

# A Business Model Approach to Measure Risks

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## **Abstract**

Enterprise risk managers should explicitly relate the firm's business model to the risk supported by the economic capital. The economic capital, risk drivers and business model are intricately integrated. The purpose of this paper is to demonstrate this point. This business model approach has many applications. For example, in order to ensure the safety and soundness of the U.S. banking system, federal bank regulators must be able to effectively monitor the underlying risks of banking institutions. This requires that the risks be assessed from the perspective of the business models used by banking institutions.

This paper presents a model of thrift's business model, and examines the model empirically using the extensive portfolio data on institutions supervised by the Office of Thrift Supervision (OTS). The paper studies the economic values of assets and liabilities on thrifts' balance sheets for the end of September 2006 and shows that the business models used by the thrifts are defined by their leverage and portfolio mix of mortgages and deposit fundings. The result shows that if the business model is not taken into consideration, the adequacy of the capital may be mis-specified. This paper further examines the characteristics of nine peer groups of similar business models and shows how they can be used to control for the variations of business models in the measurement of risks. These results have broad implications on enterprise risk management for financial institutions in general, not only specific to the thrifts.

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## 1. Introduction

The safety and soundness of banking institutions are important concerns for federal banking regulatory agencies. In order to be effective supervisors, these agencies must monitor the risk of each institution as well as the risk of the entire banking system. An important question that federal banking regulatory agencies must address is: What business models are used today by banking institutions?

Banking institutions continually change their business models in order to respond to market competition and changes in the supply of, and demand for, financial services. As a result, regulators need to take the various business models into account when assessing the risk of each banking institution. This means that regulators must pay attention to the business models of the banks and relate them to their risk profiles.

Similarly, in managing a financial enterprise, it is important to identify the business model of each business unit and formulate the risk measures pertinent to the business environment. Even if the business units are similar as corporate entities, they may have significantly different risk profiles. This paper uses an extensive data sample of all the thrifts to analyze their business models to provide insights into the importance of understanding the business models in enterprise risk management.

Specifically, this paper examines the various business models used by financial institutions in the U.S. thrift industry. Using September 2006 balance sheet data for approximately 800 thrifts that the OTS supervises, we provide an empirical description of the different business models used by thrifts. The OTS is a federal banking agency that was created in 1989 with the passage of FIRREA. It has the responsibility of maintaining the safety and soundness of federally chartered thrifts and the thrift industry as a whole.

In 1991, OTS developed the Net Portfolio Value (NPV) Model to measure the economic values of the assets and liabilities on thrifts' balance sheets and to simulate changes in an institution's equity (or NPV) over a range of interest rate scenarios. The NPV Model is used as a supervisory tool that is used to identify thrifts with excessive interest rate risk and the quantitative result is used as a starting point for assessing the quality of interest rate risk management practices at individual thrifts and determining the "S" (sensitivity) component in the

CAMELS rating. In addition, the NPV Model can also be used to identify interest rate risk trends for the entire thrift industry.

The purpose of this paper is to show that the business model approach is important for regulators, such as OTS, because the creditworthiness of a banking institution is related to the risks inherent in the particular business model that it uses to pursue its business strategies. Indeed, the use of an incorrect business model by regulators in evaluating an institution could lead to significant misspecification in the metrics used to monitor an institution's risks, such as interest rate risk and credit risk.

Despite the importance of the bank's business model to evaluate its risk exposure, there is scant literature on the subject. Allen and Rai (1996), Kwan et al. (1995) and Berger et al. (1997) describe a bank business model in terms of the cost function. They use input-output models to study the efficiency in the operations. They study the business model that minimizes the operational costs. Rose (1996) and Mester (1996) study the business model that manages the risk exposure. They seek to determine the tradeoff between operating costs and diversification. Our paper takes a different approach. We propose that banks at equilibrium seek to determine the optimal portfolio of assets and liabilities on their balance sheet that specify the business model. The model is then applied to all the banks regulated by OTS, and we can then determine the factors determining the banks' business models.

In this paper, we first propose a business model approach for assessing the risks of thrift institutions. We then provide empirical evidence on the validity of the business model approach by examining data reported on the Consolidated Maturity Rate (CMR) Schedule and output results from OTS's NPV Model. Using principal component analysis, we study the economic values of assets and liabilities on thrifts' balance sheets for September 2006 and show that the business models used by thrifts differ in terms of the capital ratio and portfolio mix of mortgages and depository fundings. Thrifts may choose to use a high or low leverage strategy in developing a specialized skill in managing a mortgage portfolio and developing a network to gather savings. The empirical analysis shows that different business models expose institutions to different types and levels of risks.

The results provide important insights for enterprise risk management of financial institutions. A set of financial institutions may have the same charter and have a similar economic function. Yet, these financial institutions may

pursue different business models taking on different risk profiles. Such differences are often not apparent in their financial statements. And therefore, in analyzing or managing an enterprise with multiple business units, it is important to take the business models of the business units into account. For example, how should their economic capital levels be set? How should value at risk (VaR) and earnings at risk (EaR) be applied conditional on the choice of business model? These are some of the issues that this paper attempts to shed light on with its empirical work.

This paper proceeds as follows. Section 2 provides a background and the theory of the business models used by banking institutions, with a focus on thrifts. Section 3 provides the empirical analysis of the business models used by thrifts in our sample. The characteristics of the business models are analyzed and the implications of the results are given in Section 4 and Section 5, respectively. Section 6 contains the conclusions.

## **2. Business Model Approach**

Because the market structure of the banking system is always changing, the business models used by banking institutions, such as thrifts, must also change to take advantage of new market opportunities. As a result, the traditional business model of a thrift institution is becoming increasingly outdated. As noted by Ho and Lee (2004), a business model describes the organizational structure, production process and financial process of a firm and how these three components contribute value to stakeholders. Business models are important because they explain a firm's business objectives and the economic reasons for its existence.

The traditional thrift is often described in a highly stylized way. According to the traditional business model, thrifts take short-term deposits and make long-term mortgages. Their profits are generated by the spread between lending and funding interest rates. However, there has been a dramatic change in the supply of and demand for financial services in recent years. The tremendous growth in capital markets, along with financial disintermediation and rapid product innovation, has served as a catalyst for thrifts to adopt different business models in order to compete more effectively. Today, thrifts provide an array of financial services that no longer fit neatly into the traditional business model.

One important change in the business models used by banking institutions today is the widespread use of capital market instruments for the purposes of funding investments. For example, many OTS-regulated thrifts currently use Federal Home Loan Bank (FHLB) structured advances to fund their investments. These short-term liabilities enable thrifts to borrow at capital market rates and to leverage their equity. Similarly, thrifts also increasingly invest in capital market instruments, such as government bonds, agency bonds and other securities in order to maintain liquidity. Finally, thrifts have also increased their use of mortgage derivatives and financial derivatives to manage their interest rate risk.

We make the following assumptions in our business model approach. First, we assume that the capital market is efficient. All securities and capital market instruments are assumed to earn no excess returns and banks use these instruments to manage their liquidity risk, interest rate risk and their equity.

Second, we assume that the banks derive their profit margins from deposit and savings accounts, mortgage loans/securities and consumer/corporate lending (i.e., non-mortgage lending). Banking institutions, such as thrifts, are not homogeneous. Indeed, they use different business models to compete effectively in the market. Business models vary according to funding and investment levels. Funding can be obtained from deposits or the capital market through instruments such as FHLB advances and wholesale CDs. Investments could take the form of mortgage loans, non-mortgage loans, and marketable securities.

A thrift's net position in the capital market (i.e., marketable securities net of borrowings) is the result of its principal activities in the markets for mortgages, non-mortgages and deposits. As such, the net position does not define the business model used by a thrift, but instead is the result of a thrift's choosing the optimal portfolio in equilibrium.

Let  $M$ ,  $L$  and  $D$  denote the ratios of total mortgage loans and securities, total non-mortgage loans and total deposits divided by the fair value of equity (NPV), respectively. The business model used by a thrift can be denoted by the row vector:

$$B = (M, L, D) \tag{1}$$

Equation (1) can be used to denote the business model for the  $i^{\text{th}}$  thrift or the average thrift, denoted as  $B_i$  and  $B_{\text{avg}}$ , respectively. In order to measure the true interest rate risk exposure of a thrift, the choice of business model must be taken into account.

The business model approach assumes that each thrift chooses the optimal business portfolio denoted by equation (1). For example, a given thrift institution may specialize in investing in mortgages, but, given the business set-up and the operating costs, the thrift may choose to fund these investments with deposit accounts. We would like to determine the most prevalent, or typical, portfolio of businesses used by thrifts. It is possible for two thrifts with the same portfolio of businesses to have different equity levels.

As noted above, according to the traditional thrift business model, thrifts take in deposits, make mortgage loans and invest in securities. For example, a traditional thrift may have total assets of less than \$1 billion. It may utilize a retail branch network to make a number of consumer loans (e.g., automobile loans or lines of credit). On the liabilities side of the balance sheet, the thrift may have retail deposits and plain-vanilla or structured FHLB advances. The thrift's earnings are driven by its net interest margin and fee income from, for example, ATM fees and overdraft penalties. However, traditional thrifts can differ in their use of the capital market to manage their equity risks.

We assume that the business models used by thrifts can be viewed relative to the average thrift,  $B_{\text{avg}}$ , where:

$$B_{\text{avg}} = ( M_{\text{avg}}, L_{\text{avg}}, D_{\text{avg}} ) \quad (2)$$

The  $i^{\text{th}}$  thrift can increase or decrease its involvement in the three principal business lines. Each business line is associated with a different business model. And so, we have:

$$V_j = ( M_j, L_j, D_j ) \text{ for } j = 1, 2, 3 \quad (3)$$

Then, the business model for the  $i^{\text{th}}$  thrift is denoted as:

$$B_i = a_{i,1} V_1 + a_{i,2} V_2 + a_{i,3} V_3 + B_{avg} \quad (4)$$

Also, we require that the principal business lines are orthogonal to each other. This means that:

$$V_i \bullet V'_k = 0, \text{ for } i \text{ not equal to } k \quad (5)$$

This paper proposes that a thrift's business model can be represented by equation (4).  $V_j$  specifies the model of the principal businesses. The variation of  $a_{i,j}$  for  $i$  across the thrifts describes the market structure of the banking system. The following section proceeds to estimate equation (4).

### **3. Estimation of the Business Models and Empirical Results**

#### **3.1 Data**

Our analysis of the business models used by thrifts is based on Schedule CMR data and Interest Rate Risk (IRR) Reports for approximately 800 thrifts for September 2006. At the end of each quarter, savings associations report outstanding balances of assets, liabilities and off-balance sheet contracts they hold in their portfolios to the OTS. These data, along with the maturities, coupon rates and repricing frequencies for the various financial instruments are reported on Schedule CMR of the Thrift Financial Report. The NPV Model uses these data as input. In calculating the economic values of the reported financial instruments, the NPV Model uses a static discounted approach and an option-adjusted approach. Cornyn and Jones (1999) provide a detailed discussion of the NPV Model, Schedule CMR and IRR Reports.

NPV is defined as the fair value of assets net of liabilities. The capital ratio is defined as the NPV divided by the fair value of total assets. When the capital ratio is negative, the asset value of an institution fails to cover its obligations.

#### **3.2. Empirical Results: The Principal Business Models**



Before calculating the business model for each thrift in the sample using equation (1), we determine the business model for the average thrift using the average values of the ratios of mortgage loans and securities, non-mortgage loans and deposits divided by the bank's equity. These results are reported in Table 1, where the first row reports the average and the second row reports the standard deviation of the ratios. The capital ratio is defined as NPV divided by the market value of total assets.

**Table 1. Average and Standard Deviation of Ratios**

Total Mortgage Loans and Securities	Total Nonmortgage Loans	Total Deposits	Capital Ratio
5.213	0.577	5.38	0.154
2.252	0.831	1.983	0.086

The results show that the typical or average thrift leverages its equity by a multiple of 5.213, 0.577 and 5.38 in mortgage loans and securities, non-mortgage loans and deposits, respectively.

Using this information, we can write the balance sheet (normalized for equity=1) of the average thrift as:

Total mortgage loans/securities	5.213	Total deposits	5.38
Total non-mortgage loans	0.577	Equity	1.000
Total securities	0.59		
<hr/>			
Total assets	6.38	Total liabilities and equity	6.38

Therefore, the average thrift invests in 0.59 of capital market securities in order to maintain a capital ratio of  $1/(6.38) = 15.7\%$ . The thrift may use capital market funding to invest in capital market securities, while keeping the business model the same. However, given that we assume that the capital market is efficient, such operations should be relatively small. Note that the item "securities" is the net position of capital market instruments held as assets and liabilities.

Table 1 suggests that variations in the mortgage loans and securities ratio and the deposit ratio are not as important as variation in the non-mortgage loans ratio. These variations, however, may be misleading because the variations may

be the result of different economic capital levels and not the portfolio positions actually taken by the thrift.

In order to test the business model hypothesis put forth in equation (4), we use principal components analysis to examine the internal structure of the assets and liabilities held in portfolio for our sample of 786 savings institutions. Given the  $i^{\text{th}}$  thrift, we determine  $B_i = (M_i, L_i, D_i)$  for  $i = 1, \dots, 786$ . The analysis below shows that thrifts can be evaluated like an asset management company, where they can be evaluated within peer groups.

**Table 2. Eigenvectors on the Mortgage, Non-mortgage, Deposit Ratios to NPV**

	Mort	Non-mort	Deposit
V1	0.7665	0.0336	0.6414
V2	-0.5997	0.3948	0.6960
V3	0.2298	0.9181	-0.3228

**Table 3. Eigenvalues of the Corresponding Principal Components**

	Eigenvalue	% explained	Cum %explained
Principal 1	7.667	79.10%	79.10%
Principal 2	1.493	15.40%	94.50%
Principal 3	0.533	5.50%	100.00%

The principal components analysis suggests that a thrift holds a portfolio of businesses which are: mortgage banking,  $V_1$ , and deposit gathering,  $V_2$ . As such, these categories are the two principal business models, and the classification is an empirical issue. In mortgage banking, the business invests in mortgage and loans, with deposit funding in the proportions of 0.7665:0.0336:0.6414. In essence, this business involves investing in mortgages funded by savings accounts. The capital ratio determines this first principal business model. The bank may use high or low capital to scale the operation. This type of business model explains 79.1 percent of the variations in all the business models.

The second principal business model is the level of the bank seeking deposit accounts. The business invests in mortgage and loans, with deposit funding in the proportions of -0.5597:0.3948: 0.6960. This business model raises

the savings position and lowers the mortgage positions. In the other words, the bank changes its portfolio mix between savings and mortgages. This change of the portfolio allocation explains 15.4 percent of the portfolio variation.

#### **4. Characteristics of the Business Models**

Thus far, the results suggest that thrifts vary their business models in two major ways. First, thrifts differ in their use of capital, with some using more capital (low leverage) and others using less capital (high leverage). Second, thrifts balance their use of deposits relative to their mortgage portfolio. This in the main characterizes the business model of thrifts.

The empirical results suggest that we can classify thrifts into peer groups. The classification is based on a thrift's leverage and the product mix. Leverage is related to the complexity of the operations and a thrift's natural franchise business. Product lines reflect the combination of funding from deposits and investment in mortgages.

Depository funding exposes the thrift to liquidity risks, but the institution is rewarded by the interest rate spreads and customer relationships. The franchise can be scaled to ATM and other fee businesses. Mortgage loan lending exposes the thrift to credit risks and prepayment risks, while it is rewarded with spreads. The portfolio can be scaled to servicing fee businesses and securitization of the loans. The leverage is related to the scaling of the franchise and the operations. Some thrifts can attain high leverage because they have the capacity to hedge their positions.

For these reasons, the performance and the measures of safety and soundness of a thrift have to be measured within the context of the appropriate business model, or a peer group as a proxy. Historically, the classification of thrifts has depended on the geographic location or the total asset size of an institution. This approach is adequate only if thrifts use the traditional business model. Today, however, thrifts hold a portfolio of businesses and the performance and risks depend largely on the style in managing such a portfolio.

This suggests that we can group thrifts according to the level of leverage (scaling along the first principal component) and the level of deposit funding (scaling along the second principal component). Using the sample of thrifts, we group the institutions by their "leverage" into three groups of equal number:

“high leverage,” “average leverage” and “low leverage.” Similarly, we classify the sample of thrifts into three groups (of equal number also) depending on their deposit level: “depository-biased banks” “thrift” and “mortgage-biased banks.” The combination of these two classification leads to nine peer groups.

The results reported in Table 4 below provide insights into the nine peer groups. In describing the peer groups, we group our sample of thrifts by business lines: mortgage-biased bank or “mortgage,” savings-biased bank or “depository” and thrifts that maintain a balance between their mortgage and savings ratios or “thrift.” We group the sample by the leverage level by low, average and high denoted by “low,” “average” and “high,” respectively. The number of thrifts in each peer group is given in the third column.

The capital ratio is the ratio of the NPV to the total asset fair value, and the stressed capital ratio is the minimum capital ratio under a parallel upward and downward shift of the yield curve within 200 basis points. Effective durations and convexities of equity are denoted by “Duration” and “Cnvtv,” respectively. The ratio of equity to book value of equity (“Eq/Bk”) and the average total asset of each peer group are presented in columns 8 and 9, respectively.

**Table 4. Capital Risk for Thrift Peer Groups**

1	2	3	4	5	6	7	8	9
leverage	business	#banks	Cap Ratio	Stressed Cap ratio	Duration	Cnvtv	Eq/Bk	Total Asset
high	deposit	94	0.10	0.08	7.60	-234	0.82	\$ 494,894
high	thrift	64	0.11	0.09	7.79	-264	0.78	\$ 1,270,087
high	mortgage	104	0.10	0.08	7.58	-280	0.87	\$ 9,240,711
average	deposit	105	0.13	0.11	5.29	-237	0.75	\$ 2,285,789
average	thrift	92	0.14	0.11	5.98	-200	0.76	\$ 523,284
average	mortgage	64	0.14	0.11	6.65	-250	0.85	\$ 1,798,920
low	deposit	64	0.17	0.15	3.39	-181	0.76	\$ 1,063,293
low	thrift	104	0.22	0.18	5.79	-179	0.85	\$ 237,780
low	mortgage	95	0.28	0.24	4.82	-126	0.87	\$ 942,410

On the basis of these results, we can make a number of interesting observations. Thrifts tend to have significant capital. The range of capital ratio from 28 percent to 10 percent shows that leverage is a dominant factor in explaining the portfolio structure of the balance sheet. The stress capital ratio shows that the low leveraged thrifts tend to be affected more by the stressed scenarios. This suggests that high leverage thrifts may have the ability to manage

their interest rate risks better. Therefore, it is also important to compare within the peer group in the risk measure. Second all thrifts have balance sheets displaying negative convexity because of the prepayment option in the mortgages and the withdrawal options in savings accounts. The selling of embedded options provides incomes, and such a business model seems to be more important to the leveraged thrifts, particularly the mortgage-biased thrifts. This shows that the convexity risk may have different impacts on the economic capital depending on the business model of the thrift.

We define the equity multiple as book equity divided by NPV. The results show that the book equity understates the capital of all banks. Such is the case particularly for the high leverage deposit thrifts. The intangible value (the embedded gains in the saving accounts) and mortgage servicing account for part of this premium. In all levels of leverage, the mortgage-bias thrifts have higher premium than the deposit-bias thrifts. This shows that the model risk on measuring the mortgage servicing present value can significantly affect the risk measurements.

## **5. Implications of the Results**

The empirical estimation of the business models of the thrifts and the analysis of the peer groups lead to several important implications to enterprise risk management. To date, much of enterprise risk management focuses on the determination of the capital ratio, ensuring that the capital is sufficient for the risks of the business. The analyses in this paper suggest that we must also identify the mix of risks that is supported by the capital.

The capital ratio level, risk level, mix of risks supported by the capital and the business model are interrelated. To focus only on the adequacy of capital in relation to the risk level, the risk monitoring process is subject to model risks and other dimensions of risks that the model has not captured. On the other hand, if management focuses on the business model and cannot relate its business risks to the capital, then the management may not be appropriately utilizing the firm's capital. Enterprise risk management should relate explicitly the institution's business model to the risks supported by the capital. This discussion is beyond the scope of this paper, and it is discussed elsewhere. (See Ho (2007).)

In analyzing the risk and performance of a financial institution without the detailed information on the firm's business model, peer group comparison

would be useful. Given these peer groups, we can construct a benchmark for each peer group such that an individual thrift can be compared to the benchmark in a peer group comparison.

The results also have several important implications for monitoring the risk of thrifts. First, systemic interest rate risk appears to be concentrated. Most thrifts tend to have the dominant business model of funding mortgage lending by using deposits. As such, it depends substantially on the business model of the average thrift. Given that the average thrift invests substantially in mortgages, the tremendous recent growth in affordability mortgage products, such as option ARMs, in conjunction with historically high real estate values, our results suggest that OTS should be diligent in monitoring the risks associated with this business model choice.

We can use appropriate benchmarks in peer grouping for proper comparison of a thrift's risk and performance. Specifically, these benchmarks can compare thrifts with similar interest rate risk, liquidity risk and credit risk. Such comparisons can be used for performance analysis and risk analysis.

## **6. Conclusion**

This paper presents results that have significant implications for effective risk measurement and management in the U.S. thrift industry. We show that the risks in the thrift industry are highly concentrated and are related to the traditional thrift business model. Furthermore, the results suggest that business models used by thrifts today are characterized by significant variation in leverage relative to the traditional thrift business model. The measurement and management of systemic interest rate risk and the use of benchmarks for peer groups, as identified by the analysis conducted here, enable regulators to focus better on the true risks of banking institutions such as thrifts.

In particular, the results suggest that OTS can simulate the scenarios on the economics of the thrifts of rising interest rates, inverted yield curves and falling real estate prices along with a withdrawal of savings deposits. Given the concentration of the business risks in these scenarios, OTS should seek to manage the risk to the thrift industry, should such a scenario occur.

Our results show that OTS should consider creating standards to measure business concentration risks in order to evaluate the safety and soundness of thrifts. Furthermore, the regulatory equity levels should be set depending on the types of thrifts, taking the tradeoff between the model risk of complex thrifts and wholesale thrifts and the liquidity risk of a traditional thrift into account. The results also suggest that scenario simulations can be used to identify the risk to the thrift industry as a whole and not just the risk of an individual thrift. Based on the empirical work in this paper, it is clear that value at risk (VaR) and earnings at risk (EaR) are risk measures that must take the choice of a financial institution's business model into consideration.

The paper also suggests that enterprise risk management must relate the firm's business model to the risks supported by the capital. Capital, risk drivers and the business model should be analyzed as a coherent whole.

## References

- Allen, L., and Rai, P. 1996. Operational efficiency in banking: An international comparison. *Journal of Banking and Finance* 20(4): 655-672.
- Berger, A., Leusner, J. H., and Mingo, J.J. 1997. The efficiency of bank branches. *Journal of Monetary Economics* 40(1): 141-162.
- Cornyn, A., and Jones, J. 1999. "An overview of the OTS Net Portfolio Value Model and recent trends in the thrift industry," Chapter 37, *Interest Rate Risk Measurement and Management*, Nawalka, S., and Chambers, D. eds. New York: Institutional Investor, Inc.
- Ho, T. 2007. Risk accounting. THC Working Paper
- Ho, T., and Lee, S.B. 2004. "Risk management," Chapter 15, *The Oxford Guide to Financial Modeling*, pp. 525-554. New York: Oxford University Press.
- Kwan, S., and Eisenbeis, R.A. 1995. An analysis of inefficiencies in banking. *Journal of Banking and Finance* 19(2-3): 733-734.
- Mester, L.J. 1996. A study of bank efficiency taking into account risk preferences. *Journal of Banking and Finance* 20(6):1025-1045.
- Rose, S.P. 1996. The diversification and cost effects of interstate banking. *The Financial Review* 31(2): 431-452.