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Modeling loan losses a macroeconomic approach

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MODELING LOAN LOSSES: A MACROECONOMIC APPROACH

by

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ABSTRACT

A sound banking system is essential to a well-functioning economy. With the financial crisis beginning in 2007, a renewed interest in the safety of financial institutions has dominated both the political and financial landscape. Mounting loan losses in real estate lending led to the failing of over 460 banks from 2008 to 2012. This crisis is not unique; in fact, the Savings & Loan Crisis of the 1980's to early 1990's led to the closure of 700 savings institutions. Both instances created a panic in financial markets and heavy losses to deposit insurance funds. These losses are ultimately borne by taxpayers and prudently managed banks, especially if the insurance fund requires re-capitalization. The focus of this paper is on explaining the contributing factors to different categories of loan losses. Namely, total loan losses, residential real estate loan losses, commercial real estate loan losses, and commercial and industrial loan losses are examined. A multivariate regression approach is taken in this paper to explain the four rates of loan losses for the period of 2001 to 2012. Aggregate macroeconomic data from 2001 to 2012 is used to explain loan losses across categories. It was found that the delinquency rate of loans, the consumer financial obligations ratio, and the financial crisis were all significant factors in explaining loan losses.

DEDICATION

To my mother and father, who shaped me into the person I am today,

To Marty and Evelyn, whose unwavering support and belief in me enabled me to succeed,

To my brother Garrett, your fight will be won.

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INTRODUCTION

The financial sector of the United States is critical to a prosperous economy, as it serves as an intermediary between borrowers and savers; as such, its stability and welfare are essential to society. Indeed, over the last thirty years, economic growth in the United States and the world has been negatively impacted by numerous financial crises. For example, the Savings and Loan Crisis of the 1980s and early 1990s led to the failure of over 700 institutions at a cost of over $160 billion to taxpayers. The Japanese banking crisis of the mid-1990s to the early 2000s resulted in the failure of 51 financial institutions by 2002. Most recently, the "Great Recession" was brought about by the financial crisis that started in 2007, which resulted in the failure of over 460 banks from 2008 to 2012. (Source: FDIC) A similar thread runs through these three crises: they were brought about primarily by mounting losses in banks' real estate loan portfolios.

When financial institutions fail, their deposit insurance fund typically arranges a merger with another financial institution and provides a payment to the acquiring firm. If no firm is willing to acquire the failing bank, then the failing institution will be liquidated by the deposit insurance fund. Either way, the deposit insurance fund absorbs at least some of the failing bank's losses. Due to its severity, the Savings and Loan Crisis required its deposit insurance fund (FSLIC) to be recapitalized by both the U.S. government and the private sector.

Similarly, the recent financial crisis created a severe strain on the Federal Deposit Insurance Corporation's bank insurance fund. Since the FDIC is funded with both taxpayers' money and prudent banks' insurance premiums, regulators and society all have a vested interest in minimizing the failure of financial institutions. Given that banks are in the business of lending

funds, the performance of those loans is crucial to their profitability and their solvency. The subprime mortgage crisis stemmed from a boom in home prices fueled by optimistic and reckless lending behavior, but when these subprime mortgages began to default, the result was disastrous for economic activity in the U.S. and the world.

The consequences of a financial meltdown affect all economic participants through higher interest rates, a freezing of credit, higher unemployment, and decreased economic output. Since loan losses are the primary factor in bank failures, a better prediction of loan losses would be advantageous for banks and society as a whole. Consequently, the focus of this paper is on the determination of contributing factors to loan losses for total loans, residential real estate loans, commercial real estate loans, and commercial and industrial loans.

Focusing on loan losses presents an opportunity to study the influence of macroeconomic variables on loan performance. Previous research on the topic of predicting bank failures is extensive, but there is little research in the way of explaining loan losses. This focus is motivated by the fact that loan losses, both realized and unrealized, are the primary reason for bank failures and seems a natural point from which to conduct a study. If loan losses can be explained with some accuracy, then it stands to reason that the failure of some banks can be predicted. Therefore, the economic damage caused by their failure such as a higher unemployment rate and a freezing of lending can be, at least, partially mitigated as regulators may anticipate and prepare for the failure of certain banks. Previous research in this area primarily focused on the prediction of bank failures using a range of measures from stock market volatility to loan charge-offs to the unemployment rate. This paper seeks to build on that body of research by using macro-economic variables to explain the rate of loan losses in the United States for different loans types.

LITERATURE REVIEW

According to Aubuchon (2010), from 2007 to 2010, 2.4% of all federally insured banks failed in the United States accounting for 6.5% of total U.S. deposits. Benston (2007) and Moosa (2010) have argued that the protection of the deposit insurance fund as administered by the Federal Deposit Insurance Corporation is a primary reason for the regulation of bank capital. Furthermore, since the deposit insurance fund needed to be recapitalized after the Savings and Loan Crisis of the mid-1980s and 1990s, the protection of taxpayers is of paramount concern in regards to bank capital regulation.

Much of the previous research on the topic of bank failures focused on the capital ratios of financial institutions; namely, the tier 1 capital ratio and the total capitalization ratio of financial institutions were examined. After the Savings and Loan crisis, capital ratios of financial firms were increasing due to regulatory emphasis on them, and few banks failed from the late 1990s until the new millennium. However, starting in 2007, the tranquility in the banking industry came to an end. The capital ratios of most financial institutions were well above the minimum regulatory requirements at this time and it appeared that the banking industry was well capitalized. According to Furlong (2011) as the financial crisis unfolded, the capital ratios of banks began to fall as losses mounted and the quality of bank assets was doubted.

The recent financial crisis has parallels with the Japanese banking crisis of the mid-1990s. In both cases, the decline of banks' capital ratios was recognized too slowly. This is in part because bank management exercises very broad discretion over when and if a loan is to be deemed non-performing or charged-off. The discretion on the part of management allows for a relatively large time lag in the realization of losses by the bank. It also enables the bank's

management to delay charge-offs in a 'delay and pray' strategy that ultimately leads to large, bank-destroying losses. In fact, according to Linsmeier (2010), many banks that ultimately failed had been classified as "well capitalized" in the twelve-month period prior to failure, and as the year wore on, their capital ratios declined to "adequately capitalized." It was not until the quarter immediately before failure that the banks' capital deteriorated to the FDIC's "undercapitalized" category.

It is important to mention that bank failures, like business failures, are a normal and expected outcome in a capitalistic economy. Ineffective management and inefficient use of resources do not benefit society through increased economic output, so bank failures, per se, are not something to be eliminated; they should, however, be minimized with prudent lending practices and adequate capital cushions. More to the point, Moosa (2010) and Johnson & Mamun (2012) have argued that financial crises should be the target for elimination, not individual bank failures. Given that the financial crisis was caused by rising loan losses on primarily subprime mortgages, it is important that loan performance be improved or, equivalently, that loan losses be predicted as accurately as possible.

Cebula (2010) examined the determinants of bank failure and found that loan charge-off rates were positively related to the bank failure rate. He also found that the unemployment rate and net loan charge-offs were positively associated with the bank failure rate. In addition, Cebula (2010) examined the relation between the volatility in the S&P 500 stock index and found it to be positively associated with the bank failure rate.

In another paper by Cebula (1997), he found that the real growth rate of gross domestic product was negatively associated with the bank failure rate. This finding is to be expected, as an

expansion of economic activity is typically negatively associated with business failures. He also examined the effect of three legislative changes in banking, namely, the Riegle-Neal Interstate Branching Act, the Federal Deposit Insurance Corporation Improvement Act, and the Gramm-Leach-Bliley Act. Cebula (1997) found that the Federal Deposit Insurance Corporation Improvement Act worked to mitigate the rate of bank failures in some of his models. The Riegle-Neal Interstate Branching Act, however, appeared to increase the rate of bank failures. It was concluded that this is most likely due to the need to build and operate more branches in numerous states, which would increase operating costs for banks and lower profit. The last of the legislative changes examined by Cebula (1997) was the Gramm-Leach-Bliley Act of 1999, which was found to be unrelated to bank failures.

Jin, Kanagaretnam, and Lobo (2011) found that growth rates of loans helped to predict bank failures. They employed a mean differences test between failed and non-failed banks and found that the growth in residential real estate loans was positively related to bank failures. In addition, they found that the growth rate in commercial real estate loans was also positively associated with bank failures. In contrast, they found that the growth rate of all loans, whether residential, commercial, or consumer based, were negatively associated with bank failures. The mix of loan types in the bank sample was also found to be negatively associated with bank failures, implying that loan diversification tends to curb bank failure. The authors concluded that the real estate loans issued for residential and commercial properties from 2006 to 2007 were of lower quality and contributed to bank failures.

Kliesen, Owyang, and Vermann (2012) compared and contrasted financial condition indices (FCI) and financial stress indices (FSI). They found that FCIs and FSIs are highly

correlated with one another, as expected, because the two measures have significant overlap in the components that comprise them. Of interest was the use of the Senior Loan Officer Opinion Survey (SLOOS). The survey is administered on a quarterly basis by the Federal Reserve and it quantifies the opinions of senior loan officers at the largest banks in the United States. The SLOOS is a useful measure for bank expectations of the next quarter because it indicates how credit conditions are changing at large banks relative to conditions in the previous quarter. Upon examination of the SLOOS, FCIs, and FSIs, it was found that all three are highly correlated with one another, as expected. Rising levels of financial stress or weakness are expected to foretell weaker economic and financial conditions.

Peni, Smith, and Vähämaa (2012), examined the effect of corporate governance on bank performance. Specifically, the relation between corporate governance, as measured by the Corporate Governance Quotient of Institutional Shareholder (ISS), and real estate loan losses was examined. It was discovered that banks that had stronger corporate governance were, on average, larger financial institutions and outperformed banks that had lower levels of corporate governance. This increase in profitability for higher levels of governance, as measured by return on assets, was accompanied by lower real estate loan losses in 2007 and 2008 but larger losses in 2009. In contrast, firms with lower levels of corporate governance had lower profitability before conditions deteriorated and fewer losses when conditions did deteriorate. Their research is supported by research conducted on the Japanese Banking crisis. For example, Horada, Takatoshi, and Takahashi (2010) found that banks that took more risk in residential real estate had abnormally high returns when compared to banks that took less risk. This is a doubled-edged

sword, however, as those riskier banks incurred significantly higher losses when Japan's housing bubble burst.

The final piece of research by Goodman, Ashworth, Landy, and Yin (2010), centers on the effects of home prices on loan charge-offs and bank failures. The authors found that negative equity trumps unemployment as a primary predictor in loan defaults. They defined loan defaults as mortgages that became 60 or more days delinquent for the first time and measured the percentage of loans that transitioned each month from "always performing" to "non-performing" for the period 2006 to 2009 in the United States. They also found that higher combined loan to value ratios (CLTV) were associated with higher default rates for all classifications of borrowers, namely, prime borrowers, alt-a borrowers, option ARM borrowers, and subprime borrowers. While unemployment was important according to their research, it served more as a catalyst for default. That is, the unemployment rate amplified the default rate when coupled with high loan-to-value ratios. For instance, with an unemployment rate of less than 8%, a CLTV of less than 80% has a transition to default rate of 0.23% for prime borrowers, while using the same unemployment rate, a CLTV of greater than 120% corresponds to a transition rate of 0.83% for prime borrowers. This paper illustrates the importance of home prices in predicting loan defaults and demonstrates the effect of unemployment when coupled with home price declines.

The body of research on bank failures ranges from legislative effects to macroeconomic variables to bank-specific factors. The common thread seems to be that the lack of loan performance at financial institutions is a primary factor in bank failure. It is important to mention that off balance-sheet activities of banks can amplify returns, both positive and negative, but

most financial institutions fail due to the poor performance of their loan portfolios. For the reasons mentioned above, the explanation of loan defaults is the subject of this research.

METHODOLOGY

This paper focuses on whether charge-off rates for U.S. chartered and insured banks can be described using macroeconomic variables for the loan categories of (1) total loans, (2) residential real estate, (3) commercial real estate, and (4) commercial and industrial loans. The charge-off rate for each category is defined as the total value of loans removed from books of U.S. insured and chartered banks and charged against loan loss reserves, net of loan recoveries, as a percentage of average loans on an annualized basis. The dependent variable, Y_i, corresponds to each of the charge-off loan categories, with i = 1, 2, 3, 4. Technically, the paper focuses on attempting to explain the charge-off rates rather than predicting the losses. The relatively small sample of quarterly observations is due to the limited data for some variables. This restricts the ability to test how well a model developed with earlier data predicts the charge-off rates.

The Model

In this analysis, the Newey-West generalized least squares multiple regression model is employed. This multivariate statistical model was chosen to correct for heteroskedasticity and possible serial correlation in the independent variables. The model is of the form

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + +\beta_{10} X_{10} + \beta_{11} X_{12} + \beta_{13} X_{13} + \mu_i,$$

where $\beta_0, \dots, \beta_{13}$ are the coefficients to be estimated and μ_i is the error term in the regression. The independent variables examined in the regression correspond to $X_1, \dots, X_{13}$. A description of each independent variable follows.

Description of Data

Each variable is an aggregate macroeconomic measure and data for all variables runs from quarter 1 of 2001 to quarter 3 of 2012 for a total of forty-seven observations. Some independent variables, such as the senior loan officer opinion survey, delinquency rates, and growth rates of loans, were specific to a dependent variable. In contrast, macroeconomic variables such as the unemployment rate, Standard & Poor's 500 stock index, KBW bank index, the consumer financial obligations ratio, and bank holding company financial ratios were included in all models.

There were four dependent variables in this study (Y_i, i=1, 2, 3, 4), one for each of the four categories of loans types. The specific dependent variables are the (1) charge-off rate for all loans, (2) charge-off rate for single family residential real estate, (3) charge-off rate for commercial real estate, and (4) charge-off rate for commercial and industrial (C&I or business) loans.

The first independent variable is the delinquency rate (X_1) for each type of loan. As with charge-offs, there were four delinquency rates, one for each dependent variable. Specifically, the delinquency rates are: (1) for total loans, (2) for single family residential real estate loans, (3) for commercial real estate loans, and (4) for commercial and industrial loans. The delinquency rate for each loan category is defined as loans thirty days or more past due still accruing interest as well as those in non-accrual status. This rate is measured as the percentage of end of period delinquent loans for U.S. chartered insured banks.

The second independent variable is the U.S. end of quarter unemployment rate (X_2), as defined by the Bureau of Labor Statistics. Unlike the previous independent variables, this measure is not specific to any one dependent variable; therefore, it was used in all four models.

The third independent variable is the Federal Housing Finance Agency's Purchase Only Home Price Index (X_3). This index is a weighted, repeat sales index for single-family homes whose mortgages are conforming and have been purchased or securitized by Fannie Mae or Freddie Mac. The purchase only index reflects average price changes in repeat sales of homes on a quarterly basis since its inception in 1991.

The fourth independent variable is the consumer financial obligations ratio (X_4). Two types of financial obligation ratios were gathered: one for all consumers and one specifically for homeowners. The first financial obligations ratio is defined as the sum of household debt obligations including revolving debt, tenant-occupied rental payments, homeowner's insurance, and automobile loan/lease payments, as a percentage of disposable income. The second is defined as the same sum but with mortgage payments in place of rental payments and with the addition of property tax payments, as a percentage of disposable income.

The fifth independent variable (X_5) is the growth rate of real gross domestic product (RGDP). This variable is defined as the annualized growth rate of RGDP, on a quarterly basis, based upon 2005-chained dollars. Like the unemployment rate, RGDP is a macroeconomic variable that is not specific to any one model so it is included in all four models.

The sixth independent variable is the growth rate of each loan type (X_6). As before, this independent variable is specific to each dependent variable for a total of four growth rates. Specifically, the growth rates are: (1) for total loans, (2) for single family residential real estate

loans, (3) for commercial real estate loans, and (4) for commercial and industrial loans. The growth rate for each loan type is defined as the end of period compounded annual rate of change in each loan category for U.S. chartered insured banks.

The seventh independent variable (X_7) is the Standard & Poor's 500 stock index (S&P 500). The S&P 500 is a market value weighted index of 500 large capitalization U.S. equities. Of the 500 companies included in the index, all are typically "leading companies in leading industries" (Source: McGraw Hill Co.) for the U.S. economy. The index is generally regarded as an adequate gauge of U.S. broad market large capitalization equities.

The eighth independent variable (X_8) is the Keefe, Bruyette & Woods (KBW) bank stock index (Ticker: BKX). BKX is a float adjusted modified-market capitalization-weighted index that attempts to reflect the performance of companies doing business as banks or thrifts. The twenty-four financial institutions included in the index must be publicly traded in the United States and are selected to be representative of leading national money centers and regional banks.

The ninth independent variable (X_9) is the senior loan officer opinion survey (SLOOS). This independent variable is also specific to each of the charge-off rates. A total of three SLOOS measures are used: (1) percentage of respondent banks reporting a tightening of credit standards for single-family residential mortgages, (2) percentage of respondent banks reporting a tightening of credit standards for commercial real estate loans, and (3) percentage of respondent banks reporting a tightening of credit standards for commercial and industrial loans. The SLOOS is a survey of approximately sixty large domestic banks and twenty-four branches and agencies of foreign banks on a quarterly basis. The survey consists of the net percentage of surveyed banks reporting a tightening of credit standards, as measured from the previous quarter. A single

SLOOS measure for all loans does not exist so a composite with a one-third weighting on each loan category is used for total loan charge-offs.

The tenth independent variable is the loan loss allowance to total outstanding loans and leases (X_{10}), expressed as a percent. This ratio is defined as the total loan loss allowance divided by total outstanding loans and leases for peer group one banks. Peer group one banks are defined as banks with assets greater than $10 billion. This independent variable is not specific to any one dependent variable hence it is used in all four models.

The eleventh independent variable is the equity capital to total assets ratio (X_{11}), expressed as a percent. This measure is defined as tangible common equity to total bank assets for peer group one banks. As with loan loss reserves, this independent variable is not specific to any one dependent variable; therefore, it is included in all four models.

The twelfth independent variable is the Tier 1 risk-based-capital ratio of peer group one U.S. commercial banks (X_{12}). Tier 1 risk-based capital is defined as tangible common equity plus non-cumulative preferred stock as a percentage of risk-weighted assets. Risk-weighted-assets are assigned a weight, from zero to over one hundred percent, depending on the risk level of the asset. For example, cash is given a weight of zero, securities issued by government-sponsored enterprises are given a weight of twenty percent, and one-to-four family qualified residential mortgages are assigned a weight of fifty percent. More speculative assets, such as bonds rated BB or below, are assigned weights of over one hundred percent, reflecting the higher risk associated with them. As with the other two financial ratios, this independent variable is used in all four models.

The thirteenth, and final, independent variable is the crisis variable (X_{13}). The crisis variable was a dummy (binary) variable that had a value of one for quarter 1-2008 to quarter 4-2010, for a total of twelve quarters. For all other time periods, the crisis variable had a value of zero. This independent variable is used in all four models in an attempt to examine the effects of the financial crisis beginning in 2008.

Data Collection

Data was gathered from numerous sources. The dependent variables, i.e. charge-off rates, for all models were gathered from the Federal Reserve's statistical release H.8: Assets and Liabilities of Commercial Banks in the United States.

For the delinquency rate and growth rate of loan type, the data sources were also the Federal Reserve's statistical releases related to Assets and Liabilities of Commercial Banks in the United States. Data for the Senior Loan Officer Opinion Survey were gathered from the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices. Data on consumer financial obligation ratios were obtained from the Federal Reserve's Household Finance Statistical Release on Household Debt Service and Financial Obligations Ratios.

Data for the unemployment rate came from the Bureau of Labor Statistics, and the growth rate of real gross domestic product was gathered from the Bureau of Economic Analysis. For the home price index, data were obtained from the Federal Housing Finance Agency's purchase only home price index.

Data for the financial ratios Tier 1 Risk-Based Capital, Equity Capital to Total Assets, and Loan Loss Reserves to Total Loans Outstanding were gathered from the National Information Center of the Federal Reserve, as compiled by the Federal Financial Institutions

Examination Council. This data was gathered for peer group one banks from the Bank Holding Company Performance Reports. Finally, the Standard & Poor's 500 stock index and the KBW bank index (Ticker: BKX) came from Yahoo! Finance.

Analytical Procedure

A uniform procedure was adopted for analyzing each of the four models. First, a correlation matrix was generated and reviewed for each dependent variable and its associated independent variables. After reviewing the matrix, a standard ordinary least squares regression (OLS) was performed on variables exhibiting the strongest correlation with the dependent variable. Second, a forward stepwise regression was performed that included all independent variables. An alpha value of 10% was chosen as the minimum significance level for entry into the model. Independent variables that passed this significance test were retained for further analysis.

Third, lagged variables up to four quarters were generated for each retained variable in each of the four models. Another correlation matrix was generated to compare the specific dependent variable and the newly generated lagged variables. If significant changes in correlations with the dependent variable were observed, the strongest correlated lagged variable(s) is regressed in place of its contemporaneous counterpart. This is done to examine the effects of the lagged variables and to compare lagged versus non-lagged models' explanatory power. If the lagged variable is significant, it was retained and used in place of its non-lagged counterpart.

Fourth, a dummy variable named “Crisis” was introduced into the analysis in an attempt to capture the effects of the financial crisis of 2008 to 2010. “Crisis” took a value of one for time periods 2008-quarter 1 to 2010-quarter 4; all other time periods received a value of zero. The fifth step entailed running an OLS regression based upon the variables of significance from the stepwise procedure but with “Crisis” inserted into the model. This model was then analyzed for the effects of the “Crisis” variable. If “Crisis” was significant, interactions with “Crisis” and the retained variables from the stepwise procedure were created. For example, if both “Crisis” and unemployment rate (UR) were significant, then an interaction term, “URxCrisis”, was introduced to the model. In the sixth step, another OLS regression was performed on the retained variables, their associated interactions, and “Crisis”.

The seventh step involved paring the model down to create a parsimonious statistical model. Variables that failed to pass a significance level of 5% were removed from the model. A final OLS regression was run on those variables that passed the 5% significance level. Assuming the previous variables continued to be significant, the model was then run as a time series model. The eighth, and final, step involved the Newey-West generalized least squares (GLS) procedure. The Newey-West procedure was utilized to correct for heteroskedasticity and possible serial correlation. A maximum lag of four periods was specified for this model. This final Newey-West model serves as the basis for analysis.

This procedure was followed for all four of the dependent variables: (1) total loan charge-offs, (2) residential real estate charge-offs, (3) commercial real estate charge-offs, and (4) commercial and industrial loan charge-offs.

RESULTS

The results of this analysis are presented in Table 1 Summary of Results Across Models. Additionally, a correlation matrix is provided for each of the four models.

Since this study examined four different models with thirteen independent variables, the discussion of results will not delineate each model. Rather, the results will focus on the significant independent variables across models. Given the similarities across models, this approach will provide a cohesive means to discuss results. Each significant independent variable is examined in turn.

Delinquency Rates

The estimated coefficient for the delinquency rate in each model was positive and significant at the 1% confidence level. This result was expected in each of the four models because a loan cannot be charged off until it first becomes delinquent. Since it is important in all four models, the delinquency rate is a statistically significant predictor of loan losses, regardless of loan category. An increase in the delinquency rate is indicative of higher charge-off rates.

In the total loan charge-off model, a one-percentage point increase in the delinquency rate, ceteris paribus, translates to an increase of over 29 basis points in the total charge-off rate. The interaction of the delinquency rate and the crisis variable is also significant at the 1% confidence level. It has the expected positive sign and demonstrates that during the crisis, charge-off rates were higher. Given the financial strain experienced during the crisis, higher delinquency rates were expected. The net effect of the delinquency rate and its associated interaction term is 0.7926; indicating that during the crisis, with all else held constant, a one-percentage point increase in the delinquency rate resulted in over a 79 basis point increase in the

charge-off rate. This finding illustrates the severity of the crisis on loan performance. Given the sizeable expansion of credit in the periods up to the crisis, it is not surprising that charge-off rates increased over 50 basis points during the crisis.

For the residential real estate model, the estimated coefficient implies that a one-percent increase in the residential delinquency rate, all else equal, would translate to an 18 basis point rise in the charge-off rate for residential real estate. In the commercial real estate model, the estimated coefficient suggests that, all else constant, a one-percent growth in the delinquency rate of commercial real estate produced an approximate 35 basis point rise in the charge-off rate of commercial real estate. Finally, the estimated coefficient in Commercial and Industrial Loan model suggests that a one-percent increase in the delinquency rate results in a 59 basis point increase in the loan charge-off rate, holding all else constant for this time period. It is interesting that the slope of the delinquency rate increased during the crisis for total loans charge-offs but not the other types of loans.

Unemployment Rate

The estimated coefficient for unemployment rate was positive and significant only in the residential real estate model. It was significant at the 1% confidence level and suggests that if all else were held constant, a one-percentage point increase in the unemployment rate would result in a 16 basis point increase in the residential real estate charge-off rate. This finding was expected since most consumers' livelihoods come from current earnings. Without an income source, consumers must rely on alternative financial sources such as savings or relatives to meet their obligations. However, if those sources are completely drawn down, consumers will default on mortgages, driving up residential real estate charge-off rates.

Home Price Index

The home price index was expected to be negatively associated with charge-offs. In this study it did not provide any significant additional explanatory power in any of the models.

Financial Obligations Ratio

The consumer financial obligations ratio was positive and significant at the 2% confidence level in all models except the commercial real estate model. This finding was expected because as consumers' financial obligations increase, the ability to service their debt agreements should suffer, resulting in more loan defaults.

For the total loan charge-off model, the estimated coefficient for the financial obligations ratio implies that, all else equal, a one-percentage point rise in consumers' financial obligations leads to an increase of over 12 basis points in total loan charge-offs.

The interaction of the financial obligations ratio and the crisis dummy variable is also significant at the 1% confidence level. Its estimated coefficient was -0.2714. This unexpected negative sign may be a by-product of the housing bubble; as consumers secured loans that required little to no down payment and little to no documentation, higher financial obligations were expected. Additionally, some consumers were struggling to make mortgage payments for loans they could not possibly honor in the long term. That is, during this period, financial obligations were rising as loan originations increased and the increase in the amount of loans outstanding may have pushed the rate of charge-offs down, especially for this three-year period.

The crux of the preceding analysis is that during non-crisis periods, rising financial obligations foretell of higher total loan charge-off rates; yet, in periods of financial crisis, higher payment obligations may be associated with lower charge-offs rates, possibly because of rapidly

expanding loan portfolios. However, the lack of significance for the crisis interaction variable with more specific types of loans causes one to question the generalizability of this result.

For the residential real estate model, it bears noting that the financial obligation ratio for all consumers was tested in addition to the financial obligation ratio for homeowners. The former was insignificant in the tested models so the latter was used in its place. Since the goal of this model was to explain specifically residential real estate charge-offs, the use the financial obligations ratio for homeowners was justified. A one-percent rise in the financial obligation ratio of homeowners would raise the residential charge-off rate over 5 basis points, all else constant.

In the commercial and industrial model, an increase of one percent in the financial obligations ratio, ceteris paribus, would result in an increase of 20.8 basis points in the charge-off rate of commercial and industrial loans. Commercial and industrial loans, also called business loans, are primarily originated to finance working capital needs and to finance capital investments. Consumer spending represents a source of business revenue, with the remainder coming from other enterprises or government spending. As consumers experience more financial strain, they will reduce spending in an attempt to meet these rising financial obligations. This cut in spending directly impacts businesses in the form of reduced revenues and a diminished capacity to service debt obligations. In turn, this adversely affects the performance of banks' commercial and industrial loan portfolios through increased charge-offs.

Real GDP Growth

The real GDP growth rate was expected to be negatively associated with charge-offs. In this study it did not provide any significant additional explanatory power in any of the models.

Loan Growth Rate

The estimated coefficient for the loan growth rate is significant only in the residential real estate model. It exhibited an unexpected negative sign and was significant at the 1% level. The sign of this coefficient was expected to be positive because high levels of loan growth were expected to contribute to higher levels of loan charge-offs. This result does not necessarily invalidate the expectation that excessively high growth rates may increase future charge-offs. Instead, it probably reflects the contemporaneous nature of the variable. As charge-offs increase, management is likely to decrease the level or growth rate of those loans. A one percent increase in the growth rate of residential real estate mortgages, ceteris paribus, denotes a decrease of half a basis point in the residential real estate loan charge-off rate.

Standard and Poor's 500

The S&P 500 is significant in only the commercial real estate model and the commercial and industrial model. In the commercial real estate model, the estimated coefficient was negative, as expected, but in the commercial and industrial model, it was unexpectedly positive.

If the S&P 500 does in fact reflect future expectations, a higher index value should point to lower charge-off rates in the commercial real estate model. Furthermore, as investors envision an optimistic future, as reflected by rising stock prices, the charge-off rate should fall. The S&P 500 may serve as a leading indicator of economic performance while the charge-off rate acts as a lagging indicator. The estimated coefficient for this variable is small so its direct interpretation is almost trivial; however, the primary takeaway from this estimated coefficient is the relationship between it and the dependent variable. This negative relationship illustrates that as expectations of the future improve, charge-off rates fall.

In contrast, the S&P 500 exhibited an unexpected positive sign in the commercial and industrial charge-off model. The positive sign of this estimated coefficient is surprising since one would expect a negative relationship between commercial and industrial charge-offs and stock market performance. This observed positive relationship may be explained by the inclusion criteria for the S&P 500. The index is comprised of "leading companies in leading industries" (Source: McGraw Hill Co.) with market capitalizations in excess of $4 billion. The S&P index committee makes its inclusion decisions based upon future profit expectations, liquidity requirements, and overall financial viability.

The composition of the index is biased toward financially successful companies while excluding poor performers. Typically, companies included in the S&P 500 are profitable, growing, and leading in their respective industry; they are not typically the type to default on debt agreements. Additionally, bank loans are an important source of funds for many firms but retained earnings are the primary source of funds for growth in most enterprises. It is plausible then, to argue that the S&P 500 could increase as loan charge-offs increased, especially since the index is composed of both financial and non-financial firms. The dependent variable for this model is the charge-off rate of commercial and industrial loans to non-financial firms. The combination of including financial firms and the tendency of the index to select viable firms may explain the observed positive relationship between the S&P 500 and the dependent variable. It is possible for stock values of leading companies in leading industries to appreciate while business loan charge-offs are rising. Essentially, the type of firm that defaults will not be a leader in its industry, and therefore, would not be included in the S&P 500 listing.

The estimated coefficient of the S&P is small, so its direct effect translates to similarly small changes in the charge-off rate for commercial and industrial loans. The key take-away from this analysis is the likelihood that loan charge-offs rates are not necessarily reflected in this broad market index.

KBW Bank Stock Index

Similarly, the KBW bank index (Ticker: BKX) is significant at the 2% confidence level in only the commercial real estate model and the commercial and industrial model. The estimated coefficient for the KBW index is negative, as expected, in the commercial and industrial model, but it is positive in the commercial real estate model.

The positive relationship between the KBW index and commercial real estate charge-offs was not anticipated. The positive sign of this estimated coefficient was unexpected because the index tracks 24 medium to large publicly traded banks in the United States. An appreciation of the underlying banks' stock value will cause the index to increase; therefore, one would expect a negative relationship between BKX and the dependent variable. Bank losses, such as charge-offs, should be falling as stock prices increase but this was not reflected in the estimated coefficient.

One explanation for this unexpected result lies in the composition of the index itself. BKX is a float-adjusted market-capitalization weighted index of twenty-four medium-to-large U.S. publicly traded banks. The largest four banks in the index, Bank of America, J.P. Morgan Chase, Wells Fargo, and Citigroup, account for approximately 35% of the index's weight, with the remaining 65% coming from the other twenty banks. Since these four banks incurred heavy real estate loan losses, it is reasonable to argue that as charge-offs were increasing, the remaining

twenty banks' stock appreciation dominated index performance. That is, the weight of the other twenty banks made it appear that as bank stocks appreciated, charge-off rates of commercial real estate increased. Obviously, this is not the case because stock prices reflect expectations of the future and investors will not respond positively to mounting loan losses. Therefore, it is reasonable to conclude the four large banks heavily contributed to commercial real estate charge-offs while not contributing as heavily to the performance of the BKX index.

Conversely, in the commercial and industrial model, the estimated coefficient of BKX is negative. This negative relationship was expected since the index is comprised of bank equities. As banks incur loan losses, investors will adjust their expectations and bank stocks will decline. This seems to be in contrast to the outcome observed in commercial real estate charge-offs but this model studied commercial and industrial loan charge-offs.

Since business loans are sought for many reasons, including financing payrolls, inventory, working capital, and capital investments, they may or may not be collateralized. This suggests that commercial and industrial loans are of higher risk than real estate loans, and as a consequence, higher loan losses are to be expected. Furthermore, there are thousands of banks involved in business lending in the United States. As economic conditions deteriorate, higher risk business loans are likely to default, especially for small to medium sized businesses. Given the vast number of small businesses in U.S., these default effects are likely to be felt industry-wide. As a result, the KBW index should move inversely with the charge-off rate of commercial and industrial loans. Stated another way, bank stock appreciation is indicative of positive loan performance. This outcome would increase the index value and point to lower loan charge-off rates.

Because the estimated coefficient for the KBW index is small in both models, it effects translate to nearly insignificant changes in the dependent variables. The key point of this analysis is the tendency of the largest banks to drive charge-offs while having a smaller effect on index value.

The unexpected positive coefficients for the S&P 500 and KBW may be related to each other. See Tables 4 and 5. Both are negatively correlated with the charge-offs. KBW has correlations of -0.816 with commercial real estate loan charge-offs and -0.595 with C&I loan charge-offs. The S&P 500 has correlations of -0.220 with commercial real estate loan charge-offs and -0.663 with C&I loan charge-offs. The correlation coefficient between S&P 500 and KBW is 0.373. These variables are also correlated with other variables in the model. Therefore, one should be careful about generalizing the effect of these variables when viewed in isolation, i.e., a simple correlation with the charge-offs versus their additional effect in a multiple regression model.

Senior Loan Officer Opinion Survey

The only model in which the senior loan officer opinion survey is significant is in the commercial and industrial model. Since the survey quantifies the net percentage of respondent banks reporting a tightening of credit conditions, this independent variable should be directly related to the charge-off rate for business loans. Senior loan officers report how credit requirements are changing from quarter to quarter; hence a tightening of standards indicates worsening expectations for loan performance. Banks will tighten credit standards as expectations about the future become more pessimistic; therefore, the survey provides an insight into the expectation of both future loan performance and existing loan performance. That is, the survey is

suggestive of senior loan officers' beliefs about future economic conditions. Taken this way, it is not surprising that tightening credit conditions are associated with increasing loan losses. The positive association between the survey and charge-off rates indicates that a one-percent increase in the survey (reflecting a tightening of lending standards) leads to a 0.2 basis point increase in charge-off rate for commercial and industrial loans.

Loan Loss Reserves

The estimated coefficient of loan loss reserves for peer group one banks is positive and significant only in the total loan charge-off model. Additionally, the coefficient estimate for the crisis interaction term is negative and significant. Both estimates are significant at the 1% confidence level.

The expected sign of this coefficient was uncertain prior to the analysis. On one hand, higher loan loss reserves could indicate riskier lending practices, necessitating a larger provision for loan losses and therefore a higher level of loan loss reserves. However, on the other hand, higher loan loss reserves could be a trait of cautious banks. Higher levels of loan loss reserves enable banks to absorb more loan losses without affecting equity capital. During normal non-crisis periods, it appears that higher loan loss reserves serve as signal that loan portfolios may be of higher risk, and to protect equity, banks boost those reserves. Specifically, a gain of one percent in loan loss reserves, ceteris paribus, suggests an increase of over 45 basis points in the total loan charge-off rate.

The estimated coefficient of the crisis interaction term for loan loss reserves is negative. The net effect of this interaction term and the loan loss reserve term is -0.9112. During the crisis, higher loan loss reserves served to mitigate loan losses by nearly 91 basis points for each percent

in loan loss reserves. This is in contrast to the effects of loan loss reserves during non-crisis periods. It is possible that as the crisis approached, banks increased their loan loss reserves in anticipation of mounting losses. The explanation may be that the much higher charge-offs during the crisis period is causing the loan loss reserves to decrease. In other words, if the loan loss provisions are less than the charge-offs, the loan loss reserves will decrease. This "releasing of reserves" has the effect of increasing net income.

Equity Capital Ratio

The equity capital ratio is significant only in the total loan charge-off model. Its estimated coefficient is negative, as expected, and is significant at the 1% level. This suggests that banks with higher equity capital ratios experienced lower loan charge-offs. It also may imply that banks with higher loan charge-offs had lower levels of equity capital as charge-offs reduced loan loss reserves. This outcome is expected because if loan loss reserves are exhausted, equity capital will begin absorbing losses, resulting in this inverse relationship. Additionally, higher equity capital may signal lower risk in a bank's loan portfolio, explaining the mitigating effects of equity capital on loan losses. In either case, a one-percent increase in the equity capital ratio translates to a 17 basis point decrease in total loan charge-offs, all else constant.

Tier 1 Risk-Based Capital

The estimated coefficient for Tier 1 risk-based capital is significant at the 1% confidence level only for the residential real estate model. It is negative, as expected, and implies that banks with higher levels of risk-adjusted capital experienced fewer residential real estate losses. Since Tier 1 RBC is a risk-weighted measure of bank assets, a higher ratio signifies better

capitalization. A more capitalized bank can better withstand losses and an adverse economic environment. Similar to the equity capital ratio, lower levels of Tier 1 risk-based capital could also indicate that banks with higher charge-offs had lower levels of Tier 1 risk-based capital. It is likely that higher levels capital will serve as a signal for lower risk assets. With all else held constant, a one percent rise in Tier 1 risk-based capital results in nearly an 18 basis point decrease in residential real estate charge-offs.

Crisis Dummy Variable

The final variable is the crisis dummy variable. It is significant at the 5% or less level for all models except the commercial and industrial model. For three models, its estimated coefficient exhibits the expected positive sign and this implies that during the crisis period of 2008 to 2010, loan losses were higher. This positive effect results in raising the baseline level of charge-offs in three of the four models. For the total loan charge-off model, losses are nearly 7 basis points higher, on average. Finally, in the residential real estate charge-off model and the commercial real estate model, this base level of charge-offs is higher by over 0.2 basis points, on average.

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Conclusions

Table 1 presents an overview of the models and significant explanatory variables. Overall, each of the four models explained its associated charge-off rate well. The delinquency rate is of particular interest because this variable was significant in all four models. This suggests that this variable is useful in explaining loan losses. Since a loan must become delinquent before it can be charged-off, this result is not surprising and this suggests that rising delinquency rates are indicative of higher loan losses in the sample period. A higher level of delinquencies may serve as a signal to bank management and regulators that higher loan losses need to be anticipated and prepared for. Although one might consider this a leading indicator of charge-offs, lags of up to four quarters did not improve its explanatory power.

The financial obligations ratio was also significant in all models except the commercial real estate model. This suggests that as consumers assume more debt, their ability to service that debt suffers. Again, this result is expected but it does show that loan performance is sensitive to consumers' financial obligations. A rising financial obligations ratio may function as an indicator of rising loan losses in future periods.

It is interesting to note that the KBW index and the S&P 500 index were significant only in the commercial real estate and the C&I models. This reflects the commercial nature of both these dependent variables; also, the signs for KBW and S&P 500 were reversed for each model. This likely illustrates the differences in scope and composition of these two indices. The generalizability of these results is also questionable.

Growth in loans and the unemployment rate were significant only in the residential real estate model. While it was expected that both variables would be important in the said model, it was surprising that neither were significant in any other. This suggests that a rising unemployment rate may impact banks' residential real estate loan portfolios. The lack of explanatory power for the unemployment rate for non-residential real estate loans may reflect that while the unemployment rate was increasing the productivity and profitability of businesses may have been increasing, offsetting the negative effect of lower employment. With respect to the growth rate of residential loans, the negative coefficient indicates that on a contemporaneous basis, as charge-offs increase banks cut back on their growth. One might expect growth rates to be a leading indicator, i.e., current above average growth rates may lead to higher future charge-offs; however, lags in this variable up to four quarters did not provide additional explanatory power.

Financial ratios were significant only in the total loan charge-off and the residential charge-off models. The total charge-off model had loan losses reserves and equity capital significant, while tier 1 risk-based-capital was insignificant. The opposite was observed for residential charge-off model. All three financial ratios are used a proxy for bank prudence so it is not surprising that two of the ratios were significant in total loan charge-offs. Similarly, banks with higher levels of risk-adjusted capital seemed to experience fewer losses in residential real estate. Since residential real estate loans comprise a substantial portion of banking assets, some similarity in the models was expected. Overall, it appears that higher levels of equity are associated with lower levels of loan losses.

The senior loan officer opinion survey was significant only in the commercial and industrial model. Banks tighten credit standards as loan performance deteriorates. The credit standards may have had an effect with C&I loan charge-offs and not the other loan types because the C&I loans deteriorated in a more normal or slower rate than the real estate loan losses. The crisis dummy variable was significant in all models except the commercial and industrial model. It was expected to be significant in all four models but it may indicate that commercial and industrial loans were not sensitive to the financial crisis. Since the crisis was primarily driven by real estate loan losses, this may explain the insensitivity of commercial and industrial loans to the crisis. For total loan losses, residential real estate loan losses, and commercial real estate loan losses, the significance of the crisis variable indicates that during that three-year period, loan losses were higher.

The home price index and real GDP were found to be insignificant in all four models. The insignificance of the home price index was unexpected in the residential real estate model because one would expect rising home prices to be inversely related to residential real estate charge-offs. Real GDP was also found to be insignificant in four models; this outcome was surprising too because improving economic conditions (i.e., rising GDP) should lead to lower charge-off rates across all loan categories. The insignificance of both variables may indicate that each one is more of a lagging indicator of loan losses or is being captured by other variables in the model.

It bears noting that the growth rate of residential real estate loans and commercial real estate loans were gathered for large, domestically chartered insured banks, not for all commercial

banks. This substitution was made because data for all commercial banks was unavailable and this change was not anticipated to be substantial.

Finally, lagged variables up to four quarters were included in each in the four models, but were found to be insignificant at the 5% level. Given the results, the total loan charge-off model had the most significant variables and was the only model to have significant interaction terms. This implies that aggregate loan charge-offs are more easily explained than individual categories of loan charge-offs, at least in a macroeconomic sense.

Suggestions for Future Research

This study relied on data from quarter 1-2001 to quarter 3-2012. The availability of the financial ratios was the bottleneck in this analysis as they were only available from 2001. The relatively few observations were the primary limiting factor in this analysis. As time passes and more data becomes available, this model could be retested to see if its results are similar.

A broader measure of stock market performance, such as the Wilshire 5000, may better reflect economic conditions than the S&P 500. Additionally, the inclusion of a transaction-based home price index may also better reflect changes in home prices and assist in explaining loan losses because it includes refinancing along with sales.

Finally, the inclusion of some type of credit standard index may help in explaining loan losses across categories. This could be accomplished by weighting some financial ratios into a single measure or surveying the credit criteria used by banks of different sizes. In any case, a larger sample size would likely improve the reliability of all four models.

Table 1 Summary of Results Across Models

	Total Loan Charge-offs	Residential Real Estate Charge-offs	Commercial Real Estate Charge-offs	C&I Loan Charge-offs
Delinquency Rate (X_1)	0.2924 (0.000) [1]	0.1806 (0.000)	0.3448 (0.000)	0.5909 (0.000)
Delinquency Rate During Crisis	0.5002 (0.000)			
Unemployment Rate (X_2)		0.1621 (0.000)		
Home Price Index (X_3)				
Financial Obligations Ratio (X_4)	0.1232 (0.001)	0.0545[2] (0.011)		0.2078 (0.000)
Financial Obligations Ratio During Crisis	−0.2714 (0.010)			
Real GDP Growth (X_5)				
Loan Growth Rate (X_6)		−0.0050 (0.001)		
S&P 500 (X_7)			−0.000006 (0.001)	0.000001 (0.00)
KBW Bank Index (X_8)			0.000069 (0.011)	−0.00011 (0.000)
Senior Loan Officer Opinion Survey (X_9)				0.00196 (0.023)
Loan Loss Reserves (X_{10})	0.4535 (0.002)			
Loan Loss Reserves During Crisis	−1.3646 (0.000)			
Equity Capital Ratio (X_{11})	−0.1721 (0.001)			
Tier 1 Risk-Based Capital (X_{12})		−0.1760 (0.001)		
Crisis (X_{13})	0.0691 (0.030)	0.0024 (0.013)	0.0021 (0.010)	

Constant	−0.0122	−0.0018	−0.0134	−0.0442
Adjusted R^2	**0.9906**	**0.9804**	**0.9791**	**0.9655**
F-Statistic	**2628.23** (0.000) [4] [3]	**844.07** (0.000) [4]	**821.11** (0.000) [3]	**263.39** (0.000) [1]

The charge-off rate for each category is defined as the total value of loans removed from books of U.S. insured and chartered banks, net of loan recoveries, and charged against loan loss reserves as a percentage of average loans on an annualized basis. The delinquency rate is the percentage of outstanding loans /leases that are thirty days or more past due in accrual and non-accrual status. Unemployment rate is defined as the percentage people looking for work divided by the labor force. The home price index is a purchase only index for repeat sales of homes owned or securitized by Fannie Mae or Freddie Mac. The financial obligations ratio is sum of consumer payment obligations divided by disposable income, expressed as a percent. The real GDP growth rate is quarterly rate of change in Real GDP. The loan growth rate is the annualized compounded growth rate of loans. The S&P 500 and the KBW bank stock indices are the adjusted closing values at the end of each quarter. The senior loan officer opinion survey quantifies the net percentage of respondent banks reporting a tightening/loosening of credit standards versus previous quarter's credit standards. The loan loss reserve ratio is the level of loan loss reserves divided by average outstanding loans/leases for peer group one banks, expressed as a percent. The equity capital ratio is tangible common equity divided by total assets for peer group one banks, expressed as a percent. Tier 1 risk-based capital is tangible common equity plus non-cumulative preferred stock divided by risk-weighted assets. Crisis is dummy variable that received a value of 1 for 2008:Q1 to 2010:Q4 and a value of 0 for all other periods.

Notes:

[1] P-values are reported in parentheses

[2] Indicates term was significant for the financial obligations ratio of homeowners

[3] Maximum serial correlation correction is reported in brackets for the F-Statistic

Table 2 Correlation Matrix: Total Loan Charge-offs

	CO Total	*DRALL*	*UR*	*HPI*	*FOR*	*RDGP*	*Loan Growth*	*S&P 500*	*KBW*	*SLOOS*	*LLR*	*EQ/TA*	*Tier 1 RBC*	*Crisis*
CO Total	**1.000**													
DRALL	**0.949**	**1.000**												
UR	**0.909**	**0.966**	**1.000**											
HPI	**-0.177**	**-0.173**	**-0.182**	**1.000**										
FOR	**-0.311**	**-0.537**	**-0.580**	**0.452**	**1.000**									
RDGP	**-0.231**	**-0.194**	**-0.093**	**-0.010**	**-0.161**	**1.000**								
Loan Growth	**-0.842**	**-0.789**	**-0.736**	**0.137**	**0.233**	**0.191**	**1.000**							
S&P 500	**-0.358**	**-0.210**	**-0.324**	**0.492**	**-0.044**	**0.202**	**0.219**	**1.000**						
KBW	**-0.854**	**-0.919**	**-0.934**	**0.336**	**0.582**	**0.254**	**0.687**	**0.422**	**1.000**					
SLOOS	**0.305**	**0.176**	**0.033**	**-0.113**	**0.369**	**-0.694**	**-0.353**	**-0.210**	**-0.230**	**1.000**				
LLR	**0.953**	**0.970**	**0.960**	**-0.265**	**-0.533**	**-0.105**	**-0.780**	**-0.322**	**-0.887**	**0.089**	**1.000**			
EQ/TA	**0.593**	**0.788**	**0.775**	**0.168**	**-0.663**	**-0.059**	**-0.457**	**0.221**	**-0.681**	**-0.180**	**0.698**	**1.000**		
Tier 1 RBC	**0.606**	**0.796**	**0.845**	**-0.151**	**-0.844**	**0.080**	**-0.460**	**-0.023**	**-0.756**	**-0.340**	**0.774**	**0.903**	**1.000**	
Crisis	**0.790**	**0.672**	**0.592**	**0.159**	**0.073**	**-0.435**	**-0.695**	**-0.255**	**-0.574**	**0.555**	**0.640**	**0.365**	**0.222**	**1.000**

The charge-off rate for total loan (CO Total) is defined as the total value of loans removed from books of U.S. insured and chartered banks, net of loan recoveries, and charged against loan loss reserves as a percentage of average loans on an annualized basis. The delinquency rate of total loans (DRALL) is the percentage of outstanding loans /leases that are thirty days or more past due in accrual and non-accrual status. Unemployment rate (UR) is defined as the percentage people looking for work divided by the labor force. The home price index (HPI) is a purchase only index for repeat sales of homes owned or securitized by Fannie Mae or Freddie Mac. The financial obligations ratio (FOR) is sum of consumer payment obligations divided by disposable income, expressed as a percent. The real GDP growth rate (RGDP) is quarterly rate of change in Real GDP. The loan growth rate (Loan Growth) is the annualized compounded growth rate of loans. The S&P 500 and the KBW bank stock indices are the adjusted closing values at the end of each quarter. The senior loan officer opinion survey (SLOOS) quantifies the net percentage of respondent banks reporting a tightening/loosening of credit standards versus previous quarter's credit standards. The loan loss reserve ratio (LLR) is the level of loan loss reserves divided by average outstanding loans/leases for peer group one banks, expressed as a percent. The equity capital ratio (EQ/TA) is tangible common equity divided by total assets for peer group one banks, expressed as a percent. Tier 1 risk-based capital (Tier 1 RBC) is tangible common equity plus non-cumulative preferred stock divided by risk-weighted assets. Crisis is dummy variable that received a value of 1 for 2008:Q1 to 2010:Q4 and a value of 0 for all other periods.

Table 3 Correlation Matrix: Residential Real Estate Charge-offs

	CO RRE	*DR_RRE*	*UR*	*HPI*	*FOR*	*FOR_HO*	*RDGP*	*Loan Growth*	*S&P 500*	*KBW*	*SLOOS*	*LLR*	*EQ/TA*	*Tier 1 RBC*	*Crisis*
CO RRE	**1.000**														
DR_RRE	**0.930**	**1.000**													
UR	**0.920**	**0.932**	**1.000**												
HPI	**-0.008**	**-0.077**	**-0.188**	**1.000**											
FOR	**-0.413**	**-0.667**	**-0.577**	**0.428**	**1.000**										
FOR_HO	**-0.256**	**-0.502**	**-0.444**	**0.698**	**0.933**	**1.000**									
RDGP	**-0.256**	**-0.135**	**-0.084**	**-0.009**	**-0.179**	**-0.161**	**1.000**								
Loan Growth	**-0.608**	**-0.475**	**-0.418**	**-0.054**	**0.088**	**0.008**	**0.335**	**1.000**							
S&P 500	**-0.130**	**0.009**	**-0.297**	**0.484**	**-0.104**	**0.026**	**0.214**	**-0.100**	**1.000**						
KBW	**-0.872**	**-0.889**	**-0.932**	**0.337**	**0.600**	**0.533**	**0.233**	**0.398**	**0.373**	**1.000**					
SLOOS	**0.383**	**0.146**	**0.125**	**0.231**	**0.358**	**0.403**	**-0.654**	**-0.487**	**-0.093**	**-0.233**	**1.000**				
LLR	**0.902**	**0.881**	**0.954**	**-0.272**	**-0.499**	**-0.409**	**-0.105**	**-0.435**	**-0.317**	**-0.871**	**0.126**	**1.000**			
EQ/TA	**0.749**	**0.907**	**0.765**	**0.154**	**-0.697**	**-0.466**	**-0.031**	**-0.336**	**0.264**	**-0.694**	**0.000**	**0.663**	**1.000**		
Tier 1 RBC	**0.699**	**0.889**	**0.838**	**-0.151**	**-0.855**	**-0.687**	**0.099**	**-0.225**	**0.027**	**-0.765**	**-0.236**	**0.745**	**0.910**	**1.000**	
Crisis	**0.759**	**0.534**	**0.578**	**0.153**	**0.098**	**0.214**	**-0.439**	**-0.579**	**-0.265**	**-0.547**	**0.677**	**0.638**	**0.319**	**0.191**	**1.000**

The charge-off rate for single-family residential real estate loans (CO RRE) is defined as the total value of loans removed from books of U.S. insured and chartered banks, net of loan recoveries, and charged against loan loss reserves as a percentage of average loans on an annualized basis. The delinquency rate of single-family residential real estate loans (DR_RRE) is the percentage of outstanding loans /leases that are thirty days or more past due in accrual and non-accrual status. Unemployment rate (UR) is defined as the percentage people looking for work divided by the labor force. The home price index (HPI) is a purchase only index for repeat sales of homes owned or securitized by Fannie Mae or Freddie Mac. The financial obligations ratio (FOR) is sum of consumer payment obligations divided by disposable income, expressed as a percent. FOR_HO is the same ratio, but includes mortgage payments and property taxes. The real GDP growth rate (RGDP) is quarterly rate of change in Real GDP. The loan growth rate (Loan Growth) is the annualized compounded growth rate of single-family residential real estate loans. The S&P 500 and the KBW bank stock indices are the adjusted closing values at the end of each quarter. The senior loan officer opinion survey (SLOOS) quantifies the net percentage of respondent banks reporting a tightening/loosening of credit standards versus previous quarter's credit standards for single-family residential real estate loans. The loan loss reserve ratio (LLR) is the level of loan loss reserves divided by average outstanding loans/leases for peer group one banks, expressed as a percent. The equity capital ratio (EQ/TA) is tangible common equity divided by total assets for peer group one banks, expressed as a percent. Tier 1 risk-based capital (Tier 1 RBC) is tangible common equity plus non-cumulative preferred stock divided by risk-weighted assets. Crisis is dummy variable that received a value of 1 for 2008:Q1 to 2010:Q4 and a value of 0 for all other periods.

Table 4 Correlation Matrix: Commercial Real Estate Charge-offs

	CO CRE	DR_CRE	UR	HPI	FOR	RDGP	Loan Growth	S&P	KBW	SLOOS	LLR	EQ/TA	Tier 1 RBC	Crisis
CO CRE	1.000													
DR_CRE	0.971	1.000												
UR	0.906	0.945	1.000											
HPI	-0.004	-0.056	-0.188	1.000										
FOR	-0.307	-0.467	-0.577	0.428	1.000									
RDGP	-0.255	-0.214	-0.084	-0.009	-0.179	1.000								
Loan Growth	-0.879	-0.935	-0.918	0.187	0.584	0.097	1.000							
S&P	-0.220	-0.127	-0.297	0.484	-0.104	0.214	0.073	1.000						
KBW	-0.816	-0.875	-0.932	0.337	0.600	0.233	0.839	0.373	1.000					
SLOOS	0.252	0.185	-0.007	-0.031	0.456	-0.637	-0.084	-0.153	-0.128	1.000				
LLR	0.931	0.949	0.954	-0.272	-0.499	-0.105	-0.922	-0.317	-0.871	0.082	1.000			
EQ/TA	0.664	0.782	0.765	0.154	-0.697	-0.031	-0.771	0.264	-0.694	-0.213	0.663	1.000		
Tier 1 RBC	0.635	0.752	0.838	-0.151	-0.855	0.099	-0.804	0.027	-0.765	-0.390	0.745	0.910	1.000	
Crisis	0.811	0.720	0.578	0.153	0.098	-0.439	-0.561	-0.265	-0.547	0.572	0.638	0.319	0.191	1.000

The charge-off rate for commercial real estate loans (CO CRE) is defined as the total value of loans removed from books of U.S. insured and chartered banks, net of loan recoveries, and charged against loan loss reserves as a percentage of average loans on an annualized basis. The delinquency rate of commercial real estate loans (DR_CRE) is the percentage of outstanding loans /leases that are thirty days or more past due in accrual and non-accrual status. Unemployment rate (UR) is defined as the percentage people looking for work divided by the labor force. The home price index (HPI) is a purchase only index for repeat sales of homes owned or securitized by Fannie Mae or Freddie Mac. The financial obligations ratio (FOR) is sum of consumer payment obligations divided by disposable income, expressed as a percent. The real GDP growth rate (RGDP) is quarterly rate of change in Real GDP. The loan growth rate (Loan Growth) is the annualized compounded growth rate of commercial real estate loans. The S&P 500 and the KBW bank stock indices are the adjusted closing values at the end of each quarter. The senior loan officer opinion survey (SLOOS) quantifies the net percentage of respondent banks reporting a tightening/loosening of credit standards versus previous quarter's credit standards for commercial real estate loans. The loan loss reserve ratio (LLR) is the level of loan loss reserves divided by average outstanding loans/leases for peer group one banks, expressed as a percent. The equity capital ratio (EQ/TA) is tangible common equity divided by total assets for peer group one banks, expressed as a percent. Tier 1 risk-based capital (Tier 1 RBC) is tangible common equity plus non-cumulative preferred stock divided by risk-weighted assets. Crisis is dummy variable that received a value of 1 for 2008:Q1 to 2010:Q4 and a value of 0 for all other periods.

Table 5 Correlation Matrix: Commercial and Industrial Loan Charge-offs

	CO C&I	*DR_C&I*	*UR*	*HPI*	*FOR*	*RDGP*	*Loan Growth*	*S&P*	*KBW*	*SLOOS*	*LLR*	*EQ/TA*	*Tier 1 RBC*	*Crisis*
CO C&I	**1.000**													
DR_C&I	**0.929**	**1.000**												
UR	**0.569**	**0.447**	**1.000**											
HPI	**-0.529**	**-0.667**	**-0.188**	**1.000**										
FOR	**0.007**	**-0.011**	**-0.577**	**0.428**	**1.000**									
RDGP	**-0.192**	**-0.037**	**-0.084**	**-0.009**	**-0.179**	**1.000**								
Loan Growth	**-0.841**	**-0.912**	**-0.454**	**0.546**	**0.006**	**-0.098**	**1.000**							
S&P	**-0.663**	**-0.780**	**-0.297**	**0.484**	**-0.104**	**0.214**	**0.691**	**1.000**						
KBW	**-0.595**	**-0.456**	**-0.932**	**0.337**	**0.600**	**0.233**	**0.426**	**0.373**	**1.000**					
SLOOS	**0.512**	**0.378**	**-0.044**	**-0.333**	**0.311**	**-0.647**	**-0.250**	**-0.296**	**-0.185**	**1.000**				
LLR	**0.666**	**0.563**	**0.954**	**-0.272**	**-0.499**	**-0.105**	**-0.542**	**-0.317**	**-0.871**	**0.039**	**1.000**			
EQ/TA	**0.020**	**-0.154**	**0.765**	**0.154**	**-0.697**	**-0.031**	**0.126**	**0.264**	**-0.694**	**-0.294**	**0.663**	**1.000**		
Tier 1 RBC	**0.149**	**0.077**	**0.838**	**-0.151**	**-0.855**	**0.099**	**-0.105**	**0.027**	**-0.765**	**-0.369**	**0.745**	**0.910**	**1.000**	
Crisis	**0.542**	**0.363**	**0.578**	**0.153**	**0.098**	**-0.439**	**-0.361**	**-0.265**	**-0.547**	**0.399**	**0.638**	**0.319**	**0.191**	**1.000**

The charge-off rate for commercial and industrial loans (CO C&I) is defined as the total value of loans removed from books of U.S. insured and chartered banks, net of loan recoveries, and charged against loan loss reserves as a percentage of average loans on an annualized basis. The delinquency rate of commercial and industrial loans (DR_C&I) is the percentage of outstanding loans /leases that are thirty days or more past due in accrual and non-accrual status. Unemployment rate (UR) is defined as the percentage people looking for work divided by the labor force. The home price index (HPI) is a purchase only index for repeat sales of homes owned or securitized by Fannie Mae or Freddie Mac. The financial obligations ratio (FOR) is sum of consumer payment obligations divided by disposable income, expressed as a percent. The real GDP growth rate (RGDP) is quarterly rate of change in Real GDP. The loan growth rate (Loan Growth) is the annualized compounded growth rate of commercial and industrial loans. The S&P 500 and the KBW bank stock indices are the adjusted closing values at the end of each quarter. The senior loan officer opinion survey (SLOOS) quantifies the net percentage of respondent banks reporting a tightening/loosening of credit standards versus previous quarter's credit standards for commercial and industrial loans. The loan loss reserve ratio (LLR) is the level of loan loss reserves divided by average outstanding loans/leases for peer group one banks, expressed as a percent. The equity capital ratio (EQ/TA) is tangible common equity divided by total assets for peer group one banks, expressed as a percent. Tier 1 risk-based capital (Tier 1 RBC) is tangible common equity plus non-cumulative preferred stock divided by risk-weighted assets. Crisis is dummy variable that received a value of 1 for 2008:Q1 to 2010:Q4 and a value of 0 for all other periods.

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