DOES A SIZE LIMIT RESOLVE TOO BIG TO FAIL PROBLEMS?

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ABSTRACT

Does limiting the size of a large bank reduce its insolvency risk? This paper shows that the answer to this question depends on how exactly paring down of the bank size is done. In fact, the insolvency risk may go down or up depending on the composition of assets and liabilities of the bank relative to its pre-paring down composition. In addition, this study investigates mean-standard deviation efficiency of a typical Canadian large bank and its various possible paring down scenarios and finds both the original bank and its pared-down versions are inefficient. It then suggests mean-standard deviation efficient compositions of assets and liabilities, which do not depend on limiting the size of the bank. Therefore, the findings of this paper raise a serious doubt about the validity of the "limit on size" solution to the too-big-to-fail problem.

JEL: G21, G01, G18

KEYWORDS: Banking, Too-Big-To-Fail, Assets and Liabilities Management, Mean-Variance Analysis

INTRODUCTION

During and after the 2007-2009 financial crisis, the term too-big-to-fail, to be denoted by TBTF hereafter, has been commonly used for a bank that is so large that its failure will trigger significant adverse financial and economic consequences for both financial and non-financial sectors (Ashcraft, 2005). These consequences termed the spillover effects, or systemic risk, were the main rationale behind governments' bailouts of large troubled banks in the USA and Europe during the crisis. The public rescue of a financially distressed large bank is known as the TBTF policy.

The gains of the TBTF policy are the avoidance of the expected spillover effects and maintenance of financial stability, but this policy involves both short–run and long-run costs. Johnson and Kwak (2010) and King (2009), among others, argue that TBTF policy creates moral hazard problem and thereby encourages excessive risk-taking and inefficiency in resource allocation in the long-run. In addition, with the TBTF policy, the frequency of future financial crises is expected to rise, which will entail more significant financial and real costs (Goodlet, 2010). The short-run costs of the TBTF policy consist of the bailout funds which are a transfer of wealth from taxpayers to financial industry. Stern and Feldman (2009a) report that long-run costs were three times the short-run costs of rescuing the savings and loans associations in the USA in the 1980s. Because of the short-run and long-run costs and competitive non-neutrality in favor of large banks of the TBTF policy, this policy is termed to be the TBTF problem.

Various measures have been proposed to tackle the TBTF problem such as, limit on size, tax on profit of TBTF banks, improving bank governance, raising capital adequacy requirements for TBTF banks, and embedded contingent capital (for a comparative evaluation of all the possible solutions to the TBTF problem that have been covered in the extant literature, see Rashid et al., 2012). Among these measures, the "limit on size" solution has been more popular in policy and academic circles. In Belgium, the Netherlands, Switzerland, U.K, and USA, calls have been heard to cap the size of domestic banks (Dermine and Schoenmaker, 2010). A sample of prominent observers who have promoted limiting the size of large financial institutions are Reich (2008), Schultz (2008), Greenspan (see Buiter, 2009), Drucker (see Dickson, 2010), King, Ex-exchequer U.K (see Treanor, 2009), Johnson and Kwak (2010), and Moosa (2010).

As stated by Stern and Feldman (2009b), the size limit solution has seemingly two attractive features that make it more popular and appearing easy to implement in practice. First, a bank's size is easily measurable. Second, the regulator can simply order across-the-board shrinkage of balance sheets for TBTF banks. However, a deeper analysis shows that the difficulties in implementing the "limit on size" solution are more serious than pretended by many of its advocates. Difficulties lie, for example, in identifying TBTF institutions, finding the optimal cut-off size, engaging into efforts to disentangle complex large banks into parts without substantially losing synergies, and the ensuing loss of positive effects of diversification and economies of scale and scope.

The main rationale for shrinking large banks into smaller sizes is that smaller banks have lower systemic risk. There are two problems with this rationale. Although systemic risk may be affected by size, there are host of complex micro-level and macro-level factors which can also affect a bank's systemic risk level. In addition, there is no agreed-upon definition and measure of systemic risk (Bisias et al., 2012), which makes the empirical test of this rationale rather difficult. Instead of systemic risk, we focus in this paper on bank's insolvency risk. The argument is that reducing the insolvency risk of a bank is equivalent to decreasing the likelihood of occurrence of its systemic risk. Accordingly, this study investigates whether limiting the size of a large bank reduces its insolvency risk and shows that insolvency risk of a large bank can be affected positively or negatively depending on how exactly shrinkage in balance sheet is done. Then, the paper tests whether the original large bank and its pared-down version are mean-standard deviation, μ/σ, efficient. Finally, it shows that achieving an efficient combination of assets and liabilities of a bank at lower risk does not require reducing the size of the bank. What matters is the portfolio composition of assets and liabilities, not the size of assets.

The rest of the paper is organized as follows: Section 2 reviews the extant literature on the topic. Section 3 provides data and methodology used in the study. Section 4 reports results. Section 5 provides concluding comments.

LITERATURE REVIEW

The "limit on size" solution seems straightforward to implement as it requires only three steps: (i) identify too-big-to-fail (TBTF) banks, (ii) shrink their balance sheets organically (e.g., non-renewal of maturing loans) and/or by divesting certain operations or assets, and (iii) not allowing small banks to rise beyond a specified threshold size. Rationale behind the solution is twofold: (i) a large bank is difficult to manage properly, resulting in higher likelihood of failure, and (ii) there are less significant spillover effects following the failure of a small bank.

Aguilar (2010) states that Paul Volcker and many others propose that the regulator should rein in the speculative activities of banks because of the key role played by speculative activities in the recent financial crisis. This requires restrictions on bank's proprietary trading and their ownership and sponsorship of hedge funds and private equity funds. Section 619 of the Dodd-Frank Act (2010), known as the Volcker Rule, is aimed at imposing such restrictions (see Acharya and Richardson, 2012).

Dickson (2010) reports the following statement from Peter Drucker, which is tantamount to the "limit on size" solution: "there comes a point where firms are too big to manage." Johnson and Kwak (2010) in their book, *13 Bankers: The Wall Street Takeover and Next Financial Meltdown*, argue in favor of limiting banks' sizes for many reasons, including: (i) the TBTF policy creates competitive disadvantages for smaller banks because their debts are not perceived by market participants as risk free as those of the TBTF institutions, and (ii) the TBTF banks have vast power and control over media, politicians, and regulators. They can campaign and lobby effectively to shape regulation in the way they want (see also, Ferguson, 2010).

Other arguments for a limit on size solution of a large bank include the size of the spillover effects, the cost/benefit analysis of the TBTF policy, and market discipline. It is commonly believed that the present value of the TBTF policy costs far exceeds the present value of its benefits (Goodlet, 2010). Moreover, depositors, creditors, and stockholders of large banks do not exercise market discipline on TBTF banks because of the expectation of government's bailouts in case of failure. Conversely, since smaller banks do not enjoy this downside protection, their investors will be vigilant about excessive risk taking activities by these banks due to possible losses in financial distress situations.

There are also several points raised by opponents to the limit on size solution. First, the regulator needs to identify banks which can cause significant spillover effects, but there is no agreed-upon benchmark for such identification (Fernholz, 2009, Moosa, 2010). Second, reducing the size of a large bank entails substantial costs of downward paring down as well as costs arising from the loss of economies of scale and scope (Allen and Friedland, 2012). Third, a limit on size will adversely impact on the diversification effect, making a bank more vulnerable to insolvency. Fourth, there is the question of regulatory regionalism. If only domestic banks are subject to a limit on size, they will be competitively disadvantaged compared with their international counterparts. Fifth, several analysts such as Allen and Friedland (2012) believe the size was not one of the most important reasons for the recent financial crisis. According to these authors, the main causes were: regulatory forbearance, banks' excessive risk-taking activities, and the Fed's low interest rate policy. In the same vein, there are also doubts whether there are significant adverse spillover effects of failure of a large institution, as claimed by the TBTF policy advocates (Helwedge, 2009, Moosa, 2010). Sixth, even if one accepts the merits of a "limit on size", there is the difficult issue of determining the "critical cut-off" size. Assuming that increasing size does increase economies of scale and scope and does increase spillover effects, there must be a trade-off between these opposing factors in determining the critical cut-off size. Further, optimal levels of economies of scale and scope may occur at different levels of size due to differences in their leverage, liquidity, capital, diversification, and the degree of interconnectedness with other financial institutions. Finally, keeping the pared down bank small overtime should be challenging to both the regulatory authorities and banks.

DATA AND METHODOLOGY

The systemic risk of a bank refers to the adverse spillover effects, also called "contagion" or "domino" effects, of its failure on other financial institutions and on the real economy. Korinek (2011) explains the amplification effects arising from fire sales of financial assets by individual banks in distress. The channels by which these spillover effects may occur are: (i) the ensuing reduction in the money supply and its effect, through the multiplier process, on the economy, (ii) the interconnectedness with other financial institutions and corporations (through inter-financial institutions' deposits and off balance sheet counterparty positions in contingent assets and liabilities), and (iii) investors' adverse reaction to the failure of a bank that leads them to reassess the vulnerability of other market segments or countries (Bekaert et al, 2009).

Despite the abundant studies on systemic risk in the economics and finance literature, there are no widely accepted definition and quantitative measure of systemic risk (Martinez-Jaramillo et al., 2010, Bisias et al., 2012). There have been several attempts to measure systemic risk. For example, Kelly (2012) quantifies it by conditional tail risk of monthly rate of return, Acharya et al. (2012) measure it by the financial firm's marginal expected shortfall, Carlson et al. (2008) use the option theory to measure the systemic risk by distance to default, Khoury and Naftilan (1999) measure it as the sequential domino effect, and others used the value-at-risk models. It appears that none of these approaches can pick up the national and global spillover effects adequately. Also, Khoury and Naftilan (1999) show that modeling systemic risk as the "domino" effect fails to explain the real world phenomenon in the banking sector. We recognize that in the context of the "limit on size" solution, measuring bank's systemic risk would have been preferable but because of the above-mentioned measurement difficulties, we opt to deal with insolvency risk in our analysis. Our argument is based on the fact that systemic risk will occur only if a bank will become insolvent. Therefore, if the insolvency risk of a bank is reduced, that will decrease the probability of occurrence of systemic risk.

The methodology of the paper involves the measure of banks' performance and bank's insolvency risk and then the computation of mean-standard deviation, μ/σ, efficiency frontier. We measure bank's performance by the rate of return on its equity, to be denoted by ROE. Other possible measures are rate of return on bank's assets, market rate of return on equity, Tobin's Q, etc. Despite the apparent desirability of the market rate of return and Tobin's Q, our use of aggregative data prevents us to consider any of such measures.

We measure the bank's insolvency risk by the standard deviation of the rate of return on its equity, to be denoted by σ_{ROE}. Equation (2) shows that the rate of return on a bank's equity depends on rates of return on all its assets and interest costs of all its liabilities. Therefore, σ_{ROE} embodies in itself the bank's financial risk: liquidity risk, default risk, funding risk, etc. The verification of this assertion can be found in equation (4) below. Therefore, σ_{ROE} can be perceived as the composite risk measure of the bank. A high level of σ_{ROE} will represent a high likelihood of failure of the bank.

To calculate rate of return and insolvency risk of a bank, we have to estimate rates of return on its assets and interest costs of its liabilities, operating expenses, and the tax rate on bank's profit. To obtain all these estimates, we use data from the Office of the Superintendent of Financial Institutions Canada (OSFI) (http://www.osfi-bsif.gc.ca/osfi/index_e.aspx?ArticleID=554). These data consist of quarterly aggregate figures of the items in the consolidated balance sheets and consolidated income statements of 76 Canadian chartered banks over the 2000Q1-2011Q2 period. The choice of the sample period is dictated by the fact that consistent data are not available before the first quarter of 2000 and the end point of the current data set is the second quarter of 2011. In Table 1 below, the main summary statistics of the data are provided.

For the balance sheet items in Table 1, we combine CA with OA for two reasons: (i) the most dominant part of OA is banker's acceptances which are credit substitutes not credit themselves, and (ii) to calculate rates of return on individual assets, the data used do not give segregation of non-interest income into a part coming from OA and other part arising from CA. On the liabilities and equity side, we combine CL and OL for the similar reasons. Appendix A provides definitions of a bank's balance sheet items according to Canadian Chartered Banks annual reports and Bank of Canada Review.

Table 1 reports mean, standard deviation, minimum level and maximum level of each of the items in the balance sheet and income statement of the banks, which are needed to measure mean rate of return on equity and insolvency risk. The notable point from the assets side is that contingent assets and other assets have the highest standard deviation per dollar of mean value, the liquid assets have also similar coefficient of variation. This may be explained by the recent financial crisis where banks' liquidity levels rose sharply. The average levels of all assets, liabilities, shareholder's equity, incomes of assets, and costs of liabilities are as expected. The coefficient of variation of demand and notice deposits is larger relative to those of other liabilities as normally is the case.

Table 1: Summary Statistics of the Data

Panel 1: Balance Sheet Items				
ITEM	**MEAN**	**STANDARD DEVIATION**	**MINIMUM**	**MAXIMUM**
Liquid assets (LA)	297,503,232	102,266,515	195,274,280	522,780,619
Non-mortgage loans less allowance for impairment (NML)	762,747,373	184,960,181	557,328,618	1,110,549,458
Mortgage loans less allowance for impairment (ML)	443,742,457	104,660,967	285,504,318	648,303,330
Other securities less allowance for impairment (S)	392,979,197	99,779,925	225,464,548	526,642,636
Contingent assets and other assets (CA/OA)	337,967,166	117,827,803	190,569,045	707,594,982
Demand and notice deposits (D)	566,591,320	217,399,424	299,587,569	1,017,508,778
Fixed-term deposits (TD)	905,719,059	157,451,681	721,611,197	1,206,584,421
Contingent liabilities and other liabilities (CL/OL)	654,465,626	186,776,601	374,146,841	1,065,923,052
Equity (E)	108,163,420	33,528,360	69,979,492	177,366,708
Panel 2: Income Statement Items				
ITEM	**MEAN**	**STANDARD DEVIATION**	**MINIMUM**	**MAXIMUM**
Interest income on deposits with regulated financial institutions	825,942	349,149	288,604	1,557,648
Interest income of securities issued or guaranteed by various levels of government	1,102,853	242,220	736,889	1,758,812
Interest income from non-mortgage loans	10,517,518	2,367,090	6,857,078	14,765,073
Interest income from residential mortgages and commercial mortgages	5,494,481	711,678	4,619,741	7,082,943
Interest and dividend income from other securities	3,650,214	1,060,377	1,563,452	5,773,536
Total non-interest income	9,436,501	1,656,730	5,496,178	12,855,371
Interest expense of demand and notice deposits	1,755,956	811,645	748,013	3,371,789
Interest expense of fixed-term deposits	7,494,603	2,489,670	4,494,119	12,462,692
Interest expense of subordinated debt	427,003	50,841	313,005	531,408
Other interest expense	2,485,953	922,848	1,372,910	4,684,070
Total of non-interest expenses	12,293,522	1,582,822	9,946,271	15,593,298
Total of current and deferred taxes	1,181,604	553,885	-275,070	2,301,307
Taxable income	5,131,309	1,882,272	1,701,572	9,045,262

This table provides descriptive statistics (mean, standard deviation, minimum and maximum) of items in the consolidated balance sheets and consolidated income statements of 76 Canadian chartered banks over the 2000Q1-2011Q2 period.

The estimates of ROE and σ_{ROE} are obtained as follows. Denoting asset i by A_i where i=1,2,3,4,5, liability j by L_j where j=1,2,3, non-interest expenses as C, the rate of return on asset A_i as r_i, the rate of interest paid on liability L_j as i_j, and bank's tax rate as t, and assuming that C and t are constant, the net income to bank' stockholders in a given period is:

Net Income, $\widetilde{NI} = \left(\sum_{i=1}^{5} A_i \tilde{r}_i - \sum_{j=1}^{3} L_j \tilde{\iota}_j - C\right)(1-t)$ (1)

Where tilde on a variable indicates the variable is random.

The rate of return on equity is:

$$\widetilde{ROE} = \left[\sum_{i=1}^{5} \left({A_i}/{E}\right) \tilde{r}_i - \sum_{j=1}^{3} \left({L_j}/{E}\right) \tilde{\iota}_j - {C}/{E}\right](1-t) \quad (2)$$

The expected level of ROE is given by:

$$\overline{ROE} = \left[\sum_{i=1}^{5} \left({A_i}/{E}\right) \bar{r}_i - \sum_{j=1}^{3} \left({L_j}/{E}\right) \bar{\iota}_j - {C}/{E}\right](1-t) \quad (3)$$

where bar over a random variable indicates its average value.

We measure the insolvency risk by the standard deviation of ROE. This standard deviation is given by the following equation:

$$\sigma_{ROE} = \left[\left(\frac{1-t}{E}\right)^2 \left[\sum_{i=1}^{5} A_i^2\sigma_i^2 + \sum_{j=1}^{3} L_j^2\sigma_j^2 + 2\sum_{i=1}^{5}\sum_{s>i}^{5} A_i A_s \sigma_{i,s} + 2\sum_{j=1}^{3}\sum_{q>j}^{3} L_j L_q \sigma_{j,q} - 2\sum_{i=1}^{5} A_i \sum_{j=1}^{3} L_j \sigma_{i,j}\right]\right]^{1/2} \quad (4)$$

Historical estimates of the rates of return and interest rates are obtained by using quarterly data in the consolidated balance sheets and consolidated income statements for all Canadian banks over the 2000Q1-2011Q2 period. In these estimations, rates of return on assets are derived by associating categories of incomes in the income statement in quarter t with the corresponding assets categories in the balance sheet at the end of quarter t-1. Similarly for derivation of interest rates paid on liabilities, categories of costs in the income statement are associated with corresponding liabilities in the balance sheet. Definitions of rates of return and interest rates used in this study are: (a) r_{LA} = (Interest income on deposits with regulated financial institutions$_t$ + Interest income of securities issued or guaranteed by various levels of government$_t$)/Liquid assets$_{t-1}$; (b) r_{NML} = Interest income from non-mortgage loans$_t$/Non-mortgage loans less allowance for impairment$_{t-1}$; (c) r_{ML} = Interest income from residential mortgages and commercial mortgages$_t$/Mortgages loans less allowance for impairment$_{t-1}$; (d) r_s = Interest and dividend income from other securities$_t$/Other Securities less allowance for impairment$_{t-1}$; (e) $r_{CA/OA}$ = Total non-interest income$_t$/(Contingent assets and other assets$_{t-1}$); (f) i_D = Interest expense of demand and notice deposits$_t$/Demand and notice deposits$_{t-1}$; (g) i_{TD} = Interest expense of fixed-term deposits$_t$/Fixed-term deposits$_{t-1}$; (h) $i_{CL/OL}$ = (Interest expense of subordinated debt$_t$ + Other interest expense$_t$)/(Contingent liabilities and other liabilities$_{t-1}$). Finally, C was obtained by total of non-interest expenses and the tax rate t was estimated by the ratio of total of current and deferred taxes to taxable income.

Following Brewer and Jagtiani (2007) who found that banks were willing to pay a premium for a merger deal that would take them over \$100 billion in assets, we choose size of \$100 billion in total assets for a bank to be considered too-big-to-fail. In Table 2 below, we obtain the levels of assets, liabilities, and equity by multiplying \$100 billion with average composition of each dollar of total assets and each dollar of liabilities and equity in our data set.

Table 2: Balance Sheet of a Bank, with Total Assets' Size of \$100 Billion (Figures are in \$Billion)

ASSETS ($BILLION)		LIABILITIES AND SHAREHOLDERS' EQUITY ($BILLION)	
LA	13.3	D	25.4
NML	34.4	TD	40.5
ML	19.9	CL/OL	29.3
S	17.6	E	4.8
CA/OA	15.1		
TA	**100**	**TL + E**	**100**

This table shows the levels of assets, liabilities, and equity of a bank with total assets' size of \$100 billion with average composition of each dollar of total assets and each dollar of liabilities and equity in our data set.

This table reports the assets, liabilities and shareholders' equity of a TBTF Canadian bank. The biggest assets on the assets side are NML, following by ML. On the liabilities side, term deposits TD constitute the largest liability. Equity is about 5% of TA.

In this study, we test also whether a given composition of assets and liabilities of a bank is μ/σ efficient. The theoretical framework used is the same as that of Markowitz (1959) recently restated in Markowitz (2010). The numerical simulations used to derive the Markowitz μ/σ frontier for infinite portfolio composition of a given bank are computed using MATLAB as suggested by Chen et al. (2010) who show how the MATLAB program can be used to solve the quadratic programming problem.

RESULTS

Using the methodology described in the previous section, the following table provides the estimated levels of all required rates of return and interest costs. Because of length, only estimates of Q2 of each year of the sample period are reported.

Table 3: Rates of Return on Assets and Interest Costs of Liabilities

	r_{LA}	r_{NML}	r_{ML}	r_S	$r_{CA/OA}$	i_D	i_{TD}	$i_{CL/OL}$
Q2-2000	0.0110	0.0195	0.0162	0.0124	0.0475	0.0078	0.0129	0.0072
Q2-2001	0.0102	0.0190	0.0166	0.0125	0.0374	0.0070	0.0124	0.0069
Q2-2002	0.0084	0.0113	0.0143	0.0087	0.0376	0.0026	0.0069	0.0042
Q2-2003	0.0071	0.0124	0.0137	0.0087	0.0285	0.0029	0.0066	0.0045
Q2-2004	0.0057	0.0119	0.0126	0.0081	0.0327	0.0024	0.0059	0.0038
Q2-2005	0.0068	0.0132	0.0119	0.0094	0.0307	0.0030	0.0072	0.0048
Q2-2006	0.0068	0.0153	0.0122	0.0094	0.0354	0.0043	0.0093	0.0060
Q2-2007	0.0078	0.0166	0.0129	0.0111	0.0343	0.0052	0.0107	0.0070
Q2-2008	0.0068	0.0142	0.0126	0.0100	0.0144	0.0040	0.0094	0.0046
Q2-2009	0.0049	0.0104	0.0100	0.0104	0.0143	0.0013	0.0059	0.0023
Q2-2010	0.0035	0.0105	0.0090	0.0067	0.0274	0.0008	0.0050	0.0022
Q2-2011	0.0033	0.0104	0.0092	0.0072	0.0299	0.0013	0.0049	0.0028
Average	**0.0072**	**0.0142**	**0.0129**	**0.0095**	**0.0304**	**0.0037**	**0.0084**	**0.0048**

This table reports the estimates of rates of return on assets and interest rates paid on liabilities obtained for the second quarter of each year from 2000 to 2011. It also shows the average rates of return on assets and average interest costs of liabilities.

In Table 3, quarterly $\bar{r}_{LA}$ = 0.72%, $\bar{r}_{ML}$= 1.29%, $\bar{r}_{NML}$= 1.42% are as one would expect, but quarterly $\bar{r}_S$ at only 0.95% needs some explanation. This rate is relatively low because of generally low interest rates and lackluster performance of the stock market in most of the decade of 2000-2010. The highest quarterly expected rate of return earned by the bank was on its contingent assets and other assets. On the liabilities side, the term deposits entailed the highest interest cost to the bank.

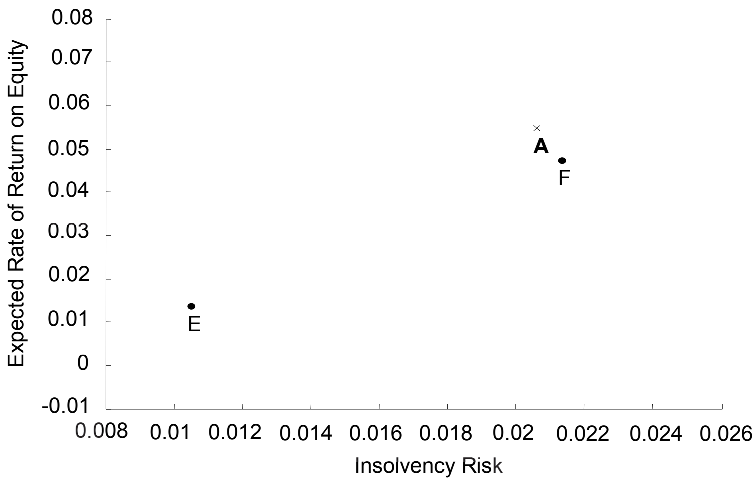
Using equations (3) and (4), and the estimates of expected rates of return, expected interest rates, C ($550,061), t (22.26%), and Table 2 data, the expected rate of return on equity, $\overline{ROE}$, was 5.47%, and insolvency risk, σ_{ROE} , was 2.06%. This plots as point A in Figure 1 below. The $\overline{ROE}$ is beyond the levels of rates of return on assets in Table 1 because individual weights are greater than 1 and the leverage effect. However, weights of all the assets and liabilities sum to 1.

We assume that the regulator requires the bank to reduce its size by $10 billion – a 10% shrinkage in bank's size. We now show that insolvency risk may go down or up depending on which asset(s) are pared down and correspondingly which liability (liabilities) are reduced. The possibilities of the 10 billion dollars shrinkage are infinite but to make the point and, without loss of generality, we report only two simulations, one showing a reduction in risk (point E in Figure 1 below) and the other indicating an increase in risk (point F in Figure 1 below).

The first simulation consists of reducing by $10 billion only one asset, contingent assets and other assets, CA/OA, on the assets side and only one liability, contingent liabilities and other liabilities, CL/OL, on the liabilities and equity side. The remaining assets and liabilities maintain the same levels as given in Table 2. Clearly, the composition of the balance sheet changes significantly by this simulation. Using equations (3) and (4) and the resulting composition of the bank's balance sheet, $\overline{ROE}$ and σ_{ROE} are now 1.36% and 1.05% respectively. This scenario does reduce insolvency risk from 2.06% to 1.05% – a decrease of 49%, but the corresponding reduction in return is from 5.47% to 1.36% – a decline of 75%. Even though, the regulator may like this substantial reduction in risk yet the bank will not accept such a sharp decline in return.

For the second simulation, we let other securities, S, to decline by $10 billion on the assets side, and CL/OL to decline by the same amount on the liabilities and equity side. As a result, insolvency risk rises from 2.06% to 2.13% – a 3.4% increase, while rate of return on equity declines from 5.47% to 4.74% – a 13.3% decrease. This scenario shows that although the bank becomes smaller, the insolvency risk has increased. What appears to be the key factor in affecting a bank's insolvency risk (and simultaneously its rate of return) is the portfolio composition of its assets and liabilities, not its size.

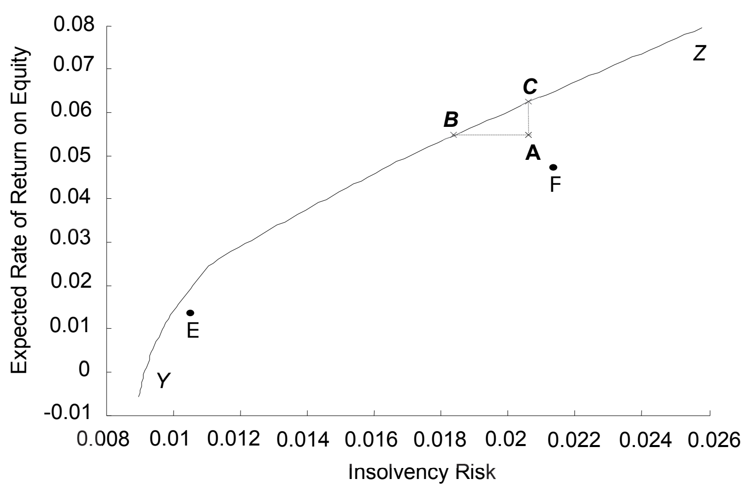
Figure 1: The Effect of Paring Down Exercises on Insolvency Risk and Expected Return



This figure shows point A which corresponds to the expected return/ insolvency risk combination of a given bank with the estimates of expected rates of return, expected interest rates, C, and t, obtained by using the quarterly data in the consolidated balance sheets and consolidated income statements for all Canadian banks over the 2000Q1- 2011Q2 period, and Table 2 data. In addition, it shows the effect of two simulations of shrinkages in bank's size on expected return and insolvency risk of the bank: $10 billion shrinkage in only CA/OA and in only CL/OL (point E) and $10 billion shrinkage in only S and in only CL/OL (point F).

Using the MATLAB program and the data as estimated above, Figure 2 plots the mean-standard deviation efficiency frontier, labeled as Y, B, C and Z. The results of the two simulations described above are again plotted as points E and F.

Figure 2: Efficiency of Various Compositions of Assets and Liabilities of the Bank



This figure plots the mean-standard deviation efficiency frontier, labeled as Y, B, C and Z. In this figure, the results of the paring down exercises in Figure 1 are again plotted as points E and F. In addition, B and C show the return/risk combinations of different compositions of assets and liabilities with the same bank's size. B corresponds to equity's return level of 5.47% - the same equity's return as at point A, but with insolvency risk of 1.84%. Point C corresponds to risk level of 2.06% - the same risk as at point A, but with equity's return of 6.23%.

The figure shows that none of the portfolio compositions considered above is efficient. Thus, a paring down, which may be regulator mandated, may not achieve a point on the efficient frontier. However, keeping size the same as before and changing composition of assets and liabilities can achieve point B in the figure, where the risk declines from 2.06% to 1.84% – a 10.7% decline and return stays the same as before (5.47%). To obtain point B, the composition of assets and liabilities required is provided in Table 4: Panel 1. In the same vein, point C in Figure 2 corresponds to risk level of 2.06% – the same risk as at point A, but with $\overline{\text{ROE}}$ of 6.23% – a 13.9% increase. Therefore, if the risk level of 2.06% is desired by the regulator, it does not require a limit on size of the bank; instead it would require the composition of assets and liabilities as given in panel 2 of Table 4.

Table 4: Balance Sheet Reflecting Efficient Points B and C

Panel 1: point B			
ASSETS ($BILLION)		**LIABILITIES AND SHAREHOLDERS' EQUITY ($BILLION)**	
LA	11.52	D	28.8
NML	38.4	TD	38.08
ML	24	CL/OL	28.8
S	14.4	E	4.8
CA/OA	12.18		
TA	**100**	**TL + E**	**100**
Panel 2: point C			
ASSETS ($BILLION)		**LIABILITIES AND SHAREHOLDERS' EQUITY ($BILLION)**	
LA	11.22	D	28.05
NML	37.41	TD	39.22
ML	23.38	CL/OL	28.05
S	14.03	E	4.8
CA/OA	13.97		
TA	**100**	**TL + E**	**100**

This table shows the composition of assets, liabilities, and equity of a given bank with the return/risk combination indicated by points B and C in Figure 2.

Table 4 panel 1 shows that to reach point B in Figure 2, the bank will need to raise its investments in NML and ML by 11.6% and 20.6% respectively and correspondingly reduce its investments in LA, S and CA/OA. On the liabilities side, demand and notice deposits increase by 13.4% with correspondingly declines in TD and CL/OL. In panel 2 of Table 4, again NML and ML rise but not as much as in panel 1 and correspondingly downward adjustments are done in LA, S and CA/OA. In liabilities, reshuffling is similar as in panel 1 but amounts adjusted are different.

In sum, the size does not need to shrink to achieve an efficient portfolio and simultaneously a lower level of risk. Assuming that a regulator will like to keep the bank on the efficiency frontier, which level of insolvency risk the regulator will choose on the efficiency frontier? It obviously depends on the degree of risk aversion of the regulator. The Association of Investment Management and Research, AIMR, commonly employs the following utility function (Chen et al., 2010), which, using our notation, is:

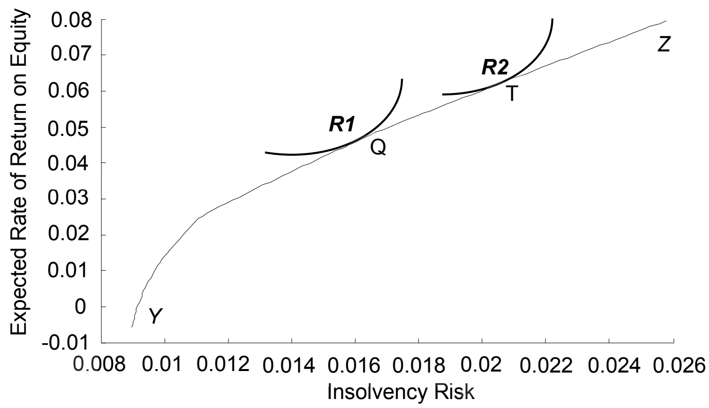
$$U = \overline{ROE} - 0.005\lambda\, \sigma_{ROE}^2 \qquad (5)$$

where λ is the coefficient of risk aversion.

The higher is the value of λ, which means higher is the degree of risk aversion, the lower level of insolvency risk will be chosen by the regulator and vice versa. Regulators of different countries may have different coefficients of risk aversion which may explain why their respective desired risk levels may be different. As suggested by Figure 2, different desired risk levels will entail different optimal compositions of a bank's assets and liabilities.

Figure 3 shows two indifference curves: R1 and R2. R1 refers to a regulator whose degree of risk aversion is higher. The country of that regulator will have to impose more restrictive regulation to achieve a lower level of risk. The opposite is the case for a regulator whose preferences are indicated by indifference curve R2.

Figure 3: Regulator's Choice of Insolvency Risk



This figure shows two indifference curves of regulators R1 and R2. R1 refers to a regulator whose degree of risk aversion is higher. R2 refers to a regulator whose degree of risk aversion is lower.

CONLUDING COMMENTS

The purpose of this paper was to investigate whether a size limit resolves the too-big-to-fail, TBTF, problems. In this context, it first analyzes the effect of limiting size of a bank on its insolvency risk and then, it examines the mean-standard deviation efficiency of the limit on size policy. For the empirical analysis, the study used quarterly consolidated balance sheet and quarterly consolidated income statement data of 76 Canadian chartered banks over the 2000Q1-2011Q2 period. The methodology used consists of measurements of the rate of return on bank's equity and insolvency risk as well as the computation of the mean-standard deviation efficiency frontier using MATLAB.

The first result of the paper was to show that the "limit on size" solution of the TBTF bank cannot necessarily lower insolvency risk of the bank involved, as a reduction in risk can take place, not by paring down, but by changing the composition of assets and liabilities of the bank. The second result of the paper is that the "limit on size" solution may not provide an efficient composition of bank's assets and liabilities. It was also shown that an efficient composition can be achieved at the same size of the bank. Finally, the paper argues that the choice of the level of insolvency risk depends on the degree of risk aversion of the regulator. Higher (lower) is the degree of risk aversion; lower (higher) level of insolvency risk will be mandated.

Some limitations are present in this research. First, since separate return on contingent assets and separate cost of contingent liabilities are not available, the paper combined other assets (liabilities) with contingent assets (liabilities). As a consequence, paring down using the essence of the Volcker Rule was not possible. Second, a size limit may have adverse implications on economies of scale and scope but the methodology of the paper did not allow us this kind of analysis. Finally, the paper uses aggregative data, not micro or individual bank's data; therefore, the effects of liquidity, leverage, and interbank interconnectedness on insolvency risk of paring down simulations could not be analyzed.

In the future research, the use of micro-level data will permit interbank comparisons and control of relevant extraneous factors in linking size with insolvency risk. Three other possible future directions of the paper are: (i) to measure systemic risk instead of insolvency risk; (ii) to incorporate market-based measures of bank's performance, and (iii) to do cross-country comparisons of the "limit on size" policy.

APPENDIX

Appendix A: Definitions of a Bank's Balance Sheet Items

BALANCE SHEET ITEM	DEFINITION
Liquid assets	Bank of Canada notes and coins, Bank of Canada deposits, Treasury Bills, Government of Canada direct and guaranteed bonds, and holdings of selected short-term assets
Non-mortgage loans	Loans to business, persons, investment dealers, regulated institutions and governments
Mortgage loans	Residential and non-residential mortgages
Other securities	Long-term corporate bonds, government bonds not included in LA, mortgage-backed securities, preferred stocks, and common stocks
Contingent assets	Derivatives and related amounts
Other assets	Assets such as goodwill and customer liability under acceptances, land, buildings and equipments, receivables from brokers, dealers, and clients, accrued interest receivable, and insurance-related assets
Demand and notice deposits	Deposits from individuals, businesses, various levels of government, and other financial institutions
Fixed-term deposits	Fixed-term deposits from all the entities listed under
Contingent liabilities	Derivatives and related amounts
Other liabilities	Acceptances, obligations related to securities sold short, and some other liabilities such as amounts payable to brokers, dealers and clients, accounts payable, insurance related liabilities, accrued interest, and cheques and other items in transit
Equity	Preferred shares, common shares, contributed surplus, and retained earnings

This table provides definitions of bank balance sheet items according to Canadian Chartered Banks annual reports and Bank of Canada Review.

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