Does Diversification Improve Bank Efficiency?

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Introduction

> In 1952, Nobel Laureate Harry Markowitz, . . . , demonstrated mathematically why putting all your eggs in one basket is an unacceptably risky strategy and why diversification is the nearest an investor or business manager can ever come to a free lunch. That revelation touched off the intellectual movement that revolutionized Wall Street, corporate finance, and business decisions around the world; its effects are still being felt today.
>
> Bernstein (1996, 6)

The choice of focus or diversification in the business activities of firms is the subject of a large body of literature in corporate finance. The evidence seems to indicate that diversification is value-destroying, leading to what is known as the "diversification discount." Theoretical explanations for this include managerial risk aversion, agency problems between managers and shareholders, inefficiency of internal capital markets, and power struggles between different segments of a firm.

Diversification is particularly important for a bank, given its nature as a financial intermediary. Since risk management is an integral part of a

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financial firm's business, the ability to gain from diversifying risks is important for such firms. However, in addition to reasons that limit the gains from diversification that apply to other types of firms, financial institutions also face regulations that create incentives to focus or diversify their portfolios. For example, capital requirements based on predetermined weights on different asset classes can distort portfolio decisions. Moreover, each source of financing that a bank can raise implies a different degree and type of market discipline. Equity-holders care about returns to their equity and might prefer a riskier portfolio than would debt-holders. Subordinated debt holders are considered effective monitors of banks, since they bear all the downside risks associated with a bank's portfolio and can exert more (though not necessarily optimal) pressure for banks to diversify. Thus, diversification per se is no guarantee of a reduced risk of failure or for better performance. We investigate whether Canadian banks hold optimally diversified balance sheets, both in terms of their asset portfolios and their liabilities (financing). Specifically, we ask whether Canadian banks can benefit from the diversification of their loan portfolios to more industries and geographic regions and from diversification in banking activities (business lines) and financing sources.

Acharya, Hasan, and Saunders (2002), henceforth referred to as AHS, study the effect of diversification in loan portfolios on the performance of a sample of Italian banks. They test the following two hypotheses: (i) diversification improves bank returns, and (ii) diversification reduces the risk of banks. They find that diversification reduces bank returns while producing a riskier portfolio. Furthermore, banks with higher risk are more likely to improve their returns with focus. Their test relies on showing that as focus increases, either returns rise and risk falls, or returns fall and risk rises. The outcome is unambiguous for a bank when risk and return move in opposite directions. However, in the event that both risk and return move in the same direction, the implications are ambiguous. We find this to be the case for Canada's Big Five chartered banks: the Bank of Montreal, the Bank of Nova Scotia, the Royal Bank of Canada, the Canadian Imperial Bank of Commerce, and Toronto Dominion Canada Trust. Hence, the AHS framework does not indicate whether the Big Five are better off focusing or diversifying their portfolios and activities. To address this indeterminacy, we construct an efficiency measure that accounts for the trade-off between risk and return as a proxy for bank performance in order to test whether diversification leads to better bank performance in Canada.

We measure efficiency by how well banks achieve an optimal risk-return trade-off in the mix of their business activities. Banks, as financial intermediaries, generate financing from three sources: depositors, equity-holders, and debt-holders. They then allocate these funds to a credit portfolio made up of securities, loans, mortgages, and so forth. As in any portfolio allocation, banks face a risk-return trade-off. Specifically, for a given level of risk, banks attempt to maximize returns. Equivalently, banks minimize risk for a given level of returns. This optimization problem leads to an efficient frontier in risk and return. Any point on this frontier indicates the optimal trade-off between risk and return for any given level of risk or return. In the presence of a risk-free asset, all efficient portfolios are a combination of the risk-free asset and the tangency portfolio, which consists only of risky asset classes. Hence, we view banks as taking inputs (deposits, equity, and debt), solving a portfolio-allocation problem in which exposures are chosen to optimize this risk-return trade-off, and producing outcomes measured by risk and return.

We measure the efficiency of Canada's Big Five banks by looking at whether the composition of each bank's assets leaves the bank on the efficient frontier. We find that banks systematically underperform over time. We thus take the distance between the bank's portfolio from the tangency portfolio as a measure of banking inefficiency. Since our measure of efficiency accounts for the risk-return trade-off, we are equipped to analyze how focus or diversification may affect those two (joint) outcomes.

1 Related Literature

It is interesting to compare our view of a bank with the literature that examines the determinants of banking efficiency. This literature takes a production-function approach to viewing banks and computes inefficiency measures as deviations of banks from an estimated (production or profit) frontier. In this literature, authors take the number of non-mortgage loans and mortgages as outputs of a bank's production process, which does not reflect return or risk. This shortcoming is serious if we consider that the business of banks is to manage risk. In nearly all of their business, financial firms earn returns by being able to separate well-priced from underpriced risk and by managing the risks involved.

There are two broad categories of methods for measuring efficiency. The first approach, called data envelopment analysis (DEA), involves solving linear programs in which an objective function envelopes the observed data, and deriving efficiency scores by measuring how far an observation lies from the "envelope" or frontier. The approach is nonparametric. The second, parametric, approach involves fitting structural models based on explicit behavioural assumptions; that is, estimating an economic function (cost or production function, which both contain all of a firm's technological information) and deriving an efficient measure from either the residuals or the dummy variables. Each approach has its advantages and disadvantages.

The advantage of the DEA approach is that no functional or distributional forms need to be specified; however, all deviations from the frontier are attributed to inefficiency, since no allowance for noise is made. The econometric approach allows for noise in the measurement of inefficiency. However, it needs to specify a functional form to the economic function being estimated and the distributional form for the errors. In both methods, the frontier is constructed using best-practice firms, and, hence, all efficiency measures are relative to the group of best-practice firms. Using either method, some researchers have estimated cost (or technical) efficiency by constructing a production frontier against which all other banks are measured, while others estimate allocative efficiency by constructing profit frontiers.

Eisenbeis, Ferrier, and Kwan (1999) found that bank risk (measured by the volatility of bank firms' stocks, financial leverage (asset-to-equity ratio) and the ratio of loan charge-offs to total loans) and managerial incompetence (measured by ratio of problem loans to total loans, ratio of book value of equity to assets, and rate of asset growth) are significantly related to bank inefficiency. Furthermore, they found that inefficient banks underperformed (in terms of their stock market valuation) relative to their more efficient counterparts. Berger and Mester (1997) found bank size to have a positive but small relationship to efficiency. In addition, conditional on having survived a merger, having a bank holding company structure and being a publicly traded firm were associated with greater efficiency. Market power in the deposit-taking market has a negative impact on efficiency, as does bank risk (as measured by the volatility of returns to assets). Most other studies also found that well-capitalized banks and those with lower non-performing loans ratios are more efficient.

While there are a multitude of efficiency analyses of U.S. banks, there are few applications of these methods to the Canadian banking system. McIntosh (2002) investigated scale economies for Canada's five largest banks, using data from 1976 to 1996. He concluded that Canadian banks have large enough returns to scale to offset the consequences of reduced competition that might have arisen from a merger between the Bank of Montreal and the Royal Bank of Canada, or between CIBC and the TD Bank, or both.[1] His estimated model predicts that all the mergers proposed in 1998 would have led to slightly lower prices and consequently to an increase in consumer welfare.

1. McIntosh's approach differs from the standard analysis of bank efficiency in that he explicitly considers the oligopolistic structure of the Canadian banking industry.

2 Measuring Bank Efficiency

We take a portfolio-theory approach to examine Canadian banks by constructing a risk-return efficient frontier over bank activities: liquidity management, non-mortgage lending, mortgage lending, securities trading, and securities investment, where exposure to an activity is measured by the proportion of bank assets belonging to that business line over total assets. These exposures sum to a positive value equal to or less than one (since some positive weight can be invested in a risk-free asset) for a bank at any given time and are equivalent to the portfolio weights in the bank's portfolio decision.

Consider a bank that is engaged in N financial activities that generate risky income. Each activity, indexed by j, has an expected return, μ_j, which depends on the level of risk undertaken in that activity, given by the variance of returns, σ_j^2. Assuming that the vector of returns is multivariate normal with mean μ and covariance matrix V, define ω as the $N \ x \ 1$ vector of portfolio weight of an arbitrary portfolio. An optimizing bank will choose a point on the risk-return efficient frontier given by

$$\max_{\omega} \ \omega' V \omega \tag{1}$$

$$\text{s.t.} \ \ \omega'\mu + (1 - \omega' l) R_f = z, \tag{2}$$

where R_f is the return to the risk-free asset and l is an $N \ x \ 1$ vector of 1's.

With the risk-free asset, all the mean-variance efficient portfolios are a combination of the risk-free asset and a risky portfolio with portfolio weights given by

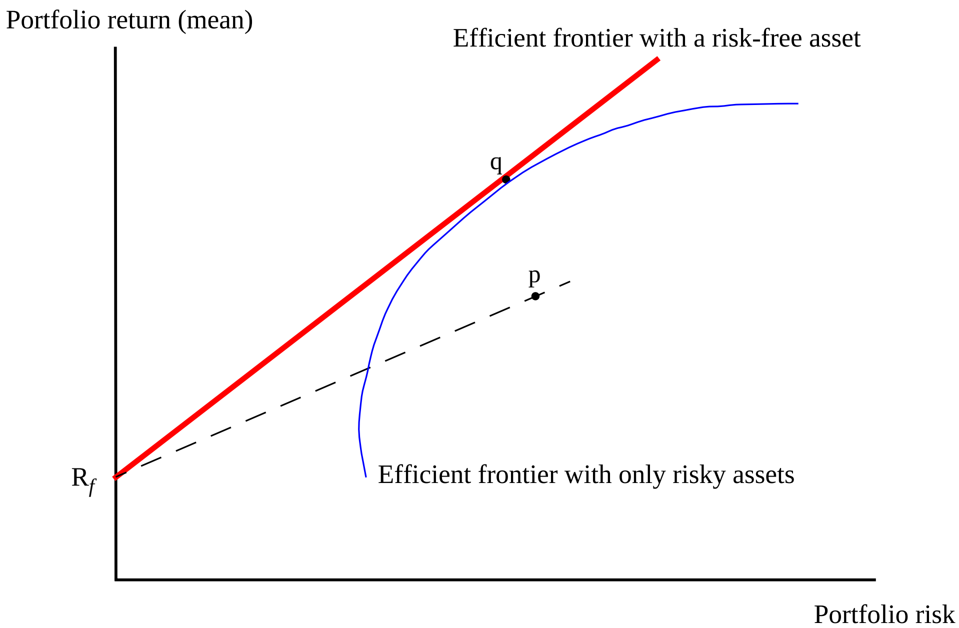
$$\omega_q = \frac{1}{l' V^{-1}(\mu - R_f)} V^{-1}(\mu - R_f l). \tag{3}$$

We call this the tangency portfolio and denote it by q. The efficient frontier, illustrated in Figure 1, is simply the straight line from the risk-free asset through portfolio q. This line is tangential to the efficient frontier generated by the risky assets only. For any portfolio p, its Sharpe ratio is defined as the mean excess return divided by the standard deviation of return,

$$SR_p = \frac{\mu_p - R_f}{\sigma_p}.$$

Figure 1 shows that the Sharpe ratio is just the slope of the line from the risk-free return $(R_f, 0)$ to the portfolio $p = (\mu_p, \sigma_p)$.

Figure 1
Efficient frontier with risk-free asset



The tangency portfolio can be characterized as the portfolio with the maximum Sharpe ratio over all risky portfolios.

In the absence of capital-adequacy requirements or market imperfections, banks optimally choose their exposures to banking activities so that they are on the efficient frontier. This assumes that banks have complete information about the risks and return characteristics of their activities and that deviations of bank portfolios from the efficient frontier are not caused by errors resulting from an incomplete information set on the part of banks. We consider efficient banks to be those that hold efficient portfolios along the risk-return frontier. However, whenever banks hold portfolios that are not optimal, we can measure the degree of their inefficiency by the difference between the Sharpe ratio of the tangency portfolio, q, and the Sharpe ratio of a given portfolio, p. Hence, we define our measure of banking inefficiency by

$$\delta(\omega_p, \mu, V) = SR_p - SR_q = \frac{\omega'\mu - R_f}{\omega'_p V \omega_p} - \frac{\omega'_q \mu - R_f}{\omega'_q V \omega_q}, \qquad (4)$$

where ω_p and ω_q are the weights of portfolios p and q, respectively.[2]

2. As the risk-free rate can change from quarter to quarter, the tangency portfolio changes as well.

3 Data

3.1 Data description and sources

Data used to construct industrial, geographic, business-line, and financing indexes, and asset portfolios of Canadian banks are taken from regulatory reports submitted to the Office of the Superintendent of Financial Institutions (OSFI, the federal regulator of Canadian banks) and the Bank of Canada. While in most cases the data are supplied on a quarterly basis, there are important exceptions. For example, disaggregated assets and liability statements are provided monthly. In this situation, monthly asset averages across each three-month period are employed as a measure of average quarterly assets. Our analysis focuses on the assets of the Big Five banks in Canada.

The fineness of the disaggregation of business lines across banks is determined by the extent to which incomes and expenses from income statements correspond to the relevant assets on a bank's balance sheet. With an accurate correspondence across income statements and balance sheets, we are able to calculate business-line returns, which are used in the construction of an efficient frontier. The disaggregation of business lines among which banks allocate credit is constrained by the availability of data on impairment charges. Information about impairment charges is necessary for an accurate calculation of historical returns to each business line. For example, non-mortgage loan income divided by non-mortgage loans is not an accurate measure of returns on this asset class, unless the appropriate impairment charges on these loans are considered. The appropriate return to non-mortgage loans is non-mortgage loan income net of impairment charges, divided by the stock of non-mortgage loans net of impaired non-mortgage loans. The data on bank assets are taken from the Monthly Average Return of Assets and Liabilities report, except for securities, which are obtained from the Securities Report. All assets are net of allowances for impairment. Each bank undertakes the following business lines.

Liquidity management. A bank undertakes liquidity management to ensure that it is able to meet withdrawals by depositors and other short-term liquidity needs. The assets in this business line consist of cash on hand, cheques, and deposits with the Bank of Canada and with other deposit-taking financial institutions. The returns to this business line represent the risk-free rate that banks face.

Non-mortgage lending. The assets to this business line include loans to governments and public sector entities, financial firms, business firms, and individuals. Income to this activity includes non-mortgage interest income as well as acceptance fees and fees for guarantees and letters of credit.

Mortgage lending. The assets to this business line include residential and non-residential mortgage loans. Income to this activity includes mortgage interest income as well as mortgage fees and real estate commissions.

Securities trading. The assets in a bank's trading activity consist of fixed-income securities, commodity securities, equity, and foreign exchange that constitutes the bank's trading account. Included in the income are investment management fees, mutual funds fees, underwriting fees, and securities commissions and fees.

Securities investment. The assets in this activity consist of fixed-income securities, commodity securities, equity, and foreign exchange that constitutes the bank's investment account.

So that the portfolio of banking activities corresponds to the portfolio-allocation problem we discussed in the previous section, it is necessary to assume that the returns to each banking activity are independent of each other. We therefore must assume that no cross-subsidization occurs across business lines. The portfolio-choice problem facing a bank will be much more complicated if we allow for cross-subsidization.

A few accounting issues must be noted. Securities (in the investment and trading accounts) are quoted in market value, while all other assets are in book value. Furthermore, income data on investment account securities do not include unrealized gains and losses, while those on trading account securities do. The incomes for investment and trading account activities are hence not comparable. Moreover, while income is net of impairment charges, it is still gross of interest and operating expenses, since we cannot allocate those expenses to the various business lines. Our return measure, therefore, is gross returns to assets. Kwast (1989) notes that the fact that the income is not net of interest expense is an advantage here, since this means that the distribution of returns is unaffected by leverage. We have also excluded insurance from a bank's credit portfolio, because it is not possible to allocate assets to those activities and hence compute returns to assets for that business line.

The computed risk-return characteristics of each activity allow us to derive the risk-return efficient frontier over the banking activities we consider. In this exercise, historical returns must be calculated in each asset class or business line. Data for the income generated from the various business lines are taken from the Consolidated Statement of Income report. We calculate income net of charges for impairment, which we obtain from the Allowance for Impairment report. For each bank, the returns to assets are computed for each business line listed above. Table 1 presents the statistics for these business lines. By pooling returns across all banks in each business line, we are assuming that banks are to a large extent homogeneous (for example, in terms of their managerial expertise and monitoring capabilities) and draw their returns to each activity from the same distribution; we assume that the returns are independent of each other. The only heterogeneity we allow for across banks is the actual chosen portfolio allocations of assets across business lines. The data on banks' asset holdings over the same period allow us to plot a bank's actual portfolio allocation each quarter in our sample period on the risk-return space relative to the efficient frontier. We find that banks systematically underperform relative to the efficient frontier with only risky assets.

Assets are also disaggregated by industrial sector based on each bank's non-mortgage loans to individuals for business purposes. Total resident and non-resident loan balances, net of allowances for impairment, are taken from the Non-Mortgage Loans report. In this report, non-mortgage loans to private businesses are broken down into the following industries: primary (agriculture, fishing, mining, and logging and forestry), manufacturing, construction and real estate, transportation and communications, wholesale, retail trade, services, multi-product conglomerates, and others (private not-for-profit firms, and religious, health, and educational institutions). The decomposition of each bank's assets into regional or geographic exposures is facilitated with the availability of the Regional Distribution of Assets and Liabilities report. Total assets (net of allowances for impairment) are broken down by province and territory, international, and other (in-Canada assets, but not allocated to any one province). Finally, we obtain revenue sources, broken down into deposits, equity, and subordinated debt, from banks' Monthly Average Return of Assets and Liabilities report.

3.2 Construction of Herfindahl-Hirschman Indexes

Diversification and focus are analyzed in each of four classifications, and measured by using Herfindahl-Hirschman Indexes (HHIs). HHI is the sum of the squares of exposures as a fraction of total exposure under a given classification. We construct four different types of HHIs: an industrial HHI *(HHI_I)*, a regional HHI *(HHI_R)*, a business line HHI *(HHI_BL)*, and a financing HHI *(HHI_FIN)*.

(HHI_I) is based on loans, net of impairment, to the following industries that constitute banks' non-mortgage lending portfolio: primary (agriculture, fishing and trapping, forestry, mining and energy); construction and real estate; transportation, communications, and utilities; wholesale trade; retail;

Table 1
Bank business lines and their risk-return profiles

	Liquidity management	Non-mortgage lending	Mortgage lending	Securities lending	Securities investment
Expected return (%)	1.07	1.55	1.61	1.86	5.12
Covariance (10^{-3})					
Liquidity management	0.0261	0.0078	0.0017	0.0020	0.0158
Non-mortgage lending	0.0078	0.0149	0.0030	0.0074	0.0132
Mortgage lending	0.0017	0.0030	0.0019	0.0019	0.0048
Securities trading	0.0020	0.0074	0.0019	0.0388	0.0124
Securities investment	0.0158	0.0132	0.0048	0.0124	0.4880
Correlation					
Liquidity management	1.0000	0.3944	0.2452	0.0617	0.1397
Non-mortgage lending	0.3944	1.0000	0.5778	0.3074	0.1545
Mortgage lending	0.2452	0.5778	1.0000	0.2256	0.1579
Securities trading	0.0617	0.3074	0.2256	1.0000	0.0899
Securities investment	0.1397	0.1545	0.1579	0.0899	1.0000

service; multi-product conglomerates; and others (private not-for-profit, religious, health, and educational institutions).

(HHI_R) is based on the regional distribution of bank assets across Canadian provinces and territories, with a category for assets in Canada that cannot be allocated (other) and one for international assets.

(HHI_BL) is based on the business lines of the banks, as we have defined them in this section. Specifically, if X_j is the total asset value in business line j, where $j = 1, \ldots, 5,$ then

$$HHI\_BL = \sum_{j=1}^{5} \left(\frac{X_j}{\sum_{i=1}^{N} X_i} \right)^2 . \tag{5}$$

(HHI_BL) has a maximum of one when all assets fall within one business line. The same formula is used to calculate regional, industrial, and financing indexes.

(HHI_FIN) is a financing concentration measure based on banks' financing sources: deposits, equity, and subordinated debt.

3.3 Control variables

A number of control variables were also calculated with data from regulatory reports. The Basel Accord requires all internationally active banks to maintain minimum capital requirements against both market and credit risks. As these requirements have been enforced since January 1997, we investigate whether deviations from the required capital ratio have important effects for bank performance. We include the ratio of total Tier 1 capital to risk-adjusted assets (CAPRATIO), obtained on a quarterly basis from the Capital Adequacy (G3) report, as a control variable. Other control variables include the log of total bank assets (LSIZE), the ratio of deposits to total assets (DEPRATIO), the ratio of commissions and fee income to net income (COMFEE), and the ratio of non-performing assets to total assets (DOUBT), which is used by AHS as a measure of risk in a bank's portfolio. Finally, the log of real GDP for the Canadian economy (LGDP) is used as a proxy for the business cycle in our analysis. Table A1.1 in Appendix 1 provides a summary of all the regression variables we use. Tables A1.2 and A1.3 present the univariate statistics and the correlation matrix for the regression variables.

4 The Effects of Diversification on Risk and Returns

In this section, we replicate the analysis of AHS, using Canadian bank data over the period 1997Q1 to 2003Q2. We employ data for the five largest banks in Canada, which comprise a large proportion of total assets of all Canadian banks. The objective of the AHS study was to measure the effect of diversification and focus on bank returns and risk. We studied these effects separately and simultaneously. We illustrate that, while the AHS methodology indicates that Canadian banks should focus by region and diversify by business line, no clear-cut implication can be drawn as to whether they should diversify or focus by industry. We propose an alternative method to answer this question by deriving efficiency measures.

To understand the relationship between average bank returns and diversification, we first consider the results of the following linear regression:

$$ROE_{it} = Bank\ dummies_{it} + \alpha_1.HHI\_R_{it-1} + \alpha_2.HHI\_BL_{it-1} + \alpha_3.HHI\_I_{it-1} + controls_{it} + \in_{it}. \quad (6)$$

The return on equity is measured by net income divided by total common equity. Results are presented in Tables A2.1 and A2.2, using data pooled across banks. Note that all standard errors reported in the tables are corrected using White's adjustment for heteroscedasticity. The null hypothesis is that diversification is better for bank returns, or that $\alpha_1 < 0, \alpha_2 < 0, \alpha_3 < 0$. To address non-contemporaneous effects, we consider the relationship between focus in quarter $t-1$ and performance in quarter t. Bank dummies are added to the regression to take into account bank-specific effects. Estimates are obtained with each concentration index entered into the equation separately, and together. Without control variables, regional concentration of the loans portfolio is not significant at the 10 per cent level. On the other hand, α_2 is positive but not significant at the 5 per cent level, and α_3 is positive and significant at the 1 per cent level, indicating that business-line and industrial focus in bank portfolios improve bank returns. The same model is re-estimated with control variables: the log of each bank's assets (LSIZE) is included to take into account scale effects; the ratio of impaired or non-performing assets relative to total assets (DOUBT) is used by AHS as a measure of risk; the ratio of total capital to risk-adjusted assets (CAPRATIO) may account for regulatory or risk-management considerations. Once such control variables are included into the estimation equation, all concentration indexes coefficients are significant at the 10 per cent level, but the signs of a couple of coefficients have reversed. Results now indicate that regional focus increases returns, business-line focus decreases returns, and, as before, industrial focus increases returns. LSIZE is highly significant at the 1 per cent level.[3]

AHS measure risk using the ratio of doubtful and non-performing assets relative to total assets (DOUBT) and use the following regression equation to explore the relationship between bank risk and diversification.

$$DOUBT_{it} = Bank\ dummies_{it} + \gamma_1.HHI\_R_{it-1} + \gamma_2.HHI\_BL_{it-1} + \gamma_3.HHI\_I_{it-1} + controls_{it} + \eta_{it}. \quad (7)$$

The null hypothesis is that diversification reduces bank risk: $\gamma_1 > 0, \gamma_2 > 0, \gamma_3 > 0$. In contrast to the Italian banks of the AHS study, our results suggest that Canadian banks increase risk by focusing on specific industrial groups while concurrently increasing returns. We also find evidence that regional focus reduces risk, while business-line focus increases risk, though the business-line coefficient is not significant at the 10 per cent level. Note that the capital-asset ratio is not significant in any of the regressions.

Since returns and risk are clearly interdependent, the analysis is re-estimated using a seemingly unrelated regression (SUR) approach. The possibility of a correlation between the equation residuals implies that the two regressions may be related. The residuals from each set of regression equations are

3. Although results are not presented here, we find that the hypothesis of AHS—that the relationship between bank returns and diversification is non-linear and U-shaped in risk—is rejected.

allowed to be heteroscedastic and correlated. The results, presented in Table A2.3, vary little from the single-equation approach.

There are several points to make regarding the AHS analysis. First, their methodology, when applied to Canadian banks, indicates, at least in the SUR estimation, that increased regional focus increases returns and reduces risk, and business-line focus reduces returns and increases risk. The methodology does not indicate whether banks should focus or diversify with respect to industry. In particular, industrial focus increases returns, but there is a concurrent increase in risk. If banks are concerned about the overall risk-return trade-off, should they focus or diversify their portfolio? In the next section, we provide an alternative approach with the same motivation in mind, but we provide an unambiguous answer.

Note, too, that in the AHS analysis, the ratio of capital to risk-weighted assets is included as a control variable, but there is little evidence that a larger capital-asset ratio affects returns or risk. In the next section, we find evidence that capital does indeed affect a bank's optimal portfolio decision. In large part, capital-based regulation is an effort to address a moral-hazard problem in banking, widely believed to stem from deposit insurance. Moral hazard is seen as arising because deposit insurance allows banks to make riskier loans without having to pay higher interest rates on deposits. As a result, banks may be prone to take on excessive risk.

5 The Effects of Diversification on Bank Efficiency

To analyze the effects of concentration on bank efficiency, we consider the linear regression:

$$INEFF_{it} = Bank\ dummies_{it} + \delta_1.HHI\_R_{it-1} + \delta_2.HHI\_BL_{it-1} + \delta_3.HHI\_I_{it-1} + \delta_4.HHI\_FIN_{it-1} + controls_{it} + \zeta_{it}. \quad (8)$$

The null hypothesis is that diversification is better for bank returns, or that $\delta_1 < 0, \delta_2 < 0, \delta_3 < 0, \delta_4 < 0$. There is no reason to believe that the concentration measures pertaining to industrial and regional diversification of the loans portfolio or the diversification of bank financing sources suffer from simultaneity or endogeneity with respect to the dependent variable. Hence, we regress the concentration indexes on the inefficiency variable in the same quarter, except for the business-line concentration index, which we lag one quarter. Since both the inefficiency measure and the business-line concentration measure depend on the allocation of assets to the various banking activities, they suffer from simultaneity. The panel feature of our analysis addresses the problem to some extent by controlling for bank-specific fixed effects with bank dummies. Estimates are obtained with each concentration index entered into the equation separately, and together.

The same model is re-estimated with control variables: the ratio of Tier 1 capital to risk-adjusted assets (CAPRATIO); the log of each bank's assets (LSIZE); the ratio of deposits to total assets (DEPRATIO); the ratio of commissions and fee income to net income (COMFEE); and the log of real GDP in Canada (LGDP). We also considered the ratio of non-interest expense to total assets (NONINTEXP) and the ratio of non-interest expense to net income (EFFRATIO), which are used by other studies as measures of management ability, but are insignificant and do not improve model specification. Consequently, we have left them out, since they are highly correlated with some of the concentration indexes and with size and GDP.[4] Several goodness-of-fit tests were used to determine that the appropriate number of lags for the dependent variable and explanatory variables (other than the business-line concentration index) is zero. We find evidence, however, that the residuals are non-normal and exhibit both skewness and kurtosis.[5]

Tables A2.4 and A2.5 in Appendix 2 present the results from the regressions.[6] δ_1 is significant, at the 1 per cent and the 5 per cent levels, when controls are included in the regression. On the other hand, δ_2 is significant only in the regressions without control variables, but its significance disappears when controls are included. δ_3 is significant, mostly at the 10 per cent level, but its sign is negative without controls in the regression and positive with controls. δ_4 is significant and positive. Summarizing the results from the regressions with controls, we find that regional focus reduces inefficiency, and business-line focus increases inefficiency. These outcomes are consistent with the results arising from the AHS methodology. The industrial-focus variable is not significant, indicating that industrial focus or diversification does not affect the risk-return trade-off faced by Canadian banks. Under the AHS methodology, we cannot say whether industrial focus matters. Financing focus increases inefficiency, indicating that a concentration in financing might distort management incentives. Finally, we find that capital-asset ratio is always

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4. LSIZE and LGDP are also highly correlated. Used separately, they are highly significant, but LSIZE becomes insignificant, while LGDP retains its significance when both variables are included in the regression. We opted to keep both variables as controls, since it does not affect the signs or significance of other regression variables and marginally improves the goodness of fit.

5. To address this problem, we will probably perform non-parametric bootstrap techniques at a later time.

6. Bank fixed effects (represented by bank dummies) are highly significant in our regressions, although we do not present those results here.

significant and capital-rich banks are more efficient. Higher capital-asset levels can imply that capital requirements are less constraining, leading to greater opportunities to search out an efficiency risk-return portfolio.

Conclusions

We have examined the question of whether banks should focus or diversify their loans portfolio with respect to industries and regions across Canada, and with respect to their business lines and financing sources. We performed the analysis using the methodology employed by Acharya, Hasan, and Saunders (2002) and showed that although the analysis can inform us about the effects on bank performance of focusing or diversifying with respect to regions and business lines, the methodology cannot examine the trade-off between increasing returns and risk concurrently and hence does not say anything about whether industrial diversification of banks' portfolios is beneficial. We propose an alternative method by constructing a performance measure based on how well banks achieve an efficiency risk-return trade-off in their activities.

Our results with respect to regional and business-line diversification are consistent with those obtained by the AHS methodology. On the subject of industrial diversification, we can show that it is not significant for bank efficiency. Table 2 summarizes our results broadly from the two methodologies. In contrast to the results obtained using the AHS methodology, we find that size per se does not affect efficiency. Rather, it is the composition of bank portfolios and business lines that matters. With respect to bank mergers, our analysis suggests that there are no important scale effects, but there can be important economies (and diseconomies) of scope to consider. A merger between banks with different business lines but with similarities in the regional composition in their portfolios can result in more efficient entities. In determining whether a merger between two financial institutions will be beneficial (in terms of improving bank efficiency), it is thus essential to consider the resulting change in the portfolio composition of the merged institutions. This is consistent with the message from the theoretical analysis in D'Souza and Lai (2002), which considered the effects of a merger between two banks on the merged institution's capital-allocation decisions and the subsequent impact on the efficiency of financial markets in which the bank is a market-maker.

Table 2
Summary of results

	Bank returns	**Bank risk**	**Bank inefficiency**
Regional focus	↑	↓	↓
Business-line focus	↓	not sig.	↑
Industrial focus	↑		not sig.
Financing focus	n/a	n/a	↑
Capital ratio	not sig.	not sig.	↓
Size	↓	↑	not sig.

Appendix 1
Regression Variables

Table A1.1
Description of regression variables

Variable	Description
ROE	Ratio of net income to common equity
ROA	Ratio of net income to total assets
DOUBT	Ratio of non-performing assets to total assets
INEFF	Inefficiency, distance from tangency portfolio
HHI_R	Regional (geographical) focus
HHI_BL	Business-line focus
HHI_I	Industry focus
HHI_FIN	Financing focus
LSIZE	Log of total assets
CAPRATIO	Ratio of total capital to risk-adjusted assets
DEPRATIO	Ratio of deposits to total assets
NONINTEXP	Ratio of non-interest expense to total assets
EFFRATIO	Ratio of non-interest expense to net income
COMFEE	Ratio of commissions and fee income to total assets
DOUBT	Ratio of non-performing assets to total assets
LGDP	Log of quarterly real GDP in Canada

Table A1.2
Descriptive statistics of regression variables

Series	Mean	Std. deviation	Min.	Max.
HHI_R	0.2523	0.0329	0.1928	0.3320
HHI_BL	0.2092	0.0231	0.2691	0.3703
HHI_I	0.1632	0.0160	0.1255	0.1952
HHI_FIN	0.8380	0.0113	0.8194	0.8649
HHI_R	2.1153	1.1417	0.4883	6.7964
LSIZE	19.3180	0.1603	18.7852	19.6922
DOUBT	–0.00068	0.0010	–0.0032	0.0022
CAPRATIO	0.0962	0.0207	0.0451	0.1262
DEPRATIO	0.6677	0.0218	0.5672	0.7187
COMFEE	4.9300	19.2905	–13.1381	191.4998
BL1 ASSETS	16.616	6.584	4.878	34.109
BL2 ASSETS	98.951	14.827	63.678	131.414
BL3 ASSETS	50.959	12.099	30.473	79.919
BL4 ASSETS	36.601	18.468	10.505	75.797
BL5 ASSETS	15.123	4.869	4.849	25.410

Notes:
BL1: liquidity management; BL2: non-mortgage lending; BL3: mortgage lending;
BL4: securities trading; BL5: securities investment.
Business-line assets are in billions of dollars.

Table A1.3
Correlation matrix

Series	HHI_FIN	HHI_R	HHI_I	HHI_BL	CAPRATIO	DOUBT	LSIZE	DEPRATIO	COMFEE	LGDP
HHI_FIN	1.000									
HHI_R	–0.3929	1.000								
HHI_I	0.0288	0.2794	1.000							
HHI_BL	–0.39928	–0.0705	0.3194	1.000						
CAPRATIO	–0.1062	0.6479	0.3673	–0.1891	1.000					
DOUBT	–0.1834	–0.0657	–0.0360	0.0800	–0.0296	1.000				
LSIZE	0.2020	–0.3267	–0.2024	–0.2471	–0.3328	0.1747	1.000			
DEPRATIO	0.2812	–0.1158	0.1403	–0.2524	–0.1628	–0.2738	–0.1987	1.000		
COMFEE	–0.0348	–0.0176	–0.0294	–0.0415	0.1137	0.0012	0.0856	–0.1287	1.000	
LGDP	0.1251	–0.0020	–0.0393	–0.5516	0.2843	0.5024	0.2773	0.0564	0.1537	1.000

Note:
HHI_BL is lagged one quarter.

Appendix 2
Regression Results

Table A2.1
The effects of diversification on bank returns

	Dependent variable: ROE_t				
HHI_R_t	–0.240			–0.274	1.439*
	(0.313)			(0.314)	(0.777)
HHI_I_t		2.040		1.951**	1.722*
		(0.801)		(0.838)	(1.052)
HHI_BL_t			0.407	0.185	–1.861*
			(0.243)	(0.255)	(0.739)
LSIZE					–0.769***
					(0.230)
$CAPRATIO_t$					1.780
					(1.601)
$DOUBT_{t-1}$					7.239
					(6.224)
$\bar{R}^2$	0.039	0.077	0.045	0.066	0.276
χ^2	0.591	2.811*	6.480***	7.848**	16.509***

Notes:
*** denotes significance at the 1 per cent level; ** at 5 per cent; * at 10 per cent.
Figures in parentheses are standard errors.

Table A2.2
The effects of diversification on bank risk

	Dependent variable: $DOUBT_t$				
HHI_R_t	–0.003654			–0.003351	–0.016265**
	(0.005561)			(0.005665)	(0.006856)
HHI_I_t		0.014344		0.016245	0.027323*
		(0.014013)		(0.013542)	(0.014947)
HHI_BL_t			–0.003900	–0.004935	0.010928
			(0.005917)	(0.006428)	(0.006899)
LSIZE					0.004876***
					(0.001292)
$CAPRATIO_t$					0.010693
					(0.022836)
$\bar{R}^2$	0.029	0.036	0.028	0.027	0.147
χ^2	0.431	1.047	0.434	3.082	24.386***

Notes:
Number of observations: 130.
*** denotes significance at the 1 per cent level; ** at 5 per cent; * at 10 per cent.
Figures in parentheses are standard errors.

Table A2.3
The effects of diversification on bank returns and risk (SUR)

Dependent variable	ROE_t	$DOUBT_t$
HHI_R_t	1.195**	–0.018249***
	(0.614)	(0.006304)
HHI_I_t	1.912*	0.030711**
	(1.136)	(0.012324)
HHI_BL_t	–1.781**	0.008762
	(0.715)	(0.007806)
LSIZE	–0.719***	0.006121***
	(0.127)	(0.001313)
$CAPRATIO_t$	1.752	0.010391
	(1.995)	(0.021879)
$DOUBT_{t-1}$	–2.513	
	(8.619)	

Notes:
χ^2 = 44.697***.
Number of observations: 130.
*** denotes significance at the 1 per cent level; ** at 5 per cent; * at 10 per cent.
Figures in parentheses are standard errors.

Table A2.4
The effects of diversification on bank inefficiency

	Dependent variable: $INEFF_t$				
HHI_R_t	–6.0068				–3.7997
	(5.407)				(5.9799)
HHI_I_t		–27.4244**			–23.9934*
		(11.2354)			(12.3862)
HHI_BL_{t-1}			–14.4669		–9.9408*
			(5.1287)		(5.7075)
HHI_FIN_t				18.1288*	13.0392
				(10.9785)	(12.8328)
$\bar{R}^2$	0.001311	0.03508	0.05225	0.01301	0.073304
χ^2	0.9662	1.938*	2.3674**	1.3401	0.073304
Durbin-Watson	1.2680	1.2711	1.2561	1.2550	1.2647
Number of obs.	130	130	125	130	125

Notes:
** denotes significance at the 5 per cent; * at 10 per cent.
Figures in parentheses are standard errors.

Table A2.5
The effects of diversification on bank inefficiency

	Dependent variable: $INEFF_t$				
HHI_R_t	–23.4521***				–17.5080**
	(6.5825)				(0.0)
HHI_I_t		–1.1661			–1.5159
		(11.4750)			(–0.1261)
HHI_BL_{t-1}			14.4805*		13.2936*
			(8.4667)		(1.6418)
HHI_FIN_t				37.5677***	26.6850**
				(12.0637)	(1.9252)
$CAPRATIO_t$	–53.5616***	–45.0460**	–52.9424***	–32.3986*	–47.6944**
	(16.5786)	(18.2495)	(18.7815)	(17.1607)	(20.3283)
$LSIZE_t$	1.6969	–0.8393	–0.04756	–1.7032	1.2963
	(1.3593)	(1.0810)	(1.2740)	(1.0742)	(1.5141)
$DEPRATIO_t$	–6.0584*	–2.5485	2.8925	–10.7469**	–5.4875
	(3.4855)	(3.5274)	(4.8000)	(4.2856)	(5.2081)
$COMFEE_t$	–0.001082	0.0008069	0.001035	0.0001374	–0.0007644
	(0.0045)	(0.0047)	(0.0047)	(0.0045)	(0.0045)
$LGDP_t$	6.6354***	9.6367***	12.0076***	9.5434***	9.0703***
	(2.1396)	(2.4501)	(2.4501)	(1.9840)	(2.5081)
$\bar{R}^2$	0.248472	0.164867	0.182750	0.2302	0.269799
χ^2	5.0997***	3.4479***	3.6610***	4.7095***	4.3822**
Durbin-Watson	1.8256	1.6454	1.7090	1.7045	1.8985
Number of obs.	125	125	120	125	120

Notes:
*** denotes significance at the 1 per cent level; ** at 5 per cent; * at 10 per cent.
Figures in parentheses are standard errors.

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