DEMAND AND SUPPLY SIDE DETERMINANTS OF COMMERCIAL AND INDUSTRIAL LOAN VOLUME

BY

JERRY W. CRIGGER

A DOCTORAL DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF ARTS/ECONOMICS

MIDDLE TENNESSEE STATE UNIVERSITY

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Abstract

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Commercial loan volume in the United States is a function of loan demand by businesses and loan supply from banks. The purpose of this dissertation is to identify those factors that determine commercial credit on the supply side and to clearly separate them from demand-side factors. In particular, the dissertation posits that banks tighten or ease credit extension in response to changes in the rate of return on their assets, most of which consist of loans, and perceived economic uncertainty as measured by volatility in the federal funds rate. The return on banks' assets, in turn, are driven by central bank actions, such as changes in reserve requirements and interest rates, by regulatory changes, and by changes that typically occur over the course of the business cycle. The demand-side determinants of bank commercial and industrial lending are dominated by non-bank firms' return on equity and the relative price of bank loans to funds raised in the capital market.

The study's results are largely consistent with the New Keynesian literature on the bank lending channel and the role of imperfect information in the credit market. This study utilizes quarterly data covering the period 1984 to 2000. The empirical methodology relies on structural time series modeling.

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Introduction

Among Keynesian economists, there is general agreement that monetary policy can and does have an impact on real output, at least in the short-run, because prices and/or costs do not instantaneously adjust. Going even further, Stiglitz (1991) argues that, even in the event of perfect price flexibility, monetary policy can affect the real economy, due to such things as nominal credit contracts, wealth redistribution associated with those contracts, and resulting economic uncertainty.

This study will add to the literature on monetary policy transmission by re-examining the determinants of commercial and industrial (C&I) loan volumes in commercial banks. The key contribution of this study is to separate these determinants more convincingly into those that can be attributed to loan demand and those that have their origin on the supply side. As part of this exercise, further evidence will be provided to show that commercial banks can and do adjust their loan supply in response to factors other than interest rate changes.

Recent literature has demonstrated that commercial banks may alter C&I loan volumes by altering non-price considerations such as tightening credit standards (Lown, Morgan and Rohatgi, 2000). What is missing from the literature is a more detailed account of what prompts the changes in credit extension by banks. This dissertation provides empirical evidence on this missing link. In particular, it suggests that banks alter their C&I loan volume in response to changes in the rate of return on their assets (ROA). Total bank loans comprise 72 percent of total bank assets and 55 percent of commercial bank revenue as of September 30, 2000[1]. Since loans are such a major factor, banks' ROA is significantly driven by

[1] Federal Reserve Statistical Release and FDIC Statistics on Banking.

the performance of the loan portfolio. This study will provide a model that identifies the determinants of banks' ROA. Those determinants will be shown to be related to central bank actions affecting reserve requirements, regulatory changes, interest rate changes, and changes in the economic environment.

This study is organized as follows. The first section will provide a review of literature with respect to the lending channel and broader credit channel. For comparison, additional background will be provided on the more traditional money view of monetary policy transmission. The second section will provide the theoretical background of the model used in this study. Section three will provide details on the data and estimation methodology. Estimation results will be discussed in section four. The fifth section discusses results of the model employed. Section six will provide some insight on how this research can be useful in the teaching of principles of economics and intermediate macroeconomics classes. To highlight its potential role as a teaching device, its core concepts will be compared and contrasted with the traditional teaching methodology. Section seven will provide conclusions regarding the determinants of commercial loan volumes and why commercial banks may constrain or expand lending activity.

1. Literature Review

Since the early 1990s, three factors have had a significant impact on the economic literature related to the role of commercial banks for the transmission of monetary policy. One factor was the slow growth in bank lending following the 1990-91 recession at a time when monetary policy was expansionary but supervisory oversight was restrictive (Glauber 1995). A second factor has been the suggested role of commercial banks as contributors to economic crises in countries such as Japan and Korea. The third factor is the question of how structural changes in banking, such as the phase out of Regulation Q in the mid-1980's and the emergence of required capital levels in the early 1990's as a result of the Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA), have impacted the commercial banking system (Peek and Rosengren 1995).

1.1 Importance of Commercial Loans in the Economy

Research has suggested several factors that determine the level of bank loans in the economy in response to monetary policy shocks. Among them are bank's capital and bank's portfolio preferences (Himmelberg and Morgan, 1995; Peek, Rosengren, and Tootell, 2000; Peek and Rosengren, 1995). While the commercial banks' share of non-financial borrowing declined from approximately 36% in 1974 to approximately 22% in 1993, the ratio of bank loans for non-financial businesses to Gross Domestic Product (GDP) has increased from approximately 7.5% of GDP in 1952 to approximately 9.75% of GDP in 1994 (Himmelberg and Morgan 1995). Thus, the importance of bank lending as a percentage of GDP has been increasing and remains important for the economy as a whole[2].

Table 1 below highlights the respective shares of financial intermediary assets in the United States over the time period measured in this study.

Table 1. Relative Shares of Financial Intermediary Assets

	1985	%	1990	%	1995	%	2000	%
Commercial Banks	1989.5	38.0%	2772.5	36.0%	3520.1	36.3%	5003.1	36.4%
Savings & Loan	1097.6	21.0%	1176.5	15.3%	913.3	9.4%	1089.1	7.9%
Credit Unions	98.4	1.9%	166.6	2.2%	263.0	2.7%	383.2	2.8%
Insurance Co.	823.1	15.8%	1478.5	19.2%	2056.2	21.2%	2481.3	18.0%
Private Pension	328.9	6.3%	471.6	6.1%	468.7	4.8%	816.4	5.9%
Public Pension	252.4	4.8%	440.0	5.7%	631.2	6.5%	766.5	5.6%
Finance Companies	311.2	6.0%	471.2	6.1%	531.0	5.5%	812.4	5.9%
Money Mkt. Mutual	178.2	3.4%	371.3	4.8%	545.5	5.6%	1297.1	9.4%
Stock & Bond Mutual	129.9	2.5%	360.1	4.7%	771.3	8.0%	1099.2	8.0%
Total	5209.2		7708.3		9699.3		13748.3	

Source: Board of Governors of the Federal Reserve System, Flow of Funds Accounts. (As suggested by Edwards and Mishkin 1995).

Since 1985, commercial banks' share of intermediary assets has fallen slightly from 38 percent to 36.4 percent. Other financial intermediaries have gained market share regarding total intemediated assets over the time period measured. For example, the percentage of intermediary assets held by mutual funds has grown most rapidly of the intermediaries measured. However, combining both money market mutual funds and stock and bond mutual funds, their percentage

[2] This contention is further supported by data from the National Federation of Independent Business that 86 percent of its members used banks as their source of loans in 1987. Additionally, the Federal Reserve Board's National Survey of Small Business Finance for 1987 states that banks and other depository financial institutions supplied 89.4 percent of the responding firms with their most recent loan (Himmelberg and Morgan 1995).

of assets held in 2000 totals only 17.4 percent compared to 36.4 percent held by commercial banks. Commercial banks' share of total intermediated assets remains over two times as large as the next closest competitor, i.e. insurance companies at 18.0 percent. Thus, commercial banks' retain a significant role in financial intermediation.

1.2 Efficiency of Banks as Intermediaries:

In order for bank lending to be important in the economy, certain necessary conditions must hold. First, transaction deposits and non-transaction deposits held at banks cannot be perfect substitutes, so that monetary policy affects bank liabilities and thus, loan levels. Second, no good substitutes must exist for bank loans, and at least some sectors of the economy must be dependent on banks for external sources of funds for operating purposes (Rajan 1995). Intermediary theory suggests that banks continue to play a special role in discovering, monitoring, and negotiating complex lending contracts. Banks are necessary to deal with agency problems inherent in providing external finance for smaller, non-publicly traded, closely held and therefore, information-problematic companies. Because monitoring and negotiating lending contracts is costly, financial intermediaries are believed to be more efficient than other market institutions in providing external funds to businesses. This idea of efficiency follows from at least two reasons. First, financial intermediaries need their loans repaid and thus have a large stake in the financial success of the firms to which they lend. Accordingly, banks are very likely to actively monitor the financial results of their borrowers. Second, an intermediary can act unilaterally to renegotiate a borrower's covenants less expensively than could widely dispersed bondholders (Himmelberg and Morgan 1995). Economic literature has supported this contention for certain sectors of the business community, specifically manufacturers and smaller businesses (Himmelberg and Morgan 1995, Oliner and Rudebusch 1995).

Other research supports the concept that financial intermediaries are integral in the transmission of monetary policy. Oliner and Rudebusch (1996); Blinder and Stiglitz (1983); Romer and Romer (1990); Bernanke and Blinder (1988, 1992); and Oliner and Rudebusch (1995, 1996) provide a distinction between a 'bank lending channel' and a 'broad credit channel'. The bank lending channel is dependent upon banks' dual nature as holders of reserve-backed deposits and as originators of loans. As stated above, the channel may exist if a reduction in monetary reserves caused by monetary policy causes levels of bank lending to decrease. Banks may not be able to insulate their respective loan supplies by rearranging their portfolio of assets and liabilities, e.g. by reducing securities and/or acquiring non-reserve backed deposits. This idea is consistent with the findings of Kashyap and Stein (1997) that the impact of monetary policy is significantly more pronounced for banks with lower ratios of cash and securities to assets. That is, banks with more cash and/or securities relative to all assets will be able to withstand a monetary contraction without being forced to reduce lending levels. Any remaining levels of cash or securities can be liquidated first in response to reduced reserves levels as the result of monetary policy tightening. This will partially insulate the loan portfolio (Kashyap and Stein 1997).

Empirical evidence on the bank lending channel is mixed. If an operative bank lending channel exists, it is expected that after a monetary policy tightening, the supply of bank loans will be reduced by more than other types of debt, such as commercial paper and finance company loans. Oliner and Rudebusch (1996) found no evidence of such a response. Their research found that the mix of bank and non-bank debt changed little after a monetary shock. However, they do find evidence of a broader, 'credit channel' in which a reallocation of all types of debt from all firms, large or small, occurs after a policy tightening (Oliner and Rudebusch 1996). In the broad credit channel scenario, all types of debt are reallocated across all sizes of firms after monetary policy tightening. That is, all forms of external finance are believed to be imperfect substitutes for internally generated funds. When monetary policy is tightened, the premium all financial institutions impose for asymmetric information increases and depresses the over-all volume of lending. The external finance premium occurs because the increased cost of borrowing causes a deterioration of borrowers' balance sheets and future cash flows (Oliner and Rudebusch 1996). Generally, the external finance premium will be the greatest in cases where the potential for moral hazard behavior is hardest to reduce or where information asymmetries are the largest. That is, small or young firms with investment projects not fully backed by collateral will face higher premiums (Gilchrist and Zakrajsek 1995).

1.3 Bank Lending Channel:

Mishkin (1996) and Bernanke and Gertler (1995) further detail the potential impact of monetary policy contraction on businesses in discussion of the "balance sheet" channel. This channel focuses on the balance sheet profile of borrowers, including net worth, cash flow, and liquid assets. As described by Bernanke and Gertler (1995), this channel works directly in at least two ways. First, should borrowers have short-term, floating rate debt at the time monetary policy is tightened and interest rates are pushed up, direct interest expenses increase without borrowers immediately being able to pass along the increased cost to customers. Such an increase in the cost of short-term debt causes cash flow to be reduced, weakening the businesses' financial condition. Second, rising interest rates are generally associated with falling asset prices; for example, in real estate. Falling asset prices serve to reduce the value of assets that can be used as collateral for loans (Bernanke and Gertler 1995).

This is consistent with the findings of Oliner and Rudebusch (1996) that the conditions of firms' balance sheets generally affect lending only when net worth is low. At other times, balance sheet considerations are not binding with respect to company borrowings.

Empirical evidence exists linking monetary policy to the financial conditions of borrowers. That is, firms with imperfect access to credit are impacted by changes in monetary policy (Oliner and Rudebusch 1996). Bernanke and Gertler (1995) provide evidence that following a monetary shock, gross income for corporations tends to fall more quickly than costs such as employee compensation. Further, historically over 40% of the short-run decline in corporate profits resulted from higher interest payments. Higher interest rates directly reduce profits via higher interest costs on variable rate borrowings. Additionally, because firms' gross income tends to fall more quickly than costs, the profit function for firms changes at all levels of borrowing (Bernanke and Gertler 1995).

Stilglitz (1991) argues that firms have a 'portfolio' of interrelated decisions at all times. That is, among the portfolio of decisions for a firm are wage, price, employment levels, and investment decisions. This contention stems from the belief that firms act in a risk-averse manner. As firms increase investment or production, borrowing levels tend to follow. Increased borrowing levels cause increased fixed contractual obligations and increased bankruptcy probability. Thus, as interest rates rise, the riskiness of the environment increases, affecting decisions of the firm (Stiglitz 1991). Similar types of portfolio decisions made by risk-averse banks further complicate this scenario. As the profit function of non-bank firms is negatively impacted by interest rate increases, banks' willingness to extend credit is reduced. The reduction in profits of non-bank firms reduces the overall credit-worthiness of bank borrowers, increasing the potential for loan losses and reducing the potential for bank profits to remain at existing levels (Keeton 1999).

Banks are simply a specialized type of firm that is primarily engaged in screening loan applicants, determining credit-worthiness, and monitoring loans. Non-bank firms borrow money from banks, and banks borrow money from depositors. Banks primary production activity is making loans, which is a business with risks. As with non-bank firms, a reduction in net worth of banks or an increase in the risk perceived in the environment will lead banks to contract their output. That is, banks will make fewer loans (Stiglitz 1991). Banks will thus increase the minimum level of acceptable credit-worthiness of borrowers in an attempt to prevent further loan portfolio deterioration. Increasing the minimum level of acceptable credit-worthiness of borrowers by banks is equivalent to tightening credit standards and constraining credit supply at all interest rate levels (Keeton 1999).

Additional indirect effects occur as the result of portfolio decisions made by banks and non-bank firms. Non-bank firms act like banks in several respects. They provide credit to their customers via accounts receivable and receive credit from their suppliers via accounts payable. Non-bank firms, like banks, have considerable specialized knowledge about their customers and suppliers with whom they trade. When access to credit from banks is denied to non-bank firms, those firms not only reduce investment, but also accept fewer new customers and decrease activity with existing customers and suppliers. This has a ripple effect on total credit-worthiness and credit availability throughout the economy (Stiglitz 1991).

The combination of increased interest expense, increased fixed contractual obligations, and potential for reduced demand for goods and services as non-bank firms denied credit by banks reduce overall business activity all contribute to potential cash flow problems following a monetary tightening. Corporations with easy access to credit have the ability to increase borrowing temporarily to smooth the cash flow burden, while companies with relatively poor access to credit markets must seek to more quickly reduce labor costs and overhead. Gertler and Gilchrist (1993, 1994)[3] are cited by Bernanke and Gertler (1995) as having found material differences between the behavior of large and small firms following monetary contractions. Larger firms are more likely to respond to monetary tightening as suggested above by increasing short-term borrowing. Smaller firms tend to respond by reducing inventories and production (Bernanke and Gertler 1995).

A key assumption of the bank lending channel is that in periods of monetary contraction, as banks lose reserve-backed deposits, those lost deposits cannot be easily replaced with other sources of funds such as certificates of deposits or equity. Prior to 1986, "Regulation Q" imposed by the Federal Reserve limited the interest rate levels banks were allowed to pay for deposits. Accordingly, when the FOMC raised rates in relation to the imposed deposit interest rate ceiling, reserves left the banking system and could not be replaced. This caused a

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[3] See Gertler, Mark and Simon Gilchrist, "The Role of Credit Market Imperfections in the Transmission of Monetary Policy: Arguments and Evidence," *Scandinavian Journal of Economics*, 95, 1993: 43-64.
See also Gertler, Mark and Simon Gilchrist, "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms," *Quarterly Journal of Economics*, 109, May 1994: 309-340.

reduction in the amount of loanable funds (Bernanke and Gertler 1995). However, with the phase-out of Regulation Q in the mid-1980s, and with the introduction of more and varied purchased liabilities, today it is thought by some that the strength of the underlying bank lending channel assumption as defined above may be diluted (Meltzer, 1995; Edwards and Mishkin, 1995). Notwithstanding the validity of the deposit substitutability assumption, the bank lending channel may still be operative for other reasons mentioned above such as bankers becoming less willing to extend credit at any interest rate, known as credit rationing. However, it remains difficult to separate balance sheet effects from the lending channel as increasing interest rates affect companies' cost of capital and attendant cash flow, as well as banks' balance sheets through reduced reserve-backed deposits and the value of securities (Bernnake and Gertler 1995).

Gibson (1997) characterizes the bank lending channel based on the following causality: As monetary policy is tightened, bank reserves fall. Because the decline in transactions deposits caused by the decline in reserves cannot be offset without costs, bank assets must decline. Some of the decline in assets is reflected in bank loans, thus affecting real output (Gibson 1997). The bank lending channel has also been expanded to include theories related to constrained loan supply, either voluntarily via credit rationing, or involuntarily via capital constrained banks (Peek and Rosengren 1995; Peek, Rosengren and Tootell 2000). Peek, Rosengren and Tootell (2000) find that credit rationing due to involuntary bank supervisory constraint is significant and affects real output in the economy.[4]

Kashyap, Stein, and Wilcox (1993), (KSW) looked at the relationship of firms' financing mix between bank loans and commercial paper. Their hypothesis is

[4] The relative importance of supervisory constraints versus reserve requirement constraints on banks' lending activities may be a subject for further testing.

that changes in credit demand do not shift the financing mix, while changes in the supply of loans, i.e. via the lending channel, would. Their findings conclude that a monetary policy contraction causes firms' financing mix to shift away from bank loans, indicating lending supply constraint. They also conclude that the financing mix helps predict movements in inventories and capital investment. Together, KSW believe that their research results support the existence of a bank lending channel (Gibson 1997).

However, Oliner and Rudebusch (1996) take exception with the findings of KSW by pointing out that empirical results have concluded that credit demand by bank-dependent firms falls relative to that of non-bank dependent firms following a monetary contraction. Thus, the assumption made by KSW regarding the mix of commercial paper relative to bank loans is invalid. Oliner and Rudebusch (1996) determine that by looking only at small firms' reactions to monetary policy contractions, the mix of bank loans and other financing sources does not change. Thus, the reason it appears from the aggregate data that the financing mix changes after a monetary policy contraction is that small firms get less credit after the contraction while large firms get more as a percentage of the whole (Oliner and Rudebusch 1996).

Still others have used alternative methods to measure the lending channel. For example, Gilchrist and Zakrajsek (1995) disaggregated firm data by firm size rather than financial leverage on the assumption that businesses with high leverage would be credit-constrained in periods of monetary contraction. Their research concludes that levels of cash flow affect inventory investment in a monotonically increasing manner with leverage across all firm sizes. This finding, while insightful, is still not persuasive with respect to the lending channel. For example, the fact that investment moves negatively with cash flow levels does not necessarily mean that banks are constraining the process. It could be that the demand for credit is reduced at the firm level, with banks not initiating any change in the supply of loans.

Kashyap and Stein (1995) use yet another approach. Micro data from banks' balance sheets are analyzed in an attempt to identify the effects of monetary policy on bank lending activity. Bank data are divided into various size categories based on believed bank heterogeneity. As expected, the authors find that bank lending declines after a monetary policy tightening at all but the very largest banks. Predicated on theoretical expectations that after a monetary policy contraction bank lending is less, the authors take their findings of less bank lending as evidence of a bank lending channel. However, their findings are also consistent with a reduction in the demand for credit by businesses, not simply a reduction in the supply of loans by banks (Kashyap and Stein 1995).

The difficulty in separating loan demand from loan supply determinants remains. Peek, Rosengren and Tootell (2000), however, believe they found a method to clearly distinguish between the two. They acknowledge that any decline in bank loans following tightening of monetary policy could be caused either by a reduction in loan supply by banks or a decline in loan demand from businesses brought on by the weaker economy. Their approach to solving the issue of distinguishing between loan supply and loan demand is to use the ratio of banks that are negatively rated by bank supervisory authorities to all regulated banks as a proxy for loan supply shocks. By using this measure they believe they have disconnected the need to identify shifts in monetary policy from loan supply shocks in the economy. That is, loan supply shocks are exogenous with respect to monetary policy shocks. Because of this exogeneity, the impact of loan supply shocks on the real economy can be identified and quantified. The authors find that changes in real business inventories exhibit the strongest reaction to changes in bank health, as proxied by the ratio of negatively rated banks. Peek, Rosengren, and Tootell (2000) conclude that the lending channel is operative in the United States and that loan supply shocks have had a significant impact on real output in the past two decades.

While the empirical results support a bank lending channel, the method employed by Peek, Rosengren and Tootell addresses only capital constrained banks. It does not address voluntary constraints of lending by bankers due to economic uncertainty or other factors. Additionally, as noted by Benston and Kaufman (1997), by 1996 only 1 percent of banks were considered "undercapitalized" by regulators. Thus, the potential real impact by capital constrained banks is nominal at present.

Another recent paper by Lown, Morgan, and Rohatgi (2000) utilizes the Quarterly Federal Reserve's Senior Loan Officer Opinion Survey from 60 large banks across the country. The authors examine the value of the Survey in predicting lending and aggregate output. They find that changes in commercial credit standards reported by loan officers are linked to aggregate loan growth. Also, those changes in credit standards help predict economic growth and measures of business activity, such as inventory investment. These findings are consistent with the work mentioned above of Peek, Rosengren, and Tootell (2000). They contend that the true "price" of a commercial loan extends beyond the interest rate. That is, bank officers establish standards that firms must meet without regard to the negotiated interest rate. As noted above, Peek, Rosengren and Tootell (2000) were able to disconnect loan supply from the market interest rate. Lown, Morgan and Rohatgi (2000) develop this line of reasoning further by looking exclusively at loan officer credit standards.

All of this is not to completely disregard the link between market interest rates and the balance sheet channel of monetary policy transmission discussed earlier in this writing. That is, when interest rates are increased via monetary policy contraction, the asset values of both firms and banks are eroded. Additionally, if the user cost of capital is increased, certain interest sensitive investments may not occur, softening demand in the economy as a whole. When demand decreases and prices and costs are not immediately flexible, cash flow and liquidity suffers. Bank officers might anticipate those negative changes and restrict lending in anticipation of weakened cash flows, liquidity, and profitability. Therefore, the link between market interest rates and the balance sheet channel simply may be delayed or indirect, rather than fully disconnected. In other words, the channels being discussed may be complementary channels, not substitute channels. Both channels may be working at the same time with ever-changing degrees of importance. At times the lending channel may precede but be weaker than the balance sheet channel. At other times the balance sheet channel, which is demand driven, may be weaker than the lending channel. Several combinations are possible with regard to the timing and relative magnitude of the respective credit channels at work in the economy.

Similar to Peek, Rosengren, and Tootell (2000), Lown, Morgan and Rohatgi (2000) believe that supply shocks occur abruptly and ease only gradually. Thus, if loan officers tighten credit, it is normally done abruptly, causing commercial loan volume at banks to fall immediately after the shock and "bottom out" only after lenders begin to loosen credit standards. Aggregate output also follows loan volume fall-off, decreasing shortly after loan standards are tightened.

It is further argued by Lown, Morgan, and Rohatgi (2000) that loan price is a secondary consideration in establishing the level of loans available. Reasoning for the argument centers on moral hazard and adverse selection issues that are generally assumed to create frictions in the credit markets. Instead of raising interest rates to restrict credit, bankers are more likely to utilize non-price mechanisms such as tightening credit standards, making loan covenants more stringent, shortening maturities or amortization schedules for certain loan types, or increasing the amount of collateral required in order to cut credit off from more marginal borrowers.

One of the continuing problems of separating loan supply from loan demand is the fact that during times of weaker demand, lenders are also more cautious with respect to extending credit. This reasoning makes sense when one considers the business cycle. During economic contractions, demand for products, services, and loans decrease. Bankers become more cautious because the depth and breath of the contraction is not known at the time. Accordingly, bankers do not wish to lend into economic situations that may be worsening, causing their newly made loan to default in short order. Likewise, in expansionary economic times, loan demand is assumed to be increasing at the same time that bankers are buoyed by the economic conditions and, therefore more likely to extend credit (Lown, Morgan and Rohatgi 2000).

The findings of Lown, Morgan, and Rohatgi (2000) are that loan officer reports of tighter standards are associated with slower loan growth at the 5 percent level of statistical confidence over every time period measured. Additionally, the authors conclude that four of the past five recessions were preceded by sharply tighter loan standards. The exception was the 1981-1982 recession when loan officers were actually loosening standards at the time the recession began. However, the Surveys show that the standards were quickly tightened as the economy began to contract.

Conclusions from Lown, Morgan and Rohatgi (2000) are as follows:

1) Credit standards appear to be largely independent of the other variables in the system.

2) Shocks to commodity prices do cause some tightening of credit standards, but the reaction is brief and barely significant.

3) Shocks to the federal funds rate also cause some tightening of credit standards, but the reaction is similar to commodity price shocks, i.e. brief and barely significant.

Taken collectively, it appears as though lenders establish their standards based on their own assessment of the economy and expectations and therefore operate exogenously with respect to the other macroeconomic forces at work in the model. Shocks to credit standards are shown to occur very sharply for a few quarters and ease gradually over two to three years before returning to their initial level. Following the lending shock, commercial loans at banks fall precipitously and continue to fall until lenders ease the standards again. As anticipated, as loan levels fall, output reductions occur, followed by federal funds rate reductions (Lown, Morgan and Rohatgi 2000).

All of the above suggests that changes in credit standards by lenders of commercial loans are established outside the interest rate environment, predicated primarily on non-price factors. The supply of commercial loans to the business community may be influenced by many factors. Increases in the federal funds rate engineered by the Federal Reserve may cause bank reserves to fall and, consequently, loan supply to decrease. Similarly, an increase in the required reserve level has the same effect on commercial loan supply. Commercial banks may also elect to voluntarily ration credit supply at any given interest rate due to economic uncertainty and concern over potential increasing borrower default rates and loan losses. During times of economic prosperity, banks and non-bank firms alike enjoy high rates of return on their respective assets and equity. With high profits, equity values improve. Banks are able to increase lending due to increased equity levels as well as an increased ability to attract more funds from outside investors and depositors (Keeton 1999). Also, as noted above, during periods of economic prosperity and increasing profits, non-bank firms' net worth, cash flow, and liquidity all improve. Commercial bankers are more willing to extend credit in circumstances such as these, but have been shown to constrain lending when economic uncertainty occurs (Lown, Morgan and Rohatgi 2000).

This study focuses on the supply- and demand-side determinants of commercial loan volumes and how they are impacted by changes in monetary policy and other economic events. It builds on the works discussed above and offers additional reasons why commercial bank lenders may act exogenously to monetary policy innovations.

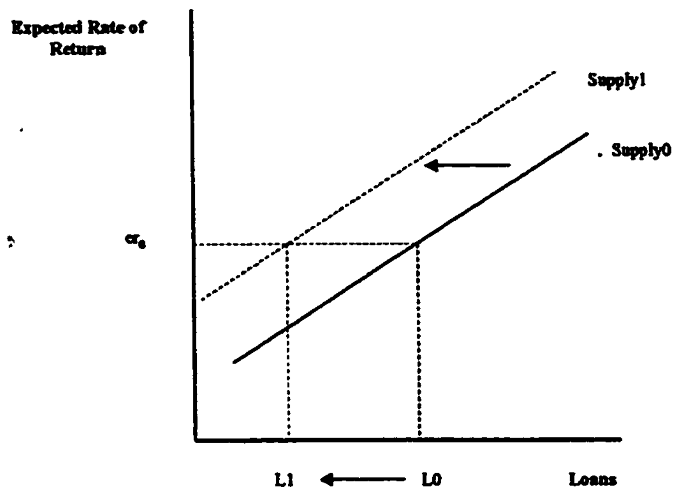
2. Theoretical Background

A significant volume of literature has explored commercial banks' role via the lending channel in monetary policy transmission. Lown, Morgan and Rohatgi (2000) recently concluded that changes in bank credit standards have an economically and statistically significant impact on key components of GDP, such as industrial production and inventory investment. As discussed earlier in this paper, the existing literature provides little discussion regarding what initiates changes in credit standards by commercial banks. This paper will attempt to provide evidence regarding why banks change credit standards.

Banks and businesses alike are believed to seek to maximize profits. However, the composition of banks' balance sheets and income statements are materially different from those of non-bank firms. A primary determinant of banks' earnings is the level and quality of loans held by banks. The supply of loans by banks is driven in a profit-maximizing world by the expected return on the loans held in portfolios. The expected rate of return on loans is not simply equal to the borrowing rate, e.g. the prime rate, which may be driving the demand for loans by non-bank firms. As interest rates fluctuate and/or economic uncertainty changes, the expected rate of return on banks' loans also changes. The more dramatic the negative changes in the environment, the greater the external finance premium needed by financial intermediaries to compensate for the uncertainty (Gilchrist and Zakrajsek 1995).

2.1 Supply Curve for C&I Loans:

Figure 1: Supply Curve for C&I Loans



The supply curve for C&I loans is upward sloping, indicating that as the expected rate of return increases, the supply of loans made available will increase. Increasing rates of return create increased bank profits, net worth, and the ability of banks to attract additional funds from outside investors and depositors (Keeton 1999). Should the required rate of return increase for any given loan level, the supply would be reduced, shifting leftward. As indicated above, a change in supply would result in fewer loans for a given expected return; for example from L_0 to L_1.

There are determinants of loan supply other than the expected rate of return. These are thought to include regulatory changes such as changes in reserve requirements and required minimum capital levels; supervisory oversight changes;

and perceived uncertainty in the environment. Banks' return on assets is believed to be determined partly by reserve requirements and partly by the stage of the business cycle, in particular the level of lending relative to trend and the level of non-performing assets. Loungani and Rush (1995) provide evidence that reserve requirements have a significant impact on bank profitability, the supply of loans, and real economic activity, particularly aggregate investment.

Supervisory oversight has also been shown to influence the supply of loans by banks. Bizer (1993) suggests that increased regulatory scrutiny decreased banks' willingness to lend in the early 1990s, ceteris paribus.[5] For example, if bank regulators increase supervisory scrutiny of lending, more banks might receive unfavorable examination ratings. An unfavorable supervisory bank examination should cause a bank to take actions to improve its rating. Unfavorably rated banks may also be prohibited from engaging in some activities such as lending. Banks with poor supervisory ratings may try to improve their ratings by reducing their perceived risks. As discussed earlier, lending money is a risky venture. Banks may seek to improve supervisory ratings by reducing lending. Empirical evidence exists that supports the idea that supervisory oversight changes may affect loan supply (Berger, Kyle and Scalise June 2000). Peek and Rosengren (1995) also find that banks under regulatory enforcement requirements reduce lending more than other banks. If bank regulation of loans is made more stringent, or if supervision of the lending process is tightened, loan supply at all levels of expected rates of return will decrease, i.e. shift leftward.[6]

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[5] See Bizer, David S. "Regulatory Discretion and the Credit Crunch," *Working Paper*, U.S. Securities and Exchange Commission, Washington, D.C., April 1993.

[6] Empirical evaluation of the issue regarding regulatory changes' impact on loan supply is statistically significant. However, economic significance has been proven very modest. (Berger, Kyle and Scalise 2000). This distinction is important for this study. Thus, the primary

Economic uncertainty as a determinant of loan supply follows from the literature's discussion of imperfect markets characterized by costly transactions and market frictions. Studies such as Stiglitz (1991) focus on the portfolio theory of non-bank firms and banks. As detailed earlier, banks are risk-averse and make decisions predicated on a portfolio of variables. Because credit markets are characterized by information asymmetries with limited transferability of firm-specific information, banks play a central role in credit distribution. However, the extension of credit is not allocated based on an auction/price system. Credit extension may often be rationed. Volatility in the perceived expectation for rates of return may cause banks to ration credit in an effort to minimize risk (Stiglitz 1991). As economic uncertainty increases, banks may reduce loan supply at all levels of expected return. This would also cause the loan supply curve to shift leftward as demonstrated above in Figure 1.

2.2 Demand Curve for C&I Loans:

Non-bank firms' demand for loans is believed to be a function of factors such as the cost of borrowing; economic activity; and the cost of C&I loans relative to alternative sources of external finance such as issuing bonds, selling equity, or issuing commercial paper.

As cited above, Stiglitz (1991) contends that non-bank firms make decisions predicated on an interrelated group of factors. For example, decisions made by non-bank firms impact wages, prices, employment and investment all at the same time. A business cannot decide to increase employment without the total wages paid by the firm increasing. Further, investment and employment are both input

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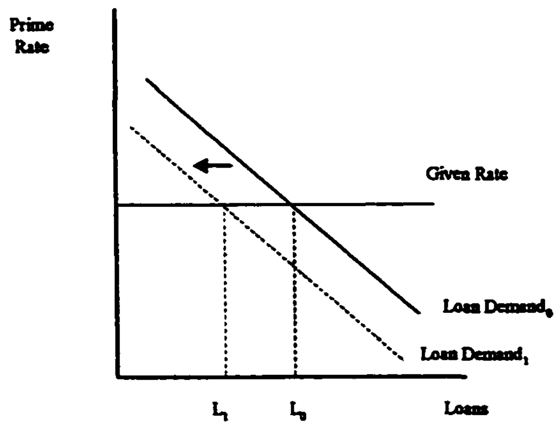
determinants of loan volumes in the economy are driven by loan demand from non-bank firms and loan supply from bank lending officers.

factors in the production process. Employment is an input factor focused on the short-run, and investment is an input factor focused on a longer perspective (Stiglitz 1991). Non-bank firms that depend on bank financing for external financing must pay market rates of interest for borrowed funds. Debt places a contractual obligation to repay on borrowers that equity does not. However, the equity market has severe imperfections. Because of those imperfections, only a fraction of new capital is raised annually in the equity markets (Stiglitz 1991). Increases in the cost of borrowing will decrease profits and cash flow, ceteris paribus. Because non-bank firms are risk-averse, under normal assumptions, decreased wealth creates a shift to safer activities such as hoarding cash and away from long-run commitments (Hubbard, Kuttner and Palia 1999). That is, non-bank firms will decrease demand for borrowed funds, represented below in Figure 2 by a change from L_0 to L_1.

Loan demand by non-bank firms is also believed to be a function of the cost of C&I loans relative to alternative sources of external finance, such as issuing bonds, selling equity, or issuing commercial paper. Kashyap, Stein and Wilcox (1993) explore relative fluctuations in bank loan volume and what they believe to be a close loan substitute, commercial paper. Their premise is that changes in both bank lending and commercial paper volume in the same direction most likely reflect changes in the demand for loans. That is, when bank lending and commercial paper issuance both decrease, the reduction is caused by a reduced demand for external financing in both cases. However, opposite changes in bank lending and commercial paper may signal that bank loan supply is being actively managed by banks. For example, if bank loan volume contracts while commercial paper issuance is rising, banks may be rationing loan supply. They find that when the federal funds rate increases, the volume of commercial paper also increases and the volume of bank loan gradually declines (Hubbard 1994).

However, the fact that commercial paper issuance increases and bank loan creation decreases does not necessarily mean that loan supply is being constrained. A pattern of increasing commercial paper issuance and reduced loan volumes is also consistent with loan demand diminishing due to a relative cost advantage of commercial paper over bank loans.

Figure 2: Demand Curve for C&I Loans



No common interest rate exists that is equally well suited to explain both loan supply and loan demand. As stated earlier, the expected rate of return that drives banks' lending activity is not equal to the borrowing rate driving the demand for loans by non-bank firms. Accordingly, the vertical axis in Figure 2 above is not the expected rate of return that is relevant for banks' supply curve, but the prime lending rate, a proxy for the cost of borrowing.[7] Loan demand is believed to be downward sloping such that an increase in the cost of borrowing results in a decrease in the demand for loans (Keeton 1999).

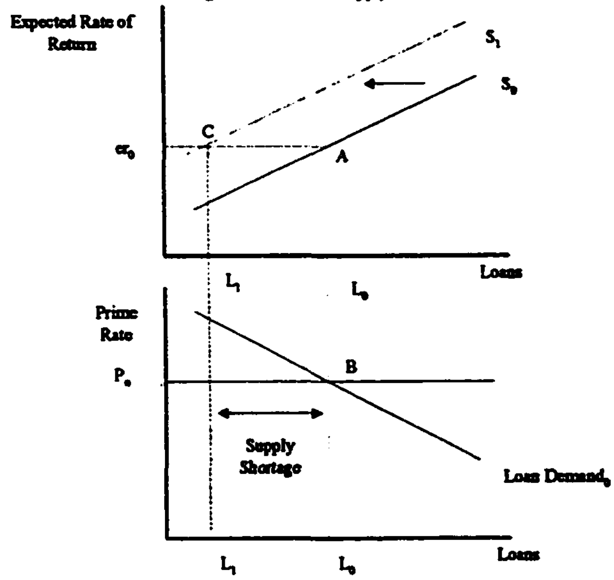
Neoclassical investment theory contends that non-bank firms seek to maximize the net present value of expected profits. If the cost of borrowing increases, the net present value of expected profits falls, assuming that other costs and prices do not adjust simultaneously. When the net present value of expected profits falls, investment is less attractive, and loan demand is reduced (Gilchrist and Zakrajsek 1995). Demand shifts may occur due to other factors noted above, such as changes in overall economic activity and the cost of bank loans relative to other external financing costs (Hubbard 1994, Stiglitz 1993). For example, if overall economic activity slows, the demand curve would shift leftward, reducing the quantity of loans demanded for a given prime rate. Further, if the cost of financing alternatives relative to bank loans declines, the quantity of loans demanded for a given cost of bank borrowing would decrease, also shifting the demand curve leftward. This is shown above in Figure 2 by the change from L_0 to L_1 for both examples cited.

[7] The prime lending rate is chosen as an approximation for the cost of borrowing from banks by non-bank firms. The largest and most credit-worthy borrowers may pay interest rates below the prime lending rate, such as a negotiated percentage over the banks' cost of funds. However, the average commercial loan customer is generally charged a rate based on a negotiated percentage over the prime lending rate. Thus, the choice of the prime lending rate as a proxy for the cost of borrowing is assumed to be a reasonable assumption.

2.3 C&I Loan Demand Combined With C&I Loan Supply:

Combining the two graphs provides a more complete story with respect to credit market frictions for C&I loans, as shown in Figure 3 below:

Figure 3: C&I Loan Supply and Demand Curves



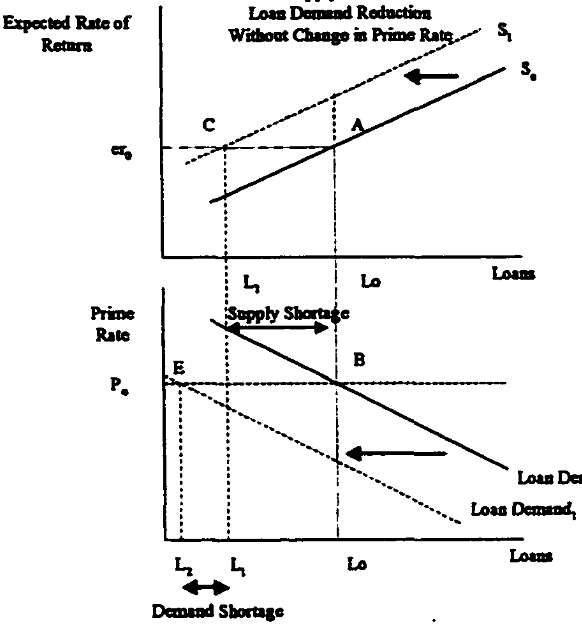
In the above scenario, the supply of loans happens to be in equilibrium with the demand for loans at points A and B. The expected rate of return for banks is thus matched with a given prime rate. If banks become more cautious about extending loans, for example due to increased economic uncertainty, the supply of loans will decrease at all expected rates of return. Such a decrease in loan supply is represented above by a leftward shift of S_0 to S_1 and the resulting decrease in loans supplied from L_0 to L_1.

If the supply curve shifts leftward, resulting in fewer loans supplied at any given expected rate of return, loan volumes supplied are constrained relative to loan volume demanded, ceteris paribus. This is represented above by a shift in the loan supply curve from S_0 to S_1. At point C, the amount of loans supplied is represented by L_1, while the amount of loans demanded at the given prime rate is L_0. Such disequilibria have been discussed earlier in this writing based on work by Lown, Morgan, and Rohatgi (2000), Peek and Rosengren (1996), and Peek, Rosengren and Toottell (2000).

2.3a Loan Supply and Loan Demand Shifts:

Many of the variables discussed above that affect the level of loan supply also affect the demand for loans. If banks act to ration credit due to economic uncertainty, non-bank firms may also demand fewer loans at any given cost of borrowing due to the same uncertainty. In such as case, the observed level of C&I loans is difficult to separate into supply driven versus demand driven components. Consider a variation on Figure 3 below:

Figure 3a
Loan Supply Reduction &
Loan Demand Reduction
Without Change in Prime Rate

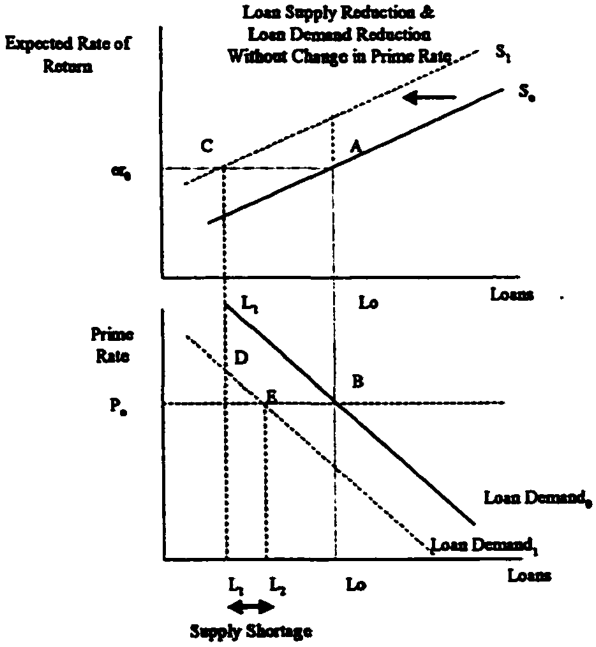


In this case, banks constrain credit availability, represented by a leftward shift in the supply curve from S_0 to S_1. The desired supply of C&I loans at the given expected rate of return of er_0 is reduced from L_0 to L_1. Assuming that banks elect to leave the cost of borrowing unchanged, excess demand occurs. Borrowers seek loans at loan level L_0, but loan supply is at loan level L_1. However, if non-bank firms elect to reduce their demand for bank loans at all levels of borrowing rates, for example due to the same identified economic uncertainty, the loan demand curve will also shift leftward. This is represented above as a shift from Loan Demand$_0$ to Loan Demand$_1$. Depending on the magnitude of the shift in loan demand versus the shift in loan supply, the final observed loan volume level might represent a supply shortage or a demand shortage.

2.3b Loan Supply and Loan Demand Curve Elasticity:

Final observed loan volumes in the economy is also determined by the relative slopes of the loan supply and loan demand curves. If, for example, the demand for C&I loans is less elastic than portrayed in Figure 3a, the impact of the shift in loan demand would be smaller. This may be seen in Figure 3b below:

Figure 3b
Loan Supply Reduction &
Loan Demand Reduction
Without Change in Prime Rate



In this example, loan demand is less elastic than loan supply regarding changes in their respective rate determinants. While both loan supply and loan demand constrict, the resulting observed level of C&I loans is supply constrained rather than demand constrained. Both loan supply and loan demand shift leftward. However, the impact of the loan supply shift is greater that that of the loan demand shift. In the above figure, loan supply after the shift is at loan level L_1, while loan demand after the leftward shift is at loan level L_2, resulting in a supply shortage. Thus, depending on the relative curve elasticities and magnitude of the relative curve shifts, different outcomes are possible.

2.3c Loan Supply and Loan Demand Shifts with Prime Rate Change:

Finally, consider the following Figure 3c in which banks constrain loan supply on or about the same time that non-bank firms reduce the demand for C&I loans. In this scenario, banks do not have knowledge that loan demand will be reduced at all interest rate levels. Accordingly, banks elect to constrain loans by increasing the cost of borrowing from P_0 to P_1, partially offsetting the change in loan supply. The remainder of the credit rationing is administered through non-price considerations such as underwriting standards, increased collateral requirements, or more stringent covenant requirements. This approach is consistent with intermediary theory detailed earlier. Banks may be cautious concerning rationing credit strictly through interest rates due to moral hazard and adverse selection considerations (Himmelberg and Morgan 1994; Stiglitz 1991).

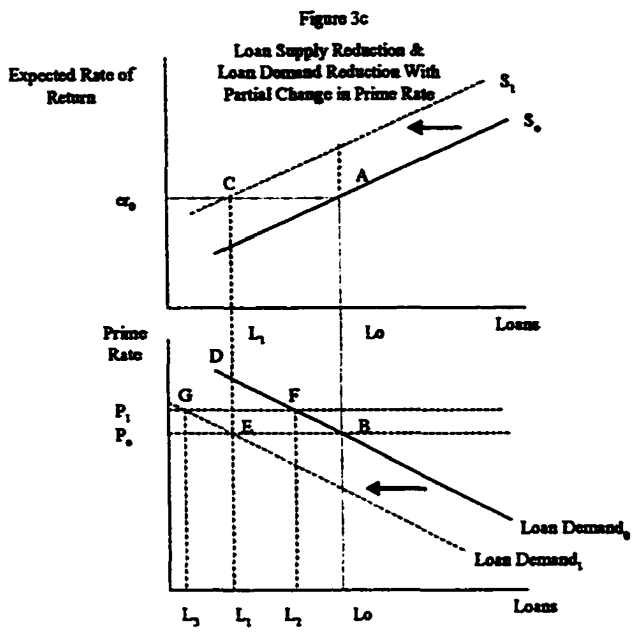


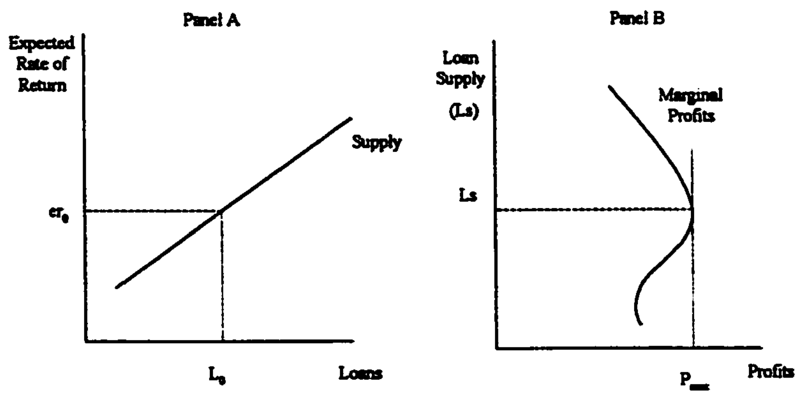
Figure 3c
Loan Supply Reduction & Loan Demand Reduction With Partial Change in Prime Rate

In the above figure, the same market dynamics are at work as in Figures 3a and 3b. Both loan supply and loan demand are constrained. However, in this case the prime rate is increased from P_0 to P_1. If banks elected to fully offset the reduction in loan supply by increasing the cost of borrowing, the prime rate would be increased to a level consistent with point D above. Such an increase assumes that banks believe their customers to be operating on the same demand curve as originally portrayed, i.e. Loan $Demand_0$. Given the partial offset in loan supply by an increase as shown from P_0 to P_1, banks would expect loan demand to fall from L_0 to L_2, and loan supply to be reduced from L_0 to L_1. Such a change results in a supply shortage equal to the gap between L_2 and L_1. However, as portrayed above, loan demand is also constrained, shifting from Loan $Demand_0$ to Loan $Demand_1$. The result is that banks wish to provide loans at loan level L_1, but loan demand at the new, higher interest rate is at L_3, leaving a demand shortage for the loan market.

The question then remains: In a profit-maximizing world, comprised of interdependent borrowers and banks with dissimilar supply and demand functions, what triggers a change in the supply of loans? One method of better understanding the loan market mechanisms is to graphically portray the relationship between bank loan supply and bank profits. Here, profit is assumed to be determined by loan supply volume that maximizes net income for banks as a whole.

2.4 C&I Loan Supply and Bank Profit Relationship:

Figure 4: C&I Loan Supply and Bank Profit Relationship

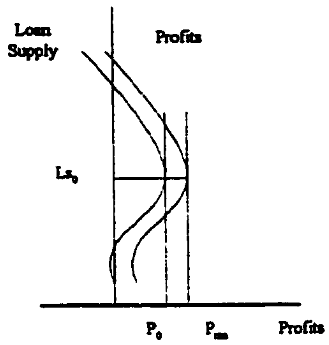


Panel A has been previously discussed above as the supply curve for banks' supply of C&I loans as a function of banks' expected rate of return on those loans. Panel B depicts profits as a function of the supply of C&I loans over the business cycle. If bank lending activities move considerably above some 'normal' level of lending activity, marginal profits would be expected to decline as the incidence of problem loans increases as more loans with marginal profit opportunities are made to borrowers with less credit-worthiness (Keeton 1999). That is, profits for banks may be affected in two ways: 1) loan losses increase, and 2) loan interest margin over the cost of loanable funds declines as banks seek to increase market share. Other factors may also reduce profits as banks attempt to increase loan supply above normal levels. For example, additional staffing or hours worked may be needed to originate and administer the additional loan volume. Additional investment may also be needed for managing the collateral and documentation of increased loan volume. Keeton (1999) provides evidence that during the 1990s, rapid loan growth tended to coincide with easing credit standards by banks. He concludes that if credit standards are eased in an attempt to increase loan supply at all levels of expected rates of return, faster loan growth leads to higher loan losses. As one would expect, Keeton found that loan growth is negatively related to credit standards, and credit standards are positively related to loan losses. Loan supply below the trend level would decrease profits due to the same level of fixed costs being allocated over fewer earning assets.

The profit curve may also shift. A shift in the profit curve may be due to factors other than loan supply such as regulatory changes in the form of reserve requirement innovations. If reserve requirements are increased, and banks elect to supply the same level of loans by attracting non-reservable, higher cost funding, profit at all levels of lending will decrease. Increases in the reserve requirements by the central bank effectively serve as a tax on bank earnings, as required reserves do not earn interest in the United States. Loungani and Rush (1995) cite a study by Santoni (1985) regarding the effects of the Monetary Control Act of 1980 that imposed uniform reserve requirements across all financial firms.[8] The Act lowered required reserves for member banks of the Federal Reserve and raised required reserves for non-member banks. Santoni found that following the implementation of the Act, member banks' after-tax earnings and stock prices increased, while the after-tax earnings and stock prices of non-member banks decreased. Loungani and Rush (1995) refer to work by Barro (1990) that further describes the tax-like effect on banks from an increase in the required reserve ratio.[9] If banks must hold more reserves, fewer loans will be made, as banks cannot costlessly replace the non-interest bearing deposits affected by the reserve requirement increase. If bank-dependent borrowers are not able to find alternate external sources of funds in light of a contraction of loan supply by banks, declines in investment and output will result. Loungani and Rush's (1995) efforts support the evidence uncovered by Santoni (1985) and Barro (1989) that the impact of reserve regulation goes beyond bank profitability and extends to the amount of financial intermediation and aggregate investment. This would be observed by a leftward shift in the profit curve in Panel B from Figure 4 as shown below, resulting in a decrease of profits from P_{max} to P_0.

[8] See Santoni, G.J. "The Monetary Control Act, Reserve Taxes, and the Stock Prices of Commercial Banks," *Federal Reserve Bank of St. Louis Review*, June/July 1985: 12-20.
[9] See Barro, Robert J. "The Stock Market and Investment," Rochester Center for Economic Research, *Working Paper No. 185*, December 1989.

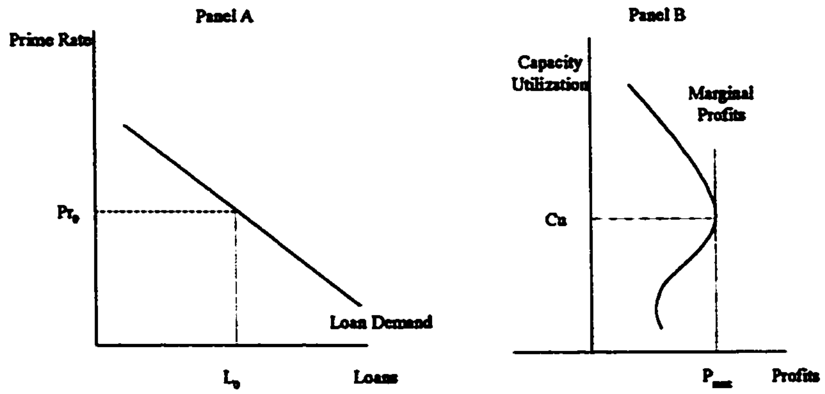
Figure 4: Panel B



2.5 Figure 5: C&I Loan Demand and Non-Bank Firm Profit Relationship:

A similar representation may be shown for the demand side of the loan market. Rather than loan supply as the variable on the vertical axis in Panel B, Capacity Utilization for non-bank firms may be substituted, providing the following graphical representation:

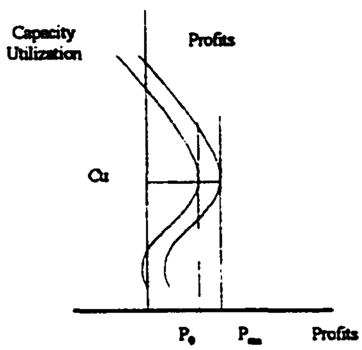
Figure 5: C&I Loan Demand and Non-Bank Firm Profit Relationship



For a given user cost of borrowing, e.g. the prime lending rate, the level of loans demanded will provide non-bank firms with a certain level of capacity utilization. That is, loans obtained from banks provide funds for non-bank firms to establish a certain level of capacity utilization. Non-bank firms are also assumed to be profit-maximizing entities. As such, firms will obtain loans at a level that will provide capacity utilization that maximizes profits. That level is shown above in Figure 5, Panel B as C_uP_{max}. However, if capacity utilization is increased above the optimal level, then marginal profits will be negatively impacted. For example, for manufacturing firms higher input factor costs for overtime labor, higher raw material costs, and higher maintenance costs will cause marginal profits to decline at utilization levels above optimal. This effect would occur for any given interest rate. If the monetary authorities anticipate rising inflation and elect to increase interest rates, profits would be eroded for a given level of capacity utilization.

According to investment theory, firms make investment decisions to maximize the net present value of profits. If the user cost of borrowing increases, the net present value of profits is reduced, assuming cost cannot simultaneously be passed along to customers. This reduction makes investment less attractive (Gilchrist and Zakrajsek 1995). The profit curve would shift leftward, causing profits at all levels of capacity utilization to decrease as shown below in Panel B from Figure 5.

Figure 5: Panel B



Should the supply of loans decrease as a result of regulatory changes, economic uncertainty, or other factors, non-bank firms would be forced to reduce production levels. This would bring about a reduction in capacity utilization and profits, as total capacity remained constant but utilization was reduced. Thus, the marginal cost per unit of output would increase as fixed costs were allocated over fewer units of production.

Linking profit levels of non-bank firms to bank lending activity is reasonably straightforward. As noted earlier in this writing, one form of the credit channel for monetary policy transmission is the balance-sheet channel. The focus of this transmission mechanism is on the relationship among net worth, profitability, and cash flow of businesses. Expansionary monetary policy reduces interest rates and, hence, the cost of borrowing. This increases non-bank firms' asset values and net worth. Improved net worth of non-bank firms reduces adverse selection and moral hazard problems for banks attempting to underwrite credit extensions. Thus, more loans are available and more business projects are undertaken, increasing profits. As profits increase, cash flow increases. This also provides incentives for banks to increase lending activity. As cash flows increase, the probability of loan default decreases. As noted earlier, the expected rate of return by banks on loans is equal to the stated interest rate of interest on a loan minus expected inflation and an expected default percentage. If the default percentage is reduced, banks will be willing to accept a lower interest rate and still maintain the same expected rate of return (Mishkin 1996, Bernanke and Gertler 1995).

The model proposed in this study concentrates only on the behavior of banks and takes the actions of non-bank firms as a given. As noted above, it postulates separate demand and supply curves due to market frictions that may occur at any time in many separate loan markets. The model does not contain a traditional demand/supply relationship with a common price on the vertical axis. At first impression it would seem that if loan trading occurs at disequilibrium prices, a model describing such behavior would appear warranted. In such a model, the actual quantity traded is the minimum of loan quantity demanded and loan quantity supplied. Such a model would make sense if the market for loans were comprised of a representative non-bank firm and a representative bank. However, many banks and non-bank firms in many different market segments conduct loan transactions. Therefore, it is likely that a multitude of different outcomes will occur at the same time. That is, excess demand for loans in one market segment can coexist with excess supply in another, and market equilibrium in yet another. Under such conditions, the concept of a unique demand and unique supply curve does not exist. That is, the unique curves cannot be identified. Observed quantities of C&I loans are driven by both demand and supply variables at the same time. The idea of joint determination of observed loan quantities is utilized in this study as the maintained hypothesis and is consistent with numerous prior studies.[10] This study posits that monetary policy innovations impact both loan supply and loan demand, working through a credit channel. The order and magnitude of the impact with respect to whether loan supply or loan demand is affected first or most, is not the focus of this work. Rather, the emphasis is on the factors that cause commercial loan volumes to fluctuate and ultimately affect real activity.

[10] See for example: Morris and Sellon 1995; Bernanke and Gertler 1995; Ramey 1993; and Hubbard 1994.

3. Data and Estimation Methodology

3.1 Data:

The data used for this study are quarterly and cover the years 1984 to approximately 2000. Crucial data are not consistently available before 1984. Additionally, it is believed to be more appropriate to analyze data in the post-Regulation Q era; that is, after the mid-1980s (Edwards and Mishkin 1995). Following the variable definitions and source tables are discussions of the model equations. As suggested by Harvey (1993), many data series are presented graphically. Harvey contends that for time series data, plotting the data is important to identify potential trends and cycles that are contained in the series (Harvey 1993, pp. 106-107).

Table 2 provides an overview of variable definitions.

TABLE 2. VARIABLE DEFINITIONS

Variables	Definitions
ROA	Rate of return on average assets (annualized)
ROAD	ROA*NBanks/10,000
Nbanks	Number of insured U.S. commercial banks
RR	(Monetary base adjusted for reserve requirement changes) / (Monetary base)
RRh	Percentage change in RR, at annual rate
DRQ	Dummy variable= one for Regulation Q period
HP_CR	Commercial and industrial loan volume, deflated by price index for GDP and detrended by Hodrick- Prescott filter
NPTL	Nonperforming loans/total loans (includes loans 90 days or more past due and non-accrual loans)
CRh	Percentage change in commercial and industrial loan volume, at annual rate
ROEBUS	Rate of return on equity for manufacturing firms as suggested by Himmelberg and Morgan (1995)
VOLFF	Coefficient of variation of federal funds rate for a given quarter, calculated from the average daily values for the quarter
PT	Prime rate/3-month treasury bill rate
SP500h	Percentage change in SP500 stock market index, at annual rate
D_98:3	Dummy variable= one for quarter three of 1998
LOCS	Net percentage of Senior Loan Officers reported tightening C&I credit standards
D_87:1	Dummy variable= one for quarter one of 1987

Table 3 provides an overview of variable sources.

TABLE 3. SOURCE OF VARIABLES

Variables	Source
ROA	St. Louis, Fred, FFIEC Reports on Condition and Income for All Insured U.S. Commercial Banks
NBanks	St. Louis, Fred, FFIEC Report
RR	St. Louis, Fred, ratio as suggested by Loungani and Rush (1995)
CR	Federal Reserve Board Statistical Release H.8
NPTL	St. Louis, Fred, FFIEC Report
ROEBUS	U.S. Census Bureau Quarterly Financial Report for manufacturing firms Table F
VOLFF	Federal Reserve Statistical Release H.15: Selected Interest Rates
PT	St. Louis, Fred
SP500	Economagic.com. Time Series Page
LOCS	Quarterly Federal Reserve Senior Loan Officer Opinion Survey

3.2 Model Format:

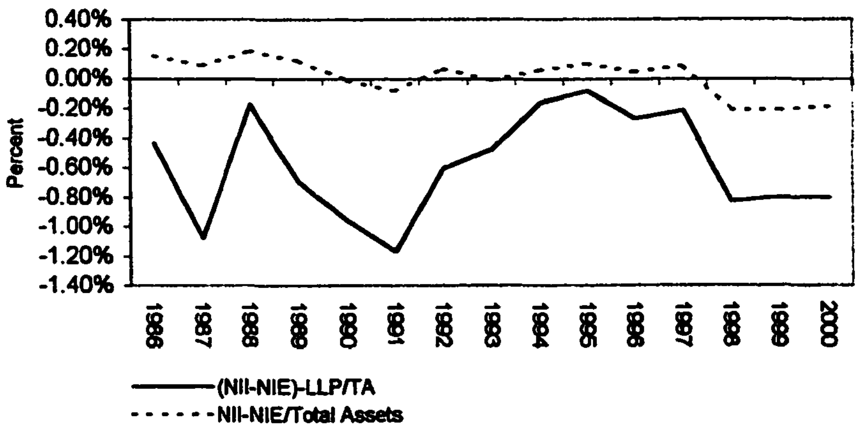
The model created for this study consists of two equations. The first equation attempts to explain bank profits, represented by banks' return on assets. The second equation tries to identify the determinants of commercial and industrial loan growth. The two equations allow for a number of causal chains. An example of a causal chain is as follows: above normal lending may lead to reduced return on assets due to increases in non-performing loans and higher default rates.

3.3 Determinants of Bank Profits:

The model concentrates on the behavior of banks. The first equation attempts to explain bank profits on their assets. Business cycle phenomena such as the magnitude of non-performing loans and the implicit tax imposed by the central bank through reserve requirement changes are expected to impact bank profits (Loungani and Rush 1995). Edwards and Mishkin (1995) suggest that a crude measure of the profitability of traditional banking may be determined by excluding non-interest income from total earnings. Calculating net interest income minus non-interest expense and comparing the result to assets provides evidence for the impact of lending on bank earnings observed over time. This concept brought forward by Edwards and Mishkin is developed further below in a figure that separates the effect of loan loss provisions from pre-tax income of banks.[11] Thus, by separating loan losses from the original calculation, one may observe the impact of loans as a function of bank asset levels on bank profits. The second series plotted below overlays an additional trend line that subtracts the loan loss provision from the original calculation. By doing so one may observe the manner in which levels of non-performing loans impact banks' return on assets. In years such as 1988, 1994, and 1995, banks' loan loss provisions were small relative to other years measured. During those years, banks did not have to rely as heavily on non-interest income to maintain trend level return on assets.

[11] Source: Federal Deposit Insurance Corporation, *Statistics on Banking*. Net Interest Income is equal to Total Interest Income minus Total Interest Expense. Non-Interest Expense is then subtracted from Net Interest Income to provide a rough estimate of pre-tax, pre-loan loss provision earnings of banks. It should be noted that the expenses associated with generating Non-Interest Income are included in total Non-Interest Expense. Accordingly, the above percentage of earnings divided by total assets does not represent solely net loan-related income. However, the measure, consistently applied, provides insight into the impact of lending on bank income over time.

Figure 6
Return on Assets for Commercial Banks Excluding Non-Interest Income



Source: Federal Deposit Insurance Corporation *Statistics on Banking*.

The figure above highlights the fact that pre-tax return on assets, before loan loss provision, has been relatively stable over the time period measured in this study. In essence, Net-Interest Income minus Non-Interest Expense has varied slightly around zero percent. However, when the provision for loan losses is also subtracted from the difference between Net-Interest Income and Non-Interest Expense, significant variations in pre-tax return on assets occurs. The figure above is admittedly a crude way of measuring the relationships among bank loans, non-performing loans, and return on assets. However, it does visually highlight the fact that relationships appear to exist. Such relationships illustrate the premise of this study that increases in non-performing loans impact bank profits from those bank assets and may contribute to decisions by banks concerning the supply of C&I loans by banks.

Additionally, bank consolidation is expected to have a positive influence on bank ROA. As the banking industry consolidates, the total dollar volume of earning assets is spread over lower input costs. This occurs due to operating efficiencies expected via industry-wide reductions in operations-related expenses. That is, a single large bank can operate using one computer system and group of operators. Two operating systems and groups of operators are not necessary as previously utilized by the two separate banks that may have joined to form one larger bank.

Consolidation in the banking industry also creates more lending market concentration. Microeconomic intuition suggests that lending market concentration contributes to market power regarding the price that banks may charge for lending. Covitz and Heitfield (1999) provide empirical evidence that that the relationship between market power of banks and interest rates those banks may charge depends on the business cycle conditions and the industry focus of bank lending. Generally, the authors conclude a positive relationship between market power and lending rates. Thus, consolidation in the banking industry and the resulting market concentration should cause banks' ROA to increase.

The model equation explaining bank profits is as follows:

ROA = f (non-performing loans,
commercial loan volume,
reserve requirements,
the number of commercial banks)

It is expected that banks' return on assets will be negatively related to the percentage of non-performing loans in their loan portfolios. As noted in Figure 4, the annual percentage change in C&I loans should also impact banks' ROA. If loans are increasing at a sustainable, trend-adjusted pace, ROA should increase. However, if loans increase at a pace significantly above normal trend levels, increases in non-performing loans associated with the above-normal loan growth may negatively impact earnings (Keeton 1999). Thus, ROA should move in the same direction as normal trend-adjusted commercial loan levels, ceteris paribus.[12]

Loungani, and Rush (1995) demonstrated that changes in reserve requirements impact both financial intermediation and real activity. Required reserves do not earn interest for the banks forced to hold such reserves. Reserves required by the central banking authority, while preserving the liquidity soundness of the banking system, reduce earnings to the extent those funds could otherwise be used for income producing activity such as lending. Required reserves are thus an implicit tax on the earnings of commercial banks. Changes in reserve requirements are therefore expected to move inversely with banks' ROA. Finally, as discussed above, the number of banks is expected to have a negative relationship with banks' ROA. As the banking industry consolidates, greater returns on assets are expected for banks as a whole due to greater operating efficiencies from economies of scale.

3.4 Commercial Loan Volume Determinants:

A second equation completes the model. Bank credit growth is explained by the following equation:

[12] For a graphical representation of commercial loan volume plotted against banks' pre-tax return on assets, see Figure 9 later in this discussion.

Commercial Loan Volume = f (economic activity,

alternative financing costs relative to commercial loans,

banks' return on assets,

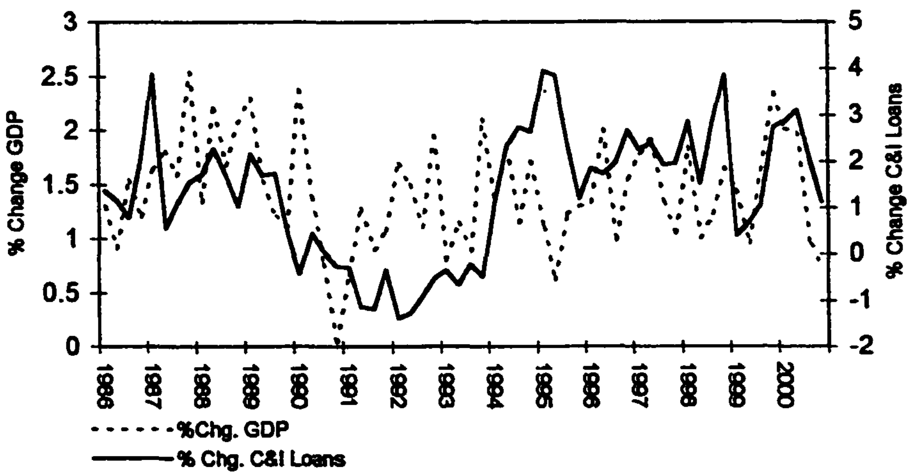
non-bank firms' profitability levels,

economic uncertainty).

3.4a Economic Activity and C&I Volume:

The annual percentage change in C&I loan volume is expected to move directly with economic activity. As activity increases, C&I loan volume increases.

Figure 7
Percent Change in C&I Loans vs. Percent Change in GDP



Sources: U.S. Department of Commerce: Bureau of Economic Analysis: National Income Accounts Data and Federal Reserve Bank of St. Louis: FRED.

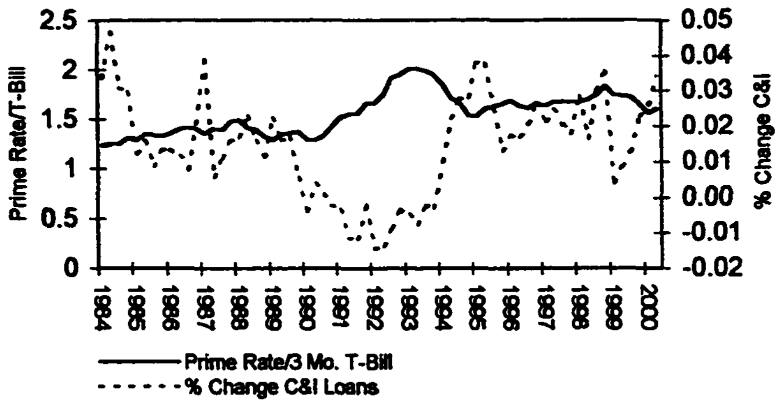
As a first step toward understanding the behavior of C&I loan volume, a general proxy for current business activity was selected—gross domestic product. Quarterly percent changes in seasonally adjusted rates of GDP are plotted against quarterly percent changes in seasonally adjusted volumes of C&I loans. With the exception of the mid-1990 to early-1992 period charted above, the level of business activity, as determined by GDP, appears to move in the same direction as C&I loan volumes. Accordingly, economic activity is included in the initial general equation for C&I loan volume behavior.

3.4b Commercial Loan Volume and Loan Rate Spread:

Loan volume is expected to be negatively related to the rate charged by banks for loans and positively to the rate at which non-bank firms can obtain credit in the bond market. Since both rates are likely to move similarly over time, it would be difficult to disentangle the effect of each of these rates on bank lending. Hence, the estimating equation employs the ratio of the prime lending rate and the 3-month treasury bill rate (the "loan spread"). The loan spread is used as a proxy for alternative short-term borrowing rates for non-bank firms. It is intended to capture the effect of own and cross price effects on loan demand. As the cost of bank loans increases, loan demand decreases. As the rate on treasury bills decreases, alternative financing to bank loans becomes more attractive to non-bank borrowers. The loan spread may increase due to an increase in the prime rate relative to alternative borrowing rates. It may also increase due to a decrease in the rate of alternative borrowing mechanisms relative to the existing prime lending rate.

Consider the following Figure 8 that plots the relationship between the quarterly ratio of prime rate to the three-month treasury bill and quarterly percentage change in C&I loan volume. Bernanke and Gertler (1995) provide evidence that the difference between the prime rate and treasury bills offer insight into predictions for the bank lending channel. They suggest that during periods of monetary contraction, the prime rate increases more than the increase in treasury bills. This suggestion appears to be consistent with the following figure, especially during the 1990-1991 recession.

Figure 8
Percent Change in C&I Loans vs. Prime Rate/ 3Mo. T-Bill



Source: Federal Reserve Board of Governors Statistical Release H.15.

As demonstrated above visually, percentage changes in C&I loan volumes appear to move generally in an inverse direction as changes in the loan spread. Banks establish the prime lending rate as the cost of borrowing for non-bank firms. However, a premise of this study supported by existing literature is that banks utilize non-price factors more often than loan rates to manage loan volume levels (Lown, Morgan and Rohatgi 2000, Stiglitz 1991). Thus, the expectation is that the prime rate/treasury bill ratio is predominately a demand-side variable, incorporating the level of loan demand predicated on the own versus cross price effect of the difference between bank borrowing and alternative financing.

Note above that from approximately 1990 through 1993 the percentage change in the loan spread was much wider than in other periods measured. During part of that period the U.S. economy was in a recession.[13] While the contraction officially

[13] The Conference Board and The National Bureau of Economic Research both identified March 1991 as the beginning of the recession. Their findings are based on Table C-51 *Survey of Current Business* (U.S. Department of Commerce), October 1994.

lasted eight months, it is evident from the above figure that C&I loans began contracting in mid-1989 and did not begin to consistently rise until 1992. It could be that banks anticipated higher default rates during that time period, and initially constrained credit extension through non-price measures. Following the initial rationing, the difference between prime rate and the treasury bill widened as loan volume fell further. A pattern described above regarding C&I loan volumes is consistent with the literature noted earlier regarding the belief that banks are prone to constrain loans abruptly and ease lending availability gradually (Peek, Rosengren and Tootell 2000; Lown, Morgan and Rohatgi 2000).

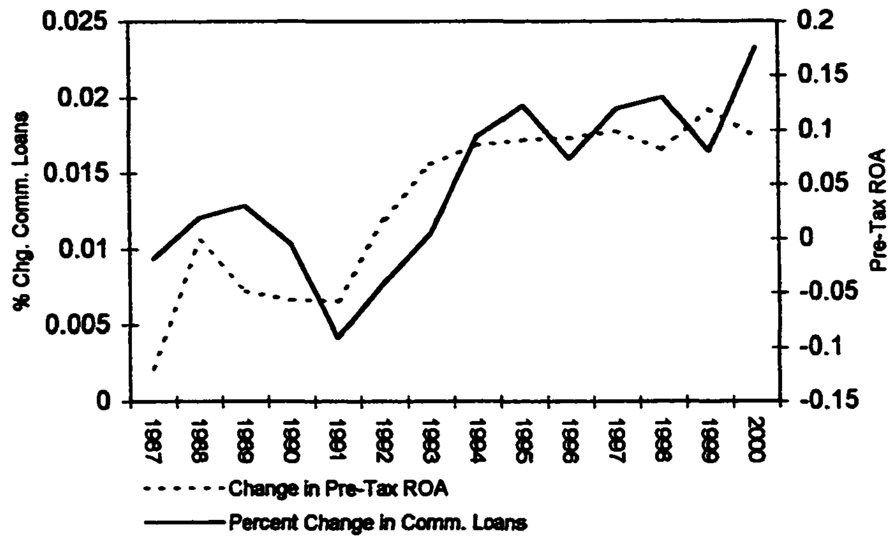
From mid-1989 through 1992, non-bank borrowers may have demanded fewer bank loans, relying on internally generated funds or other financing methods. Reduced demand may have been due to reduced overall demand for production, and hence less external funding needs. It may also have been due as mentioned above to less reliance on banks during that time due to the relatively higher cost of borrowing from banks. A further review of Figure 7 shows that GDP rebounded in late 1991, but commercial loan volume remained suppressed until late 1992. Coupled with Figure 8 that shows the prime rate/treasury bill ratio rising from 1990 through 1993, it appears that non-bank firms relied more on financing means other than banks during that time period. The model utilized in this study will provide insight into the primary determinant of the relationship between bank cost of borrowing and alternative cost of borrowing. If the relationship sign proves to be negative, the loan spread is primarily driven by demand as expected.

The relationship between *PT* and C&I lending may prove to be positive. For example, if prime rate increases relative the other short-term interest rates, banks may seek to increase loan volume to increase profits. If non-bank firms are dependent on bank financing for external funding, the demand for loans will be sustained. In this example banks control the supply of loans and benefit from receiving higher interest rates. No conclusion may be made on a priori grounds predicated solely on observation of Figure 8 to decide between demand side and supply side interpretation of *PT*. Additional discussion will be provided in the section of this study related to model results.

3.4c Commercial Loan Volume and Banks' Return on Assets:

As banks' return on assets increases, C&I loan volume is expected increase. Represented below in Figure 9 are annual data for the percentage change in commercial banks' pre-tax, pre-extraordinary income as a percentage of bank assets plotted against C&I loan volume. Intuitively, one would believe that improved profitability of banks leads to increased lending. Also, intuitively one would believe that increased lending should lead to improved profitability for commercial banks. Regardless of which variable leads the process, the relationship between the two variables is expected to be positive. Figure 9 portrays two variables that tend to move in the same direction. It is worth noting that because the figure has two scales, one may be misled into assuming that C&I loans are growing at a larger percentage than return on assets in recent years. However, upon closer observation it is apparent that, for example, on an annualized basis for 2000, C&I loans are growing approximately 2.3 percent, while return on assets is growing at a 10 percent annual pace. This conclusion is consistent with earlier discussion in this study related to the relationship between C&I lending and bank profitability composition. In recent years, a smaller percentage of bank profits has come from net-interest income, as displayed in Figure 6. Thus, banks appear to be increasing income faster through other types of loans or other non-income sources, such as fees, in order for return on assets to grow at approximately four times faster than C&I loan growth.

Figure 9
Pre-Tax ROA vs. Percent Change in Commercial Loans



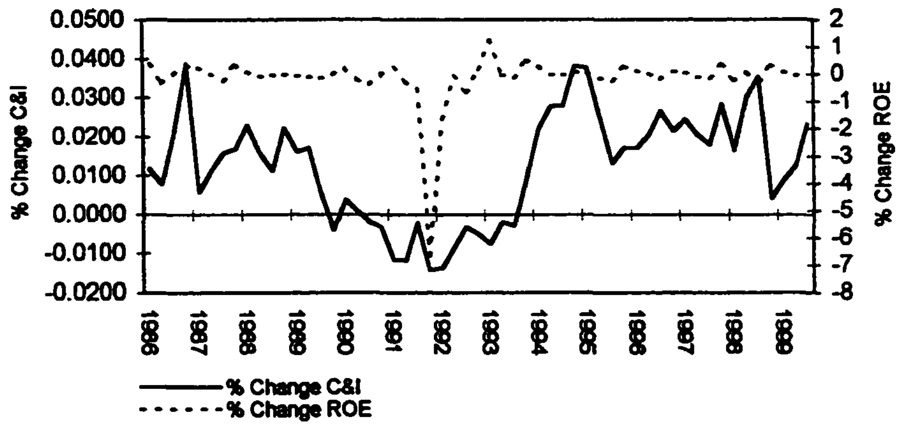
Source: Federal Deposit Insurance Corporation.

3.4d Commercial Loan Volume and Non-Bank Profitability:

As non-bank firms' return on equity improves, C&I loan volume is expected to improve, creating a positive relationship between the percentage change in C&I loans and the rate of return on equity for manufacturing firms. Himmelberg and Morgan (1995), and Oliner and Rudebusch (1996) provide empirical evidence that manufacturing firms are dependent on banks for a significant portion of their external financing. Therefore, it is reasonable to assume that the rate of return on equity for manufacturing firms is also dependent on loans from banks, as non-bank firms use bank loans for capital expenditures that create profits.

In Figure 10 below, quarterly percent changes in C&I loans generally move in the same direction as quarterly percent changes in manufacturers' return on equity. Graphical observation reveals that during the economic contraction in the early 1990s, C&I loan volume declined for an extended period of time as noted earlier. Manufacturers' return on equity, however, declined more dramatically than C&I loan volume, but for a shorter period of time during the economic contraction. The trough for both series plotted was quarter one of 1992. Given that both series below exhibit similar movements over time, a reasonable assumption is that a positive relationship exits.

Figure 10
Percent Change in C&I Loans vs. Percent Change in Manufacturing ROE



Source: U. S. Census Bureau and Federal Reserve Board Statistical Release H.8

3.4e Commercial Loan Volume and Interest Rate Volatility:

Lastly, C&I loan volume is expected to move inversely with interest rate volatility. Primary to this study is the belief that monetary policy innovation affects aggregate levels of C&I loans in the U.S. economy. This belief is well supported in the literature. Kashyap, Stein and Wilcox (1993) provide support that increases in the federal funds rate cause bank loans generally to decline. Bernanke and Gertler (1995) provide support for using the federal funds rate as an indicator of the stance of monetary policy with reference to works by Bernanke and Blinder (1992); and Christiano, Eichenbaum and Evans (1994 a,b).[14] Kashyap and Stein (1997) also refer to Bernanke and Blinder[15] regarding the validity of employing changes in the federal funds rate as a proxy for monetary policy stance. Bernanke and Blinder (1992) conclude that a contraction in monetary policy, as measured by changes in the federal funds rate, is followed by a decline in the volume of bank lending. Further reference is made to Bernanke and Mihov (1995)[16]. Research of Bernanke and Mihov provides evidence that the federal funds rate is among the best indicators of monetary policy stance prior to 1979 and during the tenure of Federal Reserve Board of Governors Chairman Greenspan (Kashyap and Stein 1997)[17]. This conclusion fits well with this study that utilizes the time period from 1984 trough 2000.

As the federal funds rate becomes more volatile, it is expected that bankers become increasingly more anxious about economic stability. This study measures federal funds rate volatility by measuring the coefficient of variation of the daily federal funds rate in that quarter. The 'normal' impact of federal funds rate variations operates in this study through variables such as non-bank firm return

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[14] See Christiano, Lawrence; Martin Eichenbaum and Charles Evans, "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds," *Mimeo*, Northwestern University, March 1994a.
See also Christiano, Lawrence; Martin Eichenbaum and Charles Evans, "Identification and the Effects of Monetary Policy Shocks," Federal Reserve Bank of Chicago, *Working Paper WP-94-7*, May 1994b.

[15] See Bernanke and Blinder, "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review*, September 1992, 82:901-921.

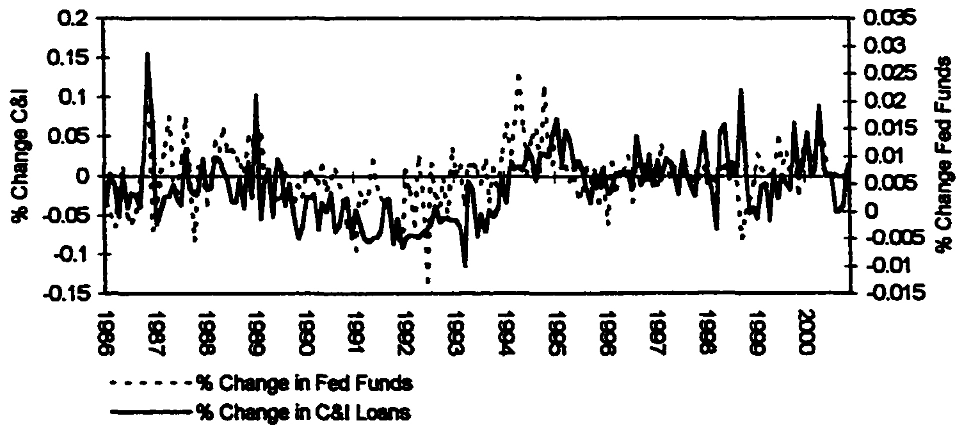
[16] See Bernanke and Mihov, "Measuring Monetary Policy," *Working Paper*, Princeton University, 1995.

[17] Chairman Greenspan has served as Chairman of the Board of Governors of the Federal Reserve System since August 11, 1987.

on equity, changes in the S&P 500 index, and the ratio of the prime lending rate to three month treasury bill rates. The concept of economic uncertainty serving to partially determine C&I loan volumes is consistent with the findings of Lown, Morgan and Rohatgi (2000) that commercial bankers react to economic volatility and uncertainty by constricting the supply of loans. Work by Stiglitz (1991) also emphasizes the manner in which commercial banks make credit decisions. He focuses on the idea that banks manage loan volumes by portfolio theory rather than managing loan volumes solely by interest rates.

Figure 11 below plots quarterly percentage changes in the federal funds rate against quarterly percentage changes in C&I loan volume.

Figure 11
Percent Change in Fed Funds vs. Percent Change in C&I Loans



Source: Federal Reserve Board of Governors Statistical Release H.8 and H.15.

Evidence from the literature cited above support the belief that C&I loan volumes and the federal funds rate move in an inverse manner over time. An increase in the federal funds rate leads to a decrease in C&I loan volume. As noted above by Kashyap and Stein (1997), such a relationship is consistent with a bank lending channel. It is also consistent with another interpretation. A decline in C&I loan volume could be driven by demand factors due to standard interest-rate effects on interest sensitive sectors of the economy. Thus, the impact of changes in the federal funds rate by the central bank may occur through both loan supply and loan demand.

4. Estimation Techniques and Expected Results

In order to model commercial loan activity over time, structural time series modeling will be utilized. Harvey (1993) argues that structural time series models provide the most useful framework for time series. He bases his argument on the fact that such models are explicitly based on the stochastic properties of the data and provide meaningful information (Harvey 1993). According to Harvey (1997), the ideal way to create an economic model is to construct a multivariate model using the original data. However, the modeling exercises in this study are more modest in scope. First, a number of lower dimensional univariate models are estimated rather than one higher dimensional multivariate model. This particular choice is conditioned on the unavailability of certain crucial data. Second, the models are estimated on seasonally adjusted rather than original data. Again, data availability is the constraining factor.

Several techniques are employed for modeling time series data other than structural time series modeling utilized for this study. Following is a brief description of alternative techniques available for time series studies along with suggested limitations of those models and improvements embodied in structural time series models.

4.1 ARIMA Models and Stationarity:

One popular method of modeling time series data is the *autoregressive-integrated-moving-average* (ARIMA) model. This modeling method is intended for only one series and not the causal modeling of many series utilized in this study. However, the technique of creating stationarity through differencing is utilized in the ARIMA model, and thus provides a useful framework for discussing the uses and shortcomings of differencing.

4.1a Stationarity:

The ARIMA method is based on the Box-Jenkins methodology of identifying the model by differencing to obtain a stationary series. A stationary series occurs when a set of observations fluctuates around a constant level and there is no tendency for its spread to increase or decrease over time (Harvey 1993). Stated differently, a stationary series has stochastic properties that are invariant with respect to time. Its mean does not depend in any way on time. While many time series in the physical sciences are stationary, most economic time series data are trending. That is, the mean changes over time. If the properties of the data are such that the mean changes over time, the series cannot be mean stationary. Box and Jenkins (1970) suggest that by taking differences most economic time series can be made stationary (Kennedy 1998, p. 264).

An example employing only a univariate time series model will help explain stationarity and differencing. A univariate time series model is one that attempts to explain the behavior of a variable, y_t, in terms of its own past. Consider, for example, a stochastic process y_t that follows a first-order autoregressive model:

$$y_t = \phi y_{t-1} + \varepsilon_t$$

where the term ε_t represents a sequence of uncorrelated disturbances with mean zero and constant variance. It is known as "white noise."

In the above equation, the variable y_t is characterized by a "random walk" if ϕ = 1. That is, this period's value is equal to last period's value plus a random error. If ϕ is within the unit circle, i.e. less than one in absolute value, the observations generated by the above equation will fluctuate around a mean of zero, i.e. the series is stationary (Harvey 1991, p. 11). Stationarity is an important concept in time series modeling. It is needed to avoid an explosive series, i.e. one where absolute ϕ is greater than one. However, as noted above, few economic time series actually display the characteristics of stationarity. The theory of stationary series may be applied to non-stationary series by taking first or second differences. This process creates an equation as follows:

$$\Delta y_t = \phi \Delta y_{t-1} + \varepsilon_t$$

where $\Delta y_t = y_t - y_{t-1}$.

If $|\phi| < 1$, then Δy_t is stationary even though y_t is not.

Once a stationary series is created by differencing, tools such as the sample autorcorrelation function may be employed to select the order of the autoregressive and moving average components (Harvey 1997, p. 193).

4.1b ARIMA Shortcomings:

A major objection to the ARIMA model arises according to Harvey (1997). The objection to ARIMA models concerns the model selection methodology. The methods suggested by Box and Jenkins (1976)[18] are primarily for the identification of simple models for large samples. However, more complex models with small samples are not appropriate for ARIMA methods. If the time series being studied is non-stationary and analysis of that series is dependent on taking the proper differences, an inappropriately specified model can create spurious results in forecasting (Harvey 1997, pp. 193-194). Thus, the limitations

[18] See Box, G.E.P. and Jenkins, G.M., *Time Series Analysis: Forecasting and Control*, San Francisco, Holden-Day Publishers 1976.

of ARIMA are sufficient that an alternative modeling technique should be used for time series if another technique more appropriately embodies the characteristics of the data being analyzed.

4.2 Vector Autoregression Models:

Vector Autoregression Models are often used for fitting multivariate time series. In its simplest form, a vector autoregression ('VAR') may be written as (Harvey 1991, p. 13):

$$y_t = \phi_1 y_{t-1} + \ldots + \phi_p y_{t-p} + \varepsilon_t$$

where y is a vector of endogenous variables.

Several of the studies referenced in this study employ VARs for time series analysis (Lown, Morgan and Rohatgi 2000; Walsh and Wilcox 1995; Gilchrist and Zakrajsek 1995). Lown, Morgan and Rohatgi (2000) support the use of VARs for analysis. Their contention is that a VAR provides information regarding the feedback among variables in a multivariate time series. That is, a VAR allows each variable in the system to depend on past values of itself and every other variable in the series. This is accomplished by regressing each current, non-lagged variable in the model on all variables in the model lagged a certain number of times (Charemza and Deadman 1997). This means that in a VAR, all the variables in the system are endogenous, i.e. explained by the model. Further, each variable can be written as a linear function of its own lagged values and the lagged values of the other variables in the system (Kennedy 1998, p. 168).

Harvey (1997) takes exception to the pervasive use of VARs. He contends that autoregressive models are employed because they are easy to fit by standard regression packages. He does agree that if a series is known to be stationary, fitting an autoregressive model is a sensible way to proceed. Further, he agrees that the short run may be modeled using a stationary VAR. However, working with non-stationary series in the long run, as is the case with most time series, is quite another matter. His primary objection to the use of VARs is that the results from autoregressive approximations can be very poor. For example, he contends that it is virtually impossible to fit an autoregressive model to data with a slowly changing seasonality. According to Kennedy (1998), others such as Cooley and LeRoy (1985) are also critical of the pervasive use of the VARs methodology.[19] Cooley and LeRoy claim that VARs are useful for forecasting but that the methodology should not be used for testing exogeneity and policy evaluation (Kennedy 1998, p. 173). Thus, while VARs are used extensively in modeling time series data, the technique has shortcomings that may be overcome with a different modeling approach.

4.3 Vector Error Correction Mechanisms:

An improvement over a pure VAR is a modification of the VAR technique incorporating cointegration restrictions that reflect long run equilibrium relationships. The vector error correction mechanism ('VECM') is useful for such purposes. It allows the researcher to test for a number of cointegrating relationships (Harvey, 1997).

Cointegration refers to a linear relationship among variables. Assume that there exist two variables that are of interest, y_t, and x_t. Assume further that both variables are driven by a stochastic trend, a random error, are non-stationary in

[19] See Cooley, T.F. and S.F. LeRoy, "Atheoretical Macroeconomics: A Critique," *Journal of Monetary Economics* 1985, 16: 283-308.

levels but stationary in first differences. Variable y_t and x_t are cointegrated if the two random walk errors are linearly dependent (Zietz 2000). As discussed earlier, non-stationary variables tend to wander according to a random walk. However, some pairs of non-stationary variables may wander in such a way that they do not drift too far apart due to forces that tend to keep them together. Examples are short and long-term interest rates; wages and prices; and household income and expenditures (Kennedy 1998, p. 269). The concept of cointegration is that it is a method available to identify long-run relationships contained in trended data. The basic concept behind cointegration analysis is for the researcher to avoid spurious regression results from trended data. That is, spurious regression results can occur if two or more trended, but economically unrelated variables are regressed against each other with the result of a high coefficient of determination (Zietz 2000).

Vector Error Correction Mechanisms were designed to overcome some of the shortcomings of the Box-Jenkins methodology employed with ARIMA models. Recall that Box and Jenkins suggested that non-stationarity could be corrected by taking differences to yield the data stationary. Doing so necessarily means that valuable information from economic theory concerning long-run properties of the data is lost. Error Correction Mechanisms mix data in levels and differences in the same equation. If the levels are non-stationary and the differences are stationary, the results could be spurious. However, if the level variables can be shown to be cointegrated, i.e. stationary in combination, then the Error Correction Mechanism will not yield spurious results (Kennedy 1998, pp. 269-270).

Fundamental problems exist, however, regarding the use of cointegration analysis for time series data. First, while cointegration in principle identifies one or more linear relationships among variables, nothing exists in the technique that insures that the identified cointegrated vectors are economically meaningful. Second, a sufficient number of observations are needed to detect common factors among stochastic trends of variables. This creates a problem for cointegration analysis in economics. The longer the time horizon measured, the more likely the trend is to change over time. As a consequence, no unique cointegrating vector will be identified. Thus, one can be of the opinion that cointegration analysis is more suited to fields of study where the underlying structure does not change, e.g. the natural sciences and not a social science such as economics (Zietz 2000).

4.4 Structural Time Series Model:

This study employs a structural time series model for the two equations. One of the primary purposes for analyzing time series data is to establish stylized facts, or empirical regularities (Harvey 1993 reference to Blanchard and Fischer 1989).[20] For the stylized facts to be useful for analysis, they need to be consistent with the stochastic properties of the data surveyed and present meaningful information. Because structural time series models are explicitly based on the stochastic properties of the data surveyed, the models provide the most meaningful framework within which to assess time series (Harvey 1993, p. 231).

Structural time series models contain unobserved components and variables that are observed. A general model may be expressed as follows:

$$y_t = \mu_t + \psi_t + \alpha x_t + \varepsilon_t \qquad t = 1\ldots\ldots.T$$

[20] See Blanchard, O.J. and S. Fischer, *Lectures in Macroeconomics*, MIT Press, Cambridge, Massachusetts 1989.

where, y_t is the observed series, μ_t is the trend, ψ_t is the cycle, x_t represents the regressor variable, and ε_t is the zero mean irregular component that is assumed to be uncorrelated with any stochastic elements in μ_t. The trend is the long-run component of the series. It indicates the general direction that the data are moving. A local level trend is defined as:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t \qquad \eta_t \sim \text{NID}\ (0,\sigma^2_\eta)$$
$$\beta_t = \beta_{t-1} + \zeta_t \qquad \zeta_t \sim \text{NID}\ (0,\sigma^2_\zeta)$$

where β_t is the slope and the normal white-noise disturbances η_t and ζ_t are independent of each other. The effect of η_t is to make the level of the trend stochastic. The effect of ζ_t is to allow the slope to be stochastic. Many models for time series employ a global time trend, represented by a deterministic function of time. The drawback with such models is that all observations receive the same weight for the purpose of forecasting. A local trend model such as portrayed above has the advantage that the trend and slope may change direction during the sample. The most recent direction is given more weight and used to extrapolate into the future for forecasting purposes (Harvey 1993, p. 109). The faster the level and slope change, the more weight is placed on the most recent observations and past observations are discounted accordingly (Harvey 1997, p. 193).

Structural time series models have an advantage over other models mentioned above in that the level and slope parameters may change over time. This is accomplished by assuming that they follow random walks. That is, structural time series models can be interpreted as simple regression models with unobserved components that are functions of time (Harvey 1993, p. 121). A primary attribute of structural time series models is that differencing is not usually necessary in order to specify a useful model. Interpretation of the model is made much easier if the model can be discussed in levels (Harvey 1997, p. 193). Additionally, such models provide a mechanism for unobserved components such as trends and cycles to be estimated. This feature allows the investigator to provide a more complete description of the series, and hence improved forecasts (Harvey 1993, p. 5). The unobserved components have another advantage: they can provide the applied economist that is interested in causal analysis with a starting point in the effort to replace at least some of the unobserved components with observed explanatory variables. In a sense, the unobserved components provide a challenge to the researcher interested in more than forecasting for finding observable equivalents.

5. Model Results

5.1 Determinants of Banks' Return on Assets:

As discussed in section 3 of this study, the first objective is to explain banks' return on assets as a function of such variables as the level of non-performing assets, commercial loan volumes, reserve requirements, and the number of commercial banks. The level of profits earned by banks and proxied by ROA is believed to be a primary determinant of many decisions made by banks' management, including the level of commercial and industrial loan volumes extended. Profits increase net worth, and increased net worth provides banks with the opportunity to attract additional deposits, which are used in turn to increase the amount of loans made.

Lown, Morgan and Rohatgi (2000) provide evidence that banks actively change the supply of C&I loans rather than only respond passively to changes in demand. This study attempts to provide the next logical step: to identify and measure the importance of the variables that cause banks to expand or contract loan volumes.

Table 4 below provides summary results from four different structural time series models. Models 1 and 2 are identical with one exception. The variable *RR(-1)*, defined in Table 2, is omitted in Model 2 because it is not statistically significant at the five percent level. Models 3 and 4 both expand on Model 2. In particular, Model 3 adds one unobserved component, a cycle. Model 4 adds 2 cycles. Models 2, 3, and 4 will be discussed in turn.

TABLE 4. DETERMINANTS OF BANKS' RATE OF RETURN ON ASSETS (ROA), 1984:4-2000:2 (63 OBS)

Variables	Model 1	Model 2	Model 3 (Model 2 with 1 Cycle)	Model 4 (Model 2 with 2 Cycles)
Nbanks(-1)	-0.001603 (-4.50)	-0.001592 (-4.39)	-0.001176 (-3.65)	-0.00096 (-3.23)
RRh	0.0119 (2.83)	0.00796 (2.76)	0.00803 (2.94)	0.00604 (2.33)
RR(-1)	3.460 (1.30)			
(DRQ*RR)(-1)	0.9274 (7.50)	0.9569 (7.67)	0.9553 (7.04)	1.0401 (8.54)
HP_CR	-0.00434 (-2.55)	-0.00457 (-2.66)	-0.00414 (-2.41)	-0.00438 (-2.72)
ΔNPTL(-1)	-0.3295 (-4.21)	-0.2903 (-3.87)	-0.2608 (-3.38)	-0.2300 (-3.16)
ΔNPTL(-2)	-0.1585 (-2.43)	-0.1327 (-2.10)	-0.1022 (-1.63)	-0.0498 (-0.80)
level = constant	11.300 (2.79)	14.70 (4.80)	11.16 (4.12)	9.347 (3.73)
slope = stochastic; final state value	-0.1176 (-2.56)	-0.1171 (-2.46)	-0.0924 (-2.46)	-0.0759 (-2.07)
R^2	0.9275	0.9252	0.9308	0.9395
Rd^2	0.7539	0.7460	0.7652	0.7948
Normality	0.0776	0.2456	1.773	15.08**
Heteroskedasticity	0.4683	0.4552	0.3835	0.3375
DW	1.770	1.776	1.905	2.068
Box-Ljung Q(P,d)	Q(7,6) 6.147	Q(7,6) 8.882	Q(10,6) 12.97*	Q(13,6) 7.098
Chow F(8, 53)	0.753	0.635	0.466	0.430
Failure $\chi^2(8)$	6.188	5.407	4.506	4.097

Notes: T-values are provided in parenthesis. R^2 compares model fit against mean of dependent variable; Rd^2 uses first differences as comparison. Normality - Bowman-Shenton (1975) statistic, approximately distributed as χ^2 with 2 degrees of freedom (5% critical value = 5.99); Heteroskedasticity - heteroskedasticity test, distributed as F(20, 20) (5% critical value = 2.12) ; DW - Durbin Watson statistic, distributed approximately as N(2, 4/T); Box-Ljung Q(P,d) - Q-statistic by Ljung and Box (1978) based on P autocorrelations, distributed approximately as χ^2 with d degrees of freedom. Chow (h,j) is a within-sample predictive test for the last h observations, distributed as F(h, j). Failure χ^2(h) is an out-of-sample predictive test for the last h observations. * and ** indicate rejection of null hypothesis at the 5 percent and 1 percent level, respectively.

Model 1 in Table 4 explains ROA as a function of 1) the number of insured commercial banks in the United States, lagged by one period; 2) the percent change in reserve requirements; 3) reserve requirements lagged one period; 4) an interaction term between reserve requirements and a dummy variable that is one for the period of Regulation Q; 5) deflated and detrended commercial and industrial loan volume; and 6) the percentage change of non-performing loans, lagged one and two quarters, in bank loan portfolios. All variables are statistically significant at the five percent level or better with the exception of lagged reserve requirements *(RR-1)*.

Model 2 in Table 4 includes all statistically significant variables from Model 1. The results of Model 2 are essentially the same as those of Model 1. There are no significant differences. In what follows, the estimation results for each variable of Model 2 are discussed.

5.1a Number of Banks:

Model 2 suggests that banks' return on assets is negatively related to the number of banks in the economy. Intuitively this makes sense in that fewer banks in the economy should create economies of scale in the delivery of loans. The same amount of loan volume spread over fewer operating and fixed asset costs results in a greater return on the assets employed. The results obtained are also consistent with the idea that return on assets has increased in general for banks at the same time the banking industry has been consolidating. This could be the result of better technology employed in information gathering and loan underwriting over the time period measured. Thus, productivity improvement in loan underwriting, resulting in improved profitability on the assets employed, may be occurring at the same time that the banking industry is consolidating. Also, as discussed in section 3.3, increasing market power due to asset concentration from banking industry consolidation may positively impact banks' ROA.

5.1b Percentage Change in Reserve Requirements:

Banks' return on assets is negatively impacted by increases in reserve requirements. Variable *RRb* measures the annualized percentage change in the monetary base adjusted for reserve requirement changes divided by the monetary base. Loungani and Rush (1995) suggest this variable as a summary measure of changes in reserve requirements on the economy as a whole. They find that increases in reserve requirements have an adverse impact on real activity. If real activity is negatively impacted by increases in reserve requirements, it follows that banks' return on assets should also be negatively impacted by those same increases. *RRb* is shown to move in the same direction as ROA. As reserve requirements increase, the numerator of the variable *RR* decreases, causing the total percentage change to decrease as well. Because the percentage changes of the variable decreases with an increase in the reserve requirements, the variable *RRb* moves in the same direction as ROA.

5.1c Level of Reserve Requirements and Regulation Q:

Reserve requirements are typically thought to have had a significant impact on banks' ROA only prior to 1987; that is, prior to the phase out of Regulation Q. Under Regulation Q, banks were less able to pay market interest rates to attract non-transaction deposits, and an increase in interest rates by the Federal Reserve had a direct negative impact on the level of reserves in the banking system. As reserves were decreased, banks were less able to create new loans. When reserves decreased, banks' ROA also decreased.

The relationship between ROA and the level of reserve requirements is shown by the variables *RR(-1)* and *(DRQ*RR)(-1)*. To make the relationship between ROA and reserve requirements more obvious, it is helpful to consider the following equation

ROA = a + b RR(-1), where b = b0 + b1*(DRQ)(-1)

This equation suggests that the variable *RR* affects ROA but that the relationship depends on the dummy variable *DRQ*, which is unity for the period of Regulation Q. Statistical insignificance of b0, together with statistical significance of b1, suggests the variable *RR* has a significant impact on ROA only during Regulation Q. This would be consistent with the popular belief that there is a relationship between ROA and reserve requirements only under Regulation Q.

5.1d C&I Loan Volume:

Commercial and industrial loan volume is deflated by the GDP price index and detrended using the Hodrick-Prescott filter (variable *HP_CR*). Its impact on banks' ROA is significant in all four models tested. *HP_CR* has a negative relationship with banks' return on assets. The negative relationship is as expected. Above trend commercial and industrial loan growth results in a decrease in banks' return on assets. This relationship makes sense assuming that lending at levels significantly above trend levels occurs as banks reduce normal borrower credit-worthiness requirements for prudent loan underwriting. Initially bank profits may increase from above trend loan volumes. However, as banks relax underwriting standards to induce above trend lending levels, increased loan defaults may ultimately result, decreasing bank profits. This creates the negative relationship between ROA and above trend C&I lending volumes.

5.1e Non-Performing Loans:

This variable represents the change in the percentage of non-performing loans, i.e. loans 90 days or more past due and loans on non-accrual status. As expected, as non-performing loans increase, banks' return on assets decreases. Loans on non-accrual do not, by definition, earn interest and therefore cannot contribute to profits measured by return on assets. Also, non-accrual loans generally precede loan losses that further reduce profits. Thus, increases in non-performing loan levels cause return on assets to decline. As measured in Model 2, this holds true for changes in non-performing loan levels lagged for one and two quarters.

5.1f Unobserved Components and Goodness of Fit:

The structural time series models employed allow for a random walk component to capture the underlying level, μ_t, plus a random 'white noise' disturbance term, ε_t. The underlying level is allowed to be stochastic, expressed as follows:

$$y_t = \mu_t + \varepsilon_t, \quad \varepsilon_t \sim NID\,(0, \sigma^2_\varepsilon) \quad t = 1 \ldots T$$

$$\mu_t = \mu_{t-1} + \eta_t, \quad \eta_t \sim NID\,(0, \sigma^2_\eta) \quad t = 1 \ldots T$$

The level is the actual value of the trend. If the level is not stochastic, i.e. if it has the characteristics of a constant as in an OLS regression, the general expression becomes:

$$y_t = \mu + \varepsilon_t, \quad \varepsilon_t \sim NID\,(0, \sigma^2_\varepsilon) \quad t = 1 \ldots T$$

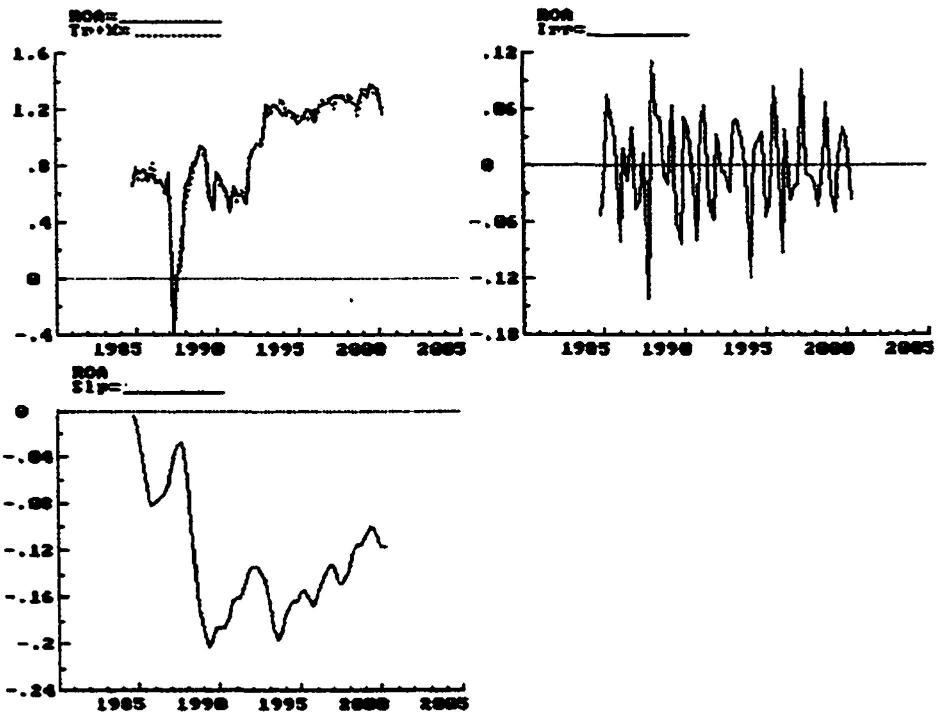
$$\mu_t = \mu_{t-1}.$$

In the above general expression, the random error term for the level is omitted, thus making the level function a constant. This is the case in Table 4 for all four models tested. In all cases tested, a constant level is statistically significant and there is no evidence that the level changes over time.

The slope of the function is also allowed to fluctuate. In all four models reported in Table 4, the slope is stochastic. Table 4 reports only the value of the slope for the final observation of the sample. For example, Model 2 has a final state slope value of –0.1171. However, as may be observed below in the ROA slope graph, the slope has fluctuated over the years.

Following are figures of various components of Model 2 from Table 4:

Figure 12: Components of Model 2 from Table 4:



Model 2 provides strong goodness of fit for the determinants of banks' return on assets. The R^2 for the model is 0.9252 and the Rd^2, using first differences as comparison is 0.7460.

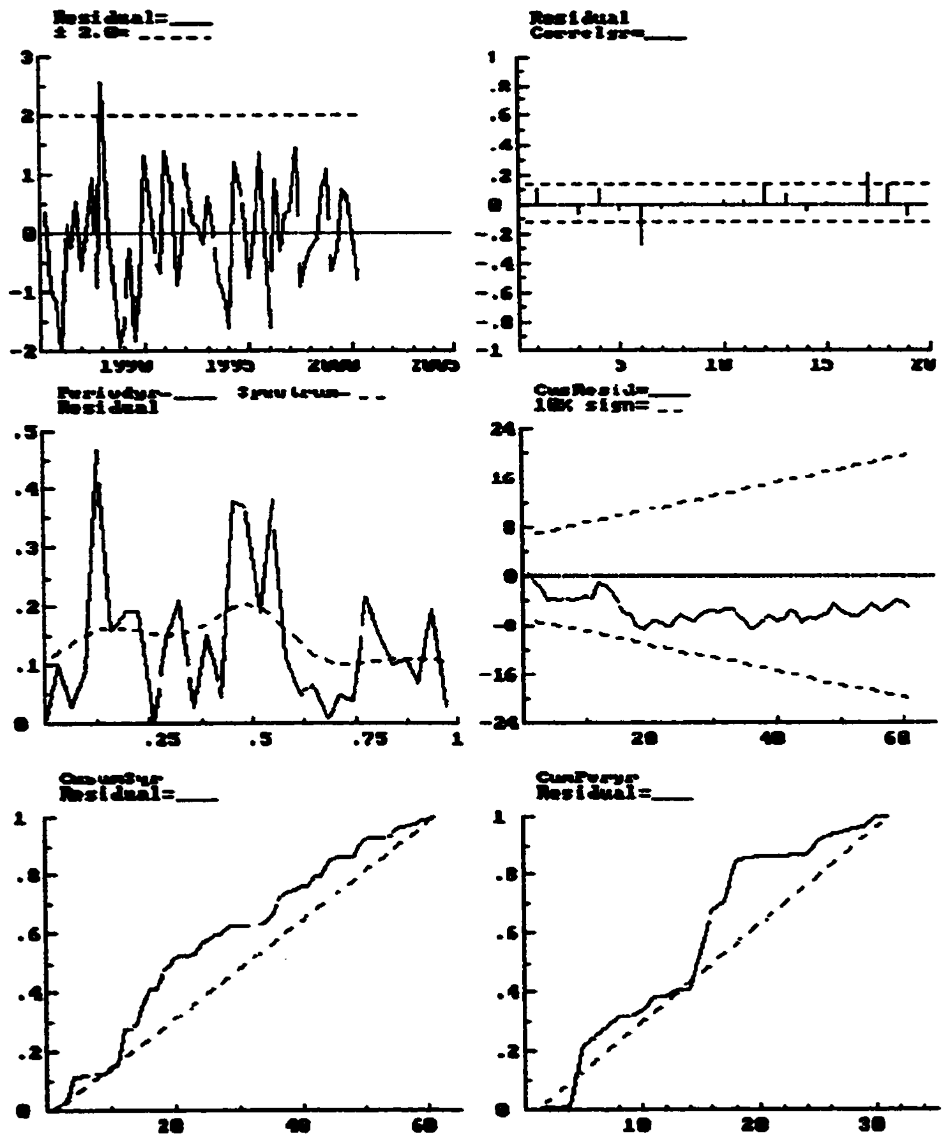
5.1g Model 2: Trend versus Actual:

As may be observed above in the figure titled "ROA Tr+x" the fitted values of the model and the actual observations are closely correlated. The irregular component or residual, graphed above as "ROA Irr," appears well behaved, moving around a mean of zero.

5.1h Model 2: Residual Analysis:

Following are figures representing residual results for Model 2 from Table 4:

Figure 13: Residual Analysis of Model 2--Table 4:



The first figure above titled "Residual" shows the variation in the model residuals around a mean of zero with a designation of plus or minus two standard deviations. With the exception of 1988, the residual series is well behaved as mentioned in section 5.6a. The remaining figures supply evidence that the reported model provides a reasonable approximation of the actual data generating process. For example, the figure titled "Residual Correlgr=" portrays the correlogram for the residuals of Model 2. The correlogram is a plot of the autocorrelation function and is used as a visual aid for identification in Box-Jenkins type modeling (Kennedy 1998, p. 278). If the time series modeled is stationary, the correlogram should fall off to numbers insignificantly different from zero. The figure above does contain some spikes when measured by the 95 percent confidence band representing plus or minus two standard deviations, but overall appears reasonably stable.

Harvey (1990) states that a good deal of information regarding the appropriateness of a model may be obtained by plotting the residuals and examining them for any distinctive patterns (Harvey 1990, p. 153). The Cusum technique is applied by plotting the cumulative sum of the residuals against time. If the model is incorrectly specified, a disproportionate number of recursive residuals will have the same sign, and there will be a tendency for the plot to move away from the mean of zero. The dotted line in the above figure titled "CusResid=" represents a significance level of ten percent. As may be observed, the model appears reasonably stable with no violations of the ten percent significance level. Some evidence of a structural break is apparent in the CUSUM test at about quarter twelve, or approximately 1987. This evidence was assessed, and combined with an a priori assumption regarding the phase out of Regulation Q at the end of 1986. The assumption stated earlier in this study is that the phase out of Regulation Q provided banks with the ability to insulate loan portfolios to some degree from changes in reserve requirements. Accordingly, a dummy variable was included in all four models related to the structural break in quarter one of 1987. This dummy variable is significant in all four models tested.

Harvey does caution that the CUSUM technique is best regarded as a 'data analytic' technique. The value of the plot lies only in the information gained by inspection. It is not a formal test of significance (Harvey 1990, p.155).

The figure titled "Periodgr=___Spectrum=" is useful to aid in identifying possible cycles within the series. The dotted line representing the spectrum provides evidence that a return on assets cycle of approximately four years may exist. This is calculated by dividing two by the scaled frequency on the horizontal axis of the figure. Based on the possibility of a cycle, a third and fourth model are added including one and two cycles, respectively.

5.1i Model 3 and Model 4 Comparisons to Model 2:

Model 2 fits well, yet it appears that there may be room for the addition of a cycle or two. Model 3 and Model 4 explore this possibility of adding a cycle as an unobserved component. Model 3 has one cycle included and Model 4 has two cycles included in the analysis. Very little difference is observed in the results from Models 3 and 4 versus Model 2. Most tests for goodness of fit for Models 3 and 4 are very close to those of Model 2. One variable that is significant in Model 2 but not in Models 3 and 4 is *ΔNPTL(-2)*, the change in the ratio of non-performing loans to total loans lagged two quarters. Additionally in Model 4, normality of the residuals appears to be rejected at the one percent level, creating a question about the ability of Model 4 to capture the data generating process of ROA. Finally, the Failure Chi-Squared out-of-sample predictive test is not as strong for Models 3 and 4 as it is for Model 2.

Additional figures for Models 3 and 4 may be found in the appendices of this study.

5.1j Concluding remarks on the determinants of ROA:

Of the four models tested, Model 2 appears to be the least complicated model that adequately represents the determinants of banks' return on assets over the time period measured. According to this model, return on assets for banks is determined by the number of banks, reserve requirement changes, C&I loan volume, and the amount of non-performing loans in relation to total loans. A stochastic trend captures longer-run trend changes in the variable ROA, with some particularly strong changes right after the phase-out of Regulation Q.

5.2 Determinants of Commercial and Industrial Bank Lending:

Table 5 below provides the estimation results for three alternative models that try to explain C&I loan volume. Models 1 and 2 share the same explanatory variables but make different assumptions about the existence of unobserved components. Both models have a constant level in common. This means that the level is not subject to any trend, neither deterministic nor stochastic. It should be noted that all models in Table 5 were initially specified with a stochastic level and slope. However, neither turned out to be statistically significant. Model 1 is a structural time series model without any unobserved component. As such, it is equivalent to a simple OLS regression. Model 2 incorporates one unobserved component, a cycle. Model 3 is the same as Model 1 with the substitution of an ROA measure that is adjusted for the number of banks. The R^2 for all three models is reasonably high, and no other statistical adequacy test suggests a statistical problem any of the models. That includes a relatively demanding 20 period ahead out-of-sample forecasting test.

TABLE 5. DETERMINANTS OF COMMERCIAL AND INDUSTRIAL BANK LENDING (GROWTH RATE), 1984:4 - 2000:2

Variables		Model 1		Model 2 (Model 1 with cycle)		Model 3
CRh(-1)		0.6578		0.5525		0.6631
		(8.21)		(6.13)		(8.31)
ROA(-1)		2.664		2.276	ROAD(-1)	3.315
		(2.43)		(2.05)		(2.57)
ΔVOLFF(-1)		-2.5348		-1.765		-3.014
		(-1.49)		(-1.07)		(-1.71)
ΔVOLFF(-2)		-4.0056		-3.296		-4.614
		(-3.25)		(-2.70)		(-3.47)
ΔPT(-1)		-22.330		-22.748		-21.530
		(-3.85)		(-4.11)		(-3.70)
ROEBUS(-1)		0.1236		0.1374		0.1466
				(1.71)		(1.86)
SP500h(-1)		-0.0491		-0.0503		-0.0511
		(-3.48)		(-3.72)		(-3.60)
D87_1		14.125		12.176		14.768
		(3.40)		(2.99)		(3.51)
D98_3		6.023		5.729		6.51
		(2.43)		(2.38)		(2.65)
level = constant		-1.663		-1.056		-2.846
		(-1.45)		(-0.93)		(-1.95)
R^2		0.8312		0.8451		0.8331
Normality		2.525		2.445		3.379
Heteroskedasticity		0.6047		0.6265		0.6179
DW		2.112		2.133		2.133
Box-Ljung Q(P,d)	Q(6,6)	3.645	Q(9,6)	5.642	Q(6,6)	2.897
Chow F(19, 42)		0.9710		0.9755		0.9727
Failure $\chi^2(20)$		24.984		24.984		24.687

Notes: see Table 4 for statistical notes.

5.2a Prior Period Growth of C&I Loans:

In all models presented in Table 5, the annualized percentage change in C&I loans depends on prior period C&I loan growth. Changes in C&I loan growth this quarter have a positive impact on the value of C&I loan growth in the next period. This conclusion is as expected based on habit-persistence theory (Kennedy 1998, p. 143). Bankers are believed to use prior period circumstances combined with current period expectations to determine the volume of credit extension available to customers. This conclusion is also consistent with assumptions regarding the demand for loans. If business conditions are favorable in the current period, non-bank firms seek bank financing for investment projects on the assumption that the next period will also bring similar favorable conditions. Thus, prior period C&I growth may be viewed as either a demand or a supply side determinant of commercial and industrial loan growth.

5.2b Return on Assets and C&I Growth:

As anticipated, banks' return on assets is positively related to the rate of growth in banks' C&I loan portfolios. Bank profits increase bank net worth allowing banks to attract more deposits that may be used to extend more loans. This relationship is shown to be significant in all three models tested. Additionally, Model 3 from Table 5 substitutes the level of ROA adjusted for the number of banks versus Model 2. Both variables are similarly significant such that either may be used as an acceptable independent variable. Feedback between C&I loan growth and banks' ROA does occur, although not in the same period. Therefore, no simultaneous equation problem arises. As observed in Table 4, banks' return on assets is dependent on the deflated and de-trended volume of C&I lending. In Table 5, the annualized percentage growth rate in C&I lending is dependent on banks' return on assets. This feedback relationship is not unexpected and is consistent with the premise of this study, i.e. that banks derive a significant portion of their income from C&I lending and that C&I lending is, in part, determined by the ability of banks to attract deposits. Banks that are capital constrained have been shown to reduce lending (Peek and Rosengren 1995; Peek, Rosengren, and Tootell 2000). Capital constraints can arise from lower net worth due to profitability losses. Capital constraints may also be a relative term. That is, if loan demand is greater than a bank's ability to supply those loans due to inadequate funding as a function of net worth, then the bank's ROA is not maximized. Thus, banks' ROA serves to drive the level of C&I loans observed in the economy.

5.2c Interest Rate Volatility and C&I Loan Growth:

The use of the federal funds rate as a proxy for monetary policy innovation has been well documented in the literature and detailed earlier in this study. As expected, changes in the volatility of the federal funds rate in the more recent past have a statistically significant impact on C&I loan growth in all three models. Additionally, the ratio of the prime lending rate to the three-month treasury bill rate, which is a proxy for alternative uses of bank reserves, is also significant for all three models. Both the federal funds rate volatility and the prime rate/T-bill ratio are negatively related to the growth rate of C&I Loans. As interest rate volatility increases, economic uncertainty increases and both banks and non-bank borrowers may become more cautious about extending or seeking credit respectively. Both $\Delta VOLFF(-2)$ and $\Delta PT(-1)$ may be viewed as either supply or demand side determinants of C&I loan growth. It is assumed, however, that federal funds rate volatility is more closely related to bank loan supply levels. By definition the federal funds rate is the rate at which banks lend to other banks over night. Thus, the federal funds rate is both an economic barometer for commercial banks and an investment option for those banks. Accordingly, banks are more likely to closely monitor the federal funds rate and use the rate's volatility as a measure of economic conditions in making decisions on their lending activity.

5.2d S&P 500 Percentage Change and C&I Growth:

Another statistically significant variable is the annual percentage change in the S&P 500 stock market index lagged one quarter. This variable is significant for all three models. Banks may consider this variable as an indicator of economic confidence. However, this index is thought to be more closely associated with the demand for C&I loans than with the supply of C&I loans. One would assume that as non-bank firms increase earnings, or as economic confidence of investors increases, the S&P 500 index increases. Improved non-bank firm earnings and buoyant investor confidence also should precede increased loan demand for investment purposes. However, the relationship between the S&P 500 index and C&I loan growth is negative. This could suggest that non-bank firms generate more non-borrowed funding as the equity index improves. An improved equity fund index provides an incentive for non-bank firms to generate external funding from the equity market versus bank borrowing. Such a scenario would explain the negative sign and also lend support to the idea that the S&P 500 index is most likely a loan demand-side variable. Thus, while no clearly defined separation is available to categorize this variable as either supply side or demand side, it more likely belongs onto the demand side.

5.2e Structural Breaks and C&I Loan Growth:

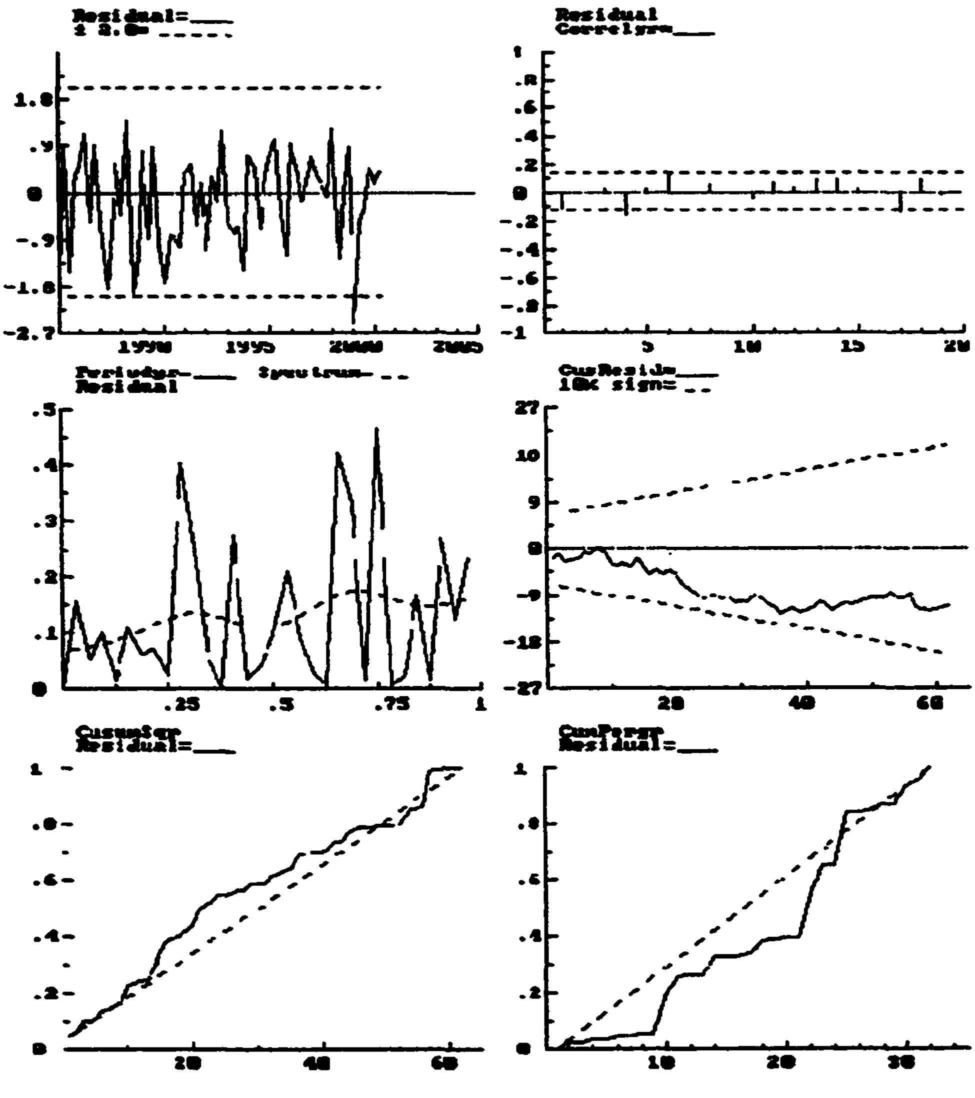
Based on a careful analysis of residuals, two observation-specific structural breaks are determined. Both structural breaks are significant in all three models. First, as expected and discussed earlier, the final phase out of Regulation Q in 1986 allowed banks to seek deposits at prevailing market rates without being constrained by regulations. A dummy variable for quarter one of 1987 is included in the models to represent the expiration of Regulation Q. The data show that a change did occur at the completion of Regulation Q.

Also noteworthy is a structural break at quarter three in 1998. In the fall of 1998 banks abruptly tightened lending standards. However at that time, demand for loans remained strong. This abrupt constraint of credit is attributed to a jump in bond yields and the resulting shift in non-bank firm financing from the bond market to banks (Keeton 1999). The Federal Reserve Board of Governors Survey of Senior Lending Officers supports this contention by Keeton by stating in the November 1998 report that less favorable and more uncertain economic conditions caused lenders to tighten credit standards at that time.

A number of factors contributed to the increase in bond yields in the fall of 1998. According to Alan Greenspan, Chairman of the Federal Reserve Board of Governors, Asian economies such as Thailand began experiencing difficulties in 1997. Concern for other economies in East Asia grew, along with concern for the Russian economy (Greenspan 1998). In mid-August of 1998, Russia announced an effective devaluation of the ruble and declared a debt moratorium. This shocked investor confidence across world markets. As a consequence, equity and debt markets worldwide became more volatile. Spreads between U.S. Treasury securities and higher-yielding debt instruments also widened sharply.

At the same time, a leveraged investment fund, Long-Term Capital Management, absorbed and acknowledged significant losses, approximating fifty-two percent for eight months. The magnitude of the losses incurred by Long-Term Capital, along with other global events fueled investors nervousness about the stability of economies globally (McDonough 1998). Thus, the combination of external market crises combined with equity and bond market volatility caused domestic bankers to abruptly constrain credit during quarter three of 1998.

Figure 14: Residual Analysis of Model 1 from Table 5:



Visual inspection of residual analysis for Models 1, 2, and 3 from Table 5 reveal very little difference in model results. All three models appear to have reasonable fit in terms of explaining C&I loan growth rates. The above "Residual" figure from Model 1 shows that with the exception of late 1998, the model explains the dependent variable reasonably well. The correlogram for explaining C&I loan volumes looks very much like the correlogram used to assess the earlier ROA model. Similar to the ROA model, the Spectrum analysis also indicates the potential for a cycle within the data. The potential cycle also appears to run in approximate four-year terms for C&I loans. Finally, the CUSUM figure above does not provide visual evidence that the model is inconsistent with the data.

As with the equation explaining bank ROA, additional figures representing C&I loan growth determinants may be found in the appendices at the end of this study.

5.2f Determinants of C&I Loan Growth Conclusions:

Commercial and industrial loan growth has been shown to be positively determined by banks' return on assets, the percentage change in the prior quarter C&I loan level, and borrowing firms' return on equity. Regulatory events influencing quarter one of 1987 and economic events in quarter three of 1998 also impact loan growth. C&I loan growth has been shown to be negatively related to increased uncertainty as measured by the volatility of the federal funds rate within a given quarter. Other negative influences on loan growth come from the interest rate spread between prime rate and three-month treasury bills, and the S&P 500 stock index.

It is apparent that C&I lending by banks is driven by a combination of supply- and demand-side variables. This study provides empirical evidence that economic variables such as interest rates have a significant impact on loan growth in the economy. Banks' return on assets also plays an important role in establishing the level of C&I loan growth. Changes in reserve requirements have been established as an implicit tax on banks. Excessive loan losses from non-performing loans also create downward pressure on bank earnings. If reserve requirements or non-performing loans increase, banks provide fewer loans. Both factors are shown to be important in determining banks' return on assets. ROA for banks, in turn, is a primary determinant of C&I loan volumes. Thus, banks' ROA can be interpreted as a supply-side determinant for loans.

5.3 Loan Officer Credit Standards:

Lown, Morgan and Rohatgi (2000) provide empirical evidence that bank lending officers actively change the supply of C&I loans made available to the market. This is done most often through methods other than loan pricing. For example, credit or covenant standards may be made more stringent, or collateral requirements may be increased as a means to reduce the number of qualifying borrowers for credit. Lown, Morgan and Rohatgi's study demonstrates that loan supply may be managed by commercial banks. It does not offer evidence as to what drives the decision by bank officers to adjust the supply of credit made available. To offer more insight into this question, the data used by Lown, Morgan and Rohatgi (2000) from the Board of Governors of the Federal Reserve System Senior Loan Officer Survey is also employed in this study. The Loan Officer Survey utilizes quarterly data from 1984 to 2000. Because the Senior Loan Officer Survey did not provide questions related to credit standards for the time period 1984 –1990, a limited sample of only 32 observations is available for this study. Additionally, the data has some missing values. Thus, the regression results based on these data have inherent limitations but can serve to augment the analysis of this study.

By adding the variable *LOCS* to Model 3 in Table 5, the impact of loan officer opinion on C&I loan growth may be calculated. The resulting equation illustrates the impact of *LOCS* on C&I loan growth:

$$CRh = 9.34 + 0.62\,CRh_{-1} - \Delta 19.17\,PT_{-1} - 0.084\,SP500h_{-1} + 0.2278\,ROEBUS_{-1}$$
$$(2.01)\quad (8.35)\qquad (-3.40)\qquad (-4.77)\qquad (3.52)$$
$$-\,7.34\,ROAD_{-1} - 5.439\,\Delta VOLFF_{-1} + 7.513\,\Delta VOLFF_{-2} + 5.80\,D98\_3 - 11.15LOCS$$
$$(-1.80)\qquad (-1.03)\qquad (1.51)\qquad (3.31)\qquad (-2.43)$$

$R^2 = 0.9468$, DW = 1.84, p-values for : LM-Het = .46, J-B Norm = 0.70

In the above equation, parenthesis terms identify t-values. The tests for autocorrelation, heteroskedasticity and normality of residuals do not identify an apparent model specification. The variable *LOCS* has the expected sign. When loan officers tighten credit standards, C&I loan growth is expected to decline. The above test confirms this. By adding the variable *LOCS* to Model 3 from Table 5, it may be observed that the variables that are suggested to be demand-side shifters such as ΔPT_{-1}, $SP500_{-1}$, and $ROEBUS_{-1}$ are affected very little. For example, the coefficient for ΔPT_{-1} in the original Model 3 from Table 5 is –21.530 with a t-value of -3.70. In the above equation with *LOCS* added, the coefficient for ΔPT_{-1} is –19.17 with a t-value of (-3.40). Similar results occur for $SP500_{-1}$ and $ROEBUS_{-1}$.

By contrast, the variables that are suggested to be supply-side shifters such as $ROAD_{-1}$, and $\Delta VOLFF_{-2}$ shift signs and become statistically insignificant when *LOCS* is added to the equation. Thus, the inclusion of *LOCS* in the original model suggests that it is measuring very similar activities related to determining C&I loan volume. In particular, the regression results suggest that $ROAD_{-1}$ and $\Delta VOLFF_{-2}$ are indeed supply-side determinants, while the other variables in the original equation may be demand-side determinants. *LOCS* then may be thought to aid in the identification of demand and supply-side variables that determine C&I loan volume.

In order to examine more carefully the apparent correlation between *ROAD*, *ΔVOLFF* and *LOCS*, a number of regressions are run to test the relationship among these variables. The results of the four models are summarized below in Table 6.

TABLE 6. DETERMINANTS OF BANK CREDIT TIGHTENING (LOCS)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	0.388 (2.24)	0.455 (2.99)	-0.004 (-0.16)	0.440 (3.04)
LOCS(-1)	0.368 (2.47)	0.378 (2.89)	0.669 (6.06)	0.416 (3.29)
ROAD	-0.332 (-2.41)	-0.392 (-2.98)		-0.362 (-2.87)
ΔVOLFF	0.292 (2.13)	0.285 (2.25)		0.193 (1.49)
ΔVOLFF(-1)	0.083 (0.38)			
ROEBUS	-0.001 (-0.39)			
ROEBUS(-1)	0.001 (0.46)			
SP500h			0.0010 (1.20)	
SP500h(-1)			-0.0011 (-1.58)	-0.0013 (-1.99)
ΔPT			0.302 (1.20)	
ΔPT(-1)			-0.264 (-1.13)	
D98_3			0.113 (1.34)	
R^2	0.6716	0.6603	0.6681	0.7036
DW	2.04	1.79	1.65	1.39
p-values for: LM-Het	0.71	0.81	0.85	0.91
JB-Norm	0.00	0.03	0.84	0.78
# of Observations	31	32	32	32

Notes: T-values are provided in parenthesis.

Table 6 suggests that the demand-side variables are not significant, with the exception of $SP500_{-1}$ in Model 4. In this regression, however, $SP500_{-1}$ has the sign that would be expected from a supply-side variable. As the S&P 500 index declines, lending becomes more restrictive. All of the suggested supply-side variables in the equation have the expected sign and are significant. The regression results of Table 6 suggest that banks' rate of return on assets and economic uncertainty are key driving forces for banks' level of credit extension.

Lown, Morgan and Rohatgi (2000) provided empirical evidence that banks do from time to time ration credit and that rationing has a macroeconomic impact. Combining the equations modeled for banks' ROA, the determinants of C&I loan growth, and the factors affecting *LOCS* provides additional empirical evidence as to the reasons that bank officers elect to ration credit at times. In fact, it provides the framework for distinguishing between the determinants of C&I loan growth that are demand driven and those that are supply driven.

6. Implications of Research for Teaching Economics

Conventional Keynesian treatment in economic textbooks of monetary policy transmission focuses on IS/LM analysis. Although the model is acknowledged to be rudimentary, it is believed to have utility for telling coherent stories about both monetary policy transmission as well as fiscal policy shocks (Bernanke and Blinder 1988).

This section will present first the traditional IS/LM model and its derivation. This includes a summary of how the market for C&I loans is typically treated. Following that discussion, fundamental concepts underlying this study will be summarized and contrasted with the IS/LM model. An alternative treatment focusing on the role of banks and credit markets for monetary policy transmission will be provided for use in the classroom.

6.1 Derivation of the IS Curve:

Planned autonomous investment by non-bank firms is assumed to be determined by the rate of interest charged for borrowing (Mankiw 2000, p. 266). Panel a in Figure 15 below depicts the curve for planned autonomous spending as a function of the interest rate. The investment curve is assumed to be downward sloping, indicating that planned investment spending is less at higher rates of interest charged for external finance or measured on a relative basis against the opportunity cost of internally generated funds.

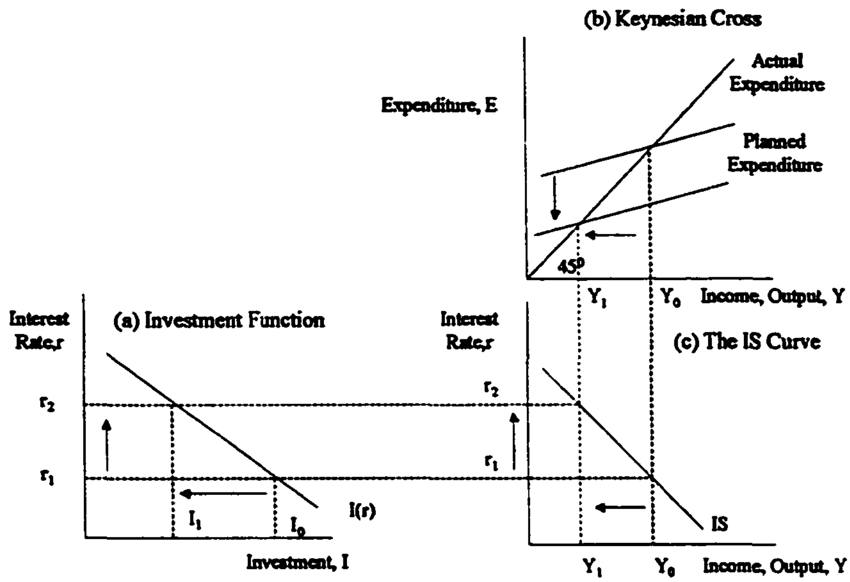
Panel b, the Keynesian Cross, below shows how income/output changes with changes in the interest rate. In Panel b, output is determined where planned autonomous expenditure is equal to actual expenditure. Because investment is inversely related to the interest rate, an increase in the interest rate from r_1 to r_2

causes the quantity of investment to fall from I_0 to I_1. The reduction in planned investment from I_0 to I_1, in turn, causes a downward shift in the planned-expenditure function as shown in Panel b of Figure 15. The shift in the planned-expenditure function causes income to be reduced from Y_0 to Y_1. According to conventional macroeconomics teaching, the result is that an increase in the interest rate lowers income (Mankiw 2000, p. 267).

The IS curve that results in Panel c is a representation of all combinations of real income and interest rates at which the commodity, or goods market is in equilibrium. In the traditional portrayal of the IS curve, the interest rate that is relevant for the demand for goods is the real interest rate. Business investment is determined by the interest rate after considering inflation. The IS curve thus combines the interaction between the interest rate and planned investment, and the interaction between planned investment and income. Because an increase in the interest rate causes a decrease in planned investment, that in turn causes income to fall, the IS curve is downward sloping (Mankiw 2000, p. 268).

In summary, Figure 15 below may be explained as follows: First, planned autonomous investment depends on the interest rate. Interest rates r_1 and r_2 are randomly chosen for example purposes. By following the plotted lines from Panel a, one may observe income levels in Panel c where both planned autonomous investment and induced saving are equal. The resulting IS curve in Panel c represents all interest rate, real income combinations at which the commodity market is in equilibrium. Any point off the IS curve in Panel c represents an economy out of equilibrium.

Figure 15: Derivation of the IS Curve



Source: Mankiw, N. Gregory. *Macroeconomics*, Fourth Edition, Worth Publishers, 2000.

6.2 Derivation of the LM Curve:

The financial sector of the economy provides a second relationship between real income and the interest rate. To understand the relationship between the interest rate and the level of income that arises from the interaction among economic agents in the market for money balances, one must begin by examining the theory of the interest rate, also known as the *theory of liquidity preference*. The theory of liquidity preference originated in Keynes' *The General Theory*. The theory relates to the interest rate determination in the short run. It posits that the interest rate adjusts to balance the supply and demand for money. The theory of liquidity preference is the foundation for the LM curve, just as the Keynesian Cross is the foundation for the IS curve (Mankiw 2000, pp. 270-271).

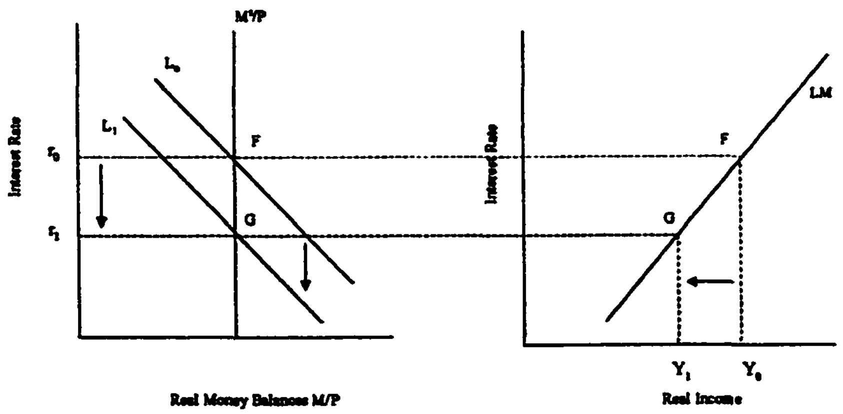
The theory of liquidity preference begins with the real money supply, M/P; where M stands for the supply of money and P stands for the price level (Mankiw 2000, p. 271). Currency and transactions accounts at commercial banks and thrifts comprise the money supply. The Federal Reserve controls the amount of money in the economy by controlling the total level of reserves held by banks. In the simple LM model, debt instruments owed to banks such as bonds and loans are lumped together and simply identified as bonds. The level of reserves held by banks is the sum of required reserves plus excess reserves (Bernanke and Blinder 1988). The Federal Reserve adjusts the money supply by purchasing or selling government bonds. In doing so, the level of reserves held in banks changes, adjusting the money supply.

By adjusting the money supply, the central bank affects interest rates. For example, the central bank may elect to contract the money supply by issuing bonds, thus reducing reserves in the banking system. In order to induce purchasers of bonds, the price of the bonds must be reduced as the government sells additional amounts. Because the interest rate on bonds varies inversely with the price of bonds, selling bonds increases the interest rate. As interest rates rise, the opportunity cost of holding money for transaction purposes increases. This causes investors to purchase bonds and contract the money supply.

Figure 16 below depicts the derivation of the LM curve, where L stands for money demand and M^s/P is the real supply of money. Both the money supply and the price level are assumed exogenous to the model. Thus, the real supply of money is a vertical line, unaffected by the interest rate (Mankiw 2000, p. 271).

The demand for money balances is assumed to be downward sloping as people choose to hold fewer money balances at higher interest rates. Money is assumed not to pay an interest rate, so the interest rate becomes the opportunity cost of holding money balances. Thus, the demand for real money balances may be written as: $(M/P)^d = L(r)$, where the function L(r) shows that the quantity of money demanded is a function of the interest rate (Mankiw 2000, pp. 272-273). The market is in equilibrium where the real supply of money crosses the demand for money. The LM curve portrays all combinations of real income and interest rate where the money supply is equal to money demand. Higher levels of income create higher demand for real money balances and a higher equilibrium interest rate. At any point off the LM curve, the money market is not in equilibrium.

Figure 16: Derivation of the LM Curve



Source: Mankiw, N Gregory. *Macroeconomics*, Fourth Edition, Worth Publishers, 2000.

In the above figure, the demand for money (L), shifts due to changes in real income. For example, if income increases, individuals engage in more transactions requiring the use of money. If income decreases, as above from Y_0

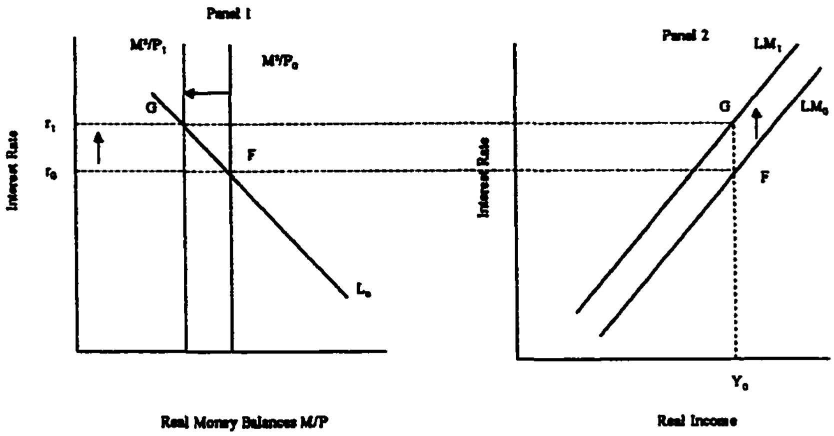
to Y_1, the demand for money also decreases, portrayed above by a shift in the money demand curve from L_0 to L_1. Thus, the quantity of real money balances demanded is negatively related to the interest rate and positively related to income (Mankiw 2000, p. 275). As shown above, a decrease in income from Y_0 to Y_1 causes the demand for money to shift downward from L_0 to L_1. With the supply of real money balances unchanged, the interest rate must fall from r_0 to r_1 to equilibrate the money market.

6.2a Monetary Policy Impact on the LM Curve:

The equilibrium interest rate thus depends on the level of income for a given supply of real money balances (M^s/P). If real money balances change, the LM curve shifts. As the central bank adjusts the level of real money balances in an effort to establish target interest rate levels, shifts occur in the LM curve.

Figure 17 below portrays a contactionary monetary policy by the Federal Reserve Bank. Real money balances are assumed to be initially established at M^s/P_0. Money demand is assumed to be represented by curve L_0. The resulting equilibrium interest rate r_0 is represented by point F at the intersection of M^s/P_0 and L_0. In Panel 2 of Figure 17, at income level Y_0, point F on LM_0 represents the interest rate, income combination resulting from money market equilibrium. If the central bank contracts the money supply from M^s/P_0 to M^s/P_1, the interest rate rises from r_0 to r_1, with the resulting equilibrium point G. For a given income level Y_0, the demand for money is affected only by the interest rate. Thus, changes in the demand for money balances move along the curve L_0 to point G. As depicted above, a reduction in real money balances by the central bank raises the equilibrium interest rate and shifts the LM curve upward from LM_0 to LM_1.

Figure 17: Contractionary Monetary Policy

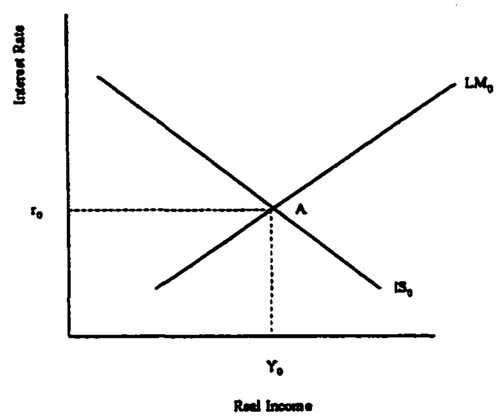


Source: Mankiw, N. Gregory, *Macroeconomics*, Fourth Edition, Worth Publishers, 2000.

6.3 Short-Run Equilibrium: The IS-LM Curve:

As developed in Figure 15, the IS curve provides all combinations of interest rate and income that satisfies the equation representing equilibrium in the goods market. As represented by Figure 16, the LM curve provides all combinations of interest rate and income that satisfy the equation representing equilibrium in the money market (Mankiw 2000, p. 278). Figure 18 below shows the IS and LM curves together in interest rate, income space.

Figure18: Derivation of the IS/LM Curve



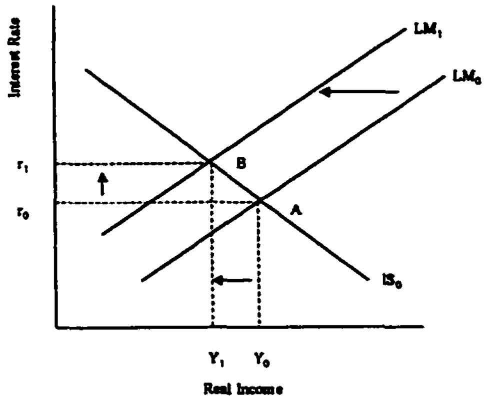
Source: Mankiw, N. Gregory. *Macroeconomics*, Fourth Edition, Worth Publishers, 2000.

The economy is at equilibrium where the goods market equilibrium interest rate-income combination equals the money market equilibrium interest rate-income combination. Point A above is representative of interest rate r_0, income Y_0 combination where both markets are equal. At point A, actual expenditure equals planned expenditure and the demand for real money balances equals the supply of real money balances.

6.3a Monetary Policy Changes in the IS/LM model:

As discussed above in 6.2a, a reduction in the money supply orchestrated by the central bank increases the equilibrium interest rate in the money market for any given income level, and shifts the LM curve upward. Figure 19 below represents the impact of a contractionary monetary policy and shows how a shift in the LM curve affects income and the interest rate.

Figure 19: Contractionary Monetary Policy and the IS/LM Curve



Assume as in the earlier Figure 17, a contraction in the money supply. A decrease in M leads to a decrease in real money balances because the price level P is assumed fixed in the short-run. The theory of liquidity preference discussed above posits that for any given income level, a decrease in real money balances leads to a higher interest rate. Accordingly, the LM curve shifts upward from LM_0 to LM_1. Equilibrium moves from point A to point B. The decrease in the money supply increases the equilibrium interest rate from r_0 to r_1 and decreases equilibrium income from Y_0 to Y_1 (Mankiw 2000, p. 285).

The conventional story of this market adjustment is as follows. The central bank, by contracting the money supply in an effort to increase the interest rate, sells bonds. To induce individuals to hold less money and more bonds, the interest rate must increase, raising the opportunity cost of holding non-interest bearing money. The money market re-establishes equilibrium at a higher interest rate. The increased money market equilibrium interest rate has implications for the goods market. A higher interest rate discourages planned investment, which decreases production and income, Y. These changes are shown above by the increase in interest rate from r_0 to r_1 and the decrease in income from Y_0 to Y_1 (Mankiw 2000, pp. 285-286).

The IS/LM model shows that monetary policy influences income by changing the money supply, that in turn, affects interest rates. This story is at the heart of traditional teaching methodology regarding monetary policy transmission mechanisms.

6.4 Alternative Teaching Approach to IS/LM:

The purpose of this study is to assess the impact of monetary policy changes and other determinants on commercial and industrial loan volumes. Through that assessment, inferences regarding monetary policy changes on economic output may be made.

Traditional teaching methodology approaches changes in C&I loans only from the liability side of banks' balance sheets through changes in deposit levels that translate into changes in loan volumes. Further, as discussed in section 6.3 above, the demand side of the money market is viewed by way of the interest rate level that affects demand for loans in interest sensitive sectors of the economy such as business investment. However, substantial literature exists evaluating whether the exchange between the central bank and the banking system has consequences beyond those for open market interest rates. That is, the traditional interest rate channel as described by the IS/LM model may be augmented by a 'credit channel' (Hubbard 1994).

Bernanke and Blinder (1988) question the use of IS/LM analysis for the purpose of understanding the financial markets. Specifically, they question IS/LM's asymmetric treatment of money and credit. While the LM curve views money as a unique asset of banks, it lumps all debt instruments together into a 'bond' market that is always assumed to be equilibrated via interest rate auctions. Thus, the IS/LM methodology makes banks' liabilities central to the monetary transmission mechanism but does not give a role to bank assets.

Bernanke and Blinder's argument for a different treatment of financial market analysis from the traditional pedagogy is furthered in a recent paper by Romer (2000). Romer argues that the IS/LM approach is too simple in its treatment of financial markets. IS/LM focuses on 'the' rate of interest, even though the pertinent rate for the goods market is the real rate of interest, while the pertinent rate for the money market is the nominal interest rate. In practice, he argues, the demand for goods depends on many different interest rates. Further, Romer suggests that total output is, in part, determined by the amount of credit available at those various rates, and that the actual impact of monetary policy on credit availability is uncertain (Romer 2000). Romer's suggestions are very similar to the premise and findings of this study. This study suggests that the demand for credit and the supply of credit are determined by different interest rates and other factors. Further, this study concludes that banks ration credit from time to time at all levels of interest rates.

Romer believes that analysis of the impact of monetary policy on financial markets should be split into two parts: one part should analyze how various developments in financial markets affect the demand for goods, and the second part should address how various forces such as monetary policy affect interest rates and credit availability. The emphasis of such analysis should be on the fact that many aspects of financial markets other that the federal funds rate controlled by the Federal Reserve affect aggregate demand. He concludes, however, that one disadvantage of such an approach is that splitting analysis of financial markets into two components will not produce a framework as simple as the IS/LM model (Romer 2000).

Romer's conclusions are consistent with others such as Hubbard (1994) who also argues that decomposing monetary policy transmission into two parts would be useful. Hubbard suggests that one aspect of the analysis should focus on the effects of policy-induced changes on the overall level of the real cost of funds, and the second aspect should focus on the effects stemming from policy actions on the financial positions of borrower and/or intermediaries.

Romer's (2000) paper furthers earlier works regarding the reaction of the credit market to monetary policy innovation. It argues that banks have an important role in the extension of credit. Banks can efficiently finance activities that cannot be financed in the bond market. If financial intermediation is reduced, either by credit rationing or by price, aggregate supply and demand may be affected. This premise is consistent with Bernanke and Blinder (1998).

6.4a Alternative Analysis to the IS/LM Model:

In the IS/LM model, the LM curve is a portfolio-balance condition for a two-asset world; i.e. asset holders must choose between money and bonds. Loans and other forms of customer-market credit are viewed as perfect substitutes for auction-market credit (bonds) and financial markets clear only by price (Bernanke and Blinder 1988). Models such as the one proposed by this study that have a distinct role for credit arise when either of the two assumptions is abandoned; i.e. either loans and bonds are not perfect substitutes, or financial markets do not always clear solely as a function of price.

Earlier works by Tobin (1970) and Brunner and Meltzer (1972) focused on imperfect substitutability between loans and bonds.[21] The lack of perfect substitutability is based on the notion that customer- and auction-credit are different due to informational problems, differences in liquidity, or high transaction costs associated with raising funds in the open market (Bernanke and Blinder 1988). For example, Bernanke (1983)[22] argues that the Great Depression may be thought of as a downward shock to the supply of credit stemming from the increased riskiness of loans and banks' concerns for liquidity in the face of possible depositor runs on banks (Bernanke and Blinder 1988).

The premise of this study is that credit market imperfections may prevent market clearing in contrast to equilibrium portrayed by the IS/LM model. Reference is made to Figure 3 in section 2.3, recreated below for convenience.

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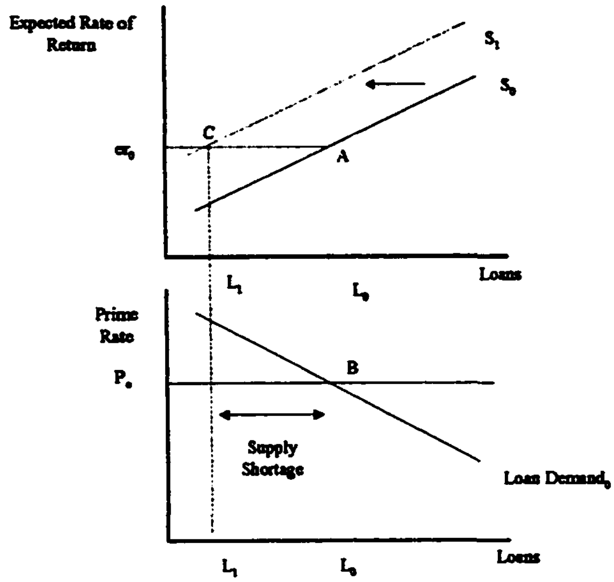
[21] See Tobin, James, "A General Equilibrium Approach to Monetary Theory," *Journal of Money, Credit and Banking* 2, November 1970: 461-472.
See also Brunner, Karl and Alan H. Meltzer, "Money, Debt, and Economic Activity," *Journal of Political Economy*, Vol. 80, No. 5, September/October 1972: 951-977.
[22] See Bernanke, Ben S., "Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression," *American Economic Review*, Vol. 73, No.3, June 1983: 257-76.

Figure 3: C&I Loan Supply and Demand Curves



One of the shortcomings noted with the IS/LM model is the fact that the model assumes only one interest rate. In reality, the goods market is impacted by the real interest rate while the money market is impacted by the nominal rate of interest. Romer (2000) further suggests that variables critical to determining final output include the amount of credit available at different interest rates. Figure 3 above reinforces the concept that different interest rates may be appropriate for different markets.

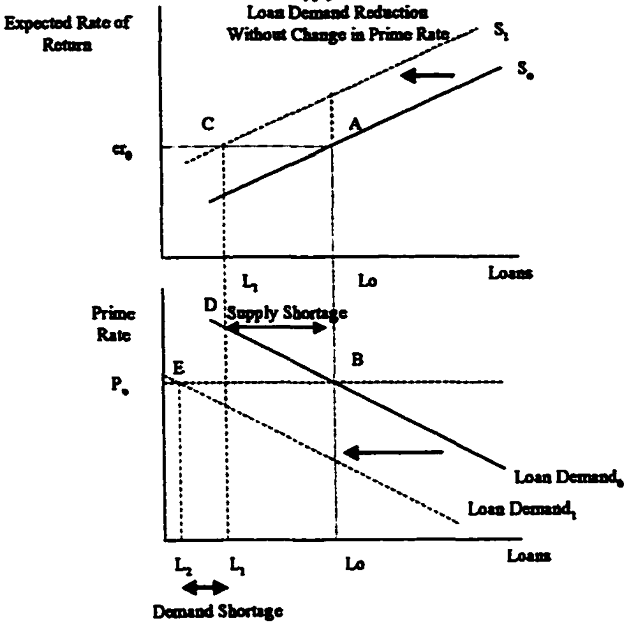
The market for the supply of loans is depicted as a function of the expected rate of return on those loans. For a given expected return, banks will supply a given level of loans. If variables other than the expected rate of return change, the supply curve will shift. For example, changes in regulatory requirements such as deposit reserves, supervisory oversight changes, and perceived economic initial supply equilibrium is at point A, representing expected return rate er_0 and loan level L_0. Loan supply curve S_1 results from banks' unwillingness to continue to supply the same level of loans for a given expected rate of return as initially shown by curve S_0. Thus, point C represents the new supply equilibrium after banks shift the level of loans available.

The impact of a shift in loan supply from curve S_0 toS_1 is apparent only when compared to the demand for loans. The lower panel in Figure 3 depicts the demand for loans determined by the cost of borrowing, assumed to be the prime rate. As shown above, initial demand is determined at the intersection of the loan demand curve and the given prime rate. The initial supply of loans at level L_0 happens also to equal the initial demand for loans at the given prime rate. Thus, as shown above, the market for loans is initially in equilibrium.

However, when the supply of loans for a given expected rate of return is reduced from S_0 to S_1, disequilibrium occurs in the loan market. As depicted above, for a given prime rate, the level of loans demanded is L_0. After the supply curve shifts, the new level of loans supplied is L_1. If the prime rate is unchanged, a supply shortage equal to the difference between loan level L_0 and L_1 will occur, and the loan market will not equilibrate.

Banks may elect to constrain credit via non-price methods such as tightening underwriting standards, increasing collateral requirements, or imposing more stringent covenant requirements. As noted earlier, the idea of non-price credit rationing is consistent with earlier works cited such as Stiglitz (1991); Lown, Morgan and Rohatgi (2000); Berger, Kyle and Scalise (2000); and Peek, Rosengren and Tootell (2000). Reducing the level of credit extension solely by interest rate increases may lead to borrower moral hazard and adverse selection problems, leaving banks with fewer loans but lower rates of return due to increased loan defaults from less credit-worthy borrowers. Thus, the supply of loans made available at various interest rates may not always equal the demand for loans at those established interest rates. The magnitude of the disequilibrium will be dependent on the size of the loan supply curve shift, the respective slopes of the loan supply and loan demand curves, and the reaction of loan demanders to the same economic phenomena observed by loan suppliers. That is, non-bank firms may observe the same economic activity and voluntarily reduce demand at all interest rate levels. As shown below in a duplicate Figure 3a, loan market disequilibrium resulting from a leftward shift in the supply of loans from S_0 to S_1 and a leftward shift in loan demand from Loan $Demand_0$ to Loan $Demand_1$, is ambiguous. Whether a demand shortage or a supply shortage occurs is, again, dependent on the relative magnitude of the demand and supply curve shifts and the respective slopes of the curves.

Figure 3a
Loan Supply Reduction &
Loan Demand Reduction
Without Change in Prime Rate



6.5 Alternative Teaching Methodology Summary:

The IS/LM framework has long been used in the college classroom as the foundation for understanding economic equilibrium by incorporating the fundamentals of the goods market equilibrium with money market equilibrium. However, its usefulness for teaching the concepts of credit market fundamentals is limited. As shown above in Figures 3 and 3a, a better presentation is made by separating the market for loan supply form the market for loan demand. This separation allows an economics instructor to bring forward ideas related to each market regarding topics such as differences between the expected rate of return and rates for borrowing; balance sheet effects of changes in the cost of borrowing; moral hazard and adverse selection problems associated with managing loan volumes solely through interest rate; and the role of banks as efficient financial intermediaries in the economy. Focusing on the fundamentals underlying the respective loan supply and loan demand markets allows one to build a model from those fundamentals. In doing so, students will take from the classroom experience a richer understanding of the importance of banks in the economy, the interdependence of banks and non-bank borrowing firms, and the impact of actions by the central bank on interest rate levels.

7. Conclusions

The fact that commercial and industrial loan growth is driven by both demand and supply-side factors is not new. The literature contains numerous references to the difficulty in separating supply-side factors from demand-side factors. This study provides additional empirical analysis designed to aid in disentangling factors related to loan demand from those related to loan supply. Identifying variables that determine C&I loan growth is accomplished by first modeling banks' return on assets, believed to be a primary determinant of C&I loan growth. Empirical results provide support for the idea that banks' ROA is driven by central bank decisions regarding reserve requirements and the incidence of non-performing loans in banks' portfolios. ROA is reduced as C&I loan growth is extended beyond normal trend levels. If that occurs, non-performing loans become more prevalent as banks relax credit standards to induce more borrowing.

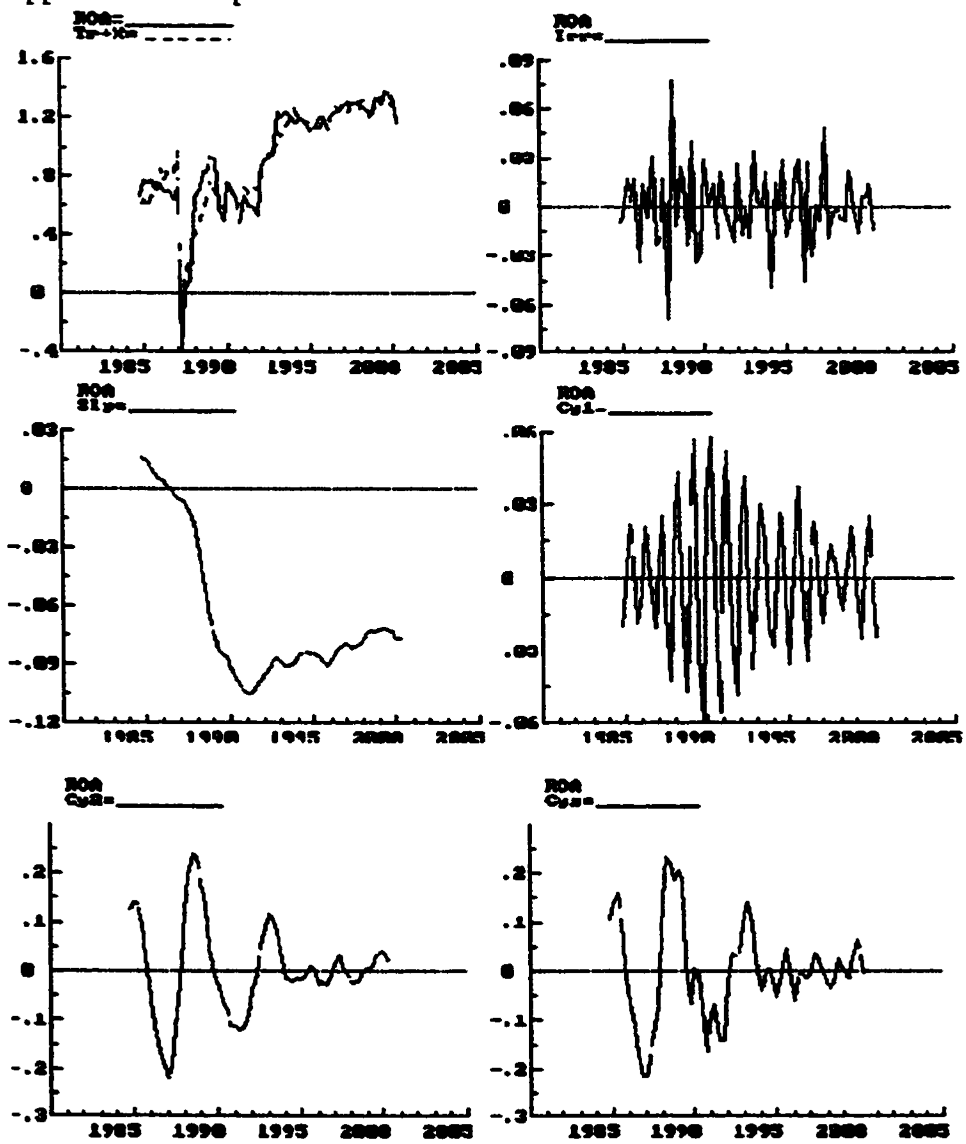
As the central bank manipulates the federal funds rate, banks' perception of economic uncertainty may change. This study demonstrates that federal funds rate volatility plays a significant role in determining the level of C&I loan growth. The findings suggest that federal funds rate volatility is a supply-side determinant of C&I loan growth along with reserve requirement changes and the levels of non-performing loans in banks' portfolios.

The demand for credit from banks is shown to be driven mainly by the relative cost of bank financing to bond market debt or equity financing. This is empirically suggested by the negative relationship between commercial and industrial loan growth and the ratio of bank lending rates to treasury bills. It is further suggested by the negative relationship between commercial and industrial loan growth and the S&P 500 equity index.

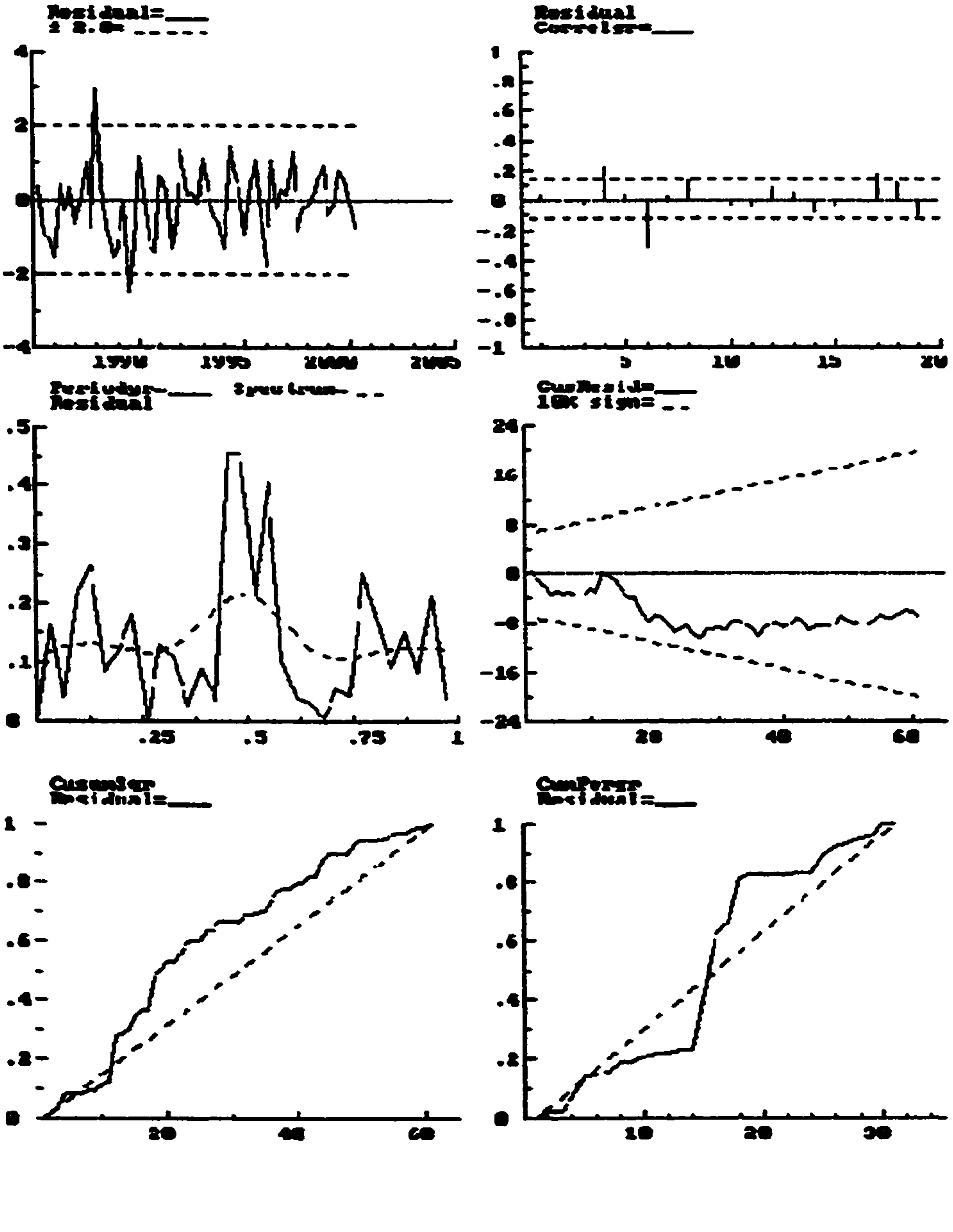
A general assessment of the nature of the credit market for bank loans may made by focusing on the determinants of banks' ROA and, in turn, the determinants of C&I loan growth. A more coherent story to the existing literature results from providing empirical evidence that divides commercial and industrial loan growth determinants between supply- and demand-side. Finally, by adding existing analysis utilizing lending officer credit standards, this study provides additional support for the separation between loan supply and demand determinants.

Appendix

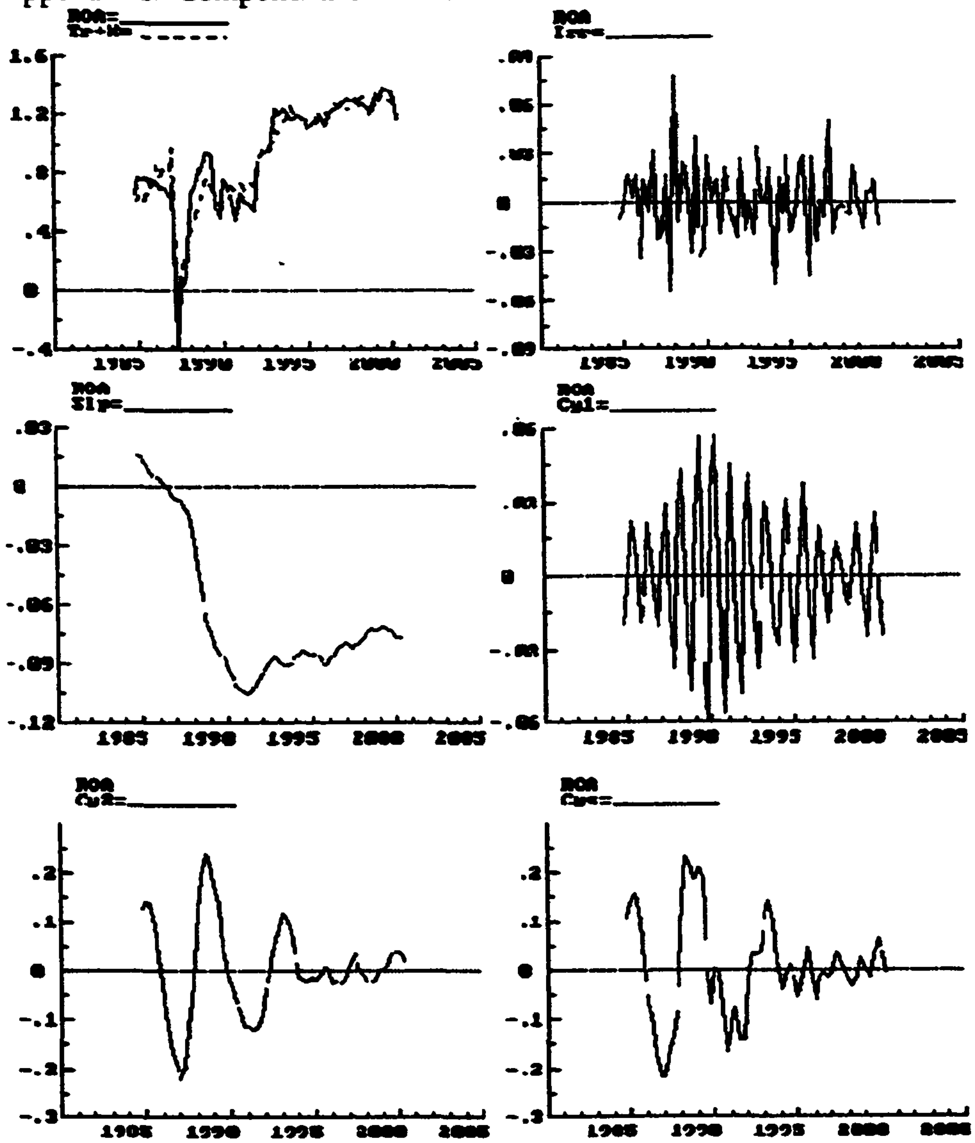
Appendix A: Components of Model 3—Table 4:



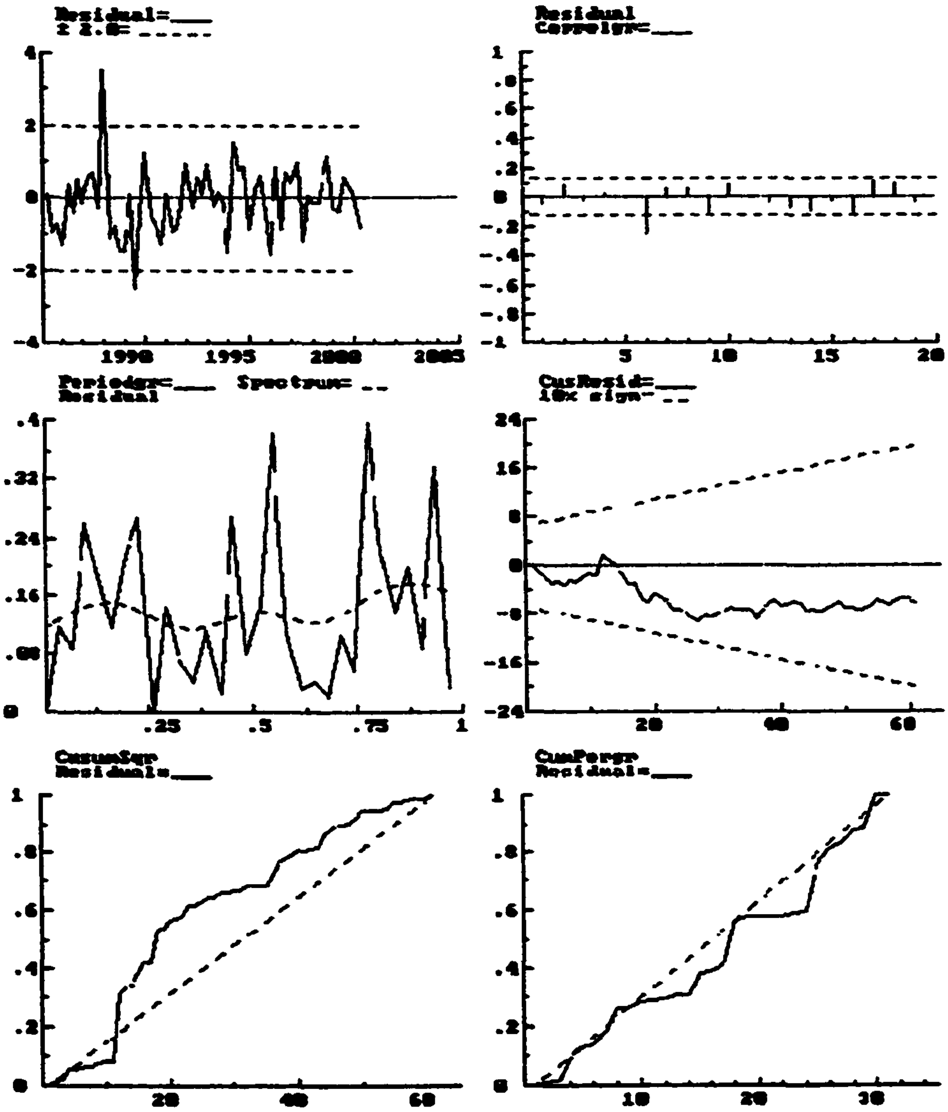
Appendix B: Residual Analysis of Model 3—Table 4:



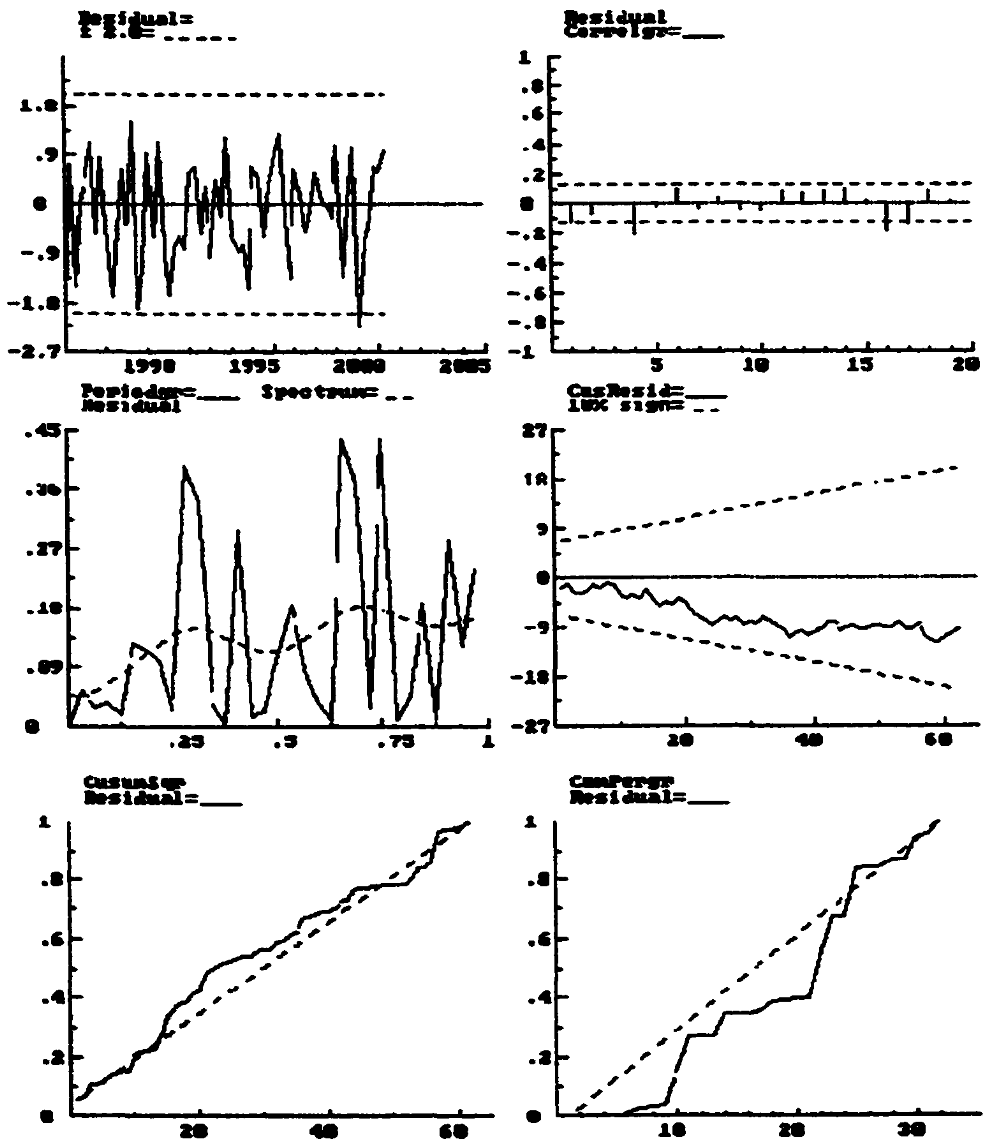
Appendix C: Components of Model 4—Table 4:



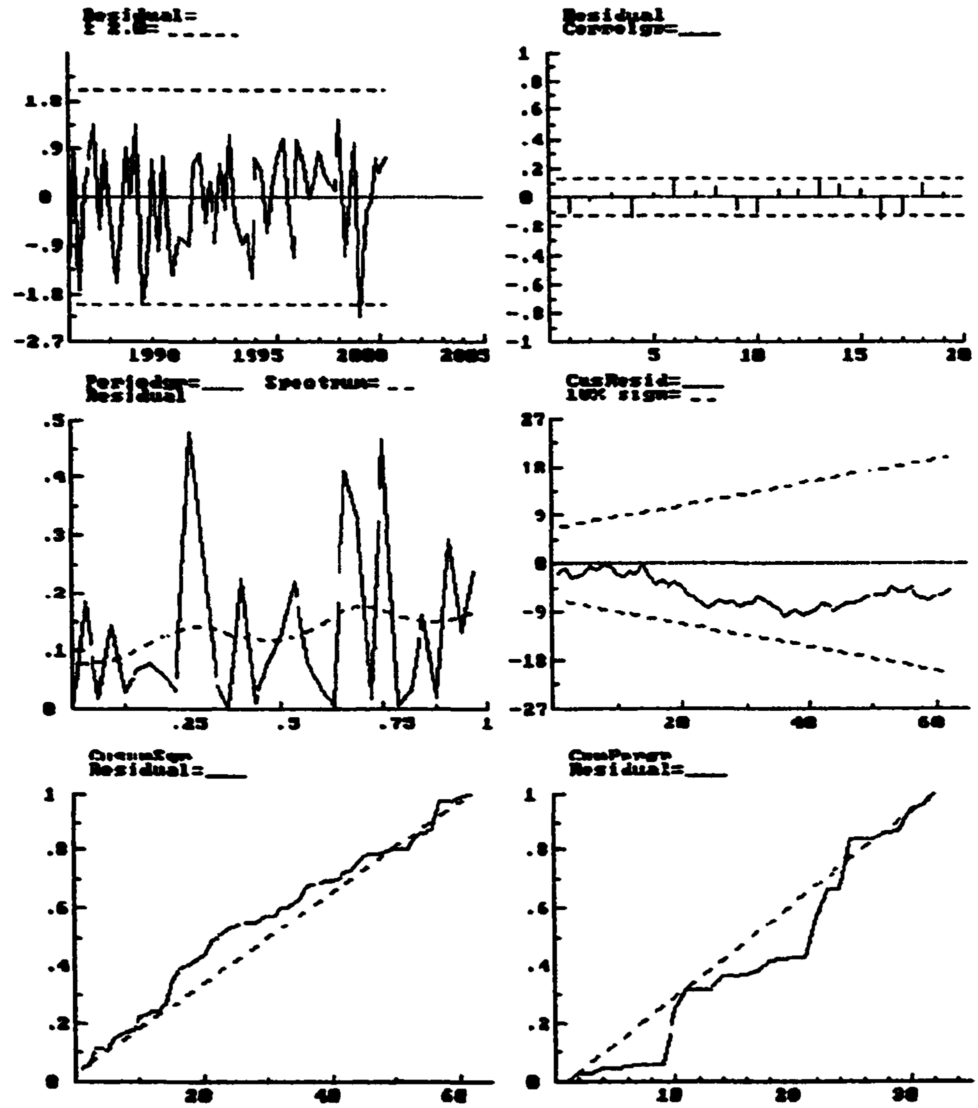
Appendix D: Residual Analysis of Model 4—Table 4:



Appendix E: Residual Analysis of Model 2—Table 5:



Appendix F: Residual Analysis of Model 3—Table 5:



Appendix G: Input Data:

Date	LOCS	FEDF	TBILL	PRIME	SP500	COMLN	ROEBUS	CPIEXP	GDPEXP
1984-1 30772		9.68667	9.01333	11.07000	159.88333	429.83333	12.5	4.81	4.98
1984-2 30863		10.55667	9.84333	12.30667	154.59333	449.96667	14.5	5.3	5.38
1984-3 30955		11.39000	10.34333	12.99000	161.14667	463.86667	11.9	4.95	4.75
1984-4 31047		9.26667	8.97333	11.80333	165.63667	477.66667	11	4.43	4.41
1985-1 31137	-3.3	8.47667	8.16667	10.53667	180.49	483.63333	10.5	4.13	3.99
1985-2 31228		7.92333	7.52333	10.19667	187.07667	491.3	10.9	4.35	4.33
1985-3 31320		7.90000	7.10333	9.50000	187.21	495.7	9.9	4.25	4.21
1985-4 31412		8.10333	7.14667	9.50000	201.09	502.33333	9.3	3.85	3.97
1986-1 31502		7.82667	6.88667	9.36667	225.86667	509.16667	9	3.59	3.33
1986-2 31593		6.92000	6.13000	8.61000	244.57	515.1	12.2	3.41	3.15
1986-3 31685		6.20667	5.53333	7.85333	240.12333	519.13333	8.4	3.5	2.62
1986-4 31777		6.26667	5.34000	7.50000	245.12333	529.93333	8.5	3.63	3.11
1987-1 31867		6.22000	5.53333	7.50000	283.32667	550.5	11.2	3.9	3.7
1987-2 31958		6.65000	5.73333	8.04667	294.15333	553.6	14.2	4.36	3.92
1987-3 32050		6.84333	6.03333	8.40000	323.43	559.7	14.6	4.5	4.14
1987-4 32142		6.91667	6.00333	8.86667	243.05667	568.46667	11.4	4.38	3.62
1988-1 32233		6.66333	5.76000	8.58667	261.26	578.1	15.8	4.2	3.76
1988-2 32324		7.15667	6.23000	8.78000	265.66333	591.33333	17.4	4.58	3.94
1988-3 32416		7.98333	6.99333	9.71000	268.48333	600.66667	15.9	4.98	4.18
1988-4 32508		8.47000	7.70333	10.18333	276.79667	607.36667	15.2	4.9	4.37
1989-1 32598		9.44333	8.53333	10.97667	293.73333	620.9	15.2	4.85	4.56
1989-2 32689		9.72667	8.44000	11.35667	316.04667	630.9	14.6	4.95	4.58
1989-3 32781		9.08333	7.85000	10.66000	348.89333	641.63333	13.2	4.24	3.95
1989-4 32873		8.61333	7.64000	10.50000	346.58333	645.2	11.1	4.23	3.98
1990-1 32963		8.25000	7.75667	10.03667	333.63667	642.56667	10.8	4.35	4.02
1990-2 33054		8.24333	7.76667	10.00000	350.01667	644.9	13.4	4.2	3.82
1990-3 33146		8.16000	7.49333	10.00000	328.25333	645.43333	11.1	4.45	4.38
1990-4 33238	46	7.74333	7.02333	10.00000	318.81333	644.1	7	4.51	4.26
1991-1 33328	34.5	6.42667	6.05333	9.19000	362.07333	642	6.9	3.66	3.64
1991-2 33419	12.5	5.86333	5.59333	8.66667	378.77667	634.56667	8.6	3.84	3.38
1991-3 33511		5.64333	5.40667	8.40000	390.36667	627.06667	6.5	3.77	3.35
1991-4 33603		4.81667	4.58333	7.59667	394.92	625.73333	3.1	3.55	3.19
1992-1 33694	3.4	4.02333	3.91000	6.50000	408.39	616.73333	-17.5	3.4	3.29
1992-2 33785	-1.8	3.77000	3.72333	6.50000	412.81333	608.3	11.4	3.53	3.09
1992-3 33877	-1.7	3.25667	3.13000	6.00667	418.68	603.03333	10.4	3.33	2.81
1992-4 33969	1.2	3.03667	3.07667	6.00000	428.58	601.1	3.7	3.25	2.7
1993-1 34059	1.2	3.04000	2.99333	6.00000	444.61	598.1	4.3	3.23	2.78
1993-2 34150	-5.9	3.00000	2.98333	6.00000	446.97	593.53333	9.7	3.38	2.75
1993-3 34242	-16.8	3.06000	3.02000	6.00000	456.87333	592.36667	9.5	3.3	3.05
1993-4 34334		2.99000	3.08000	6.00000	465.35667	590.63333	8.5	3	2.79
1994-1 34424		3.21333	3.25000	6.02000	464.84	596.56667	13.1	3.2	2.7

1994-2	34515	-11.1	3.94000	4.03667	6.89667	450.56	609.83333	17	3.28	2.92
1994-3	34607	-7	4.48667	4.51000	7.50333	465.48667	626.73333	16.6	3.33	3.08
1994-4	34699	-17.4	5.16667	5.28333	8.13333	461.77	644.3	16.2	3.43	3.06
1995-1	34789	-6.3	5.81000	5.78000	8.83333	486.17333	668.86667	17.4	3.41	2.89
1995-2	34880	-6.2	6.02000	5.62333	9.00000	530.95333	694	18.5	3.53	2.96
1995-3	34972	-4.6	5.79667	5.38000	8.76667	569.45	711.2	16	3.28	2.56
1995-4	35064	-2.9	5.72000	5.27000	8.71667	600.93333	720.56667	12.2	2.95	2.33
1996-1	35155	5.8	5.36333	4.95000	8.33333	640.65	732.93333	15.6	2.78	2.38
1996-2	35246	0	5.24333	5.04000	8.25000	664.64	745.46667	17.7	2.88	2.46
1996-3	35338	-3.1	5.30667	5.13667	8.25000	659.75667	760.83333	18.3	3	2.54
1996-4	35430	-9.4	5.28000	4.97000	8.25000	734.34333	781.1	15.1	3.03	2.53
1997-1	35520	-5.5	5.27667	5.06333	8.26667	778.03333	797.83333	17	3.08	2.61
1997-2	35611	-6	5.52333	5.07333	8.50000	844.92	817.43333	18.3	3	2.42
1997-3	35703	-3.9	5.53333	5.05667	8.50000	933.68667	834.1	16.8	2.85	2.45
1997-4	35795	-5.3	5.50667	5.08667	8.50000	946.81667	848.93333	14.7	2.6	2.3
1998-1	35885	0.9	5.52000	5.07667	8.50000	1043.79	873.06667	20	2.25	2.23
1998-2	35976	-4.4	5.50000	5.00667	8.50000	1112.1367	887.4	14.9	2.45	2.05
1998-3	36068	2.7	5.53333	4.88000	8.49667	1031.6533	914.13333	16.5	2.48	2.04
1998-4	36160	26.2	4.86000	4.31333	7.92000	1163.8433	946.53333	11.8	2.33	1.85
1999-1	36250	5.6	4.73333	4.42333	7.75000	1268.1133	950.36667	15.9	2.2	1.54
1999-2	36341	9.2	4.74667	4.46000	7.75000	1336.5767	958.63333	17.4	2.2	1.74
1999-3	36433	3.6	5.09333	4.69667	8.10333	1310.6133	970.7	17.1	2.38	1.87
1999-4	36525	5.6	5.30667	5.06000	8.37333	1407.0833	993.16667	15.7	2.53	1.81
2000-1	36616	10.2	5.67667	5.54333	8.68667	1419.82	1018.9	17.9	2.48	1.99
2000-2	36707	23	6.27333	5.77667	9.24667	1442.5433	1053.6		2.6	2.22
2000-3	36770	28.8	6.52000		9.50000	1461.6733	1078.2667		2.73	2.37

ROA	ROE	GDP	POTGDP	VOLFF	BANKS	NPTL	RRATSA	DRRATSA	PGDP
0.73	11.97	5402.3	5521.8	0.08100	14388	3.1500001	0.96841	0.96841	70.589996
0.64	10.57	5493.8	5561.9	0.36490	14369	3.1099999	0.96622	0.96622	71.18
0.68	11.11	5541.3	5602.9	0.11347	14373	2.99	0.95852	0.95852	71.739998
0.66	10.66	5583.1	5645.1	0.75204	14372	2.8900001	0.95207	0.95207	72.239998
0.77	12.33	5629.7	5688.3	0.07202	14360	3.02	0.96309	0.96309	73.010002
0.76	12.07	5673.8	5732.6	0.21354	14336	2.99	0.95828	0.95828	73.489998
0.77	12.19	5758.6	5777.9	0.07782	14322	2.98	0.95676	0.95676	73.879997
0.71	11.22	5806	5824.2	0.42381	14258	2.6900001	0.94911	0.94911	74.400002
0.75	11.88	5858.9	5871.2	0.45172	14232	2.8499999	0.95889	0.95889	74.690002
0.69	10.74	5883.3	5918.8	0.03033	14162	2.9000001	0.95604	0.95604	75.040001
0.69	10.77	5937.9	5966.6	0.13139	14156	2.97	0.95621	0.95621	75.510002
0.64	10.01	5969.5	6014.5	1.97934	14048	2.76	0.94628	0.94628	76.050003
0.73	11.43	6013.3	6062.5	0.78056	13926	3.8099999	0.95845	0.0000	76.730003
-0.38	-5.98	6077.2	6110.6	0.10898	13799	3.6900001	0.95420	0.0000	77.269997
0.02	0.32	6128.1	6158.8	0.12437	13700	3.6199999	0.95233	0.0000	77.830002
0.1	1.55	6234.4	6207.1	0.15986	13531	3.46	0.94289	0.0000	78.459999
0.66	10.9	6275.9	6255.5	0.04473	13373	3.45	0.95316	0.0000	78.989998
0.69	11.37	6349.8	6304.1	0.12117	13242	3.26	0.95091	0.0000	79.790001
0.83	13.44	6382.3	6353	0.05897	13070	3.3399999	0.95208	0.0000	80.730003
0.83	13.37	6465.2	6401.9	0.08946	12955	2.9200001	0.94886	0.0000	81.360001
0.94	14.67	6543.8	6450.8	0.13192	12833	2.9300001	0.95693	0.0000	82.199997
0.92	14.25	6579.4	6499.6	0.04797	12779	2.97	0.95651	0.0000	83.019997
0.58	8.9399996	6610.6	6548.1	0.03462	12660	3.1300001	0.95781	0.0000	83.620003
0.49	7.7199998	6633.5	6596.3	0.07579	12542	3.01	0.95462	0.0000	84.239998
0.76	12.04	6716.3	6644.1	0.00520	12428	3.1300001	0.95976	0.0000	85.190002
0.7	10.92	6731.7	6691.3	0.01650	12339	3.1900001	0.95978	0.0000	86.169998
0.61	9.5500002	6719.4	6738	0.05800	12249	3.4100001	0.96263	0.00000	87
0.48	7.5500002	6664.2	6784	0.27631	12182	3.71	0.96282	0.0000	87.760002
0.66	10.11	6631.4	6829.5	0.47911	12084	3.8599999	1.00212	0.0000	88.779999
0.61	9.2399998	6668.5	6874.4	0.05737	11994	3.8699999	1.00028	0.0000	89.410004
0.59	8.8800001	6684.9	6918.8	0.05027	11916	3.9100001	1.00142	0.0000	89.989998
0.54	8.0200005	6720.9	6962.6	0.15390	11777	3.7	0.99613	0.0000	90.470001
0.87	12.76	6783.3	7006.2	0.05593	11665	3.7	1.00290	0.0000	91.160004
0.93	13.33	6846.8	7049.6	0.05974	11549	3.54	1.02299	0.00000	91.68
0.96	13.49	6899.7	7093	0.06964	11461	3.4100001	1.02448	0.0000	91.980003
0.95	13.26	6990.6	7136.7	0.09894	11317	3.0599999	1.01994	0.0000	92.559998
1.24	16.190001	6988.7	7181.1	0.05153	11212	2.9100001	1.02862	0.0000	93.330002
1.21	15.65	7031.2	7226.2	0.02444	11091	2.6199999	1.02531	0.0000	93.830002
1.24	15.93	7062	7272	0.02203	10971	2.3900001	1.02568	0.0000	94.260002
1.22	15.64	7168.7	7318.6	0.00863	10859	1.99	1.02121	0.0000	94.790001
1.17	14.89	7229.4	7366.1	0.05039	10744	1.86	1.03004	0.0000	95.279999

1.1799999	14.97	7330.2	7414.6	0.15042	10623	1.61	1.02474	0.00000	95.720001
1.1900001	15.17	7370.2	7464.2	0.08129	10497	1.46	1.02389	0.00000	96.290001
1.17	14.91	7461.1	7514.8	0.20747	10358	1.29	1.01950	0.00000	96.739998
1.11	14.16	7488.7	7567.7	0.08140	10151	1.33	1.02771	0.00000	97.449997
1.14	14.48	7503.3	7622.1	0.00785	10079	1.26	1.02210	0.00000	97.860001
1.21	15.22	7561.4	7678.5	0.05098	9963	1.23	1.02137	0.00000	98.309998
1.2	14.99	7621.9	7736.6	0.07101	9855	1.16	1.01713	0.00000	98.790001
1.12	13.79	7676.4	7796.2	0.09486	9753	1.17	1.02329	0.00000	99.400002
1.21	14.99	7802.9	7857	0.02720	9602	1.12	1.01811	0.00000	99.739998
1.24	15.24	7841.9	7918.9	0.13010	9502	1.1	1.01525	0.00000	100.23
1.25	15.28	7931.3	7981.9	0.04682	9445	1.03	1.01093	0.00000	100.63
1.27	15.26	8016.4	8045.8	0.07471	9370	1.04	1.01913	0.00000	101.36
1.3099999	15.85	8131.9	8110.7	0.04369	9228	0.99	1.01423	0.00000	101.82
1.3	15.73	8216.6	8176.4	0.02459	9133	0.98	1.01382	0.00000	102.12
1.3	15.66	8272.9	8242.9	0.02528	9060	0.96	1.01046	0.00000	102.49
1.26	15.1	8404.9	8310.2	0.02413	8939	0.97	1.01692	0.00000	102.75
1.27	15.1	8465.6	8378.4	0.04379	8901	0.94	1.01275	0.00000	103.04
1.24	14.55	8537.6	8447.5	0.02084	8827	0.94	1.01213	0.00000	103.42
1.23	14.5	8654.5	8517.5	0.10610	8690	0.96	1.00892	0.00000	103.69
1.33	15.42	8730	8588.5	0.03546	8640	0.99	1.01568	0.00000	104.25
1.29	15.01	8783.2	8660.4	0.02170	8595	0.94	1.01112	0.00000	104.63
1.38	16.25	8905.8	8733.3	0.03028	8540	0.98	1.01039	0.00000	104.9
1.36	16.040001	9084.1	8807	0.06132	8496	0.94	1.00657	0.00000	105.31
1.35	16.309999	9191.8	8881.2	0.09248	8431	0.97	1.01356	0.00000	106.17
1.17	14.03	9318.9	8956.1	0.07008	8387	0.99	1.00958	0.00000	106.8
		9373.5	9031.7	0.01157	8286				

GDPH	D1NPTL	D1VOLFF	RRH	CRh	Crreal	SPH	PT	HPCR	D1PT
0.08739							1.22818	-28.61633	
0.06775	-0.04	0.28390	-0.90546	18.73594	632.15322	-13.23465	1.25025	-12.04983	0.02207
0.03458	-0.12	-0.25143	-3.18847	12.35647	646.59420	16.95632	1.25588	-4.26233	0.00563
0.03017	-0.1	0.63857	-2.69060	11.89997	661.22187	11.14513	1.31538	3.75517	0.05950
0.03339	0.1299999	-0.68002	4.62988	4.99651	662.42065	35.86967	1.29020	-1.58484	-0.02517
0.03133	-0.03	0.14152	-1.99888	6.34089	668.52635	14.59730	1.35534	-1.92082	0.06513
0.05978	-0.01	-0.13572	-0.63566	3.58233	670.95292	0.28509	1.33740	-5.81209	-0.01794
0.03292	-0.29	0.34599	-3.19829	5.35270	675.17920	29.65654	1.32929	-7.75189	-0.00811
0.03644	0.1599998	0.02791	4.12460	5.44127	681.70659	49.28473	1.36012	-7.20725	0.03083
0.01666	0.0500002	-0.42139	-1.18917	4.66121	686.43389	33.12279	1.40457	-8.24298	0.04445
0.03712	0.0699999	0.10106	0.07013	3.13208	687.50274	-7.27263	1.41928	-12.67653	0.01471
0.02129	-0.21	1.84795	-4.15368	8.32156	696.82224	8.32905	1.40449	-8.55275	-0.01478
0.02935	1.05	-1.19878	5.14486	15.52397	717.45077	62.34141	1.35542	7.24074	-0.04907
0.04251	-0.12	-0.67158	-1.77272	2.25250	716.44885	15.28507	1.40349	1.82376	0.04807
0.03350	-0.07	0.01539	-0.78526	4.40751	719.13142	39.81144	1.39227	0.56608	-0.01122
0.06939	-0.16	0.03549	-3.96664	6.26526	724.53055	-99.40121	1.47696	2.55341	0.08469
0.02663	-0.01	-0.11513	4.35933	6.77847	731.86481	29.95735	1.49074	7.05763	0.01378
0.04710	-0.19	0.07644	-0.94508	9.15643	741.11208	6.74169	1.40931	14.10834	-0.08143
0.02047	0.0799999	-0.06220	0.49205	6.31342	744.04390	4.24598	1.38847	15.52438	-0.02084
0.05196	-0.42	0.03048	-1.35509	4.46171	746.51753	12.38562	1.32194	17.20148	-0.06653
0.04863	0.01	0.04247	3.40440	8.91279	755.35283	24.47525	1.28633	25.98829	-0.03561
0.02176	0.04	-0.08396	-0.17719	6.44226	759.93740	30.38584	1.34558	31.29044	0.05925
0.01897	0.1600001	-0.01334	0.54448	6.80509	767.32039	41.57192	1.35796	40.15888	0.01239
0.01386	-0.12	0.04116	-1.33297	2.22349	765.90695	-2.64837	1.37435	40.98096	0.01638
0.04993	0.1200001	-0.07058	2.15554	-1.63257	754.27474	-14.94205	1.29394	32.29149	-0.08040
0.00917	0.0599999	0.01129	0.00897	1.45251	748.40433	19.63813	1.28755	30.00256	-0.00639
-0.00731	0.22	0.04151	1.18578	0.33080	741.87739	-24.87120	1.33452	27.60716	0.04697
-0.03286	0.3	0.21831	0.07782	-0.82632	733.93344	-11.50331	1.42383	24.23740	0.08931
-0.01969	0.1499999	0.20280	16.32999	-1.30415	723.13585	54.27627	1.51817	18.33198	0.09435
0.02238	0.01	-0.42174	-0.73553	-4.63136	709.72670	18.45298	1.54946	9.99317	0.03129
0.00984	0.0400002	-0.00710	0.45621	-4.72764	696.81818	12.23940	1.55364	2.18188	0.00417
0.02154	-0.21	0.10363	-2.11187	-0.85052	691.64731	4.66570	1.65745	1.97760	0.10382
0.03714	0	-0.09797	2.71742	-5.75325	676.53939	13.64327	1.66240	-8.45326	0.00495
0.03744	-0.16	0.00381	8.01161	-5.46968	663.50349	4.33246	1.74575	-17.26174	0.08334
0.03091	-0.13	0.00990	0.58517	-3.46320	655.61352	5.68457	1.91906	-21.52878	0.17332
0.05270	-0.35	0.02930	-1.77487	-1.28241	649.41661	9.45830	1.95016	-24.85127	0.03110
-0.00109	-0.15	-0.04741	3.40314	-1.99634	640.84430	14.96103	2.00445	-31.42830	0.05429
0.02432	-0.29	-0.02709	-1.28539	-3.05412	632.56242	2.12321	2.01117	-38.70910	0.00672
0.01752	-0.23	-0.00241	0.14250	-0.78625	628.43905	8.86264	1.98675	-42.92099	-0.02442
0.06044	-0.4	-0.01341	-1.74305	-1.17045	623.09666	7.42730	1.94805	-49.51273	-0.03870
0.03387	-0.13	0.04177	3.46134	4.01829	626.11952	-0.44410	1.85231	-48.94448	-0.09574
0.05577	-0.25	0.10003	-2.06082	8.89535	637.10126	-12.28810	1.70851	-41.63602	-0.14380
0.02183	-0.15	-0.06913	-0.32936	11.08500	650.88101	13.25166	1.66371	-32.73112	-0.04480

0.04933	-0.17	0.12618	-1.71507	11.21157	666.01201	-3.19379	1.53943	-23.63337	-0.12428
0.01480	0.0400001	-0.12607	3.22097	15.25169	686.36910	21.13895	1.52826	-10.40431	-0.01117
0.00780	-0.07	-0.07355	-2.18451	15.03040	709.17637	36.84283	1.60047	4.25852	0.07222
0.03097	-0.03	0.04313	-0.28649	9.91354	723.42592	29.00192	1.62949	9.43211	0.02902
0.03200	-0.07	0.02003	-1.66072	5.26809	729.39231	22.11491	1.65402	5.47326	0.02452
0.02860	0.01	0.02384	2.42552	6.86497	737.35747	26.43665	1.68350	2.74023	0.02949
0.06592	-0.05	-0.06766	-2.02763	6.84009	747.40995	14.97854	1.63690	1.39446	-0.04660
0.01999	-0.02	0.10291	-1.12256	8.24539	759.08741	-2.93893	1.60610	1.04483	-0.03080
0.04560	-0.07	-0.08328	-1.70140	10.65498	776.20990	45.22071	1.65996	5.58170	0.05386
0.04292	0.01	0.02790	3.24233	8.56911	787.12838	23.79813	1.63265	3.42572	-0.02731
0.05763	-0.05	-0.03103	-1.92190	9.82661	802.82198	34.38756	1.67543	5.62218	0.04277
0.04166	-0.01	-0.01910	-0.16328	8.15561	816.78415	42.02370	1.68095	5.72861	0.00552
0.02741	-0.02	0.00069	-1.32419	7.11346	828.30847	5.62501	1.67104	3.09908	-0.00991
0.06382	0.0100001	-0.00115	2.55605	11.37113	849.69992	40.96816	1.67433	10.09553	0.00329
0.02889	-0.03	0.01966	-1.63906	6.56689	861.21894	26.19173	1.69774	7.03343	0.02341
0.03402	0	-0.02296	-0.24347	12.05018	883.90384	-28.94728	1.74112	14.99978	0.04338
0.05477	0.02	0.08526	-1.26991	14.17736	912.84918	51.25365	1.83617	29.13345	0.09505
0.03490	0.03	-0.07064	2.68071	1.61995	911.62270	35.83644	1.75207	13.03712	-0.08409
0.02438	-0.05	-0.01376	-1.79748	3.47936	916.21271	21.59534	1.73767	2.71580	-0.01440
0.05583	0.04	0.00858	-0.28942	5.03495	925.35747	-7.77010	1.72534	-3.08366	-0.01233
0.08008	-0.04	0.03104	-1.51137	9.25792	943.08868	29.44270	1.65481	-0.32268	-0.07053
0.04742	0.03	0.03116	2.78049	10.36416	959.68731	3.62073	1.56705	1.28851	-0.08776
0.05531	0.02	-0.02241	-1.57400	13.62253	986.51683	6.40175	1.60069	13.12238	0.03364
		-0.05850		9.36472		5.30452			

D1ROA	D1ROEBUS	VOLFH	ROAH	HPGDP	GDPG	D1GDPG	ROAAD	ROAD
				-35.45598	0.97836		0.50737	1.05032
-0.09	2	1401.9086	-49.31509	3.49275	0.98776	0.00940	0.44540	0.91962
0.04	-2.6	-275.6152	25.000014	-1.53637	0.98901	0.00125	0.47311	0.97736
-0.02	-0.9	2251.062	-11.76469	-12.22335	0.98902	0.00001	0.45923	0.94855
0.11	-0.5	-361.6941	66.666637	-18.04725	0.98970	0.00068	0.53621	1.10572
-0.01	0.4	786.02036	-5.1948	-26.27950	0.98974	0.00004	0.53013	1.08954
0.01	-1	-254.2362	5.2631529	6.31975	0.99666	0.00692	0.53763	1.10279
-0.06	-0.6	1778.5237	-31.16883	1.70679	0.99688	0.00022	0.49797	1.01232
0.04	-0.3	26.341993	22.535224	2.83396	0.99791	0.00103	0.52698	1.06740
-0.06	3.2	-373.1462	-32	-24.24750	0.99400	-0.00390	0.48722	0.97718
0	-3.8	1333.0344	0	-20.78807	0.99519	0.00119	0.48743	0.97676
-0.05	0.1	5625.8467	-28.98551	-39.92312	0.99252	-0.00267	0.45558	0.89907
0.09	2.7	-242.2585	56.250022	-46.37500	0.99188	-0.00063	0.52420	1.01660
-1.11	3	-344.1529	-608.2192	-32.14113	0.99453	0.00265	-0.27538	-0.52436
0.4	0.4	56.487429	-421.0526	-30.18992	0.99502	0.00048	0.01460	0.02740
0.08	-3.2	114.14328	1600.0001	28.03030	1.00440	0.00938	0.07390	0.13531
0.56	4.4	-288.0696	2240.0001	22.49004	1.00326	-0.00114	0.49353	0.88262
0.03	1.6	683.49541	18.1818	50.54234	1.00725	0.00399	0.52107	0.91370
0.14	-1.5	-205.3248	81.159412	38.52614	1.00461	-0.00264	0.63504	1.08481
0	-0.7	206.76253	0	78.34882	1.00989	0.00528	0.64068	1.07526
0.11	0	189.88318	53.012056	115.39367	1.01442	0.00453	0.73249	1.20630
-0.02	-0.6	-254.5634	-8.51063	110.99501	1.01228	-0.00214	0.71993	1.17567
-0.34	-1.4	-111.2645	-147.8261	103.71504	1.00954	-0.00273	0.45814	0.73428
-0.09	-2.1	475.54516	-62.06895	89.54659	1.00564	-0.00391	0.39069	0.61456
0.27	-0.3	-372.5397	220.40814	136.51768	1.01087	0.00523	0.61152	0.94453
-0.06	2.6	868.18767	-31.57895	117.10033	1.00604	-0.00483	0.56731	0.86373
-0.09	-2.3	1006.5838	-51.42856	70.68128	0.99724	-0.00880	0.49800	0.74719
-0.13	-4.1	1505.4548	-85.24592	-18.32596	0.98234	-0.01490	0.39402	0.58474
0.18	-0.1	293.58329	150.00003	-85.05203	0.97099	-0.01135	0.54618	0.79754
-0.05	1.7	-352.1037	-30.30304	-82.41611	0.97005	-0.00095	0.50859	0.73163
-0.02	-2.1	-49.46923	-13.11478	-101.38424	0.96619	-0.00385	0.49513	0.70304
-0.05	-3.4	824.4898	-33.89827	-101.97096	0.96529	-0.00091	0.45852	0.63596
0.33	-20.6	-254.6225	244.44442	-77.62741	0.96819	0.00290	0.74582	1.01486
0.06	28.9	27.217792	27.586208	-53.84103	0.97123	0.00305	0.80526	1.07406
0.03	-1	66.300636	12.903213	-42.45072	0.97275	0.00152	0.83762	1.10026
-0.01	-6.7	168.27776	-4.166663	5.03826	0.97953	0.00678	0.83945	1.07511
0.29	0.6	-191.6798	122.10527	-42.25283	0.97321	-0.00632	1.10596	1.39029
-0.03	5.4	-210.2624	-9.67741	-47.20586	0.97301	-0.00019	1.09097	1.34201
0.03	-0.2	-39.45667	9.9173456	-65.97629	0.97112	-0.00189	1.13025	1.36040
-0.02	-1	-243.3934	-6.451607	-10.99010	0.97952	0.00840	1.12349	1.32480

-0.05	4.6	1936.9312	-16.39347	-4.13201	0.98144	0.00192	1.08898	1.25705
0.01	3.9	793.97535	3.4188003	40.72011	0.98862	0.00718	1.11080	1.25351
0.0100001	-0.4	-183.8399	3.3898678	22.69099	0.98741	-0.00121	1.13366	1.24914
-0.02	-0.4	620.92586	-6.722722	53.47989	0.99285	0.00545	1.12956	1.21189
-0.06	1.2	-243.0616	-20.5128	18.87192	0.98956	-0.00329	1.09349	1.12676
0.03	1.1	-361.4452	10.8108	-30.88128	0.98441	-0.00515	1.13106	1.14901
0.0700001	-2.5	2199.0135	24.561422	-39.33982	0.98475	0.00034	1.21449	1.20552
-0.01	-3.8	157.18629	-3.305782	-47.64455	0.98517	0.00042	1.21766	1.18260
-0.08	3.4	134.30969	-26.66668	-64.21169	0.98463	-0.00054	1.14836	1.09234
0.09	2.1	-285.3209	32.142869	-11.02773	0.99311	0.00848	1.26015	1.16184
0.03	0.6	1513.5871	9.9173456	-47.53898	0.99028	-0.00284	1.30499	1.17825
0.01	-3.2	-256.0584	3.2258034	-35.78488	0.99366	0.00338	1.32345	1.18063
0.02	1.9	238.34932	6.3999939	-30.37518	0.99635	0.00269	1.35539	1.18999
0.04	1.3	-166.1054	12.598413	3.50278	1.00261	0.00627	1.41959	1.20887
-0.01	-1.5	-174.8764	-3.053432	4.78061	1.00492	0.00230	1.42341	1.18729
0	-2.1	11.241256	0	-24.01225	1.00364	-0.00128	1.43488	1.17780
-0.04	5.3	-18.14945	-12.30768	21.35064	1.01140	0.00776	1.40955	1.12631
0.01	-5.1	325.87436	3.1746002	-5.98927	1.01041	-0.00099	1.42681	1.13043
-0.03	1.6	-209.6821	-9.44881	-23.30386	1.01067	0.00026	1.40478	1.09455
-0.01	-4.7	1636.8593	-3.225803	3.13871	1.01608	0.00542	1.41542	1.06887
0.1	4.1	-266.3261	32.520332	-12.81514	1.01648	0.00039	1.53935	1.14912
-0.04	1.5	-155.1964	-12.0301	-51.92096	1.01418	-0.00230	1.50087	1.10875
0.09	-0.3	158.11982	27.906988	-22.32627	1.01975	0.00557	1.61593	1.17852
-0.02	-1.4	410.07993	-5.797096	62.45383	1.03146	0.01171	1.60075	1.15546
-0.01	2.2	203.28446	-2.941174	76.31821	1.03497	0.00351	1.60123	1.13819
-0.18		-96.90967	-53.33335	109.42672	1.04051	0.00554	1.39502	0.98128
		-333.946		69.99147	1.03784	-0.00266		

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