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RISK-BASED CAPITAL STANDARDS AND THE RISKINESS OF BANK PORTFOLIOS: CREDIT AND FACTOR RISKS

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ABSTRACT

Bank risk-based capital (RBC) standards require banks to hold differing amounts of capital for different classes of assets, based almost entirely on a credit risk criterion. The paper provides both a theoretical and empirical framework for evaluating such standards. A model outlining a pricing methodology for loans subject to default risk is presented. The model shows that the returns on such loans are affected by the complicated interaction of the likelihood of default, the consequences of default, term structure variables, and the pricing of factor risks in the economy. When we examine whether the risk weights accurately reflect bank asset risk, we find that the weights fail even in their limited goal of correctly quantifying credit risk. For example, our findings indicate that the RBC weights overpenalize home mortgages, which have an average credit loss of 13 basis points, relative to commercial and consumer loans. The RBC rules also contain a significant bias against direct mortgages relative to mortgage-backed securities. In addition, we find large differences in the credit riskiness of loans within the 100 percent weight class and potentially large benefits to loan diversification, neither of which are considered in the RBC regulations. We also examine other types of bank risk by estimating a simple factor model that decomposes loan risk into term structure, default, and market risk. One implication of our findings is that although banks have reallocated their portfolios in ways intended by the RBC standards, they may have merely substituted one type of risk (term structure risk) for others (default and market risk), of which the net effect is unknown.

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1 Introduction

Bank risk-based capital (RBC) regulations, which required full compliance as of December 1992, represented a fundamental shift from previous bank capital standards. Prior to the adoption of the RBC standards, banks were required to hold a flat minimum percentage of capital against all assets. By contrast, the RBC standards require banks to hold differing amounts of capital depending upon the amount of assets held in various (risk-weighted) asset categories. The risk-weights, however, are determined almost entirely on the basis of *credit* risk. Implicit in the regulations is the view that credit risk is the primary risk faced by banks, that the regulations accurately quantify the credit risk of asset classes, and that banks adjust their behavior in the manner envisioned by the regulators.

We present evidence that banks adjusted their portfolios in ways intended by the RBC regulations. Since the adoption of the RBC standards, banks have dramatically adjusted their portfolios toward assets in the low weight classes (securities and home mortgages) and away from assets in the high weight class (business and commercial real estate loans). These portfolio reallocations resulted in a substantial increase in the number of banks that were able to meet the new standards. Therefore, *if* credit risk is all that matters, and *if* the weights penalize the assets with the greatest credit risk, then the RBC regulations would have to be considered a success.

The analysis then goes on to examine whether such assumptions do in fact hold true. We begin by presenting a pricing model for loans subject to default risk. The model is an extension of the contingent-claims pricing of default free bonds. In addition to allowing for stochastic interest rate dynamics, we also include a realistic modeling of default. There are two distinct aspects of default modeled: the likelihood of default and the consequences of default. The likelihood of default is permitted to fluctuate stochastically over time, and to be correlated with shifts in the term structure. The consequences of default, modeled as a payoff contingent upon the arrival of a Poisson-directed process, is also permitted to be dependent on the other state variables of the model. The key conclusion of the model is that one cannot delineate the riskiness of defaultable loans by considering any single risk factor in isolation. That is, considering only credit risk (or only interest-rate risk) will lead to a misspecification of the factors that drive loan returns. The returns on loans are affected by the complicated interaction of the likelihood of default, the consequences of default, term structure variables, and the pricing of factor risks in the economy.

Our empirical analysis begins with the question: even if credit risk is the only risk faced by banks, do the RBC standards weight the riskiness of assets properly? Using data on bank loan chargeoffs, as well as real estate loan delinquencies, we find the ordering of the asset weights to be roughly correct. However, even in terms of credit risk alone, the regulations are lacking in several important ways. First, we find that the 50 percent risk weight on home mortgages appears to be too high as judged by the credit risk metric alone. For example, the average annual chargeoff percentage for home mortgages is only 13 hundredths of one percent. This is not to imply that mortgages are not risky (they clearly are from an interest-rate risk perspective). However, since mortgage-backed securities are placed in the 20 percent category, and the default risk of underlying mortgage loans is so minuscule, banks are provided with an incentive to replace direct mortgage lending with investing indirectly through the secondary mortgage market. Second, while commercial real estate loans do indeed have a relatively high degree of default risk, the weightings implicitly assume that all commercial real estate loans are equally risky. In fact, we find a wide range of default experience across property types: industrial and retail loans having the least delinquencies and office and hotel loans having the most. Therefore, banks that wish to continue to hold risky loan portfolios will have an incentive to make the riskiest loans within the same risk-weighting class. Finally, the regulations ignore portfolio diversification. In particular, we find that the volatility of credit losses can be greatly reduced (by about 50 percent) by simply diversifying across geographic regions.

While credit risk is the stated focus of the RBC standards, it is not an adequate measure of bank risk. We thus move on to consider more general notions of bank asset riskiness. We do so by estimating the sensitivity of (proxies for) bank loan returns to three important risk factors: term structure shifts, default risk, and market risk. We find that while home mortgages have less default risk and market risk than commercial real estate and business lending, they have the greatest sensitivity to term structure shifts. This has important policy implications. While the RBC regulations may have led to reallocations that reduced default risk, they may have increased bank sensitivities to interest rate shocks. We also find that both commercial real estate and business loans are sensitive to all three risk factors; but commercial real estate is even more sensitive to default and market risk.

There has been little research done on the correctness of the credit risk weights and more generally on the adequacy of the RBC standards. Avery and Berger (1991) assess the adequacy of the RBC standards by analyzing the correlations between the RBC risk weights and various measures of bank performance. Using an impressively large panel of banks, they find that the risk weights have explanatory power in predicting bank performance and conclude that "RBC constitutes a significant improvement over the old capital standards." There is, however, an alternative reading of their evidence. The coefficients in their regressions imply that the RBC weights are not correct. Moreover, the explanatory power of the risk-weights is extremely low. For example, they regress the most basic bank performance measures (nonperforming loan, chargeoff, and failure rates) against the ratio of risk-weighted to unweighted assets. With a sample of more than 9,500 observations, the coefficients have t-statistics of 0.75, 1.58 and 1.99, respectively, and R-squared statistics of only 0.002, 0.007 and 0.011. Moreover, the correlations are historical and therefore do not take account of any behavioral responses of banks because of the regulations, a point made by the authors themselves.[1] Thus, one could also conclude from their evidence that the weights are not correct and that, even with historical data, the association between the RBC weights and measures of bank risk is extremely weak.[2]

Cordell and King (1995) compare stock market measures of bank and thrift risk with the RBC standards. They find that the weighting of the asset risk categories does not correspond closely to their market measure of asset risk, although many of their results are quite sensitive to their market model. They conclude that "the lack of correspondence between the market and regulatory measures of asset risk suggests that other sources of risk, such as interest rate risk and asset concentration risk, should be examined. In addition, the risk of different activities within the broad 100 percent category could be examined as well." In addition to providing a framework for such analysis, the contribution of our paper is an examination of these and related issues.

The paper proceeds as follows. Section 2 provides a background on the RBC guidelines and describes in detail the RBC rules. Section 3 discusses the evidence of portfolio reallocation and the

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[1] Avery and Berger write in their conclusion: "It must be cautioned that because the results reported here are based on historical associations, care must be taken in extrapolating any conclusion about future bank performance and behavior. Once the RBC regulations are fully in place, banks will be reacting to different relative and absolute prices than those embodied in our data set, and this could change the implications of our results."

[2] Bradley, Wambeke and Whidbee (1991) study the RBC standards in the thrift industry and do not find empirical support for the risk weights.

success of banks in meeting the RBC regulations. Section 4 presents a theoretical model of the determination of returns on loans subject to default risk. In Section 5 we examine how well the risk-weights in the regulations match the actual credit risk of bank assets. In Section 6 we consider the riskiness of bank lending using more general notions of factor risks. Section 7 discusses some of the practical difficulties in enforcing risk-based capital guidelines. Section 8 concludes.

2 The Risk-Based Capital Rules

Since the adoption of risk-based capital standards, U.S. commercial banks have been required to meet capital standards that relate capital to *risk-weighted assets*. The new U.S. risk-based capital regulations are the result of an international agreement -- the so-called Basle Accord -- made between the bank regulators of the 12 major industrialized countries in June of 1988. The U.S. bank regulators were largely responsible for forging the consensus that led to the international accord, which went a long way toward standardizing bank capital requirements among the twelve nations. The stated purpose of the Basle Accord was to "strengthen the soundness and stability of the international banking system," and to coordinate bank regulation of capital adequacy in order to reduce "an existing source of competitive inequality among international banks."[3] Shortly thereafter, in December of 1988, the Federal Reserve Board approved a draft of the U.S. risk-based capital guidelines. The new guidelines contained interim risk-based capital standards for 1990. The final standards were fully phased in as of December of 1992. Table 1 provides a brief summary of the notable events concerning bank capital regulation, including a few actions that will be discussed in later sections of this paper.

Unlike previous bank capital standards, the RBC regulations required that banks hold differing amounts of capital, depending on the "riskiness" of their asset portfolio. When formal capital ratios were first introduced in 1981, there were two capital standards. First, primary capital, which included equity, loan-loss reserves and some convertible debt and preferred stock, was required to be 5.5 percent of total, unweighted, on-balance sheet assets. Second, total capital, which was broadened to include subordinated debt and the remaining preferred stock, was required to be 6

[3] See Basle Committee on Banking Regulations and Supervisory Practices, "International Convergence of Capital Measurement and Capital Standards," July 1988.

percent of total assets, defined in the same way.

The RBC standards represent a fundamental shift from the previous capital standards by explicitly including risk in the calculation of two of the three capital ratios. The unweighted capital ratio requirement, called the "leverage requirement," is 3 percent for the small fraction of banks that have the highest examination rating (i.e., those that have a CAMEL rating of 1) and is 4-5 percent for banks with lower ratings.[4] The leverage requirement uses the "Tier 1" measure of capital in the numerator. Tier 1 capital consists of common stockholder equity, some preferred stock, and minority interest in consolidated subsidiaries less goodwill. The denominator for the leverage ratio is total (unweighted, on-balance sheet) assets.

The RBC regulations also instituted two risk-based requirements: the "Tier 1 requirement," which requires that banks have a minimum Tier 1 capital to risk-weighted assets (hereafter RWAs) ratio of 4 percent, and the "Total requirement", which requires that banks have a total capital (Tier 1 plus Tier 2 capital) to RWAs ratio of 8 percent. Tier 2 capital includes loan loss reserves (up to a maximum of 1.25 percent of RWAs), and subordinated debt (up to a maximum 50 percent of Tier 1 capital). Tier 2 capital also includes some preferred and convertible stock. In addition, Tier 2 capital must not be larger than Tier 1 capital in the RWA calculation, which implies that all banks that fail the Tier 1 requirement automatically fail the Total requirement.

In order to calculate the denominator for the RBC ratios, regulators create a measure of risk-weighted assets (RWAs) by assigning weights to different assets. Because of the difficulty of evaluating the riskiness of individual assets or loans, the risk weightings are assigned to broad classifications of assets on the view that certain broad classifications of assets tend to have greater *credit* risk than others. Note that only credit risk was explicitly taken into account in determining the riskiness of assets. Not considering other types of risk -- especially interest rate and portfolio risk -- is a potentially serious problem with the regulations, a subject to which we shall return.

Government securities are given a zero risk weight. Because they are considered to be "unconditionally guaranteed" by the U.S. government, they are assumed to have essentially zero credit risk. Most mortgage-backed securities (e.g. FNMA, FHLMC) are in the 20 percent category.

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[4] The CAMEL ratings are not publicly available, but it is widely believed that only a small minority of banks have the highest rating of 1.

Home mortgages, or more precisely, "loans fully secured by first liens on 1-4 family residential properties," are given a 50 percent risk weighting. Since these loans are backed by tangible capital, they are considered to be have less credit risk than commercial and industrial (C&I) loans, commercial and all other real estate loans, and consumer loans, all of which have the benchmark 100 percent risk weighting.

We summarize the three capital requirements below. The Tier 1 requirement is:

$$\frac{Tier\ 1\ Capital}{0 \times RWA(0\%) + .2 \times RWA(20\%) + .5 \times RWA(50\%) + 1 \times RWA(100\%)} > .04$$

The total requirement is:

$$\frac{Total\ Capital}{0 \times RWA(0\%) + .2 \times RWA(20\%) + .5 \times RWA(50\%) + 1 \times RWA(100\%)} > .08$$

The leverage requirement is:

$$\frac{Tier\ 1\ Capital}{unweighted\ on\text{-}balance\ sheet\ assets} > .03$$

or higher, depending on the CAMEL rating. The RBC rules are summarized in greater detail in Tables 2a and 2b.

Another important difference between the old capital standards and the RBC standards is that off-balance sheet activities that potentially increase the riskiness of banks are factored into the RWA calculations. For example, loan commitments and letters of credit increase the riskiness of the bank since the bank is guaranteeing the creditworthiness of another party. Likewise, contracts such as interest rate swaps may involve risk that does not show up on a bank's balance sheet. These and other off-balance sheet items are included in the denominator in RBC calculations.

There are two additional facts that we should point out about the RBC regulations. First, the required capital ratios are "minimums" and not "targets." Banks are expected to maintain capital "well above the minimum risk-based ratios," although the regulations do not explicitly state what a reasonable buffer is. Second, regulators have much authority to take action against banks that do not comply with the regulations. The "Prompt Corrective Action" provision of the Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991 gives regulators this strong authority.[5]

3 Asset Portfolio Reallocation

In this section, we consider bank incentives, and then assess whether banks have reallocated their portfolios in the ways intended by the RBC standards. In other words, have banks reduced their risk according to the criteria of the risk-based capital standards? While we do not endorse the RBC standards as a good measure of actual bank risk (as will become clear in subsequent sections), an assessment of bank asset portfolio reallocation is a useful starting point to our analysis.

3.1 Bank Capital Structure, Deposit Insurance and Bank Risk

The existence of flat-rate deposit insurance is the main reason why banks are among the most highly levered companies in the United States. Because of deposit insurance, bank deposits are priced as riskless debt, regardless of the underlying riskiness of bank assets. Given that depositors are not motivated to constrain risk-taking incentives, the agency and bankruptcy costs of debt are not reflected in the cost of debt. Instead, such deadweight costs are borne principally by outsiders: the taxpayers. Without risk-sensitive pricing of deposit insurance, banks have stronger incentives than most companies to be highly levered.

The analysis of Merton (1977) provides a helpful way to think about this issue. Merton showed that deposit insurance represents a put option on the assets of the bank. In the event of failure, the bank "sells" its assets to the insurer for an exercise price equal to the deposit liabilities. Such an option is valuable to the bank. Given a fixed cost to the bank of the option (flat-rate deposit insurance premiums), the bank can increase its value by increasing the value of the option. Banks may increase the value of this option in two principal ways: by increasing leverage and by increasing the volatility of their assets. In the absence of risk-adjusted deposit insurance premiums, such incentives may be quite powerful.

How should banks be expected to respond to the RBC standards? The answer depends on the tradeoff between the relative costs of reducing leverage and holding less risky assets. Because banks

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[5] The Prompt Corrective Action provision is Section 38 of the Federal Deposit Insurance Act (Section 131 of the FDICIA of 1991). See Jones and King (1995) for an assessment of Prompt Corrective Action.

not meeting the standards face a choice between two costly alternatives, it remains an open question as to whether banks will respond by reallocating their portfolios towards less risky assets or by decreasing their leverage, or some combination of both.

3.2 Portfolio Reallocation

Have banks reallocated their portfolios in ways intended by the RBC standards? The growth rates of different bank assets between 1988 and 1992[6] are almost exactly what one would expect if banks were, in aggregate, reallocating their portfolios in response to the risk-based capital requirements.[7] Total securities, which are typically in the zero or twenty percent categories, grew very rapidly -- at almost 12 percent *per year*. Home mortgages (1-4 family), which are typically in the intermediate 50 percent risk category, increased at nearly the same rate, 11.3 percent per year. Loans in the 100 percent category, which includes commercial real estate, consumer, and business (C&I) all grew at much slower rates -- respectively, 2.0, 0.5 and -2.6 percent.[8] Note that there was significant portfolio adjustment in bank real estate lending. In 1988, the dollar value of commercial mortgages was 29 percent below that of commercial real estate loans. In 1992, mortgages were 15 percent larger than commercial real estate loans, a virtual reversal from just four years earlier. While there is no doubt that over-building in the commercial real estate market had much to do with the decline in commercial real estate lending (Hendershott and Kane [1992]), the size of the portfolio adjustment is striking.

To what extent has this portfolio reallocation translated into higher RBC ratios? In other words, how successful have banks been in meeting their RBC ratios? In order to answer this question, we use data from the Report of Condition and Income (the call reports) for all domestically-insured commercial banks, which are available on a quarterly basis.[9] Table 3 indicates the extent to which

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[6] Because agreement on RBC standards was a gradual process, it is difficult to know exactly when banks became sufficiently convinced that the RBC standards would be imposed that they began to take action to comply with the standards. We choose 1988 as a starting point because this is the year that the Fed approved the regulations; but the analysis that follows would not be substantively different if the starting date were a year earlier or later.

[7] Hall (1993) shows that these same portfolio changes exist if comparisons are made across business cycles. That is, there were larger portfolio shifts following the 1990 NBER business cycle peak relative to average shifts following past business cycle peaks.

[8] In an earlier paper, Hall (1993) compared forecasts of C&I lending and holdings of government securities with their actual levels during the 1988 to 1992 period. Bank holdings of government securities rose to approximately 25 percent above its forecasted level, while commercial and industrial lending fell to 25 percent below its forecasted level.

[9] The data are actually end-of-quarter data (i.e. Q1 data are for March 31 while Q4 data are for December 31).

banks would have met the final RBC capital requirements if these requirements had been in effect in 1990Q1[10], 1991Q4 and finally in 1992Q4, when they became binding.

For each time period, Table 3 reports the percentage of banks (weighted by size) that would have failed to meet the Total requirement. The results are virtually identical for the Tier 1 requirement and are not reported. In addition, a sensitivity analysis is done in order to see how close banks are to the margin. Thus, the (weighted) percentage of banks that would have failed if the ratios were 1, 2, and 5 percentage points higher respectively are also reported. The average total ratio is also reported for each time period.

The key result that comes out of this analysis is that banks made remarkable progress in meeting the RBC standards. At the beginning of 1990, banks representing almost 30 percent of bank assets would have failed the RBC standards were they in force at the time. By the time the RBC ratios became binding (the end of 1992), only a few small banks, representing less than one percent of bank assets, failed the RBC standards. Note also that there was a pervasive increase in the degree to which banks met the standard. For example, only about 16 percent of banks had total capital ratios below 10 percent. This is likely the result of banks' desire to maintain a small buffer between actual and required levels of capital. Nevertheless, it is clear that those banks that were initially not meeting their RBC requirements (those with the lowest capital ratios) were the ones that made the most progress in raising their RBC ratios.

Our conclusions about portfolio switching can therefore be summed up as follows. Since the adoption of the RBC standards, banks have dramatically adjusted their portfolios toward assets in the low weight classes and away from assets in the 100 percent weight class.[11] There was also a dramatic shift in bank real estate portfolios; the amount of home mortgage loans on bank balance sheets increased at a much faster rate than commercial real estate loans. These portfolio reallocations resulted in substantial improvements in the number of banks that were able to meet their RBC ratios. Thus, as judged by the metric of the RBC standards, banks became much less risky since the adoption of the standards. We now move on to analyze whether the RBC standard

[10] This is the first date for which the risk-based data are available for all banks.

[11] The evidence on whether this portfolio reallocation was the direct result of the RBC standards or other factors is mixed. See Hall (1993), Berger and Udell (1994) and Hancock and Wilcox (1994). More general research on the existence and effect of a credit crunch has been conducted by Bernanke and Lown (1991), Peek and Rosengren (1994), Hancock and Wilcox (1993), and Fergus and Goodman (1994).

is an appropriate metric of bank riskiness.

4 A Pricing Model for Defaultable Loans

In this section we develop a modeling framework for the valuation of contracts subject to default risk. Using a variant of traditional term structure models, we are able to isolate the factors that affect the pricing, and thus the riskiness, of defaultable loans. Specifically, we shall find that the returns to such loans are affected by the complicated interaction of the likelihood of default, the consequences of default, term structure variables, and the pricing of factor risks in the economy.

Consider a loan contract that promises a coupon payment flow of C dollars per unit time, and a lump sum payment of X dollars at time T. The value of this loan will be denoted by V. In the absence of default risk, this contract may be valued by the standard models of the term structure of interest rates such as Cox, Ingersoll, and Ross (1985) ("CIR") and Vasicek (1977). That is, this contract could be replicated by a portfolio of default-free zero-coupon bonds. Of course, this will not hold true in the case of defaultable loans; periodic payments subject to default are dependent and no longer additive in value.

Our model of defaultable loans will build upon the traditional term structure models. Thus, our model also begins with an underlying process for the short-term riskless rate r. Let the interest rate process evolve as follows:

$$dr = \mu_r(r,t)dt + \sigma_r(r,t)dz_r \tag{1}$$

where $\mu_r(r,t)$ is the instantaneous conditional expected change in r per unit time, $\sigma_r(r,t)$ is the instantaneous conditional standard deviation in r per unit time, and dz_r is an increment of the standard Wiener process. In order to ensure the non-negativity of r, we assume that $\sigma_r(0, t) = 0$ and $\mu_r(0, t) \geq 0$. More generally, the underlying term structure could depend upon a multitude of factors. In such a case, the stochastic differential equation (1) would be replaced by a vector of stochastic differential equations.

We now consider the additional complications of default. The standard approach to modeling defaultable debt contracts is to define default by the predictable stopping time at which the issuing firm's value falls to a prespecified default boundary [e.g., Leland (1994), Longstaff and Schwartz

(1993), Merton (1974)]. There are two difficulties with such an approach for the case of bank loans. First, it is very difficult to measure the value of issuing firms, because many borrowers are private, non-traded firms. Even in the case of firms with publicly traded equity, typically not all components of its capital structure are publicly traded. The second difficulty is that the predictability of stopping times may lead to implausible behavior of credit spreads as maturities shorten [Duffie and Singleton (1995)]. Accordingly, we assume that the default time is unpredictable ("inaccessible"). This is the approach followed by Madan and Unal (1993), Jarrow, Lando, and Turnbull (1993), and others. Default is modeled as a Poisson arrival process with a time-varying default intensity so that the likelihood of default may change with the business cycle.

Specifically, let the occurrence of default be the first passage time of a Poisson (jump) process with intensity h. The Poisson-driven process is denoted by the stochastic process $dQ(t)$, which can be characterized by:

$$\begin{aligned} dQ(t) &= 1 \quad \text{if default occurs} \\ dQ(t) &= 0 \quad \text{if no default occurs} \end{aligned}$$

where the probability of default over the next interval of length dt is (approximately) $h \cdot dt$.

The *likelihood* of default is permitted to evolve stochastically over time. For example, borrowers are more likely to default during business cycle downturns. Thus, let the default intensity process h evolve according to the stochastic differential equation:

$$dh = \mu_h(r,h,t)dt + \sigma_h(r,h,t)dz_h \qquad (2)$$

where μ_h is the instantaneous conditional expected change in h per unit time, σ_h is the instantaneous conditional standard deviation per unit time, and dz_h is an increment of the standard Wiener process. In order to ensure the non-negativity of h, we assume that $\sigma_h(r, 0, t) = 0$ and $\mu_h(r, 0, t) \geq 0$.

We allow the instantaneous mean and standard deviation of the default likelihood process to depend on the interest rate process, as well as time and its own level. This generality allows for the fact that the likelihood of default and the level of interest rates are likely to depend on the same set of state variables. Let $\rho(r, h, t)$ denote the instantaneous correlation of dz_r and dz_h. The processes dz_r and dz_h, however, are assumed independent of $dQ(t)$.

Now, we consider the *consequences* of default. Upon the occurrence of default, we assume that the lender receives a proportion, ω, of the loan's value had it not ended in default. That is, if V_t is the value of the loan at time t, and default occurs at time $t + dt$, the lender receives $\omega \cdot V_t$ at time $t + dt$. This assumption is most similar to that of Duffie and Singleton (1995). Note that ω does not necessarily have to be less than 1. For example, the par value could be greater than the market value at the moment of default. The recovery rate ω may depend on the other state variables of the model. Thus, let us denote the recovery rate as $\omega(r, h, t)$.

We now solve for the value of the defaultable loan, $V(r, h, t)$. Using the contingent-claims pricing approach for mixed Wiener-Poisson process, as described in Brennan and Schwartz (1982) and Shimko (1989), the value of $V(r, h, t)$ must solve the following partial differential equation:

$$\begin{aligned}0=&\frac{1}{2}\sigma_r^2(r,t)V_{rr}+\sigma_r(r,t)\sigma_h(r,h,t)\rho(r,h,t)V_{rh}+\frac{1}{2}\sigma_h^2(r,h,t)V_{hh}+\\&[\mu_r(r,t)-\phi_r]V_r+[\mu_h(r,h,t)-\phi_h]V_h+V_t+C-(r+h[1-\omega(r,h,t)])V\end{aligned} \tag{3}$$

subject to the terminal condition $V(r, h, T) = X$. Here, ϕ_r denotes the market price of interest rate risk and ϕ_h denotes the market price of default intensity risk. The specifications for these market prices of risk must follow from a model of underlying capital market equilibrium. Potential specifications follow from models such as CIR or Merton (1973). In order to rule out the possibility of arbitrage, however, they may be a function of only r, h, and t.

For certain specifications of the underlying stochastic processes and equilibrium prices of risk, closed-form solutions may be obtained. For example, if one assumes that the interest rate and default intensity processes are independent square-root processes (as in CIR), that the recovery proportion is a constant, and that the market prices of risk are linear, the value of a defaultable contract promising one dollar at time T is simply the product of two modified "CIR-type" bond prices.[12] More generally, such partial differential equations may be solved numerically through a finite-difference algorithm.

The pricing of a loan subject to default risk will depend on all of the underlying parameters of the model, because the value V must solve partial differential equation (3). Thus, loan returns will depend on the underlying stochastic processes for interest rates and the default intensity (including

[12]The solution is available from the authors.

their interaction), the market prices of interest rate and default risk, the default recovery rate function, and the contractual terms such as the payment schedule and maturity date. The important point is that a defaultable loan's risk and return are not simply a function of default risk, or interest rate risk, but a combination of both. Thus, one cannot delineate the riskiness of defaultable loans by considering any single risk factor in isolation. In Section 6, we present empirical evidence that bears on this model using a more general methodology for examining the interaction of several sources of risk. However, in the next section, we follow the lead of the regulators and look at credit risk in isolation.

5 The Credit Risk of Bank Loan Portfolios

While the previous section demonstrated that the stochastic properties of loan returns are impacted by the interaction of credit, term-structure, and market risk factors, the stated focus of the RBC rules is credit risk. That is, the RBC regulations are intended to mitigate credit risk alone, and are silent on more general risk characteristics such as term structure related risk. With this in mind, in this section we confine our analysis to the credit risk of bank loan portfolios. This analysis is primarily descriptive; the limited amount of accurate data on the credit risk experiences of different loan categories makes a more rigorous analysis presently untenable. However, the data reveal that there are large differences in credit risk across loan categories, which we shall examine.

The most direct way to measure the credit riskiness of loan categories is to look at the actual amounts of bank loans gone bad. Such data have the advantage over foreclosure or delinquency rates, which measure the probability of a particular events, rather than the dollar amounts of losses. We use bank call report data to examine the net chargeoffs of commercial banks. Chargeoffs represent the actual amount of loans "charged off" (i.e., removed from the bank's books) minus recoveries in a given year. Therefore, in what follows, we divide the amount of net chargeoffs to loans for each loan category to create chargeoff ratios. These chargeoff ratios imply both the likelihood (h in the model) and consequences (w in the model) of credit risk.

A potential problem with this measure of credit risk, however, is that the chargeoffs are not matched with the actual loans to which they refer. That is, a chargeoff in a given year is considered as a loss against the loans outstanding during that year, but not against the actual loan gone bad (which was likely made in a previous year). Therefore, if loan volume is increasing, this tends to understate the loss rate; if loan volume is decreasing, this overstates the loss rate. The effect of this bias is likely to be negligible when we consider chargeoff averages over time; but it is potentially problematic when we consider contemporaneous correlations of chargeoffs across loan classes because banks may chargeoff some types of loans faster than others. That is, what matters is any systematic bias in terms of the lag between when loans in a class go bad and when those loans are charged-off.[13] However, even if there is a systematic lag of several months for some loans relative to others, the fact that we are using annual data makes it unlikely that our results are biased in a significant way.

The chargeoff data are available on a consistent basis in the bank call reports for the years 1978-1993 (excluding 1983[14]). The loan categories available for these years are: real estate loans, commercial and industrial loans (C&I), and consumer loans. In addition, for the years 1976, 1977, 1991, 1992 and 1993, the real estate loan category is broken down between home mortgages and commercial real estate mortgages.

Figure 1 plots the time-series of the chargeoff ratios for real estate loans, C&I loans, and consumer loans, while Figure 2 plots a more limited time-series for the 1-4 family and commercial real estate loan subcategories. Table 4 provides summary statistics. There are three important characterizations of the national data. First, the credit riskiness of C&I and consumer loans is much greater than that for real estate lending. The average proportion of real estate loan payment dollars charged-off was less than one-half of one percent, while that for C&I and consumer loans was greater than one percent per year. Thus, non-real estate lending leads to greater than twice the losses experienced with real estate lending. A simple t-test for differences in means reveals that average real estate loan chargeoffs were significantly less than that for C&I and Consumer loans at the 1 percent level of significance.

Second, the chargeoff experiences of these three loan categories move together closely. As shown in Table 4, consumer loans have a 0.75 correlation coefficient with both C&I and real estate loans. The correlation between real estate loans and C&I loans is more moderate at 0.63. This

[13] Unfortunately, data do not exist to test for such a systematic lag.

[14] The data in 1983 include a smaller set of banks and are therefore not comparable to the other years.

would indicate that credit losses on loans have a strong systematic component; losses across categories are driven by economy-wide fundamentals. Third, within the real estate loan category, there is a substantial difference between the credit riskiness of home mortgages and commercial mortgages. The average chargeoff percentage for home loans is a minuscule 13 hundredths of one percent, while that for commercial real estate was 1.7 percent. Thus, the credit riskiness of commercial real estate is on the same order of magnitude as that of non-real estate commercial lending, while the credit riskiness of home mortgages is an order of magnitude smaller.[15]

Let us interpret these findings with respect to the RBC regulations. Given the regulator's goal of designing weights to accurately reflect credit risk, the ordering of the loan categories is roughly correct. The riskiest loans (commercial real estate, C&I, and consumer loans) are in the 100 percent risk category, while the least risky loans (mortgages) are in the 50 percent category. However, given the minuscule percentage of home mortgage dollar losses, the rules may be far too strict in their case. In addition, consider the fact that most mortgage-backed securities are in the 20 percent category. While mortgage-backed securities essentially have no default risk, they share most of the other stochastic properties of the underlying mortgages. Thus, as a first approximation, the negligible credit risk of home mortgages implies that they should be in the same risk-weight class as mortgage-backed securities. The RBC guidelines contain a significant bias against direct mortgage lending and toward securitized lending. Consistent with this bias, banks increased the amount of mortgage-backed securities from 2.9 percent of assets in 1988 to more than 9 percent in 1993.[16]

An additional flaw in the RBC standards is the neglect of diversification considerations. If the occurrences of default are not highly correlated across regions and loan types, then diversification can lower the variance of losses. That is, diversification may not reduce the average default rate, but it will make loan losses more predictable. This is important because banks may find it easier to plan for, and hedge against, the risk of default when default occurrences are easier to forecast. In addition, lowering the variance of loan default rates across banks will presumably lower the

[15] Even though we have only five years of data for the real estate breakdown, rendering statistical analysis meaningless, the real estate delinquency data that we discuss shortly suggest strongly that the data are representative of a longer period.

[16] Source: Call Reports.

probability of bank failure, which in turn reduces the risk to the Bank Insurance Fund.

While the correlations in Table 5 indicated that national chargeoff rates across loan classes were highly correlated, and thus unlikely to provide significant diversification benefits, this result does not hold when the possibility of geographic diversification is considered. Table 5 presents summary statistics for bank loans broken down by four geographic regions. As seen in the correlation matrix, regional correlations can be quite small. For example, C&I loan losses in the Midwest have a negative correlation with real estate loan losses made in either the Northeast or South. Even within the same loan class, there can be benefits to geographic diversification. For example, there is only a 0.51 correlation across real estate loan losses from the West and the South.

Consider the following two examples of the potential benefits of geographic diversification. A C&I loan portfolio comprised entirely of Northeastern loans would have a chargeoff ratio with a mean of 0.012 and standard deviation of 0.008. However, a geographically diversified portfolio of C&I loans (equally balanced across the four regions) would have a chargeoff ratio with a mean of 0.01 and a standard deviation of 0.005. The standard deviation is almost cut in half. Similarly, a real estate loan portfolio concentrated in the Northeast would have a chargeoff ratio with a mean of 0.0063 and a standard deviation of 0.0066. A geographically diversified real estate loan portfolio would have a chargeoff ratio with a mean of 0.0046 and a standard deviation of 0.0035. Once again, the standard deviation would be almost halved.

We now examine the credit risk of real estate lending more closely. To do so, we utilize two data series collected by the American Council of Life Insurance (ACLI). Since 1965, the ACLI has tracked the delinquencies of the loan portfolios of participating life insurance companies. The first series gives semi-annual delinquency rates for both residential and commercial real estate lending from 1965 to 1993. This will allow us to see whether the results from the chargeoff data, where the breakdown of real estate lending into 1-4 family and commercial real estate categories covers only five years, hold over a longer time-frame. The second ACLI series covers loan delinquencies broken down by finer gradations in property type. This data set begins in 1988 and is available quarterly through the first quarter of 1994. The property types we consider are 1-4 family homes, apartments, retail, office, industrial, and hotels/motels. This data set allows us to examine the implicit assumption underlying the fact that the RBC standards place all commercial real estate lending into one class: that all commercial real estate lending is equally risky.

It is worth noting the differences between the ACLI data set and the previously discussed bank chargeoff data. First, it is unlikely that the real estate loan characteristics of insurance companies precisely replicate that of commercial banks. An obvious example is commercial real estate lending, where commercial banks frequently make short-term construction loans to developers, while insurance companies often provide the permanent ("take-out") loans on the completed properties. Second, the ACLI data track loan delinquencies, including loans in process of foreclosure. A loan is considered delinquent if two or more scheduled payments are past due. This is to be contrasted with the chargeoff data that include the actual dollar amount of loans written off.

Figure 3 plots the ACLI delinquency rates for residential and commercial real estate lending. Summary statistics are reported in Panel A of Table 6. There are two facts to note about this data. First, the average delinquency rate for home mortgages is approximately half the rate of that for commercial real estate. While this is consistent with our findings using the chargeoff data, the difference between the two rates is much smaller in the delinquency data than in the chargeoff data. The relatively high rate of home mortgage delinquencies reflects the fact that homeowners who never actually default on home loans may still be late with some payments. Further, even when homeowners do default, banks typically recover most of the loss upon foreclosure (which leads to low chargeoff rates for home mortgages). This is not typically the case with commercial loan defaults. Thus, while the delinquency data may be helpful in observing general trends in credit riskiness over time, they should not be used to measure the relative credit riskiness of home and commercial loans, underscoring the importance of using chargeoff data. Second, the delinquency rates for home mortgages are relatively stable over time. More importantly, the delinquency data for the years for which we have chargeoff data (1976-77, 1991-93) do not seem to be unusual, giving us confidence that the relatively small number of years of chargeoff data are representative of longer time periods.

Figure 4 plots the ACLI mortgage delinquency rates for the different property types, while summary statistics are reported in Panel B of Table 6. This both confirms, and extends, the lessons from the bank chargeoff data. It is true that home loans have lower credit risk than commercial real estate, but it is also true that commercial real estate is not uniform in its credit risk properties. The average commercial delinquency rates ranged from 2.94 percent (industrial) to 9.67 percent (hotels). It should be kept in mind, however, that this ACLI data set is a short sample and may not be illustrative of real estate lending over the long-term.

Once again, we consider these results in light of the RBC standards. While the RBC standards treat all commercial real estate lending as identical, it is clear that credit risk may vary by property type. While we have examined only a very short period of time, the fact that hotel lending has over three times the average delinquency rate as industrial lending makes it likely that the credit risk of these two categories is not equivalent. Thus, if a bank wanted to take on greater risk (and potentially greater return), without having to alter its capital structure, it may be able to do so by increasing its lending to the riskier commercial property types such as hotels and offices.

6 The Factor Risk of Bank Loans: Interest Rate, Default, and Market Risk

We now move on to examine more general measures of bank asset risk. As demonstrated in Section 4, the stochastic properties of returns on loans subject to default depend on a complicated function of default risk (probability and consequences of default), term structure risks, and market risk. In this section, we consider such general notions of asset riskiness. We do so by estimating the sensitivity of bank loan returns to three important stochastic factors: term structure shifts, default sensitivity, and market risk factors. It is clear from the model in Section 4 that a precise model of bank returns would be highly complex and dependent upon the nature of the stochastic processes underlying the term structure, default probabilities, and the market pricing of risk factors. We employ a less precise, simplified factor model formulation that attempts to broadly characterize the factor risks of bank loans.

We follow the structure of Fama and French (1993), in which they identify the risk factors that capture common (shared, and thus undiversifiable) variation in bond returns. They find that two factors, a term structure factor and a default premium factor, account for the shared variation in bond returns (both corporate and government). In addition, they find that a stock market risk premium also helps to explain excess returns for low-grade corporate bonds. We use this approach to analyze the sensitivities of real estate and commercial loan returns to pervasive risk factors.

6.1 The Returns on Bank Loans: Market-Based Proxies

A key difficulty with almost any serious approach to evaluating more comprehensive measures of bank asset risk is the lack of market-based returns for bank loan classes. Thus, we must use market-based proxies for the true returns of bank loans. In all cases, we use total returns (cash outflow plus capital gains).

Our proxy for commercial business lending is a high-yield (junk) bond index: the Morningstar High Yield Corporate Bond Index. Merton and Bodie (1993) argue that junk bonds are a reasonable proxy for commercial bank loans. While some business loans are made to high credit-quality borrowers, typically it is the smaller, less credit-worthy borrowers who choose to obtain bank loans rather than turn to the public debt markets.

Our proxy for residential mortgage lending is an index of 30-year mortgage backed securities: the Lehman GNMA 30-Year Index. This proxy is imperfect because, unlike direct mortgage lending, mortgage-backed securities are insured against default risk. However, in the previous section, we found that the default risk of home loans is quite small (a chargeoff percentage of one-tenth of one percent). We believe, therefore, that the general factor sensitivities of this index will approximate those of direct mortgage lending.

Our proxy for commercial real estate lending is an index of mortgage real estate investment trusts (REITs): the NAREIT mortgage index. Mortgage REITs are publicly traded closed-end mutual funds that exclusively hold real estate debt in their portfolios. An examination of the REIT Handbook (1993) reveals that mortgage REITs invest primarily in commercial real estate loans, both construction and permanent lending. Once again, this is likely to be only an imperfect proxy for actual bank commercial real estate because the type of real estate loans made by REITs do not precisely replicate those of commercial banks.

6.2 The Risk Factors

We follow Fama and French (1993) in their determination of the pervasive factors explaining bond returns. The first common risk factor arises from unexpected shifts in the term structure. This factor, TERM, is the difference between the monthly long-term government bond return (Lehman Long-Term Government Bond Index) and the one-month Treasury bill return (Salomon Bros. 3-Month T-Bill Index). Changes in this factor represent shifts in the ratio of long-term to short-term interest rates.

The second factor identified by Fama and French is a default factor. The default factor, DEF, is the difference between the return on an index of long-term high-quality corporate bonds (Lehman

Long-Term Corporate Bond Index) and an index of long-term government bonds (Lehman Long-Term Government Bond Index). This factor proxies for changing economic conditions that make the average firm more likely to default. In a general sense, it is a proxy for expectations of future recessions. It is crucial to note, however, that even a loan that is not subject to default may be sensitive to this default factor because rates on nondefaultable loans may be sensitive to the same economic conditions that make default more likely on corporate bonds.

The third and final factor is the market risk premium, MKT, which is simply the return on the S&P 500 index minus the Treasury bill return. We include this market factor because Fama and French found evidence that the market factor helped account for the variation in returns on low-grade corporate bonds. This is simply the beta factor in the classic Capital Asset Pricing Model. Thus, we seek to determine the sensitivity of bank lending returns to systematic market shocks.

6.3 Estimation of Factor Risks

Using monthly total return data over the period from January 1980 through September 1994, we regress the excess returns of our proxies for bank loan returns against our factor risk variables: TERM, DEF, and MKT. Excess returns are calculated by simply subtracting the one-month Treasury bill rate from the return on the appropriate index. The results are displayed in Table 7.

In Panel 7a, we present the results for our C&I loan proxy, the return on the high-yield corporate bond index. In the first column, we regress the excess returns against the two bond market factors, TERM and DEF. Including only these two variables in the specification produces an adjusted R^2 of 0.61. Both factors show up with highly significant t-statistics. The second column presents the results of regressing the excess returns against MKT alone, providing an estimate of its stock market beta. The R^2 falls to 0.26, and the beta estimate is 0.26. When all three factors are included in the third column, all factor sensitivities remain significant. Thus, our proxy for commercial lending has statistically significant sensitivities to term structure, default, and market risk.

Panel 7b presents the results for regressions using our proxy for home mortgages, an index of 30-year mortgage-backed securities. As was the case for C&I loans, home mortgages are sensitive to both the TERM and DEF factor risks. The stock market factor is not statistically significant when included in the full regression. Note, however, that the home mortgage proxy is more sensitive to term structure risk than the C&I loan proxy, but less sensitive to the default and market risk factors.

Panel 7c presents the results for regressions using our proxy for commercial real estate loans, an index of mortgage REITs. In this case, all three factor risks are significant. The stock market and default risk sensitivities are greater than that for residential and C&I loans, but the term structure risk is much lower than that for residential lending.

6.4 Analysis of Results

When we compare the factor risk sensitivities of the three loan classes, several results are notable. First, home mortgages contain risk sensitivities that are decidedly different from the other two lending forms. While home loans have the lowest default and market risk sensitivities, they have the highest term structure risk sensitivity. This aspect is significant, but virtually ignored in the RBC regulations. The reasoning is clear: home loans have the longest maturity. Even though these loans may be prepaid, the average duration is longer than that for commercial lending. The regulations have encouraged portfolio switching into home lending (both direct and through mortgage-backed securities) and away from commercial real estate and business lending. While we have evidence that some forms of risk may be lessened, notably default and market risk, sensitivity to term structure spreads may be increased. Regulators need to consider whether they have simply substituted one form of risk for another.

Of course, to the extent that the increase in mortgages on bank balance sheets reflects an increase in adjustable rate rather than fixed rate loans, banks have not increased their exposure to interest rate risk. However, the opposite has happened. For example, in 1988 adjustable rate mortgages comprised 43 percent of all convential single-family mortgages held by commercial banks. By 1992, that figure had fallen to 25 percent.[17]

Another interesting aspect of the estimation results is the similarity between commercial real estate lending and C&I lending. Each is sensitive to all three risk factors. However, commercial real estate lending is even more sensitive to market movements. This is not a trivial result; bond and bond-like securities typically have negligible betas (e.g., see Fama and French [1993]). Because the regulations have encouraged portfolio switching out of commercial real estate and business loans, the default and market risk of bank asset portfolios have fallen. Of course, as we have just seen,

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[17] These data are from the Federal Housing Finance Board.

these risks may have been merely replaced by term structure risk.

In summary, the RBC standards fail to capture the complexities of more general notions of risk. As our analytical model shows, and now the empirical results demonstrate, bank loans are sensitive to multiple stochastic risk factors. Any regulation that concentrates on only one, be it interest rate risk, or credit risk, is incomplete and may do more harm than good.

7 Risk-Based Capital and the Regulation Problem

In previous sections, we analyzed what are perhaps the key potential problems of the RBC guidelines -- that the mandated risk-weights focus exclusively on credit risk, and neglect the interaction of more general factor risks. In this section, we briefly discuss another important issue: even if bank risk was measured perfectly, can we reasonably expect bank regulators to successfully use this information, given the dynamic nature of financial markets and the incentives of regulators.

One potential problem with the RBC standards might be called the Merton critique (Merton [1994]). As Merton has argued, the traditional approach to regulation is to take the current institutional structure as given, and to make policy that is intended to ensure that these institutions perform their functions safely and profitably. The RBC standards are an example of this framework. However, in competitive and dynamic financial markets, institutional structures become less relevant. The most efficient provider of the particular economic function will come to dominate the market. Institutions that are regulated because they have a particular name or charter often can be replaced by institutions that do not have the same name or charter. We have seen this phenomenon in the area of single-family home mortgages: institutions far removed from the banking or thrift industry, along with the secondary mortgage market, have usurped a considerable role from traditional mortgage lenders. It is not the institutional form that survives; it is the function.

This regulatory bias can also be exploited by the regulated institutions themselves. There is now a well-developed technology of trading in derivatives markets to replicate almost any conceivable payment scheme. By using swaps, options, and futures, banks can replicate their traditional portfolios in ways that will be less penalized by institutional regulations. For example, the RBC standards require zero capital for Treasury bonds, and four percent capital for mortgages. A bank that invests in Treasury bonds and enters into an amortizing swap in which it pays the total return from these bonds and receives the total payments on mortgages will earn the economic equivalent of holding mortgages directly, but will face a capital requirement much closer to zero than four percent.[18] Over time the regulators will close such "loopholes," but they are destined to remain one step behind the private sector.

The use of derivative securities by commercial banks has skyrocketed in recent years. In 1988, commercial banks reported holding a notional value of $2.22 trillion in swaps, futures, forwards, and option contracts. By 1993, this figure rose to $11.87 trillion.[19] The use of derivatives by banks should not necessarily be taken as evidence of increased risk-taking, as it is so often portrayed in the popular press. For example, banks may use derivatives to reduce their risk exposures by hedging out sensitivities to interest rates or foreign exchange positions.[20] Of course, some banks may be using derivatives to increase their risk exposure in hopes of counteracting regulatory constraints. The important point is that banks are becoming very familiar with the use of what are essentially the building blocks for replicating virtually any financial asset imaginable.

As one indication of the difficulty of regulating banks while financial markets evolve, the regulators have struggled for years to figure out how to add interest rate risk to the risk-based capital standards, as FDICIA of 1991 requires them to do. A major stumbling block is the difficulty in finding a single model that adequately captures the interest rate risk of all banks, given the increasing complexity of financial instruments. A current proposal, being seriously considered by bank regulators, is to let banks use their own internal interest rate exposure models, which are often quite sophisticated. However, it seems unlikely that any bank will use its own model to show regulators that it has large interest rate exposure.

Another related reason why the RBC standards may be difficult to enforce is the "regulatory forbearance" resulting from the principal-agent problem inherent in bank regulation. As Kane (1989, 1993) has argued, the agents (regulators) do not have the same incentives as the principals (taxpayers) and therefore cannot be expected to act in their best interests. When banks have capital problems, regulators have an incentive to practice regulatory forbearance so that the public does not

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[18] This example is taken from Merton (1994).

[19] Source: Call Reports.

[20] In 1993, 60% of the commercial bank's derivative contracts (by notional value) were interest rate derivatives, and 37% were foreign exchange derivatives.

become aware of the problem. It is better for public officials "to delay tough actions and to gamble on making a 'clean getaway' either to another term in office or to a high paying job in the private sector."[21] Note that this "incentive-conflict" problem is made possible by asymmetric information -- regulators have more information about the capital positions of banks than the public. While this problem exists with any bank regulation that does not rely on market discipline (or at least market value accounting or market signals), the situation is exacerbated by complicated regulatory rules that increase the asymmetric information. There is no doubt that the RBC guidelines represent a significant change in the direction of complicating the rules. Further, the regulations will almost surely become more complex as interest rate and other types of risks are added to the increasingly large bank regulatory apparatus.

8 Conclusion

An analytical framework for pricing bank loans subject to default risk is presented. The model indicates that the riskiness of such assets are determined by a complicated interaction between credit risk, term structure risk, and the market price of factor risk. However, since the RBC standards focus solely on credit risk, it is not at all clear that the portfolio changes made by banks -- which dramatically increased the RBC ratios of banks in aggregate -- had the desired effect of reducing bank risk. In addition, we find that the RBC standards fail even in their limited goal of correctly quantifying credit risk. The risk-weights over-penalize home mortgages relative to commercial loans, contain a significant bias against direct mortgage lending and towards securitized lending, mistakenly treat all commercial real estate loans as equally sensitive to default, and ignore what we find to be potentially large benefits of diversification.

When we estimate a simple factor model that decomposes loan risk into term structure, default, and market risk, we again find the regulations seriously deficient. In particular, by encouraging banks to reallocate their loan portfolios away from commercial lending and toward home mortgage lending, the regulations are inducing banks to substitute one type of risk (term structure risk) for other types of risk (default and market risk), of which the net effect is unknown.

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[21] See Kane (1993).

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Table 1

Summary of Major Bank Capital Regulatory Events in Past Decade	
Feb. 87	US-UK Joint Proposal on capital adequacy is agreed upon.
Jun. 88	Basle Accord, which requires signatories to implement similar risk-based capital requirements, is signed by twelve nations.
Aug. 88	Governors of the Federal Reserve System approve the Basle Agreement by a vote of 5 to 1.
Dec. 88	Draft of the Fed's risk-based capital regulations approved.
1989	FIRREA of 1989 is passed, which establishes the Office of Thrift Supervision and the Resolution Trust Corporation
Mar. 89	Risk-Based capital (RBC) regulations take effect.
1991	FDICIA of 1991 is passed, which establishes "Prompt Corrective Action" giving regulators more authority to close poorly capitalized banks.
Dec. 90	Banks must meet less stringent, interim RBC targets: 3.25 percent (Tier 1 ratio) and 7.25 percent (Total ratio).
Dec. 92	Banks must meet final RBC targets of 4 percent (Tier 1 ratio) and 8 percent (Total ratio).
Work-in-progress	Regulatory Agencies work on a proposal to regulate interest rate exposure of banks.

Table 2a

Summary of The Risk-Based Capital Regulations

Asset Weights for RBC Standards

A) On-Balance Sheet Assets

I. 0 Percent Risk Category

- Cash
- All claims (loans and securities) unconditionally guaranteed by the U.S. government, any OECD government, and some U.S. government agencies (e.g. GNMA).

II. 20 Percent Risk Category

- Claims guaranteed by some U.S. government sponsored agencies (e.g. FNMA, FHLMC, SLMA).
- Cash items in the process of collection.
- U.S. and OECD interbank deposits and guaranteed claims
- General obligation municipal bonds

III. 50 Percent Risk Category

- Loans fully secured by first liens on 1-4 family residential properties.
- Revenue municipal bonds
- Some privately-issued mortgage backed securities

IV. 100 Percent Risk Category

- All other assets. Includes C&I loans, other real estate loans, loans to individuals, etc.

B) Major Off-Balance Sheet Items

Bankers acceptances conveyed (20 percent)
Commercial letters of credit (20 percent)
Performance-related standby letters of credit (50 percent)
Unused portion of loan commitments, maturity greater than 1 year (50 percent)
Direct-credit-substitute standby letters of credit (100 percent)
Interest rate swaps, forward contracts (weightings vary)

Table 2b

Summary of the Risk-Based Capital Regulations (cont.)

Capital Requirements

I. Leverage Requirement

3 percent: Ratio of Tier 1 capital to (on balance sheet) assets. Is 4-5 percent for banks without CAMEL rating of 1.

II. Tier 1 Requirement

4 percent: Ratio of Tier 1 capital to risk-weighted assets.

- Tier 1 capital includes common equity, some preferred stock, minority interest in consolidated subsidiaries minus goodwill.

III. Total Requirement

8 percent: Ratio of Total capital to risk-weighted assets.

- Total capital equals Tier 1 plus Tier 2 capital.
- Tier 2 capital includes loan loss reserves (limited to 1.25 percent of risk-weighted assets), subordinated debt (limited to 50 percent of Tier 1 capital,) and other preferred and convertible stock.
- Tier 2 capital must not be larger than Tier 1 capital.

Sources: Hall (1993), Federal Reserve Bulletin (March, 1989), Avery and Berger (1991)

Table 3

Weighted Percentage of Banks That Would Have Failed the Total Requirement
1990Q1 - 1992Q4

ALL COMMERCIAL BANKS			
	weighted percent		
	1990Q1	1991Q4	1992Q4
8 percent (Total Ratio)	29.5	9.1	0.6
9 percent (Total Ratio + 1 percent)	48.8	33.3	3.2
10 percent (Total Ratio + 2 percent)	63.9	52.8	12.1
13 percent (Total Ratio + 5 percent)	84.7	81.8	73.1
Average Total Ratio	9.8	10.8	12.5

Note: Banks are weighted by asset size.

Table 4

Ratio of Net Chargeoffs by Type of Loan: National Data

Summary Statistics

	All Real Estate	**C&I**	**Consumer**	**1-4 Family**	**Commercial Real Estate**
Mean	.004	.011	.013	.0013	.017
Std. Dev.	.004	.005	.006	.001	.007
Maximum	.013	.023	.025	.0024	.024
Minimum	.0004	.003	.005	.0001	.008

Correlations			
	All Real Estate	*C&I*	*Consumer*
All Real Estate	1.0		
C&I	.63	1.0	
Consumer	.78	.75	1.0

Source: Call Reports

Note: Data for All Real Estate, C&I, and Consumer loans are available annually from 1976-1993, excluding 1983. Data for 1-4 Family and Commercial Real Estate are available annually for the years 1976, 1977, 1991-1993 only.

Table 5

Ratio of Net Chargeoffs by Type of Loan: Regional Data

RE=All Real Estate, CI=Comm. and Industrial, CS=Consumer
Region 1=West, Region 2=Midwest, Region 3=Northeast, Region 4=South

Summary Statistics
(1976-1993, excluding 1983)

	RE1	***RE2***	***RE3***	***RE4***	***CI1***	***CI2***	***CI3***	***CI4***	***CS1***	***CS2***	***CS3***	***CS4***
Mean	.003	.004	.006	.005	.012	.009	.012	.009	.015	.014	.013	.012
S.D.	.003	.002	.007	.004	.007	.006	.008	.005	.008	.006	.006	.006
Max	.011	.010	.020	.013	.024	.030	.034	.019	.030	.023	.026	.025
Min	.000	.001	.000	.001	.003	.003	.004	.003	.005	.005	.007	.005

Correlations

	RE1	*RE2*	*RE3*	*RE4*	*CI1*	*CI2*	*CI3*	*CI4*	*CS1*	*CS2*	*CS3*	*CS4*
RE1	1.0											
RE2	.63	1.0										
RE3	.70	.88	1.0									
RE4	.51	.76	.76	1.0								
CI1	.48	.24	.07	.23	1.0							
CI2	.28	.20	-.04	-.02	.63	1.0						
CI3	.78	.67	.80	.71	.48	.25	1.0					
CI4	.47	.27	.18	.53	.79	.53	.59	1.0				
CS1	.91	.48	.64	.48	.47	.17	.83	.50	1.0			
CS2	.68	.19	.30	.47	.55	.18	.68	.75	.83	1.0		
CS3	.76	.67	.85	.60	.18	-.01	.85	.22	.84	.54	1.0	
CS4	.81	.52	.68	.68	.45	.11	.91	.64	.92	.89	.82	1.0

Source: Call Reports

Table 6

Real Estate Loan Delinquency Rates
Evidence from Life Insurance Companies

A. 1-4 Family and Commercial Real Estate Loans

Summary Statistics on Proportion of Loans Delinquent

	1-4 Family	*Commercial*
Mean	.013	.022
Std. Dev.	.005	.017
Maximum	.030	.075
Minimum	.007	.005

Source: ACLI

Note: Semi-annual data from 1965 through 1993.

B. 6 Classes of Real Estate Properties

Summary Statistics on Proportion of Loans Delinquent

	1-4 Family	*Office*	*Industrial*	*Hotel*	*Retail*	*Apartment*
Mean	.020	.053	.029	.097	.033	.045
Std. Dev.	.007	.025	.012	.035	.016	.013
Maximum	.033	.095	.052	.159	.058	.071
Minimum	.012	.024	.012	.014	.014	.024

Source: ACLI

Note: Quarterly data from 1988Q1 through 1994Q2.

Table 7
Factor Risks for Bank Loans

Panel 7a. Commercial and Industrial Loans

Proxy for C&I loan total returns: Morningstar High Yield Corporate Bond Index

Specification			
Constant	.05 (.52)	.12 (.82)	-.01 (-.09)
TERM	.61 (16.47)		.54 (14.95)
DEF	1.19 (10.23)		1.14 (10.74)
MKT		.26 (7.75)	.15 (6.25)
R^2 (adjusted)	.61	.26	.68

Notes: Regressions of excess return on C&I loan proxy against TERM, DEF, and MKT. Data are in percentages, and cover all months from January 1980 through September 1994. The t-stats are in parentheses.

Definitions

-Dependent variable is the return on an index of junk bond returns (Morningstar High Yield Corporate) minus the return on T-bills (Salomon T-bill index).
-TERM is the return on long-term government bonds (Lehman Long-Term Government) minus the return on T-bills (Salomon T-bill index).
-DEF is the return on long-term corporate bonds (Lehman Long-Term Corporate) minus the return on long-term government bonds (Lehman Long-Term Government).
-MKT is the return on the S&P 500 minus the return on T-bills (Salomon T-bill index).

Table 7
Factor Risks for Bank Loans

Panel 7b. Residential Mortgage Lending

Proxy for residential mortgage loan total returns: Lehman GNMA 30-Year Index

	Specification		
Constant	.015 (.21)	.20 (1.03)	.03 (.42)
TERM	.84 (33.92)		.85 (32.82)
DEF	.91 (11.86)		.92 (12.08)
MKT		.17 (3.99)	-.03 (-1.98)
R^2 (adjusted)	.87	.07	.87

Notes: Regressions of excess return on home loan proxy against TERM, DEF, and MKT. Data are in percentages, and cover all months from January 1980 through September 1994. The t-stats are in parentheses.

Definitions

-Dependent variable is the return on an index of GNMA 30-year mortgage-backed security returns (Lehman) minus the return on T-bills (Salomon T-bill index).
-TERM is the return on long-term government bonds (Lehman Long-Term Government) minus the return on T-bills (Salomon T-bill index).
-DEF is the return on long-term corporate bonds (Lehman Long-Term Corporate) minus the return on long-term government bonds (Lehman Long-Term Government).
-MKT is the return on the S&P 500 minus the return on T-bills (Salomon T-bill index).

Table 7
Factor Risks for Bank Loans

Panel 7c. Commercial Mortgage Lending

Proxy for commercial mortgage loan total returns: NAREIT index of Mortgage REITS

Specification			
Constant	-.40 (-1.47)	-.40 (-1.5)	-.57 (-2.34)
TERM	.74 (8.15)		.54 (6.30)
DEF	1.58 (5.56)		1.44 (5.67)
MKT		.49 (8.16)	.38 (6.71)
R^2 (adjusted)	.27	.27	.42

Notes: Regressions of excess return on commercial mortgage proxy against TERM, DEF, and MKT. Data are in percentages, and cover all months from January 1980 through September 1994. The t-stats are in parentheses.

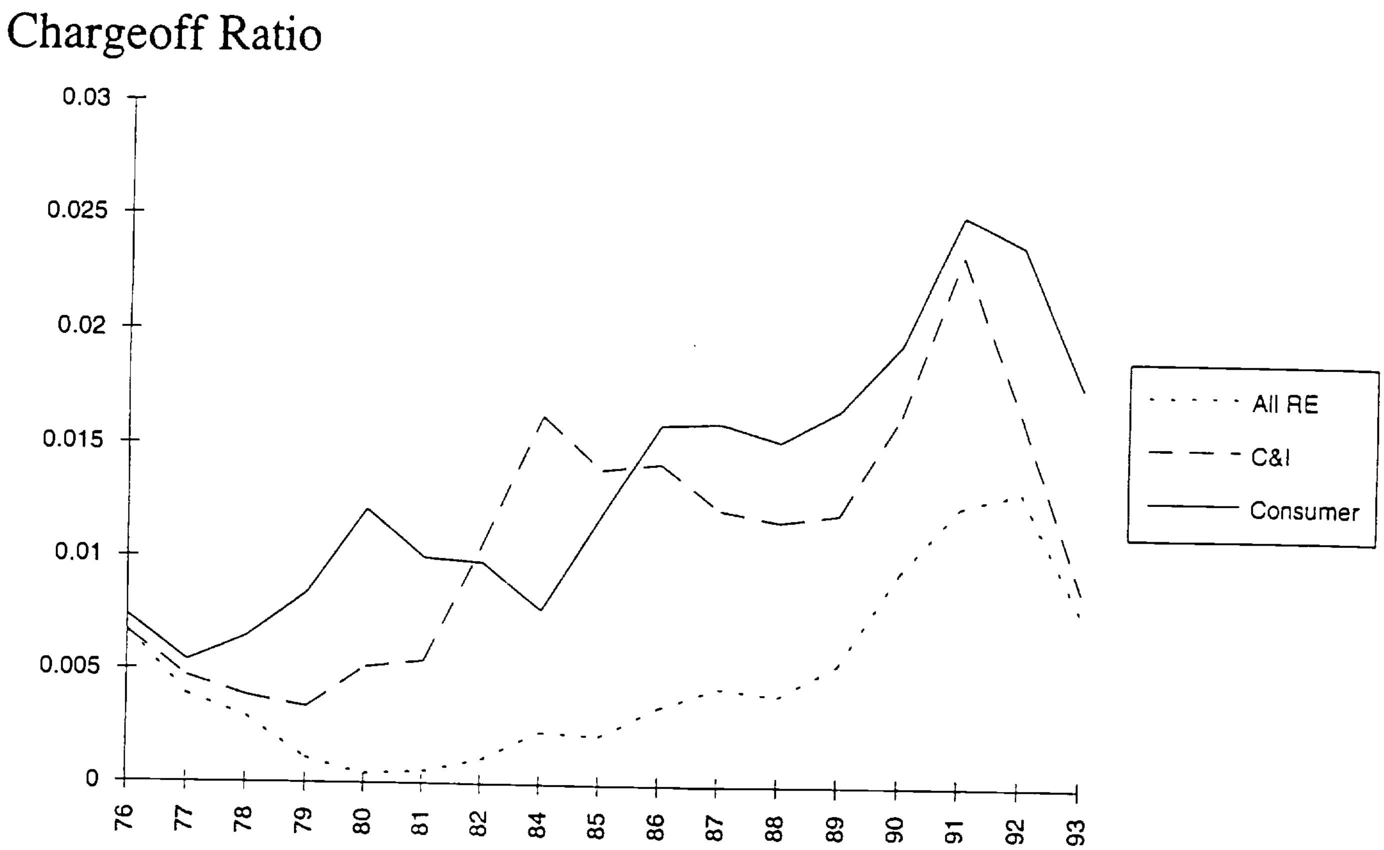
Definitions

-Dependent variable is the return on an index of mortgage REIT returns (NAREIT) minus the return on T-bills (Salomon T-bill index).
-TERM is the return on long-term government bonds (Lehman Long-Term Government) minus the return on T-bills (Salomon T-bill index).
-DEF is the return on long-term corporate bonds (Lehman Long-Term Corporate) minus the return on long-term government bonds (Lehman Long-Term Government).
-MKT is the return on the S&P 500 minus the return on T-bills (Salomon T-bill index).

Figure 1

Bank Chargeoffs: Real Estate, C&I, and Consumer Loans

National Data



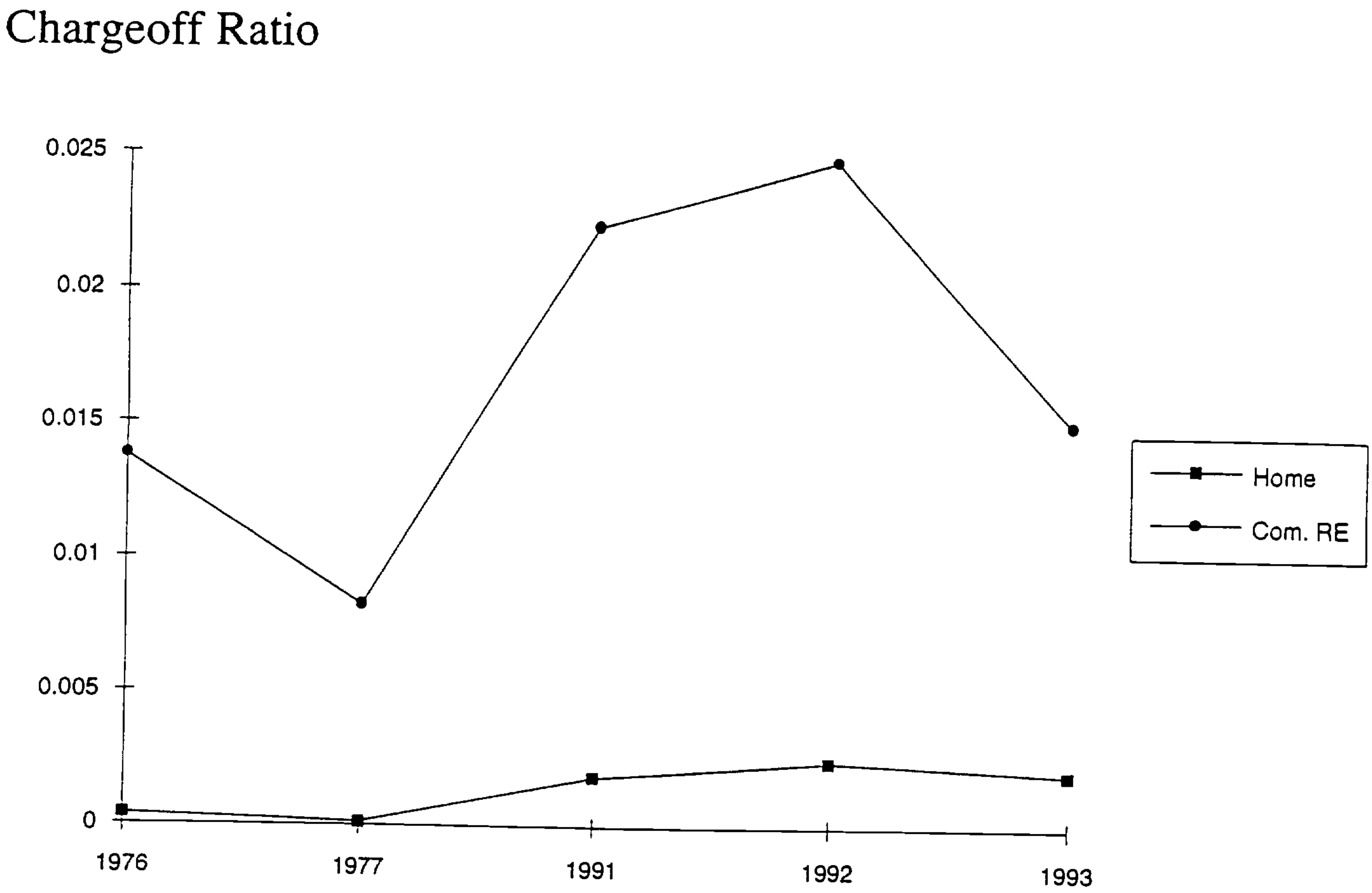
Source: Call Reports

Note: Data for 1983 unavailable

Figure 2

Bank Chargeoffs: 1-4 Family and Commercial Real Estate Loans

National Data



Source: Call Reports

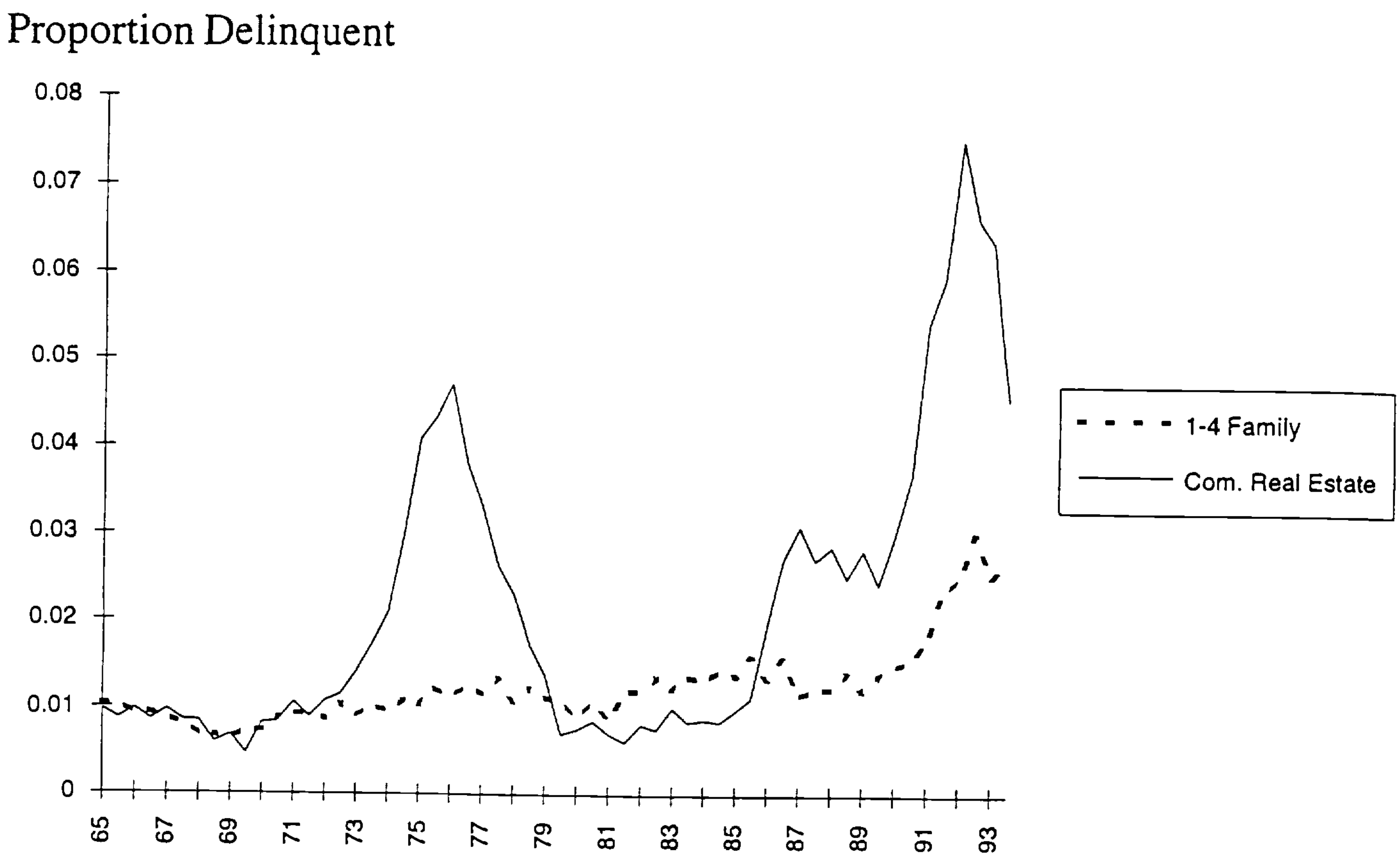
Note: Data for 1976, 1977, 1991-1993 only.

Figure 3

Real Estate Loan Delinquency Rates

Evidence from Life Insurance Companies

1-4 Family versus Commercial Real Estate



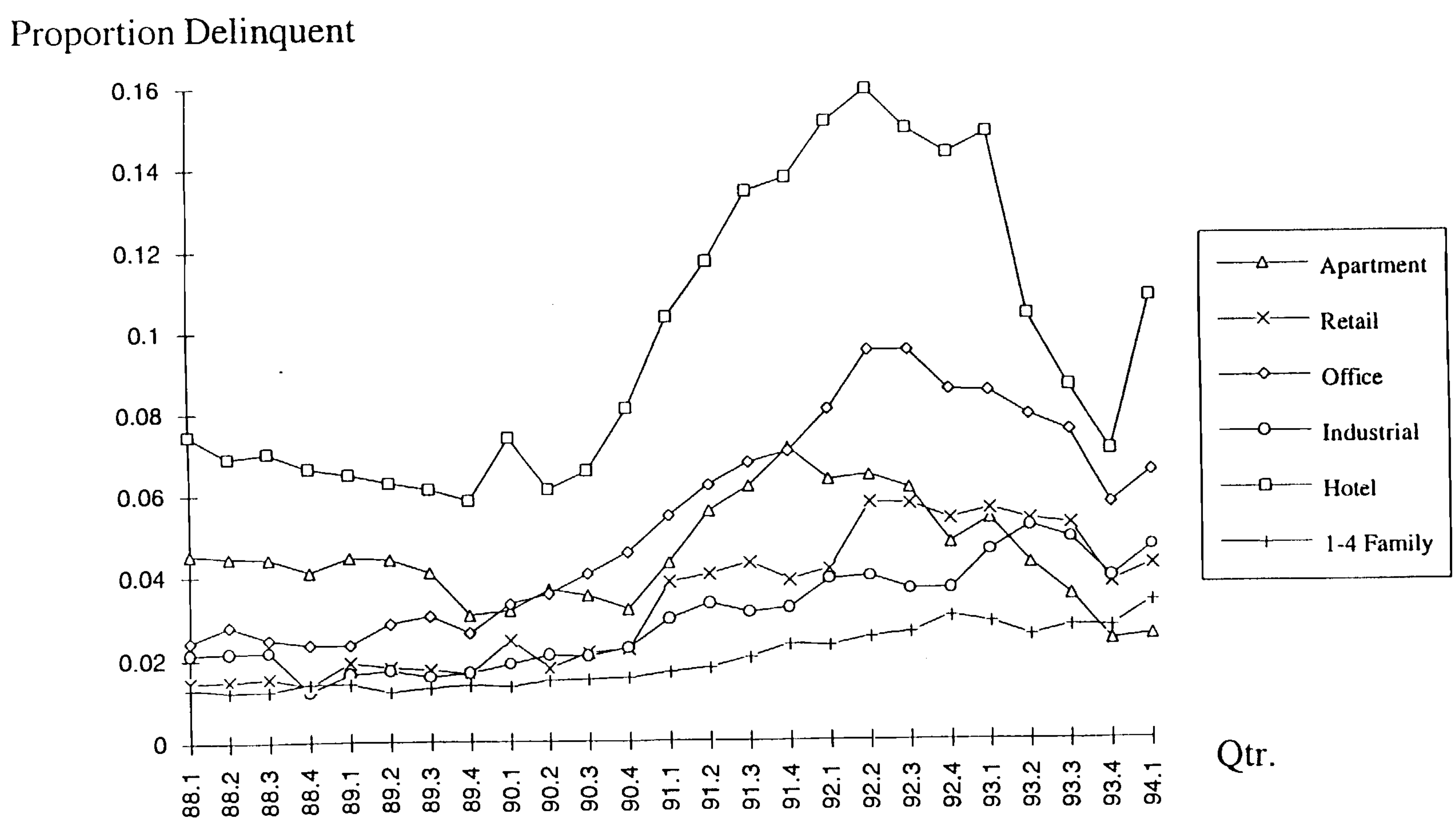
Source: ACLI

Figure 4

Real Estate Loan Delinquency Rates

Evidence from Life Insurance Companies

6 Classes of Real Estate Properties



Source: ACLI