All-bank average; A(B) indicates significantly above (below) all bank average at 1 per cent confidence level based on Wilcoxon rank sum test.

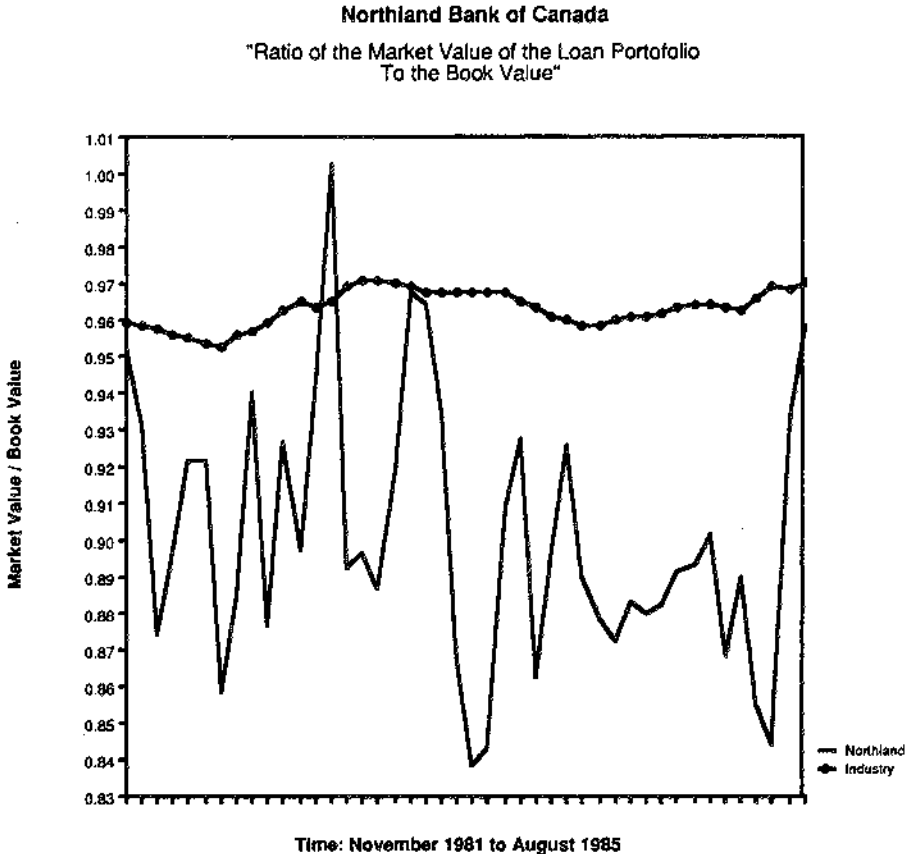


FIGURE 1

Table 1 reports the market value estimates as well as the corresponding book values for each October in the sample period.⁹ The market value estimates are consistently below the book value estimates, suggesting a systematic difference in the two value measures. Of course, it could be the case that this systematic difference is the same for each bank, implying that the market value adds little to the information provided by book values. If this were the case, then the average ratio of the market value to book value would be the same for all banks.

In table 2 we provide evidence that in fact significant differences exist in the ratio of the market value to the book value of the loan portfolio. This table contains *t*-tests for the significance of the difference between the mean ratio for each bank relative to the industry average. We also report the non parametric Wilcoxon rank sum tests for distributional differences. We focus on the loan

⁹ October was reported because it is the banks' fiscal year end. Other months are not reported in this table owing to space limitations.

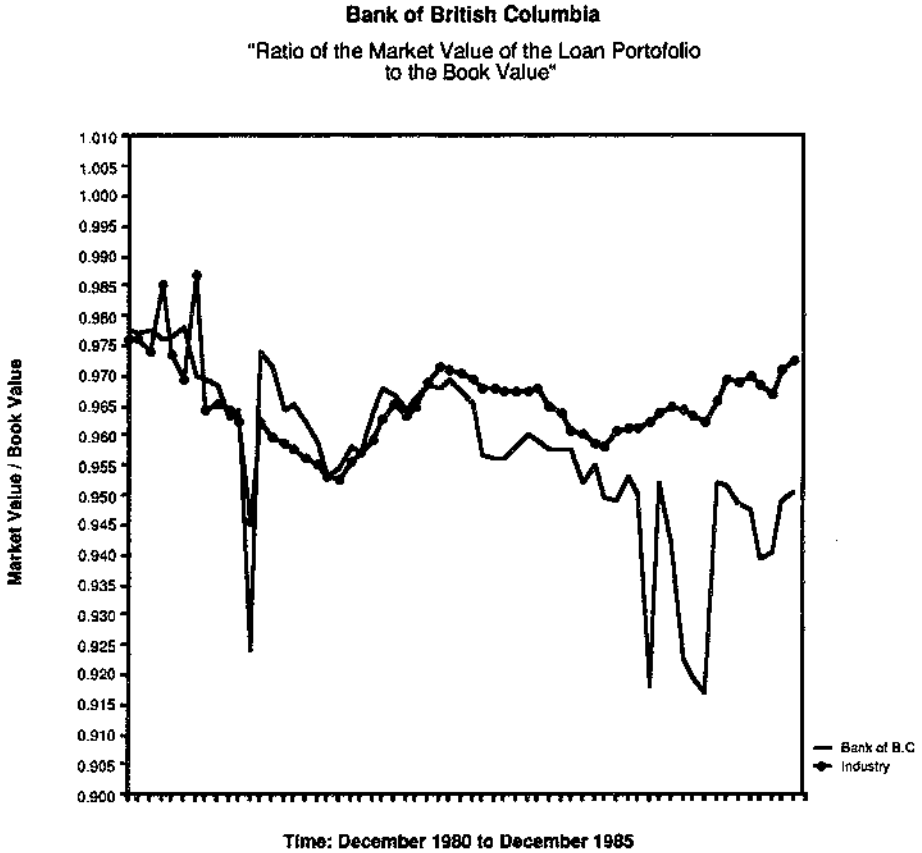


FIGURE 2

portfolio because of its importance and the fact that it is the major asset held by the banks for which market values are difficult to estimate. The book value of the loan portfolio is derived by taking the reported loan portfolio which excludes provisions for losses, adding liabilities incurred under acceptances and subtracting appropriations for contingencies. This last step is taken to reflect managerial recognition of potential losses which are, for accounting purposes, written off over time. On the other hand, the market values are computed by taking the estimate of the market value of the assets and subtracting the book value of cash, securities, and other assets excluding acceptances.

The most striking feature of table 2 is the frequency with which we reject the hypothesis that an individual bank's ratio of market value over book value is the same as the industry ratio. Typically, only three of the banks are not distinguished from the average at the 1 per cent confidence level. Another noteworthy feature is the dramatic difference between the estimates of the

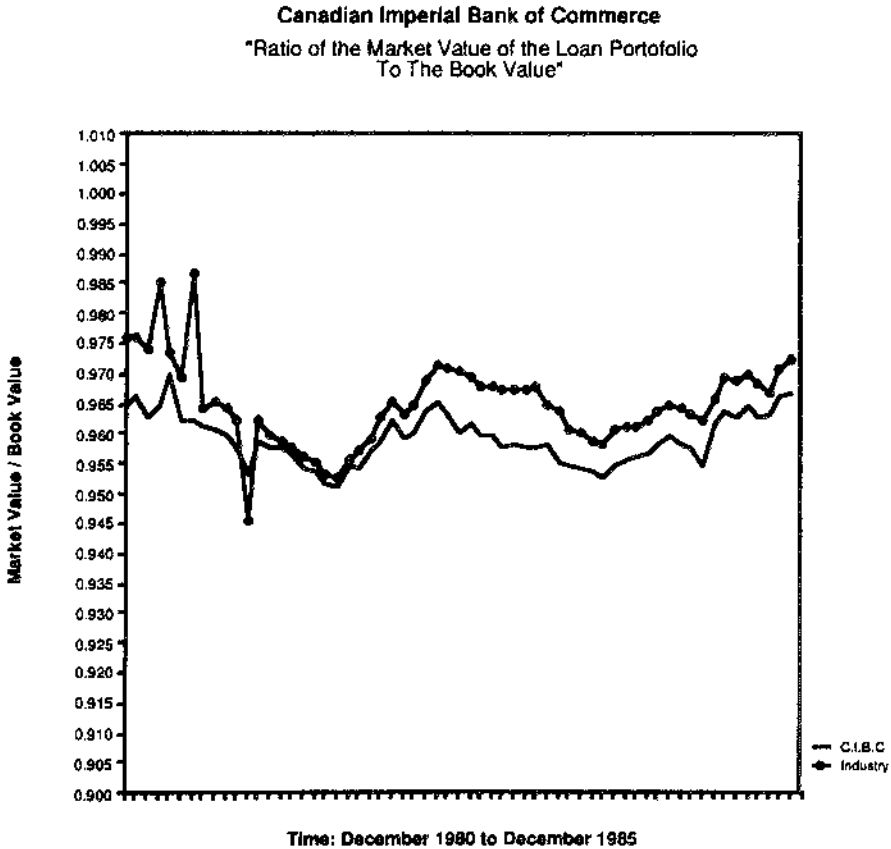


FIGURE 3

Northland Bank relative to all others. Typically market values tend to range between 94 and 98 per cent of book value, whereas the range for the Northland is 89 to 91 per cent.

Two banks in our sample, the Northland Bank and the Bank of British Columbia, entered financial distress during the sample period. In the case of the Northland Bank, the OIGB, having failed to arrange a merger with another bank, declared that the bank was no longer 'viable' on 1 September 1985. On the other hand, the Bank of British Columbia was successfully taken over by the Hong Kong Bank in 1986. To shed some light on the question of whether or not the market estimates have reflected the deterioration of these banks, in figures 1, 2, and 3 we have plotted the ratio of the market and book value of the loan portfolios for the Northland Bank, the Bank of British Columbia, and an average large bank, the CIBC, each with the industry average. The Northland Bank was below the industry average for virtually the entire sample period. We

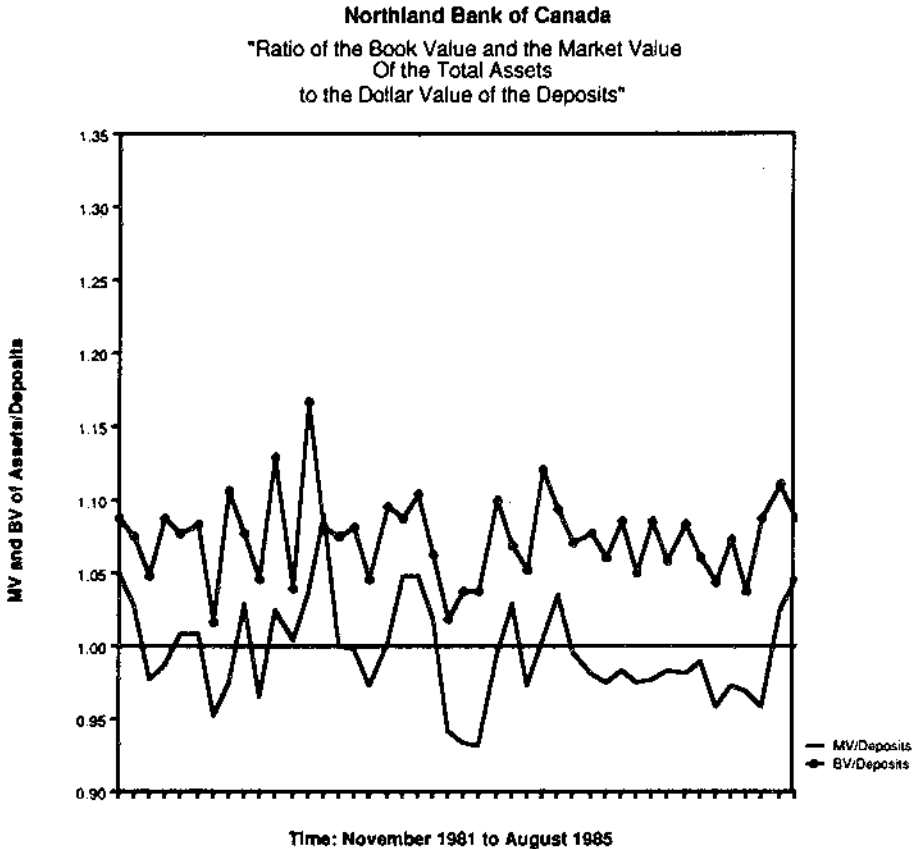


FIGURE 4

observe that the ratio of the Bank of British Columbia was close to the industry average until May of 1983. Subsequently, the ratio of its market value to book value dropped significantly.

We have also plotted the ratio of the total market and book values, both divided by the dollar value of deposits for these banks¹⁰ in figures 4, 5, and 6. Equity is 'out of the money' when this ratio drops below one. As indicated in these figures, both the book and market values for the Bank of BC and the CIBC remain above one throughout the sample period, but, in sharp contrast, the Northland Bank is consistently below one. In contrast to the conclusion of the Estey Commission, which we referred to in the introduction, these figures suggest that the market was in fact aware of the difficulties faced by the bank well before the bank was closed down.

¹⁰ In computing total deposits we added cheques in transit and advances from the Bank of Canada to reflect claims that would have to be settled by the deposit insurer.

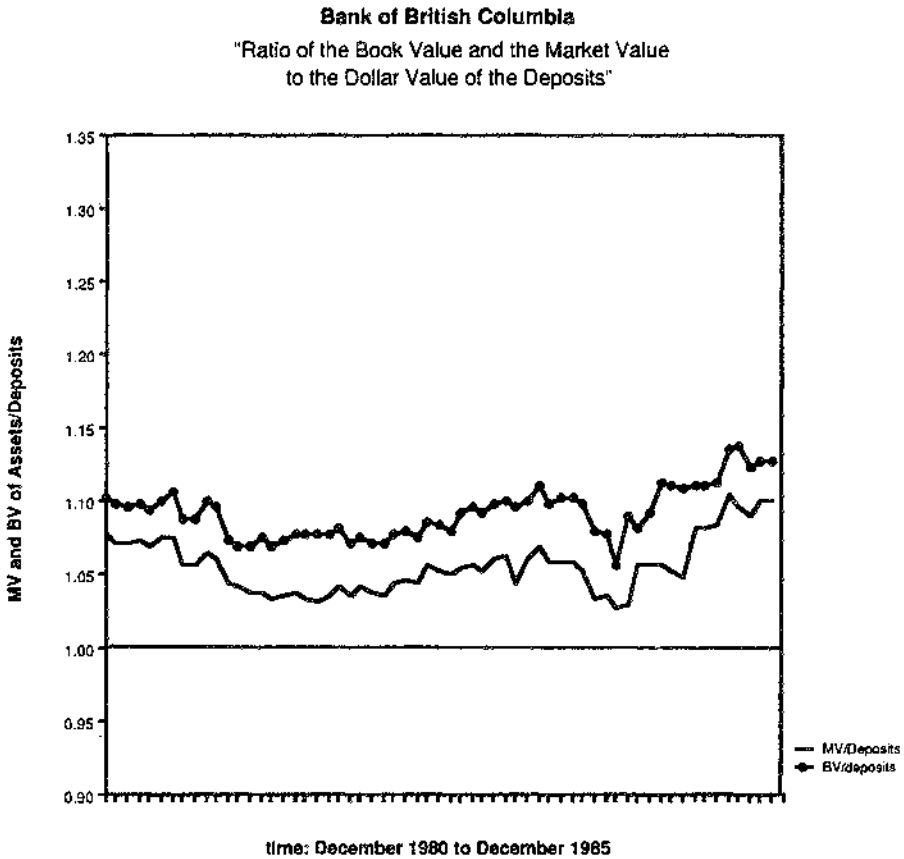


FIGURE 5

OPTION PRICING AND DEPOSIT INSURANCE

In this section we estimate risk-adjusted deposit insurance premia for the nine banks during the sample period. We thereby determine the extent of cross-subsidization induced by the rate system in place during this period.

Deposit insurance was introduced to the Canadian banking system in 1967 through the creation of the Canadian Deposit Insurance Corporation (CDIC). Through the CDIC, deposit insurance is available *at one rate* to all federally incorporated deposit-taking institutions as well as to all provincially incorporated institutions meeting certain criteria. From the outset, the primary purpose of the corporation has been to enhance depositor confidence and avoid negative economic externalities that could be generated by a loss of such confidence.

In enhancing the stability of deposit-taking institutions, the CDIC insures

Canadian Imperial Bank of Commerce
 "Ratio of the Book Value and the Market Value
 Of the Total Assets
 to the Dollar Value of the Deposits"

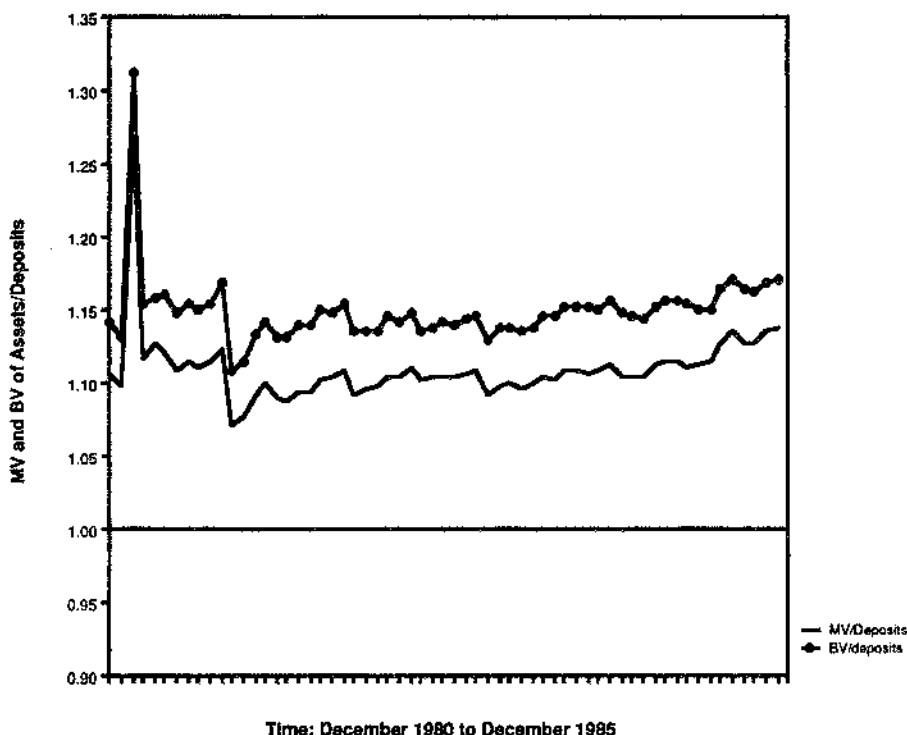


FIGURE 6

deposits up to a stated maximum,¹¹ provides advice to institutions that are facing financial difficulties, and inspects financial institutions other than the chartered banks supervised by the Inspector General of Banks. In performing this function, the CDIC charges an annual premium for its services which, throughout the period under examination, was 1/30 of 1 per cent of the face value of the insured deposits.

Without deposit insurance, riskier banks would have to offer higher interest rates to their depositors. With deposit insurance, the risk of deposits is assumed by the insurer, implying that the bank no longer must compensate depositors for bearing risk. If the insurer is unable to monitor the riskiness of the bank and charges a flat fee for insurance, then managers may have incentives to increase the risk of the assets so as to increase the expected return to equity holders.

¹¹ The stated maximum was initially \$20,000 and was subsequently raised to \$60,000, where it currently stands. We argue below that in practice there is no effective maximum.

TABLE 3

Average annual deposit insurance premia, December 1980 – December 1985

Bank	Calculated premia		Amount charged ^a
	Per cent	\$ (millions)	\$ (millions)
Bank of Montreal	0.979	27.9	0.9
CIBC	0.006	3.8	19.0
Mercantile	0.354	13.6	1.2
BMO	0.007	4.1	19.4
National	0.171	26.9	5.5
Northland	4.430	35.6	0.2
BNS	0.059	28.9	15.9
Royal	0.027	20.4	25.4
TD	0.041	15.2	13.0
All banks	0.055	167.5	101.0
std error	(0.029)	(90.2)	

^a This is the amount that *would* have been paid had the banks paid 0.03 of 1 per cent on *all* deposits. They actually paid less than this, since premia are charged on an insured deposit basis only.

It has been shown by Merton (1977) that deposit insurance can be viewed as a put option on the assets of the bank. The exercise price is the face value of the total debt outstanding. If the value of the bank's assets is less than the face value of the debt, deposit holders would receive

$$VB_1/(B_1 + B_2),$$

where B_1 is the face value of insured deposits and B_2 is the face value of all other debt liabilities. With deposit insurance, deposit holders receive B_1 . Hence, the value of deposit insurance at maturity is given by

$$\max \{0, B_1 - [VB_1/(B_1 + B_2)]\}.$$

In determining B_1 empirically, we take into account the fact that the CDIC is authorized to acquire the assets of an insured institution if this will reduce its own losses. When this authority is used, all outstanding deposits, including uninsured deposits, are typically repaid so as to eliminate other senior claimants to the assets of the bank. If such actions are anticipated by the market, then all deposits become effectively insured regardless of the stated maximum. Consequently, the option's exercise price will *effectively* be the face value of *all* deposits, not just those below the stated maximum. Accordingly, we have assumed that all deposits are insured for the purposes of this study.

Based on this view of deposit insurance, we can again apply the Black and Scholes option-pricing model to obtain the equilibrium per dollar insurance premium d :

$$d = N(y + \sigma_V\sqrt{T}) - (1 - \delta)^n(V/B)N(y),$$

TABLE 4
Significance of differences in means and Wilcoxon rank sum test

Bank	Average Annual Premia														
	1981			1982			1983			1984			1985		
	Per cent mean prem	t	A/B	Per cent mean prem	t	A/B	Per cent mean prem	t	A/B	Per cent mean prem	t	A/B	Per cent mean prem	t	A/B
Northland	**			3.5501	6.4	A	4.9048	8.1	A	4.5945	16.4	A	4.7910	8.1	A
Bank BC	0.3789	13.5	A	0.9012	9.1	A	1.0016	8.5	A	0.7130	3.6	A	1.9484	11.7	A
Mercantile	0.3370	5.3	A	0.5084	12.8	A	0.3228	3.8	-	0.1059	3.0	-	0.4981	4.1	A
National	0.2370	3.3	A	0.2227	4.9	A	0.3471	6.4	A	0.0218	5.5	B	0.0195	7.4	B
BNS	0.0314	.8	-	0.0330	12.7	B	0.0629	4.7	B	0.0759	3.2	-	0.0928	2.5	-
TD	0.0232	2.8	-	0.0360	8.5	B	0.0472	5.2	B	0.0621	5.6	A	0.0384	4.3	B
Royal	0.0200	2.1	-	0.0410	3.2	-	0.0614	7.2	B	0.0083	6.6	B	0.0027	7.6	B
BMO	0.0062	4.8	B	0.0086	8.3	B	0.0208	13.3	B	0.0009	9.2	B	0.0009	7.4	B
CIBC	0.0049	5.0	B	0.0069	9.9	B	0.0201	12.7	B	0.0003	9.4	B	0.0001	7.3	B
All banks*	0.0375			0.0576			0.0817			0.0443			0.0543		

NOTES

* Due to missing observations, Northland Bank excluded.

** Omitted due to insufficient observations.

t-statistic is pairwise t; Bank's mean premium = All-bank average; A(B) indicates significantly above (below) all-bank average at 1 per cent confidence level based on Wilcoxon rank sum test.

where

$$y = \{ \ln [B/V(1 - \delta)^n] - \sigma_V^2(T/2) \} / \sigma_V \sqrt{T} \quad (5)$$

$$B = B_1 + B_2$$

δ = dividend per dollar of value of the assets paid n times per period.¹²

Equation (5) describes the risk adjusted value of deposit insurance as a function of the total value of the bank, V , and the standard deviation of the rate of change in V , σ_V . We can now use the results from the previous section where we derived V and σ_V to solve for the value of deposit insurance.

Using the theoretical approach outlined above, we have generated monthly estimates of the annual risk-adjusted deposit insurance premia which the banks should have paid over the 1980–5 period. Tables 3 and 4 summarize our main results. The estimated annual premium for all the banks averaged over the entire sample period is about one-twentieth of 1 per cent in contrast to the fixed premium of one-thirtieth of 1 per cent which was actually charged.

Perhaps the most striking result of our analysis is the interbank differences in premia evident in table 3. In percentage terms the Northland Bank's risk-adjusted premium is about eighty times the average. In absolute dollar terms, the Northland, despite its very small size, should have paid more than any other bank and more than four times the amount the Canadian Imperial Bank of Commerce (CIBC) and the Bank of Montreal (BMO) combined should have paid. Along similar lines, the average dollar premium which the Bank of BC should have paid is greater than that of any other bank in our sample except the Bank of Nova Scotia and the Northland.

It should be noted that these conclusions must be tempered by the fact that the variance of the monthly estimates for the insurance premium is quite high. This reflects the high variability of the option's value, which in turn is explained by the very high debt to equity ratio in the banking sector. A natural question to ask is whether or not the premia estimates are significantly different from a common industry average, given the high variance in the series. Table 4 presents evidence which bears on this. This table displays the pairwise t -statistic and the Wilcoxon rank sum test for the difference between the computed premium for each bank relative to the industry average. This comparison is done for each year within the sample period in order to allow for the possibility that the relative premia might change significantly over time. As indicated, the Bank of British Columbia, the Northland Bank, and the Mercantile Bank are consistently above the industry average with significance at the 1 per cent level, while the Bank of Montreal, the Canadian Imperial Bank of Commerce, and the Royal Bank are significantly below the industry average. Our results also indicate that for most of the remaining banks, it is

2 Dividends appear in this valuation expression because the writer of the option, the deposit insurer, is not dividend protected. Adjustments for dividends were not needed in equation (3), because in that case the holder of the option, the equity holder, is dividend protected.

also inappropriate to charge a flat fee. In most years eight of the nine banks are significantly different from the industry average.

CONCLUSION

We have employed option pricing theory to infer the market value of the loan portfolios for nine major Canadian Schedule A banks. We have consistently found that the ratio of estimated market value to book value differs significantly across banks. Thus, market value estimates seem to discriminate among the banks and can be used to help monitor deposit-taking institutions. It also seems that market data provided evidence that the Northland Bank was in considerable difficulty well before the bank collapsed.

In addition we have been able to find evidence that the deposit insurance system has induced significant cross-subsidization among Canada's banks. The differences between the estimates of the risk adjusted premia and of the common fee actually charged is striking. Moreover, these results suggest that destabilizing factors may be introduced by a flat fee schedule. Since deposit insurance can be viewed as an option written by the CDIC, its value increases with the riskiness of the underlying asset value – the bank's loan portfolio. It seems that some banks may have responded to this classic adverse incentive in a not surprising way: by holding high variance assets.

Thus, we have presented evidence that the option-pricing model applied to the corporate balance sheet provides a view of the economic condition of a firm which is significantly different from the view provided by accounting standards. However, given the modelling issues discussed throughout the paper, we do not take this to imply that the valuation technique based on option-pricing theory should replace conventional methods of monitoring and insuring deposit-taking institutions. Instead, we feel that our analysis supports the use of market based techniques in conjunction with other more traditional monitoring techniques. Similarly, while our results indicate that there are serious problems with the current system of fixed-rate deposit insurance, we do not advocate adoption of a risk-adjusted deposit insurance system until implementation problems have been carefully studied. Our results do, however, reveal, that such study is warranted.

REFERENCES

- Black, F. and M. Scholes (1973) 'The pricing of options and corporate liabilities.' *Journal of Political Economy* 81, 637–59
- Cox, J. and M. Rubinstein (1984) *Options Markets* (Englewood Cliffs, NJ: Prentice-Hall)
- Estey, W.Z., Commissioner (1986) *Report of the Inquiry Into the Collapse of the CCB and the Northland Bank* (Ottawa: Minister of Supply and Services, Canada)
- Fischer, S. (1978) 'Call option pricing when the exercise price is uncertain.' *Journal of Finance* 33, 169–76

- Galai, D. and R.W. Masulis (1976) 'The option pricing model and the risk factor of stock.' *Journal of Financial Economics* 3, 53-81
- Geske, R. (1977) 'The valuation of corporate liabilities as compound options.' *Journal of Financial and Quantitative Analysis* 12, 541-52
- (1979) 'The valuation of compound options.' *Journal of Financial Economics* 7, 63-81
- Hull, John and Alan White (1987) 'The pricing of options on assets with stochastic volatilities.' *Journal of Finance* 42, 281-300
- Johnson, H.E. and David Shanno (1985) 'Option pricing when the variance is changing.' Graduate School of Administration Working Paper 85-07, University of California, Davis
- Marcus, A.J. and I. Shaked (1984) 'The valuation of FDIC deposit insurance using option pricing estimates.' *Journal of Money, Credit and Banking* 16, 446-60
- Merton, R.C. (1973) 'Theory of rational option pricing.' *Bell Journal of Economics* 4, 141-83
- (1977) 'An analytic derivation of the cost of deposit insurance and loan guarantees.' *Journal of Banking and Finance* 1, 3-11
- Ronn, E.I. and A.K. Verma (1986) 'Pricing risk-adjusted deposit insurance: an option-based model.' *Journal of Finance* 41, 871-95
- Working Committee on the Canada Deposit Insurance Corporation (1985) *Final Report* (Ottawa: Minister of State (Finance), Canada)
- Working Group of the Cabinet Council on Economic Affairs (USA) (1985) *Recommendations for Change in the Federal Deposit Insurance System*