

Effect of Macroeconomic Variables on Health Care Loan/ Lease Portfolio Delinquency Rate

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Abstract

Delinquency rates are closely related to the economic conditions and can be analyzed using measures of economic growth and stability. In an attempt to predict the delinquency rate for the health care equipment financial industry, we investigated the relationship between delinquency rate and key macroeconomic variables for the period from 1998 to 2008. The study reveals that the tightening credit standards and unemployment rate are the key macroeconomic indicators influencing the delinquency rate. The analysis further helps in arriving at a trigger to monitor the delinquency rate based on the macroeconomic indicators, thus enabling proactive portfolio management.

Key words: Delinquency Rate, Macroeconomic, Statistical Triggers, Portfolio Management, Health Care Financial Services.

1. Introduction

The health care industry plays an important part in the economy of the United States. Its proportion to the gross domestic product (GDP) has been steadily increasing for several decades and is expected to reach 20.3 percent of GDP by 2018 (National Health Expenditure Data, 2007). Health care spending in the United States is provided by many legal entities, including both private- and public-owned. In 2007, the United States spent more on health care than any other nation in the world at an average of \$7,439 per person (U.S. Health System Performance, 2008). About 580,000 establishments make up the health care industry and consist of establishments or offices of dentists and doctors, protective care, nursing, pharmacies, allied medical, health services and hospitals (Bureau of Labor Statistics, 2006). Credit requirements for the health care establishments are mainly funded by commercial banks. Business conditions of the borrowers are tied to the economic cycle (in an expansion, demand is strong and business is good; and vice versa during recession) and keeping a business profitable with the cycle is a challenge. Identification of key macroeconomic variables affecting the business cycle and developing statistical triggers facilitate proactive portfolio management of loans or lease for the lender or commercial banks.

Studies show that loan defaults are linked to the movement in macroeconomic variables, and this has important consequences for credit risk management as well as for regulation and systemic risk management. Helwege and Kleiman (1996) studied the relationship between recession and actual default rate and modeled growth in GDP (created dummy variable, 1, when the GDP growth exceeds 1.5 percent per year level and zero otherwise). Kearns (2004) employed a fixed effects framework on a panel of credit institutions to examine the relationship between loan-loss provisions and explanatory variables, which include GDP and unemployment rate. They found unemployment and GDP growth significantly increased the level of provisioning.

Bellotti and Crook (2008) tested the hypothesis that probability of default (PD) is affected by general economic conditions that are measured by macroeconomic variables such as bank interest rates, unemployment index, house price, etc. They showed that the inclusion of macroeconomic variables gives a statistically significant explanatory model of the data and a lift in predictive performance. Allen and Saunders (2003) surveyed both academic and proprietary models to examine how macroeconomic and systematic risk effects are incorporated into measures of credit risk exposure. Pesaran and Schuermann (2003) provided an overview of the conditional credit risk modeling approach. Asset value changes of a credit (loan) portfolio are linked to a dynamic global macroeconometric model, allowing macro-effects to be isolated from idiosyncratic shocks from the perspective of default.

Researchers applied different tools and techniques to estimate the macroeconomic impact. Yiping Qu (2008) used a multifactor fixed effect model to analyze the effect of certain macroeconomic factors on the probability of default on an industrial level. Wilson (1997) constructed a model using a pooled logit regression, which allows for the macroeconomic variables to influence a firm's probability of default. Petr Jakubík (2007) followed Merton's approach to structural analysis toward default rate modeling. A latent factor model is introduced within this framework. Hamerle et al. (2004) derive a Merton-style threshold-value model for the

default probability, which treats the asset value of a firm as unknown and uses a factor model instead.

In this paper we investigated the effect of both quantitative and qualitative macroeconomic variables on default rate for a health care equipment finance portfolio using a simplistic statistical approach. A lag model was developed using quarterly data of delinquency rate, macroeconomic attributes, and established a relationship between them. Triggers were developed using a statistical approach to understand the threshold. The model was then validated and found to be useful in understanding the movement of the delinquency rate for the new defaults. Significant lag variable was tracked and monitored quarterly, and would facilitate proactive portfolio management of loans or lease.

2. Data and Methodology

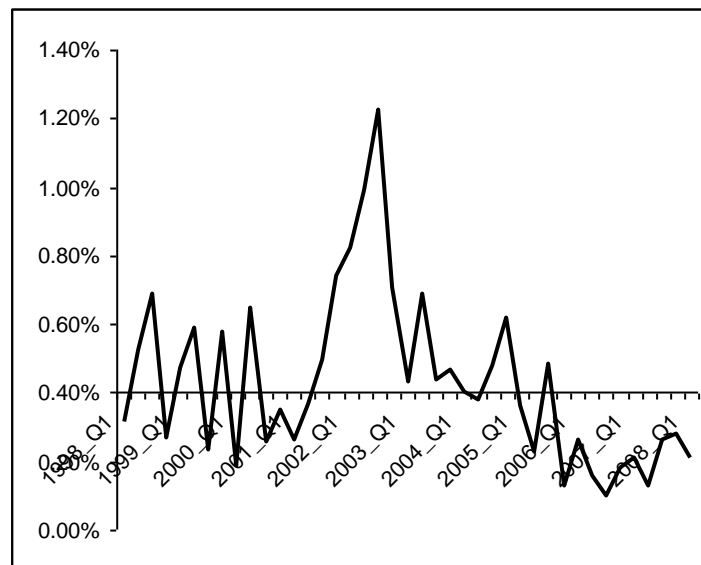
2.1 Data

The estimations are based on 10 years of quarterly data covering the period from 1998 to 2008. The data includes both qualitative and quantitative variables [survey data from Federal Reserve database and Federal Reserve System, respectively]. Qualitative variables are an opinion survey on bank lending practices (domestic and foreign banks) conducted by the Federal Reserve Board. The survey collects information on changes in the supply of, and demand for, bank loans to businesses and households over the past three months. Monthly data was collected for quantitative variables and also the response variable, which were then converted into quarterly averages over years. For qualitative variables, quarterly data was analyzed from commercial and industrial loans for large and middle market firms. All quantitative variables are time-series data, which has inherent characteristics of trends and seasonality. So to remove the seasonal disturbances we have computed quarter-over-quarter change.

2.1.1 Delinquency Rate (% Change, Quarterly)

Delinquency rate (%) is a response variable and computed as the ratio of total 90 days-past-due, \$ and total exposure \$. Newly delinquent accounts were considered in the calculation. It is health care equipment finance portfolio data. Figure 1 shows the variation of delinquency rate (%), which attained local maximum during Q3 2002 showing the effect of the U.S. recession on payment.

Figure 1
Variation of Delinquency Rate across the Period

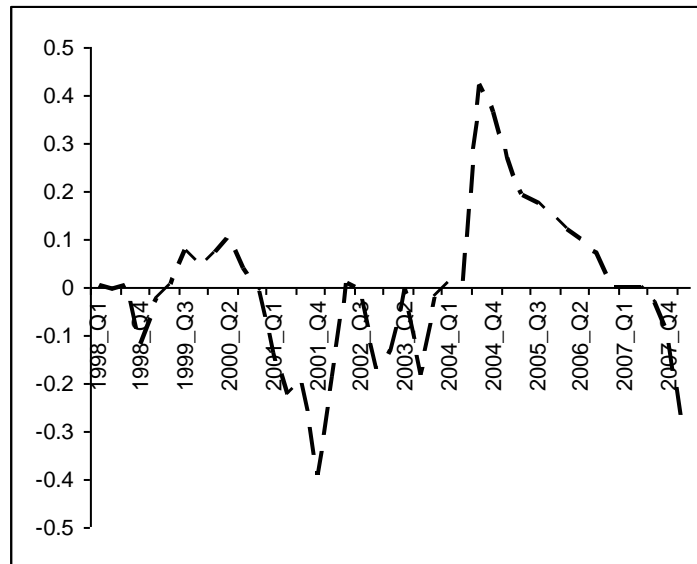


It is believed that with recession the delinquency rate increases. During 1998 to 2008, the U.S. economy has undergone many economic changes, including the dot-com boom, other calamities and the mortgage crisis. While health care has fared better than other industries, it will not be immune from the effects of the current recession.

2.1.2 Federal Fund Rate (% Change, Quarterly)

Federal funds rate is the interest rate at which a depository institution lends immediately available funds to another depository institution. A higher fed funds rate means banks will lend less money out, and that the money they do lend will be at a higher rate since they themselves are borrowing money at a higher rate. The Federal Reserve has responded to a potential slowdown by lowering the target federal funds rate during recessions and other periods of lower growth. Figure 2(a) shows variation of fed fund rate change (%) over the period. It was observed from the data that during the period Q4 2000 to Q1 2004, the change was either negative or zero. Negative change was also observed during recent years from Q2 2007, thus revealing that the economy was under stress during these periods.

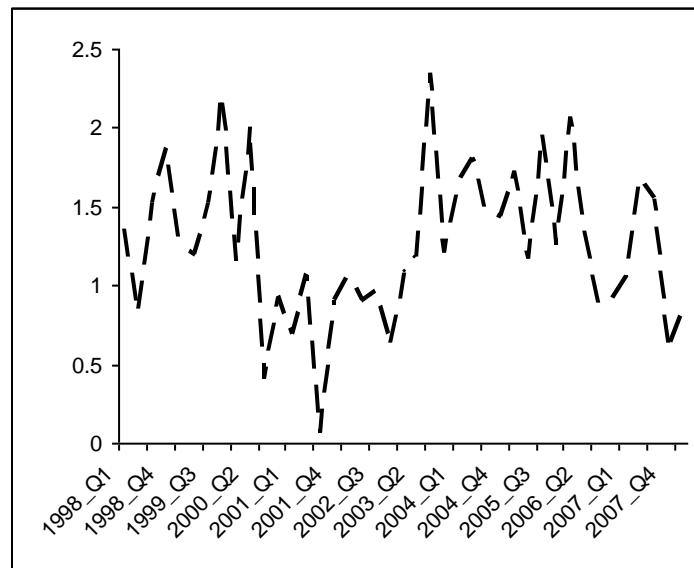
Figure 2(a)
Variation of Federal Fund Rate Across the Period



2.1.3 Gross Domestic Product (% Change, Quarterly)

One of the basic measures of a nation's economic performance is GDP, which is defined as the total market value of all final goods and services produced within the country in a given period of time. There are two ways to measure GDP; one of these is Real GDP (selected for study), which is the dollar value of production using a given base year price. It is widely used by economists, as its variations are relatively quickly identified. Figure 2(b) shows the variation of Real GDP % change over the period. It was noted that from Q3 2000 to Q4 2002, the % change is below 1.0 and came to as low as 0.06 during Q3 2001.

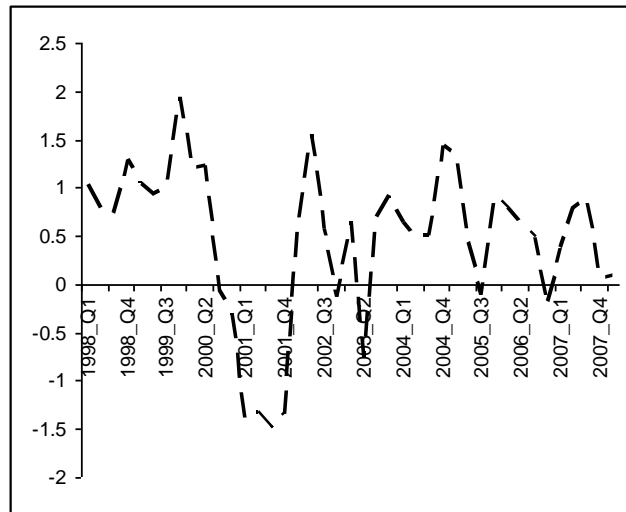
Figure 2(b)
Variation of GDP Across the Period.



2.1.4 Industrial Production Index (% Change, Quarterly)

The Industrial Production Index (IPI) is an economic indicator that measures real production output and is released monthly by the Federal Reserve Board. It is expressed as a percentage of real output with base year. Production indexes are computed mainly as Fisher's index with the weights based on annual estimates of value added. Figure 2(c) shows the variation of IPI over the period. It has been found that a negative change observed during the period Q3 2000 to Q4 2001 explains the effect of a slowdown in the economy.

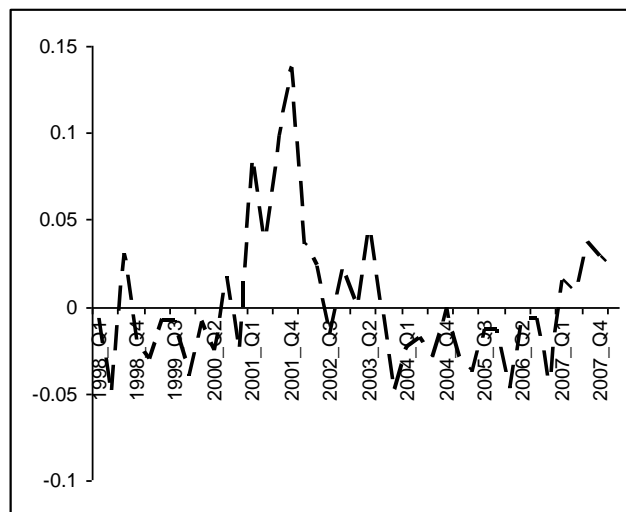
Figure 2(c)
Variation of Industrial Production Index Across the Period



2.1.5 Civilian Unemployment Rate (% Change, Quarterly)

The unemployment rate is the ratio of the number of unemployed people to the total size of the labor force. The Bureau of Labor Statistics measures employment and unemployment statistics and publishes monthly data. It is also an indicator used to determine the health of the economy. However, the unemployment rate is a lagging indicator of recession and anticipates the severity of a recession before it occurs. Figure 2(d) shows the variation of civilian unemployment rate across the quarters. It shows a mostly positive rate during Q3 2000 to Q3 2003 and also started increasing from Q1 2007 onwards.

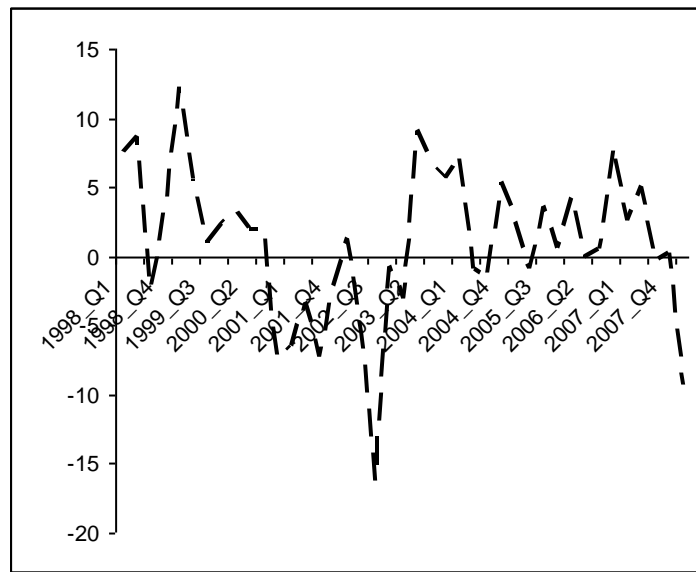
Figure 2(d)
Variation of Civilian Unemployment Rate Across the Period



2.1.6 S&P 500 Index (% Change, Quarterly)

The S&P 500 is a value-weighted index, published since 1957, of the prices of 500 large-cap common stocks actively traded in the United States. Movements in the prices of stocks with higher market capitalizations have a greater effect on the index than companies with smaller market capitalizations. It is considered as a bellwether for the American economy, and is included in the Index of leading indicators. Figure 2(e) shows the variation of S&P 500 Index, % change across the quarter. The S&P index change was negative during the period Q4 2000 to Q1 2003 and shows the effect of recession.

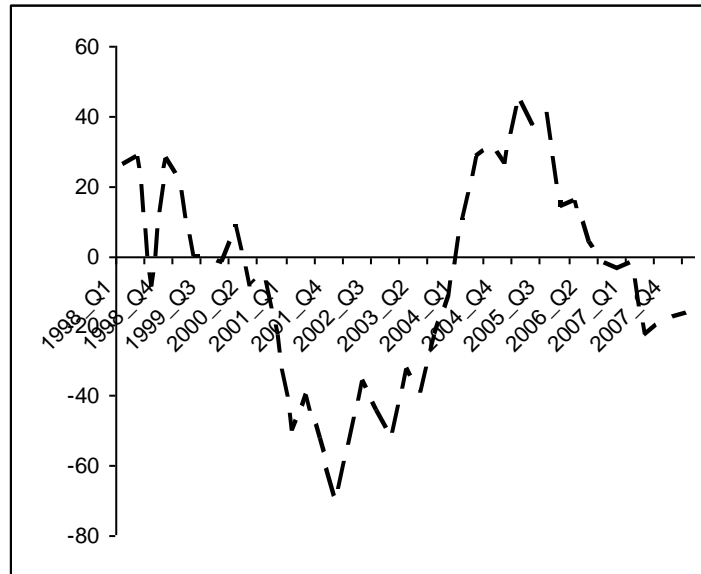
Figure 2(e)
Variation of S&P 500 Index Across the Period



2.1.7 Reporting Stronger Demand for Commercial and Industrial (C&I) Loans (Net Percentage of Domestic Respondents, Large and Medium)

This includes the response on survey of change in demand for C&I loans for large and middle-market firms (annual sales of \$50 million or more) over the past three months apart from normal seasonal variation. If the net percentage of respondent's response for substantially stronger or moderately stronger is positive over moderately weaker or substantially weaker, then there is an overall stronger demand for C&I loans for a selected period. Figure 3(a) shows the variation on net percent demand for C&I Loans during the selected period. It has been observed that the banks had reported weaker demand for C&I loans during the period Q2 2000 to Q4 2003. Also, from Q3 2006 onwards there is weaker demand for C&I loans.

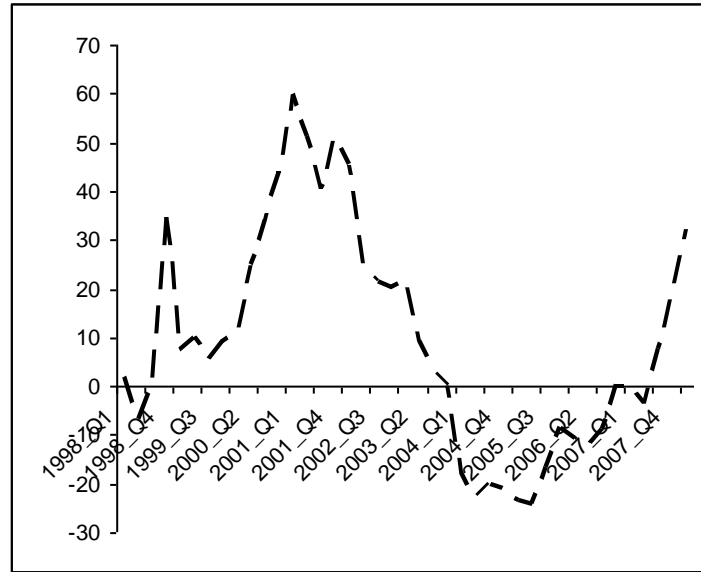
Figure 3(a)
Variation of Reporting Stronger Demand for C&I Loans Across the Period



2.1.8 Tightening Standards for C&I Loans (Net Percentage of Domestic Respondents, Large and Medium)

This includes the response on survey of bank’s credit standards for approving applications for C&I loans to large and middle-market firms (annual sales of \$50 million or more) other than those to be used to finance mergers and acquisitions in the past three months. If the net percentage of respondent’s response for tightened somewhat or tightened considerably over eased somewhat and eased considerably is positive, then there is an overall tightening in the standard for a selected period. Figure 3(b) shows the variation on net percent tightening standards for C&I loans during the selected period. It has been observed that the banks had tightened their lending standards on C&I loans during the period Q4 1998 to Q3 2003. Also, from Q3 2007 onwards there is a tightening in the standards.

Figure 3(b)
Variation of Tightening Standards for C&I Loans (Large & Medium)
Across the Period



2.2 Methodology

Regression models using time-series data frequently include a time lag variable in the regression. If the time period between changes in the independent variables and their effects on the dependent variable is sufficiently long, then a lagged explanatory variable may be included in the model. Various studies suggest that some of the key indicators have a lag effect on the delinquency rate. All independent variables (qualitative and quantitative) in our study were lagged a quarter till eight quarters and analyzed. In total, eight lag variables were created from each variable. The correlations and trend for each variable were studied with respect to the delinquency rate. SAS Version 9.1 software was used for the analysis and model development. A multivariate linear regression model was developed to study the relationship between the independent variable and the dependent variable. The model considered was first order linear regression model as,

$$Y = \beta_0 + \sum_{i=1}^n \beta_i X_i + \varepsilon$$

Y is the dependent variable, X_1 to X_n are independent variables, $\beta_0, \beta_1 \dots \beta_n$ are parameters, and ε is random error.

The model accuracy was checked using R^2 and p value. The measured R^2 value should be as high as possible, and the p -value with 95 percent significance was considered. The model was validated with out of time data from Q2 2008 to Q1 2009.

A trigger was developed using actual delinquency rate and significant macroeconomic variables. Mean value of delinquency rate was estimated for the period and mapped with the corresponding value of leading indicator. If the leading indicator value at any time is more than the calculated value and change is positive during two consecutive periods, this gives an indication of the deteriorating condition of this portfolio.

3. Results and Discussion

Preliminary statistical analysis of both quantitative and qualitative variables revealed five lag variables to be significant in explaining the delinquency rate based on their coefficient of correlation (R-value), Table 1.

TABLE 1
Statistical Description for Significant Lag Variables

Variable	Description	R-Value (p-value)	Sign
GDP_3	Gross Domestic Product (% Change Qtly) at 3rd Lag	0.45 (0.0028)	-ve
UNEMP_3	Civilian Unemployment Rate (% Change Qtly) at 3rd Lag	0.64 (<.0001)	+ve
FEDRATE_3	Effective Federal Funds Rate (% Change Qtly) at 3rd Lag	0.63 (<.0001)	-ve
RE_ST_DE_3	Net Percentage of Domestic Respondents Reporting Stronger Demand for C&I Loans (Large and Medium), % at 3rd Lag	0.62 (<.0001)	-ve
TI_STD_CNI_6	Net Percentage of Domestic Respondents Tightening Standards for C&I Loans (Large and Medium), % at 6th Lag	0.72 (<.0001)	+ve

Among the quantitative variables, GDP, civilian unemployment rate and effective federal funds rate were significant at three-quarter lag. GDP (three-quarter lag, GDP_3) and federal funds rate (three-quarter lag, FEDRATE_3) had a negative influence on the delinquency rate implying that, with an increase in both these variables, the delinquency rate tends to decrease post a three-quarter. On the other hand, the civilian unemployment rate (three-quarter lag, UNEMP_3) is positively related to the delinquency rate, thus supporting the evidence that as unemployment increases there is an increase in the delinquency rate post a three-quarter. Qualitative variables that became significant were net percentage of domestic respondents reporting stronger demand for C&I loans and tightening standards for C&I loans at three- and six-quarter lag, respectively. In terms of the influence of these variables on the delinquency rate, increasing the tightening standards for C&I loans (six-quarter lag, TI_STD_CNI_6) is positively correlated. On the other hand, an increase in stronger demand for C&I loans (three-quarter lag, RE_ST_DE_3), would lead to a decrease in delinquency rate. A similar study (Jonsson and Fridson, 1996) on credit quality of speculative-grade bonds also found the effect of lagged independent variables on default rates over time.

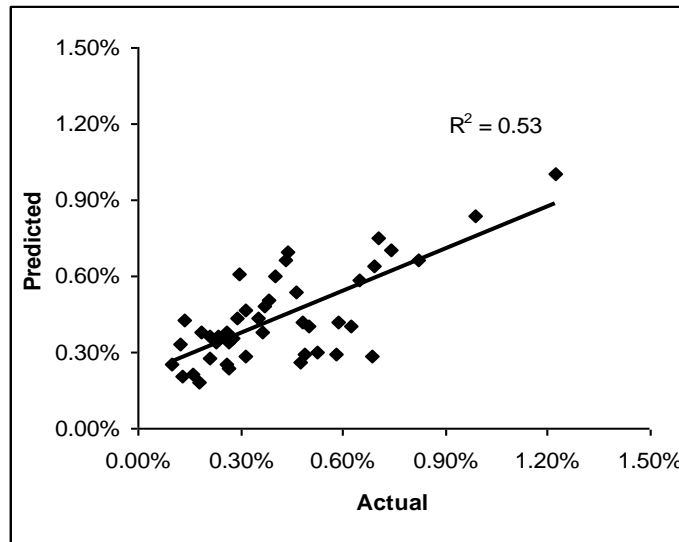
Correlation analysis between explanatory variables was performed to check for the multicollinearity. As evident from the correlation table (Table 2) variable RE_ST_DE_3 had a high correlation with TI_STD_CNI_6 and hence was removed from the final model.

TABLE 2
Correlation Matrix for Significant Lag Variables

	GDP_3	UNEMP_3	FEDRAT_E_3	INDPRO_O_4	TI_STD_CNI_6	RE_ST_DE_3
GDP_3	1.00	-0.48	0.32	0.24	-0.42	0.48
UNEMP_3	-0.48	1.00	-0.58	-0.66	0.61	-0.72
FEDRATE_3	0.32	-0.58	1.00	0.50	-0.68	0.73
INDPRO_4	0.24	-0.66	0.50	1.00	-0.47	0.61
TI_STD_CNI_6	-0.42	0.61	-0.68	-0.47	1.00	-0.83
RE_ST_DE_3	0.48	-0.72	0.73	0.61	-0.83	1.00

Final statistical regression model results show that explanatory variables TI_STD_CNI_6 and UNEMP_3 are statistically significant with a model predictive power of 53 percent (R^2 value). The predicted versus actual delinquency rate for development period is as shown in Figure 4.

Figure 4
Predicted versus Actual Delinquency Rate (Development)



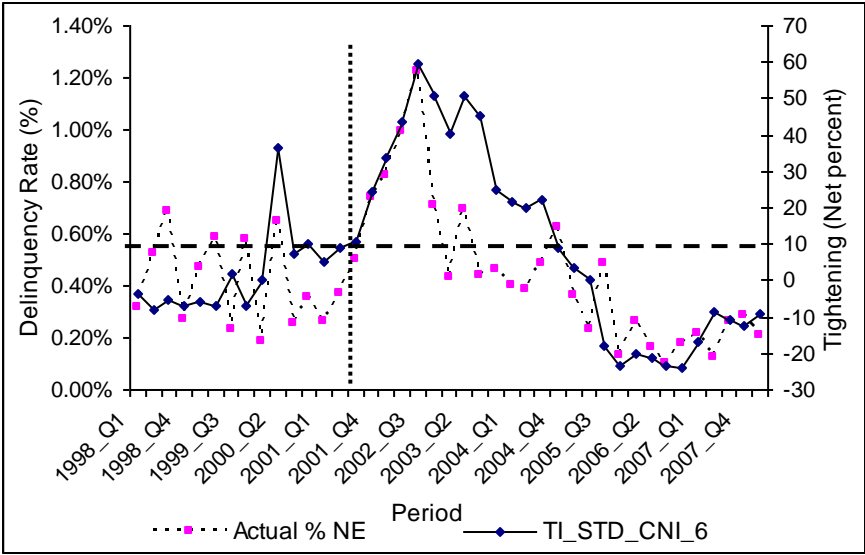
The coefficient signs for both the explanatory variables are positive, thus indicating that an upward trend in these variables would lead to an increase in the delinquency rate (as exhibited in the graph for the respective variables). As for variable TI_STD_CNI_6, it is evident from the findings of surveys on C&I lending conducted by the Federal Reserve Bank that large majorities of both domestic and foreign banks reported a less favorable or more uncertain economic outlook, a worsening of industry-specific problems, and a reduced tolerance for risk as important reasons

for tightening credit standards and terms on C&I loans. Thus, as the model indicates, if credit standards are tightened, the delinquency rate tends to increase after a lag of six quarters. Further, an increase in defaults by borrowers in public debt markets, decreased liquidity in the secondary market for business loans and deterioration in their banks' expected capital position were important reasons for the change in C&I lending policies over the survey period. This study thus points out that that both tightening credit standards and delinquency rates are co-integrated.

The second predictive variable in the model, i.e., unemployment rate, had a significant effect on the delinquency rate post three-quarter lag and the coefficient sign indicates an increase in the unemployment rate leads to an increase in the default rate as well. This relationship between unemployment rate and delinquency rate is in sync with the conclusion from the study conducted by Peterson and Luckett (1987). In their analysis of the delinquency rate for closed-end consumer loans between 1951 and 1974, they found that portfolio credit quality was significantly associated with variables related to employment conditions. Bellotti and Crook (2008), in their study, concluded that a positive sign for coefficients of variables indicates a marginal increase in hazard (risk of default) with increases in bank interest rates and levels of unemployment.

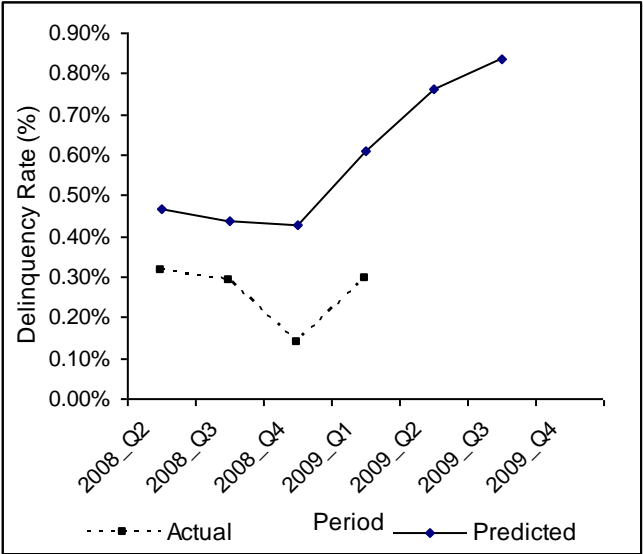
Figure 5 shows the variation of actual delinquency rate and the key variable (TI_STD_CNI_6).

Figure 5
Variation of Actual Delinquency Rate and Tightening Standards for C&I Loans



The mean value of actual delinquency rate 0.43 percent corresponds to 10.0 (approx) for TI_STD_CNI_6. If for any two periods (or quarters) the change is positive and is above the threshold value 10.0 for variable TI_STD_CNI_6, then the portfolio is going to be in critical state and immediate attention will be required. It can be seen that from Q3 2001 to Q2 2002, the portfolio was critical. Model performance assessed on a hold-out sample, Figure 6 illustrates the variation of actual and predicted delinquency rates. It shows that predicted delinquency rate follows the same trend as the actual delinquency rate for the validated quarters. The predicted delinquency rate continues to show an upward trend for the remaining quarters.

Figure 6
Variation of Actual Delinquency Rate and Predicted Delinquency Rate



Implementing the model on portfolio and quarterly tracking of delinquency rates predicted by the model enable an understanding of portfolio health. If the delinquency rate goes beyond the cutoff trigger value, then necessary proactive measures (including ways to manage their cash flow and credit quality) need to be taken by the portfolio risk management team to reduce the loss. Some of the proactive measures generally recommended are introducing a well-designed borrower screening, specialized loan monitoring groups, early warning systems, careful loan structuring, close monitoring, clear collection procedures and active oversight by senior management.

4. Conclusion

An attempt has been made to investigate the effect of macroeconomic variables on the default rate for a health care equipment finance portfolio. The study established a relationship between default rate and significant macroeconomic indicators; this further facilitated in development of a trigger.

Key macroeconomic indicators have a lag effect on the delinquency rate. Independent variables (qualitative and quantitative) in this study were quarter lagged (for eight quarters) and analyzed. A regression model was developed using significant macroeconomic indicators to predict the delinquency rate. Tightening standards for C&I loans (six-quarter lag) and unemployment rate (three-quarter lag) are statistically significant with a model predictive power of 59 percent (R^2 value). Mean value of the delinquency rate for a period was used to arrive at a trigger value and in this study, the mean value of actual delinquency rate corresponds to 10.0 (approx) for tightening standards for C&I loans (six-quarter lag), which would help to monitor the portfolio status across time periods.

The model was validated using hold-out sample and found the predicted delinquency rate following the same trend as the actual delinquency rate. Future scope includes implementation of the model on portfolio by quarterly tracking of delinquency rates predicted by the model.

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