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The Ohio State University

Ph.D. 1985

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A SWITCHING REGRESSION APPROACH TO EVENT STUDIES:
THE CASE OF DEPOSIT-RATE CEILING CHANGES

Dissertation

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of the Ohio State University

By

Haluk Unal, B.S., MACC.

* * * * *

The Ohio State University
1985

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To My Mother
and
Meltem
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"I would...wish to learn...why the legislator should be more anxious to limit the rate of interest one way, than the other? Why should he set his face against the owners of that species of property more than of any other? Why should he make it his business to prevent their getting more than a certain price for the use of it, rather than to prevent their getting less?...Let anyone, that can, find an answer to these questions; it is more than I can do."  

Jeremy Bentham, 1787

The primary objective of this dissertation is to investigate the effect of employing the switching regression model developed by Goldfeld and Quandt (1972, 1973, 1976) in event studies. The events studied in this dissertation are changes in provisions governing deposit-rate ceilings. An event study seeks to measure the effects of an information flow or event on the return generating process assumed to apply to a given common stock or portfolio of stocks.

The return generating process assumed in this dissertation is the market model. The market model posits a linear relationship between a security's return and the return on the market portfolio. The model's slope and intercept parameters have the following
interpretations: the intercept estimates the average movement of the stock returns when market returns are unchanged; the slope estimates the market sensitivity of the returns on the security. Within the context of Capital Asset Pricing Model (CAPM), the slope coefficient (beta) captures an asset's systematic risk while the residuals constitute estimates of unsystematic risk.

Event studies investigate whether and how the time path of a stock's or a portfolio's price was deflected from its normal trajectory by particular information flows. In an event study focused on regulatory change, two fundamental inferences may be drawn. The first inference concerns "information content and market efficiency." The issue is how quickly security prices adjust to reflect the full effect of new information. The second inference relates to the distribution of benefits and costs among different parties from given adjustments in regulation.

The events analyzed in this dissertation are four major changes in federal deposit-rate ceilings that occurred during the decade running from 1970 to 1980. Using the switching regression technique, the effect of these changes on the value of a portfolio of bank common stocks is estimated. The issue is whether the parameters of the market model remain stationary around these four ceiling change announcements. The purpose of the exercise is to provide evidence concerning changes in the risk structure of banks and to make inferences about whether a representative bank's common stockholders have benefited from these changes in ceiling rates. The first issue pertains to the risk impact
of deposit-rate ceiling changes and the second issue addresses the wealth impact.

Purported effects on risk formed part of the rationale for originally establishing deposit-rate ceilings. Federal ceilings on deposit interest rates were first imposed in the wake of massive bank failures during 1929-33. It was commonly hypothesized that during and immediately prior to the Depression, banks had overcompeted for funds, to finance the high cost of funds that resulted from this overcompetition, it was claimed that they sought increasingly risky investments, which contributed to the wave of failures. This hypothesis was challenged by Cox (1964, 1967) and Benston (1964). They provide evidence that no relation exists between interest rate competition and bank failures. Using primarily data drawn from institutions' financial statements, Mingo (1978), and Koehn and Stangle (1980), and recently Smirlock (1984) using capital market data examined the issue of whether absence of ceilings increase bank risk. The accumulated evidence from these studies suggest that risk should not increase due to suspension of ceilings.

The approach used in this dissertation to examine the risk impact of ceiling changes is similar to that employed by Smirlock (1984) but departs from it in two important ways. First, the switching regression technique employed here does not require the researcher to make an ad hoc choice of the dates on which parameters of the market model are assumed to shift. Switching regression enables the researcher to estimate the parameters and the shift dates simultaneously. Second, it
is not necessary to assume in advance whether the shift is gradual or abrupt. This information, too, can be obtained simultaneously. In these ways the switching regression technique yields additional information by making fewer assumptions.

The wealth effect focuses on whether and by how much depository institutions have been subsidized by ceilings. If a subsidy exists a statistically significant decline in the market value of commercial banks should be observed on dates when ceilings are unanticipatedly removed or relaxed.

James (1983) found evidence of wealth effects of ceiling changes, employing a widely used technique called Cumulative Abnormal Returns (CAR). The CAR method is explained at length below. It implicitly assumes that the estimated parameters of the market model are stationary throughout an arbitrarily selected estimation period. Then the parameters estimated are used to provide a benchmark from which to calculate abnormal returns. Because stationarity is an ad hoc assumption, it is desirable to use switching regression to test whether or not this assumption holds.

In summary, the switching regression technique has some clear advantages over techniques traditionally used in event studies. It explicitly recognizes the possibility of parameter nonstationarity and investigates this possibility statistically. Other statistical methods which recognize parameter nonstationarity impose more restrictive assumptions. In formulating the regime change, they assume that the hypothesized structural change is abrupt in nature. However,
researchers often have no \textit{a priori} information to support this assumption. Especially in event studies, the speed of adjustment of stock prices to new information and whether the shift occurs abruptly or gradually should be a major concern. To my knowledge, no study has addressed this issue in a market-model context.

The dissertation is organized as follows: Chapter 1 provides a historical review of changes in federal deposit-rate ceilings since 1933. This chronology serves to identify the characteristics of these changes and to help highlight changes in the stated purposes of ceilings during different periods between 1933-1984. Chapters 2 and 3 review and discuss relevant literature. Theoretical studies that support the hypothesized existence of risk and wealth impacts are examined in Chapter 2. Empirical studies undertaken to test these hypotheses are summarized and discussed in Chapter 3. Also, Chapter 3 re-examines the wealth effect using the method employed in James (1983). This exercise in replication is undertaken to highlight a few problems encountered by James (1983). Chapter 4 explains the switching regression model and elaborates the application of this technique to event studies. Chapter 5 explains a special numerical optimization routine, GQOPT, which is used to carry out the tests, and then presents empirical results. Chapter 6 interprets the results and compares them with the findings of earlier studies. It also identifies issues for further research.
Chapter I

HISTORICAL OVERVIEW OF DEPOSIT-RATE CEILINGS

1.1 INTRODUCTION

Federal control of the explicit interest rates commercial banks may offer on deposits began in 1933. Since then, numerous regulatory and statutory changes have restricted the level and character of interest payable on deposits. This chapter gives a chronology of changes made in deposit-rate ceilings for commercial banks during the past fifty-three years. This chronology clarifies what the United States banking system has gone through during this half-century. It simultaneously compiles candidate dates for use in conducting an event study of the effects of deposit-rate ceilings. Finally, since 1986 is the year when U.S. banking system is scheduled to operate without restrictions on nontransactions accounts, this is a particularly timely occasion to sum up the "ceilings-period."

Appendix A lists ceiling changes in chronological order. The dates given in this chronology pertain to the dates when announcements of the ceiling changes were first published in the Wall Street Journal (WSJ) not the effective dates of these ceilings. Also other important
announcements which affect the operation of these ceilings are also listed in Appendix A.

A quick glance at this chronology yields some interesting observations. During the twenty-four years following 1933, only three ceiling changes took place. In contrast, during the following twenty years twenty-two ceiling changes were made. Fifteen of these changes went into effect during the 1970-80 period. It is also interesting to note that with the exception of 1966, all actions concerning ceiling changes during 1960-80 period moved in the direction of increasing (i.e., relaxing) ceiling rates.

Over this 53-year period, changes in market conditions induced regulatory authorities to follow different policies at different times. The 1933-50 period may be characterized as one in which ceiling rates ranged above market rates most of the time. Table 1 compares the ceiling rates with market rates for the 1933-1979 period. Market rates, represented in Table 1 by U.S. Treasury Bill annual total returns and average 4-to-6 months prime commercial paper rates, were far below the ceiling rates established for passbook savings and short-term time deposits for the 1933-1950 period. Rates being paid by banks during this period were also well below the ceiling rates. Table 2 compares average yields on deposits of savings and loan institutions (S & Ls), and commercial banks. S & Ls offered rates both above the rates paid by banks and market rates. During the 1951-1965 period the financial institutions began experiencing the pressure from market rates. Table 1 shows that market rates accelerated starting 1951 and
by early 1960s they broke through the ceilings. Higher market rates "reduced the market value of the S & Ls' relatively long-term assets and threatened their solvency" (Kane, 1979). To protect the S & L industry, legislative actions were taken in 1966 and the Interest Rate Adjustment Act of 1966 began a "bail-out" period for S & Ls. During the 1966-1980 period, market interest rates often far exceeded ceiling rates. As the pressure from market interest rates continued, regulatory steps to reshape the ceiling system were taken. At the end of this period, the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980 marks the start of a deregulated era in the U.S. banking system. During what we may call the post-DIDMCA period, actions were taken to deregulate the ceilings in line with requirements of the Act. The following sections in this chapter discuss the significant ceiling changes during these periods.

1.2 1933-1950 PERIOD

Cox (1967), describes the era when ceilings on deposits were first born as one of "economic chaos and even hysteria". In 1933, the United States was in the midst of the Great Depression and with the Depression banks profits dropped. The opinion among bankers became prevalent that the high interest paid on deposits for the last ten years was the cause of decreased profits and bank failures (Benston, 1964 and Cox, 1967). John M. Miller, president of the First and
Merchants National Bank of Richmond, at a convention of the Virginia Bankers Association in 1932, expressed his feelings as follows:

"The evils of paying interest at high rates are bound to lead you into trouble, as they have already led hundreds and thousands of banks in the United States into trouble. This high rate of interest is a disease, a chronic disease that is eating into vitals of our business. It is leading into loans and investments which are not only slow and unliquid, but which are not likely to be collected. It needs courageous and heroic treatment and action." \(^2\)

Another banker, C.S. L'Engle (1932), indicates the following:

"A recent study revealed that interest paid on deposits for more than ten years had been rising out of proportion to other bank costs, resulting in the serious impairment of bank profits. It was also found that banks, in their efforts to pay the established high rates on deposits, were tempted into accepting undue credit risks that they might earn enough to pay the unsound high rates on deposits.

In this lies the greatest of all danger. Unliquid investments have always borne a greater return - and greater returns were necessary in order to pay the higher rates of interest."

The study L'Engle is referring was undertaken by Association of Reserve City Bankers. This Association formed a committee in 1928 to
investigate the relationship between interest on deposits and bank failure (Benston, 1964). The chairman of this committee, Richard Hawes gives the following information:

"Records show that as interest paid to depositors went up, fatalities to banks have increased and it has become a noted fact to those who have studied the situation, that as interest paid increased, the human element entered into it and the bankers have sought for higher investments with greater risks, and therefore, increased failures caused by competition with other banks in their communities and paying too high a price for their raw materials".\(^3\)

Also, the regulatory environment in 1933 was very convenient for the establishment of ceilings on deposits (Cox, 1967). Dudley Pegrum describes this environment as follows:

"The spirit of the time was to keep everybody in business and put a bottom under prices. Consequently, there was a demand for the extension of price regulation especially as it applied to minimum prices".\(^4\)

Therefore, the general opinion among bankers that interest rate competition was destructive to banking, coupled with the hysteria for price controls in all sectors of the American economy made it possible to undertake the needed "courageous and heroic treatment and action". The Banking Act of 1933 (known as the Glass-Steagall Act) among other provisions authorized the Federal Reserve Board (FRB) to set
limitations on the interest rate member banks could pay on time and savings deposits and prohibited the payment of interest on demand deposits or checking accounts. The Board's first action on this matter went into effect on November 1, 1933 when it established a 3 percent rate ceiling on all existing savings deposits. As given in Table 1, the ceilings set in 1933 remained above the market rates until the early fifties. During this period, two actions were undertaken by the Board, both causing ceilings to decrease. In 1935, the Board lowered the ceiling on savings and time deposits to 2.5 percent when the rates being paid by banks were well below the previous limit of 3 percent. Beginning in 1936 savings and time deposits were treated differently. Time deposits are defined as those which mature after a certain period of time with banks commonly issuing certificates of deposit for them whereas savings deposits have no specific maturity date. The rate schedule put into effect on January 1, 1936 set a very low ceiling for short-term time-deposits (1 percent) thus encouraged banks to rely upon long-term time deposits. For the rest of the period the interest paid by banks on deposits remained below ceiling rates. As reported in Table 1, market rates were below ceiling rates too. However, during this period S & L's paid higher interest rates than banks and as shown in Table 2 the differential was higher than 1.5 percent most of the time. At the end of the period, on September 21, 1950, "Federal Deposit Insurance Act" is passed. Among the important changes made by the new Act was an increase in the amount of an insured deposit from $5000 to $10000 (Fed Annual Report, 1950, p.38).
1.3 1951-1966 PERIOD

Starting in 1951, S & Ls which were not subject to federal ceilings, began offering rates above ceilings that were applicable to banks. Table 2 shows that by 1957 the average yield on S & L deposits increased above 3 percent whereas the average yield on banks' time and savings deposits ranged around 1.5 percent. Also, Table 3 shows that S & Ls experienced yearly record levels of growth starting 1952. In 1955 they had an all-time high yearly asset growth of 19 percent. During this period S & Ls expanded their deposit base and grew four times as rapidly as commercial banks.5

To reduce the competitive disadvantage that commercial banks had in attracting deposits, the Federal Reserve Board and the Federal Deposit Insurance Corporation (FDIC) raised the ceilings on savings and time deposits for member and nonmember commercial banks, respectively, by a half percentage at the beginning of 1957. However, market rates and S & Ls offering yields still remained higher than ceilings. In 1962 savings deposits and long-term time deposits (1 year or more) were increased by 0.5 and 1 percentage, respectively. Following this change the average yield differential between S & L and bank deposits dropped. Despite these developments, S & Ls maintained a high asset growth of 14.9 percent in 1963.

1964 and 1965 changes marked an important policy shift of the regulators toward encouraging short-term funds. On November 24, 1964,
for the first time, rate ceilings on time deposits maturing in less than ninety days were increased to 4 percent from the previous 1 percent. A year later ceilings on all maturities, 30 days or more, were increased to 5.5 percent while the rate on all savings deposits remained at 4 percent. Table 1 shows that these actions brought ceiling rates in line with market rates.

1966 was the year when the policy rationale for deposit-rate ceilings shifted. As indicated earlier, ceilings on deposit interest rates were originally established in the wake of massive bank failures during 1929-33. It was believed that establishment of ceilings would increase bank soundness and make it easier for banks to pay FDIC premiums. In 1966, in addition to this original rationale, deposit-rate ceilings began to be conceived, first as a tool of general monetary policy, and second as a means of influencing deposit flows between commercial banks and thrift institutions to subsidize housing finance.  

In contrast to the mid-fifties, thrift institutions started experiencing difficult times in the mid-sixties. Table 3 shows that S & Ls' asset growth dropped to 8.6 percent in 1965 and plunged to a all-time low level of 3.4 percent in 1966. This was the lowest yearly growth rate of S & L assets since 1940. The mortgage market was hard hit in 1966. Funds supplied to the one-to-four-family residential mortgage market dropped from $16 billion in 1965 to $12.5 billion in 1966. One major reason for the slowdown of S & Ls operations was the
severe decline in net savings inflow to S & Ls. The increase in net savings inflow during 1966 was $3.6 billion, the smallest gain since 1952, and the third year in succession in which net savings inflow was smaller than in the previous year. In the Federal Home Loan Bank Board's 1966 annual report, the reason for the severe decline in the inflow of savings to S & Ls is explained as follows: "The most important cause of loss at savings was commercial bank competition. Their aggressive competition for savings last year (1966) was an intensified continuation of a longer range trend that had been a factor in the more modest decline in savings flows to associations in 1964 and 1965."

In fact, Table 2 shows that starting in 1962 the differential between yields on S & Ls and banks deposits declined. By 1966, it had reached to an all-time low level.

A series of actions to protect the S & Ls industry from commercial bank competition were taken in 1966. The first action was on July 18, 1966 when a new multiple-maturity time deposit for commercial banks was established. This account differed from the old (single-maturity) time deposits in that it was automatically renewable on the date of maturity. The rates established for these new accounts represented a decrease from the previous ceiling rates. The rates on single-maturity deposits were also lowered to the level of multiple-maturity deposit rates on September 26, 1966. With these actions, ceilings on short-term time deposits were lowered to 4 percent from 5.5 percent and long-term time deposits to 5 percent from 5.5 percent. Thus, for the first
time since 1935 a decrease in ceilings was realized. Shortly after the July 18 change, Congress passed the Interest Rate Adjustment Act which became law on September 21, 1966. This Act gave the FDIC and Federal Home Loan Bank Board (FHLBB) the authority to regulate the deposit rates of federally-insured mutual savings banks and federally-insured thrift institutions, respectively. Also for the first time, a rate differential was established on all savings instruments in favor of thrift institutions (S&Ls, Mutual Banks) over commercial banks. This differential ceiling "has become the centerpiece of thrift and bank marketing and lobbying strategies" (Kane, 1979). S&Ls were provided advantaged access to small savings, whereas commercial banks, especially after 1970 when ceilings on large CDs ($100,000 or more) were suspended, focused on exempted large CDs, for their liability management (Kane, 1979).

1.4 1967-80 PERIOD

In the 1970s, federal regulators (FRB, FDIC and FHLBB) were occupied extensively in adjusting ceiling rates toward market rates by either removing ceilings on some instruments or introducing new instruments with higher ceilings. First, ceilings on large CDs were removed by 1973, then variable ceilings for small-denomination deposits were established. By the mid-seventies, a very complex ceiling schedule had been created.
The first action taken by the FRB, FDIC and FHLBB in 1970 was on January 21, 1970 when ceilings on passbook savings was increased to 4.5 percent from 4 percent. This was the first change made in passbook-rates since November 1964. Also ceilings on single-maturity time deposits were increased. On March 4, 1970 multiple-maturity time deposit ceilings were brought in line with single maturity time-deposit rates. These two changes in early 1970 increased the rates on the large certificates of deposits (CDs) (i.e. those whose denomination was at least $100,000) the most.

A third action, on June 24, 1970, further suspended all ceilings on large CDs maturing in less than 90 days. Thus since 1933, for the first time a "no-ceiling" deposit-instrument was recognized. Market conditions at the time induced the regulators to take such an action. On June 22, 1970 Penn Central filed a bankruptcy petition covering its railroad subsidiary and rumors spread that Chrysler was caught "in an acute cash bind like the one besetting Penn Central". These events adversely affected the vulnerable commercial paper market and the possibility arose that the circumstances could force companies to seek more short-term funds. Banks, could then face massive credit demands. To enable the banks to attract more deposits in the immediate future the ceilings on short-term large CDs were suspended. Another reason was the difficulty of preventing repurchase agreements from circumventing the ceiling in large short-term CDs.
In 1973 a desire to curb bank credit and to restrain inflationary pressures emerged. Ceilings on large CDs maturing in 90 days or more were suspended and supplemental reserve requirements were imposed on further increases in outstanding large CDs on May 16, 1973. With this action, all ceilings on large CDs regardless of maturity were removed. According to a FRB analyst quoted in the WSJ, these changes "are expected to result in higher costs to business borrowers because banks will be paying higher interest rates on the large-denomination CDs used to raise funds and because the higher reserve requirement on the increase in certificates will tend to tighten the supply of lendable funds."¹¹

However, this action reinforced existing inequities against small savers. In less than two months, on July 9, 1973, to ameliorate this problem, rates on savings deposits were increased and a new no-ceiling, minimum $1000 denomination and four-year maturity time-deposit introduced. These so-called "wild card" certificates were aimed to appeal to the small saver and immediately drew extensive attention. Some institutions started paying rates on these certificates higher than the ceilings imposed on higher denomination.¹² However, on October 17, 1973, the Fed, the FDIC and the FHLBB adopted a 7 1/4 percent ceiling on these "wild card" certificates. The stated reason was "to bring a greater degree of order into the offering ... of (this new) time deposit ...".¹³
The last action taken in 1973 was to include Negotiable Order of Withdrawal (NOW) accounts, in the two states where they can be offered, under ceiling shelters. On December 10, 1973 NOW accounts offered in Massachusetts and New Hampshire were subjected to a 5 percent ceiling to be effective by the beginning of 1974. These accounts allowed funds to be withdrawn as under normal savings accounts or by the functional equivalent of a check, and the number of checks that could be written on an account each year were limited. NOW accounts began to be offered in May 1972 in Massachusetts and New Hampshire following the Massachusetts Supreme Court ruling that mutual savings banks were not prohibited from offering such accounts. However, this created a competitive disadvantage for federally chartered and insured depository institutions in these states and depository institutions of all sorts in neighboring states. Congressional attention was soon drawn to this problem and a legislation was enacted which authorized all depository institutions (except credit unions) in Massachusetts and New Hampshire to offer NOW accounts beginning January 1974. Congress expanded NOW accounts to all six New England states in March 1976, New York State in January 1979 and New Jersey in January 1980. Nationwide authorization of NOW accounts came with the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980.

During the next six years, regulatory authorities basically adjusted ceiling rates to market rates by introducing new instruments which either had no ceiling or rates comparable to market rates.
First, so-called investment certificates (6-year, $1000 minimum denomination, 7.5 percent ceiling) were introduced on December 9, 1974. Second, in May, 1978 two new instruments were authorized. One of them was an eight-year maturity, $1000 minimum denomination and 7.75 percent ceiling savings certificate and the other were the Money Market Certificates (MMC). The MMC required $10,000 minimum denomination, had a 6-month maturity and the maximum rate payable was pegged to the weekly auction discount rate on U.S. Treasury bills with similar maturities. Third, a new four-year certificate paying rates tied to the average yield on four-year Treasury securities was authorized on May 31, 1979. Finally, on December 17, 1979 so-called Small Savers' Certificates (SSC) were authorized. SSCs had no minimum denomination and 2.5-year maturity, and interest-rate ceiling pegged to the return on equivalent Treasury securities. During this period ceilings on passbook savings were increased to 5.25 percent from 5 percent on May 31, 1979.

Toward the end of the decade extensive arguments for deregulating the deposit-rate ceilings gained ground. For the first time in February, 1979, Carter Administration came out in favor of a phaseout of Regulation Q.¹⁵ In April, 1979, the Administration task force on Regulation Q sent to the white House a study paper indicating the options which could result in a phase-out of interest rate ceilings.¹⁶ In June, 1979, Senate Banking, Housing, and Urban Affairs Committee (SBHUAC) Chairman Proxmire introduced a comprehensive financial reform
package which called for nationwide interest-bearing transactions accounts, with a 10-year phase-out of deposit-rate ceilings. This legislative plan was endorsed by Carter Administration. In September 1979, the SBHUAC voted to phase-out deposit-rate ceilings gradually and make other changes in the financial industry. On November 1, 1979, a bill supporting the elimination of Regulation Q cleared the Senate. Finally, on February 29, 1980 the congressional conference committee agreed to phase-out interest-rate controls on deposits at banks and S & Ls within six years, and on March 31, 1980, the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980 became law which required the phase-out of all ceilings on time and savings accounts by 1986.

1.4 POST-DIDMCA PERIOD

The Depository Institutions Deregulation and Monetary Control Act (DIDMCA), P.L. 96-221, was approved on March 31, 1980. The Act sought to make progress on three longstanding issues in depository-institution regulation. These issues were payment of interest on transactions accounts, the Federal Reserve System's membership problem and staged elimination of interest rate ceilings on time and savings deposits. The content of the Act is examined extensively in Cargill and Garcia (1982).
One of the most important clauses of the act is the creation of the Depository Institutions Deregulation Committee (DIDC). DIDC is composed of the secretary of the Treasury, the chairman of the Board of Governors, the heads of FDIC, FHLBB and National Credit Union Administration (NCUA), with the Comptroller of the Currency serving as nonvoting member. The committee's responsibility and authority according to Title II of the DIDMCA was to preside over an orderly phaseout and eliminate deposit-rate ceilings on time and savings accounts by March 31, 1986. During the phaseout period authority to determine deposit-rate ceilings was transferred from member agencies to the DIDC. The Act required the DIDC to meet at least every quarter and the highlights of each meeting is summarized in DiNuzzo (1984).

Significant actions taken by DIDC in 1980 concern Money-Mark Certificate (MMC), Small-Savers' Certificate (SSC), and NOW accounts. First, on May 28, 1980, DIDC established new ceilings for the six-month Money-Market Certificate (MMC) and the two-and-one-half-year small-savers' certificate (SSC). For the MMC and the SSC, they imposed a minimum ceiling of 7.75 percent and 9.25 percent for commercial banks respectively. The maximum ceiling set for SSC was 12.24 percent. Next on September 9, 1980, the DIDC increased the rate ceiling for NOW accounts from 5 percent to 5.25 percent.

One of the significant actions of the DIDC in 1981 was the approval of a deregulation plan for time-deposits. At its June 25,
1981 meeting, the DIDC approved a plan to phase out ceilings on all
time deposits during the next four years. D IDC approved a plan to phase out ceilings on all
time deposits during the next four years.21 1982 is the year when depositors were finally allowed, with some
restrictions, to have accounts paying rates competitive with market
instruments. DIDC created the money market deposit account (MMDA) and
the so-called Super-NOW account, in 1982. The MMDA was created to
facilitate section 327 of the Garn-St Germain Depository Institutions
Act of 1982, which required DIDC to authorize a deposit account that is
equivalent and competitive with money market mutual funds. 22 DIDC
authorized commercial banks and S & Ls to offer the MMDA and the super-
NOW account on November 15, 1982 and December 6, 1982, respectively.
Both these instruments are ceiling free for accounts with an average
balance of at least $2,500. The MMDA is available to all depositors,
with only six automatic or telephone transfers per month (three of them
by check) and unlimited withdrawals in person. 23 The Super-NOW account,
however, is fully transactional and is available only to those
depositors eligible to maintain a NOW account (individuals,
governmental units, and certain nonprofit organizations). 24

The MMDA was created to increase the banks' and the S & Ls'competitiveness with other market exempt institutions, such as money
market mutual funds. The effects of these new instruments on money
market mutual funds, banks' and S & Ls' liability management is
analyzed in Furlong (1983). He indicates that sources of MMDAs are
funds shifted from money market funds, savings deposits and small-denomination time accounts. He estimates that the assets of general-purpose and broker/dealer funds and institution-only money market funds declined about $37 billion and $6.5 billion, respectively between November 1982 and March 1983. During this same period, savings deposits and small-denomination time deposits at all institutions fell $48 billion and $130 billion, respectively, constituting the major source of MMDAs. On the other hand, DiNuzzo (1985) indicates that by mid-February, 1983 the MMDA balances exceeded $265 million. Furlong (1983), also points out that banks and S & Ls reduced their managed liabilities and built up liquid assets, while S & Ls increased their mortgage assets.

In 1983 deregulation activities of DIDC continued. On July 1, 1983, ceilings on time deposits over 31 days maturity and time-deposits having 7-31 days maturity with minimum $2500 denomination, are suspended. Table 4 exhibits the remaining ceilings-structure in effect as of December 31, 1984. Passbook savings and time deposits having 7-31 days maturity with less than $2500 denomination have 5.5 percent ceiling for all depository institutions. These institutions are allowed to pay 5.25 percent on NOW accounts. Also, zero interest rate ceiling on demand deposits still exists.

To complete the process of deregulation, someone must convince the Congress either to remove the zero interest rate ceiling on demand deposits or transfer this authority to an interregulator committee such as the DIDC.
Chapter II

HYPOTHESES

2.1 INTEREST RATE COMPETITION AND BANK RISK

A conceptual typology of bank risk is necessary to evaluate correctly various hypotheses concerning the effect of deposit-rate ceilings on bank risk. Kane (1985) focuses on total return risk and distinguishes two major categories: financial risk and service-facility risk. Financial risk traces to variations in the market values of the asset and liability items, whereas service-facility risk is associated with the factors that affect the operating side of the business. He separates financial and service-facility risks into several sub-categories. Market values of deposit-institution assets may fluctuate due to risks growing out of the operations of its affiliates (affiliated-institution risk), from unpredictable cash shortages caused by customer withdrawals (liquidity risk), and from defaults by borrowers (credit risk). A deposit institution's asset and liability values may also be affected by changes in market interest rates (interest-rate risk) or foreign exchange rates (foreign-exchange risk). Finally, the risk of a breakdown of management integrity (internal-integrity risk) may cause fluctuations in asset-liability
values. The sub-categories for service-facility risk are as follows: factors that cause a deposit institution to operate inefficiently (operating-efficiency risk); unforeseen regulatory actions (regulatory risk); technological changes which result in reduction in the value of existing system to render services to related parties (technology risk).

Using this framework, we look at opposing hypotheses concerning the effects of deposit-rate ceilings on bank risk. Brealey and Myers (1984) observe that "One endearing feature of economics is that it can always accommodate not just two, but three opposing points of view." As they would predict, several positions may be distinguished in the literature on the risk impact of ceilings. The traditional view hypothesizes that ceilings eliminate competition for deposits, decrease bank risk and increase bank soundness. An opposing view claims that ceilings, during times of high market interest rates, cause disintermediation which is ultimately costly to banks. Finally, what we may call the indifference view proposes that ceilings do not have any impact on bank risk since banks would be forced to pay implicit interest rates to make up the difference between market and ceiling rates. These opposing views are discussed below.
Federal ceilings on deposit interest rates were originally established in the wake of massive bank failures during 1929-33 with the passage of the Banking Act of 1933. As explained in Chapter 1, both the political environment and prevalent opinion among bankers made it possible to establish ceilings in 1933. The claim was that banks had "over-competed" for funds, and to compensate the higher cost of these funds, they sought increasingly risky investments which led to a wave of failures. On the other hand, price controls in all sectors at the American economy started with the National Industrial Recovery Act which "incidentally" became law on the same day as The Banking Act of 1933. The objective was simple and clear. Price competition in industry was destructive and had to be prevented, just as interest-rate competition was destructive to banking and had to be suspended and controlled (Cox, 1967). This "solution" for bank safety "created a cartel among the banks that had survived the Great Depression". Banking laws constituted the rules of the cartel and had the objective to prevent "intra-industry" competition, resulting in a "safe banking system" (Huertas, 1983). This objective, to create a safe and sound banking system, is also reflected in the establishment of the deposit insurance system. The intention was to prevent panics by providing a federal financial guarantee on deposits when one bank failed. However, this restricted competition as well (Huertas, 1983). It made deposits
of one bank equivalent to the deposits of any other thus eliminating the competition for funds by offering lower risk deposits.

Benston states this traditional view in the form of a testable hypothesis, and names it the "profit target hypothesis". According to this hypothesis, the rate of return on invested assets is a function of deposit rates. Bank management sets a short-run profit target, and given cost of deposits managers adjust their investment policies to attain the target profit. If interest rate competition causes the cost of deposits to increase, then management would seek higher yielding investments at the expense of higher risk. This business policy would result in "unsound, overly-risky" banking practices. In Benstons's words, "since higher gross yields almost always are purchased at the cost of greater risk, ceteris paribus, bankers would engage in unsafe investment activities". Within the risk framework reviewed in the previous section, affiliated-institution and credit risks would increase, thus cause a higher financial risk.

In summary, the premise is that establishment of ceilings eliminates "intra-industry" interest rate competition, and creates a cartel. Banks under these circumstances do not have to offer higher deposit-rates to maximize deposit growth. Since the pressure to attract more deposits by increasing higher rates would be eliminated, bank soundness and safety would be increased.
Ceilings have no impact on bank risk:

Klein (1971) uses his microeconomic model of the banking firm to analyze the relationship between zero deposit-rates on demand deposits and bank investment behavior. Asset-side decision variables of the Klein-model are proportions of private securities, government securities and cash holdings to total assets. Rates of interest offered on demand deposits and time deposits constitute the liability side decision variables. The solutions for each of the three bank asset-selection variables do not incorporate the cost of deposits. Thus, Klein concludes that rates paid on deposits "cannot affect asset selection". However, the solutions for optimum rates on deposits show that the interest rate banks are willing to pay depends on total portfolio yield. Formally Klein demonstrates that:

\[
\begin{align*}
  R_1 &= E_a - D_1(R_1) / D_1'(R_1) , \\
  R_2 &= E_a - D_2(R_2) / D_2'(R_2) ,
\end{align*}
\]

where \( R_1 \) and \( R_2 \) are the yields (implicit and explicit) offered on demand deposits \( D_1 \) and time deposits \( D_2 \), respectively. \( E_a \) is the bank's total portfolio yield. It is assumed that the supplies of \( D_1 \) and \( D_2 \) to the individual bank are increasing functions of the yields, i.e.,

\[
D_1 = D_1(R_1), \quad D_1'(R_1) > 0 ,
\]

and
\[ D_2 = D_2(R_2), \quad D_2'(R_2) > 0 \quad (4) \]

The first deposit-supply function, equation (3), ensures that a positive yield must be paid on demand deposits to induce depositors to have such accounts and equation (1) determines the yield to be paid on demand deposits. Since, banks are prohibited from paying explicit rates on demand deposits, banks induce depositors by paying implicit yields, such as "preferential treatment on loans and free ancillary services", or to charge fees for the transactions banks perform for customers at rates below bank costs. Whatever way is chosen, banks would engage into "non-price competition". Klein assumes that the only "outlet for such non-price competition is in the setting of service charges", and demonstrates that \( R_1 \) is positive if the cost of providing transactions services (such as processing checks) exceeds the service charge applied for such transactions.

In sum, Klein shows that
\[ R_1 > 0 \quad \text{if} \quad E_a > D_1(R_1) / D_1'(R_1) \quad (5) \]

and the prohibition of paying positive explicit \( R_1 \) is offset by offering below-cost services. The implication of Klein's result on bank risk and deposit-rate ceilings may be expressed as follows: Deposit-rate ceilings aim to eliminate "destructive" price competition. However, one unintended result is the creation of non-price competition in the form of offering below-cost services. Since, "competition" is not completely eliminated, \textit{ceteris paribus}, we should not expect any change in bank risk. This hypothesis is appealing to the extent that
implicit-rate competition among banks is limited to service charges. However, as indicated in Klein, there are other ways to pay implicit prices. Whether or not engaging in competition in these other areas increases bank risk is an important issue which should not be overlooked.

Kane (1981) cites merchandise premiums, customer-service improvements, bigger parking lots, longer hours, drive-in windows, increased branching, electronic accessibility, automatic tellers, preferential loan treatment and bank-sponsored social and educational activities as examples of implicit interest payments. These noncash benefits offered to depositors tend, after an "avoidance lag" in which optimal avoidance schemes are discovered and put into place, to eliminate the difference between the explicit interest that a bank can pay (ceiling rates) and market interest rates. Among the list of noncash benefits, for example, building extensive branch office networks to pay "convenience-yields" may easily lead to increased risk. Therefore the hypothesis that ceilings do not effect bank risk has some grounds if the form in which implicit rates are paid does not cause bank risk to increase.

Another issue within this context is whether or not and by how much do banks pay implicit rates. This empirical question has attracted considerable attention and an extensive literature exists regarding the level and importance of implicit payments. Startz (1979) reviews this literature. He distinguishes three competing hypothesis concerning the payment of implicit interest rates on demand deposits:
1. Beyond the ceiling, no explicit or implicit interest rate is paid (the traditional hypothesis); 2. Above the ceiling some implicit interest is paid (the modified-traditional hypothesis); and 3. Implicit rates paid by banks raises total returns to depositors until they are fully equal to the explicit rate under no ceilings circumstances (the competitive hypothesis). Startz (1979), and in a comment on his study, Rush (1980) provide estimates of implicit interest paid by commercial banks on demand deposits. Spellman (1980) estimates nonrate competitive costs per dollar deposit for savings and loan industry. The accumulated evidence from these studies reject the hypothesis that beyond the ceiling, no explicit or implicit interest rate is paid. Startz estimates that implicit deposit rate is well above zero and responsive to market rates. Rush provides evidence that banks pay implicit rates equal to the competitive market rates. Spellman shows that ceilings established for S & Ls in 1966 caused them to engage in nonrate competition which resulted an increase in the number of branch offices between 1972 and 1974.

To sum up, there is strong evidence that financial institutions engage in nonrate competition when ceilings are established. To the extent that there is no risk inherent in the form of the noncash benefits supplied to depositers, ceilings would not affect bank risk. However, we do not have any evidence to support this assumption. To the contrary, some forms of implicit payment do increase bank risk. This issue is discussed in the next section.
Ceilings increase bank risk:

Every regulation has intended and unintended effects. This fact gives rise to what Kane (1977) calls the "regulatory dialectic." This concept describes a life cycle for regulations where regulations induce loop-hole exploiting endeavors, leading to the regulatory response of passing loophole-closing regulations, which in turn creates more regulated life. As this cycle continues, unintended effects become increasingly costly and important relative to intended operating benefits (Kane, 1977).

The regulatory dialectic of ceiling regulations leads the regulatees to engage more in regulation-induced innovation, too. As a general rule, the longer the economic controls remain in force and the more controversial they are, the more time and energy is devoted to undermining them (Kane, 1977). Endeavors to undermine ceiling controls can be placed in three categories. The first group includes the creation of schemes for paying implicit interest; second group covers the introduction of financial innovations (ceiling-exempt instruments) to circumvent the ceilings and in the third group belongs the emergence of exempt institutions.

In the previous section the issue of implicit interest is examined, and examples of such schemes are given. Empirical evidence suggests that implicit interest payments constitute an important way to avoid ceiling constraints. One problem with implicit interest is its effect on operating costs. Kane (1980) indicates that implicit
interest on demand deposits causes operating costs to be less flexible. In other words, burdened with high fixed costs, such as through more branching, financial institutions would have difficulty adjusting their expenses to sudden market changes. This would result in increased operating risk for financial institutions. If (as many argue) deposit insurance subsidies to risk taking exist, such a result is particularly likely.

The introduction of ceiling-exempt instruments is another avenue that financial institutions follow to circumvent the ceiling constraints. Eisenbeis (1980) gives a list of Regulation-Q-related financial innovations and regulatory responses to each of these innovations, which took place between 1960-1979. Among these, placement of negotiable CDs in early 1961 and short-term promissory notes in 1964, development of federal funds market in mid-1960s and Eurodollar market in mid-1966, repurchase agreements, loan sales and small capital note sales in 1969, NOW accounts (1972), Citicorp's floating rate notes (1974) and rising rate notes (1977) can be noted as important innovations induced by ceiling constraints. However, these innovations create some additional risks. Kane (1980) argues that interest rate risk and foreign exchange risk of banks would increase. Also, since, each of these financial innovation led to re-regulation, they introduce an important category of "regulatory risk" and "technology risk" for financial institutions which also impacts indirectly on liquidity risk.
The emergence of "extra-industry" competition is one of the most important unintended effects of ceiling regulations. Not only the regulated financial institutions seek to find ways around the ceilings but depositors, open market borrowers, less-regulated financial firms and nonfinancial companies do also seek industriously to circumvent the ceiling constraints.

Especially during rising market interest rates depositors tend to lend directly to corporate and government borrowers rather than indirectly through regulated financial institutions to earn market rates. This causes a slowdown or even a reversal of the flow of funds to financial institutions, corresponding to an increased flow of funds to open market instruments. In banking, this "crisis" is called "disintermediation". The U.S. banking system has experienced disintermediation first in late 1950s, then during liquidity crunches of 1966 and 1969-70 and finally in 1979 (Huertas, 1983). Table 1 shows that market rates during these periods rose above the ceilings substantially. The result was corporations and consumers withdrew their deposits and invested directly in money market securities (in late 1960s) and money market mutual funds (in late 1970s).

The magnitude of the flow of funds between regulated financial institutions and open market instruments is empirically documented for some periods. Kane (1978) estimates that commercial banks, due to the wide gap between ceiling rates and market rates, lost at least $5 billion of potential deposits to open market instruments between July 1st and October 31st of 1973. This is the period when ceiling-free
"wild card" consumer certificates were allowed. He also argues that if it were not for the "wild card" instrument, banks and thrifts would have lost even more consumer funds to market instruments. King (1984) estimates that the introduction of the six-month money market certificate (MMC) in June 1978, added about $25 billion to thrift deposits from mid-1978 through 1980. Finally, as indicated in Chapter 1, after financial institutions are allowed to offer money market deposit accounts in 1982, assets of money market funds declined considerably.

We can now incorporate the preceding discussion into Benston's (1964) second hypothesis concerning deposit-rate ceilings and bank risk, and extend it to state the "ceilings increase bank risk" hypothesis. According to Benston, interest paid on deposits is a function of the rate of return earned on assets and bank management behavior must be consistent with the neoclassical model of profit maximization. Managers would equate the marginal interest cost of deposits to their marginal revenue. Thus, "the interest rate on deposits offered by a banker is a function of the investment possibilities (and their associated risks) available to the banker, rather than the reverse". Benston names this "the profit maximization hypothesis". The implications of the hypothesis are straightforward. Increasing deposit rates indicate that in the market investment opportunities exist that make it profitable to obtain funds for investment even at higher cost. In other words, even though deposit rates are bid up to obtain more deposits, these higher-cost funds may
be employed profitably by the bank. Explicit interest on deposits is one way bankers pay to obtain funds to be used in their investments. Constrained with ceilings, bankers are induced to pay implicit interest and engage in financial innovation to attract the needed funds. However, these endeavors create inefficiencies. Notably interest rate, foreign-exchange, technology and regulatory risks are increased. Together with disintermediation these regulation-induced innovations could in worst-case circumstances cause grave trouble for financial institutions.

In sum, whatever "good intentions" underlie the establishment of rate-ceilings, "unintended evil" is created. This evil consists of inefficiencies and distribution effects. Among the inefficiencies, we focus here on increased bank risk and the possibility that increased risk-taking is facilitated by defects in federal deposit insurance pricing and coverage.

2.2 CEILING CHANGES AND WEALTH IMPACT

Hypotheses regarding the impact of regulation on economic profits have been developed in Stigler (1971), Jordan (1972), Posner (1974) and Peltzman (1976). The two extremes in these studies hypothesize that a given regulation is aimed either to protect consumers or producers. When an industry is regulated, benefits are either reaped by the consumers at the expenses of the members of the regulated industry (the consumer-protection hypothesis) or by the regulated industry at the
expense of the consumers (the capture or producer-protection hypothesis).

Empirical research investigating the impact of regulation has taken two different avenues. One is to use financial data to measure the effects of regulation. Stigler and Friedland (1962) and Peltzman (1965) are the first studies to adapt this approach. Schwert (1981) points out the second avenue and argues that capital market information is a powerful tool for measuring the effects that regulation has on the value of the regulated firm. In this approach the behavior of security values permits inferences to be drawn concerning the distribution of benefits and costs from given adjustments in regulation and avoidance. This method has attracted a lot of attention in accounting and finance literature. Izan (1978), Binder (1983), Dann and James (1983), James (1984), and Chen and Sanger (1984) may be cited as examples of studies which can be called "event study of regulatory change". Also Schwert (1981) develops a comprehensive list of literature which deals with measuring the effects of regulatory changes.

In this dissertation what is called the "wealth effect hypothesis" regarding deposit-rate ceilings employs the following premises. As indicated previously, the original rationale to establish ceilings was to create a sound banking system by reducing interest-rate competition among banks. The resulting cartel is controlled by federal regulatory agencies. The rules of this cartel are the nation's banking laws (Huerton, 1983, p. 20). If this view is correct then commercial banks
may have been subsidized by deposit-rate ceilings. If a subsidy exists when a measure is adopted, a statistically significant change in the market value of commercial banks should be observed when ceiling adjustments are announced. In other words, the banks would gain or lose anticipated subsidy payments. If capital markets are efficient this value change must be reflected in stock prices, causing the stockholders to incur a change in their wealth.

Stigler (1974) and Posner (1974) further argue that there can be differential effects of a regulation on an industry. Each firm within the same industry may not be affected by the regulation symmetrically. Stigler (1974) indicates that interests of larger firms are different from smaller ones. This view posits that there is an asymmetry in the impact of regulation on the members of an industry. Within the same industry some firms may gain economic profits while others lose. Thus, second hypothesis of interest is the "intra-industry hypothesis". Deposit institutions may be affected differently when ceilings are instituted or relaxed, depending on their customer base and liability structures. Dann and James (1978) and James (1983) investigates this issue empirically. Lam and Chen (1985) demonstrate theoretically that "banks of different sizes (capitals) may react differently to changes in capital regulation when Regulation Q no longer exists". Thus, removal of ceilings directly or indirectly may cause some groups of banks to gain while others lose.
Chapter III

EMPIRICAL EVIDENCE

3.1 TESTING THE RISK IMPACT HYPOTHESIS

It has been over fifty years since the ceilings on deposits were first established. Over this period numerous arguments for and against the ceilings have been made. However, the issue of how ceilings affect the banks' risk has not been resolved. It is ironic that in a recent government report concerns are expressed as follows:

"... is banking becoming riskier? Are large banks riskier than small banks? What effect has interest rate deregulation had on the risks faced by the banking system? ... We do not have good answers to these questions." 30

Early empirical research (Cox (1964, 1967), Benston (1964), Mingo (1978), and Koehn and Stangle (1980)) has utilized mainly financial statements information to answer questions concerning bank risk and deposit-rate ceilings. Recently Smirlock (1984) used capital market information to investigate the impact of ceilings on bank solvency risk. This section reviews the empirical literature concerning the risk impact of deposit-rate ceilings.
3.1.1 **EMPIRICAL EVIDENCE**

Cox (1964, 1967), is the first study to provide an extensive analysis of the impact of interest rate regulation on banks. He challenges the hypothesis that ceilings decrease bank risk. He provides evidence from 1919-33 period that the effective interest rate paid on deposits by banks does not exhibit any "over-bidding" when compared to other short-term rates of the period. Also, after an analysis of the interest expenses of 285 banks he concludes that they were not excessive. Finally, he finds no evidence concerning the relationship between interest rates paid in 1929 by banks and their survival during the 1930-33 wave of failures. Cox's major conclusion is that "destructive rate competition for bank deposits in the twenties, lacks solidity".\(^{31}\)

As explained in the preceding section Benston (1964) is the first to formalize the hypotheses concerning the risk impact of ceilings into the profit target and profit maximization hypotheses. In his study Benston also analyzes earnings, expense and loss data for 412 New York State banks for the 1923-34 period and examines the relation between the average interest rate paid on demand deposits, earnings and losses on invested assets and expenses other than interest for all national banks for the years 1928, 1931, and 1932. He also investigates the relationship between bank failures and interest paid by the failed banks. His findings contradict the profit-target hypothesis but are
consistent with the profit-maximization hypothesis. Hence Benston concludes that ceilings do not decrease bank risk, but rather increase it.

Mingo (1978), and in a comment on his study, Koehn and Stangle (1980) both confirm the view that absence of ceilings do not increase bank risk. The former study regresses the ratio of variance of accounting earnings to average net income (defined as risk) on various balance-sheet/income statement data and market characteristics (concentration, firm market share, firm size). His key independent variable is the ratio of total interest expense to total operating expense (TIE/TOE), and he finds a significant negative correlation between risk and TIE/TOE ratio. He infers from this finding that ceilings are associated with higher risk.

Koehn and Stangle adopt a similar procedure. They first specify a bank stock's beta as a function of a set of independent variables. These variables are, TIE/TOE ratio (the key variable), capital to total assets ratio, total assets, and dummy variables to account for membership status and branching characteristic of the bank. Then, they substitute the beta equation into a market-model regression equation to obtain a cross-sectional test equation where the difference between bank returns and risk free return is regressed on the above variables. They find that the coefficient of TIE/TOE variable is insignificant and conclude that deposit-rate ceilings do not affect banks' systematic risk and that removing the ceilings "may reduce the chance of bankruptcy".
Smirlock (1984) adopts a different approach and uses capital market data to test the risk impact hypothesis. His method is based on Aharony, Jones and Swary (1980), using the least-squares variance partition:

\[ \text{var}(R_{jt}) = b_j^2 \text{var}(R_m) + \text{var}(\varepsilon_{jt}) \]  

(6)

derived from the market model

\[ \tilde{R}_{jt} = a_j + b_j \tilde{R}_m + \varepsilon_{jt} \]  

(7)

In (1) and (2),

\( R_{jt} \) = rate of return on asset \( j \) on day \( t \),

\( R_m \) = rate of return of the CRSP equal-weighted index on day \( t \),

used as a proxy of the market portfolio of risky assets,

\( a_j = \text{E}(\tilde{R}_{jt}) - b_j \text{E}(\tilde{R}_m) \),

\( b_j = \text{Cov}(\tilde{R}_{jt}, \tilde{R}_m) / \text{var}(\tilde{R}_m) \),

\( \varepsilon_{jt} \) = disturbance term for security \( j \) on day \( t \), \( \text{E}(\varepsilon_{jt})=0 \),

\( \text{var}(.) \) = variance operator.

Equation (6) posits that total risk of a security measured by the variance of its rate of return can be partitioned into two components: the systematic risk, \( b_j^2 \text{var}(R_m) \), which measures how the security covaries with the market, and the unsystematic risk, \( \text{var}(\varepsilon_{jt}) \), which is independent of the market. Also the slope coefficient of the market model parallels the beta in the Capital Asset Pricing Model (CAPM).
Smirlock examines these risk elements for a portfolio of bank stocks around four regulatory ceiling changes. Announcement dates for these changes are the dates of the Fed's official press release and are given in Table 5. The number of banks used in Smirlock (1984) is given in Table 6. Smirlock defines 10 days prior through 10 days after the ceiling changes as the event-period. He estimates equation (7) for pre-event and post-event periods which cover 60 trading days prior and after the event period, respectively. Using the risk characteristics obtained from each regression of equation (7), he tests whether the elements of systematic risk and unsystematic risk differ significantly from each other between the two periods. Effectively, he estimates the market's response to ceiling changes and investigates whether either systematic or unsystematic risk has shifted after the announcement of the regulatory changes.

His major finding is that the slope coefficient of the market model, which captures systematic risk, did not shift in any of the four events analyzed. Only in the 1970 CD event does the total variance of the bank portfolio for the post-event period prove significantly lower than the pre-event period. This difference is attributed to a shift in the variance of the market portfolio. Except for the 1970 CD event, the shift in unsystematic risk is not significant around the events analyzed. In the case of the 1970 CD event, unsystematic risk decreased and the shift is significant at the ten percent level.

He also estimates equation (1) for each bank in the portfolio, and then cross-sectionally regresses changes in each of the risk elements
on non-passbook time deposits (TD) to total assets (TA) ratio. In other words he runs the following cross-sectional regressions:

\[ \Delta \text{Var}(R_j) = a + b \frac{(TD/TA)}{} + u_j, \quad (8) \]
\[ \Delta B_j = c + d \frac{(TD/TA)}{} + v_j, \quad (9) \]
\[ \Delta \text{Var}(e_j) = e + f \frac{(TD/TA)}{} + w_j, \quad (10) \]

where \( j \) denotes the \( j \)-th bank. His premise is that if deregulation affects bank risk, then coefficients \( b, d, \) and \( f \) in the above regressions should be positive and significant. The regression results show that these coefficients are neither positive nor significant and he concludes that "bank solvency-risk and deposit-rate ceilings are independent".

3.1.2 DISCUSSION

In summary, empirical evidence concerning deposit-rate ceiling changes and bank risk, using different data and methods, confirm each other. The accounting-data studies of Cox (1964, 1967) and Benston (1964) find no relation between interest rate competition and bank failures. Benston's analysis supports the profit maximization hypothesis over the profit target hypothesis, which indicates that bank risk is increased under deposit-rate ceilings. Mingo-Koehn and Stangle also reject the hypothesis that ceilings decrease bank risk. Mingo
claims that bank risk is increased by the existence of ceilings. Finally, Smirlock's market model evidence supports no relation between bank solvency risk and deposit-rate ceilings. The accumulated evidence thus suggests that risk would not increase due to suspension of ceilings.

The earlier studies of Benston-Cox utilize data relevant to pre and post-Depression era and may be considered of limited relevance to the present complex banking system times. For example, today the existence of the guarantee provided by the Federal deposit-insurance system has complicated effects on banks' risk taking behavior. The importance of their findings is to provide evidence showing that the original policy rationale in imposing deposit-rate ceilings has no grounds. Although interest rate competition was blamed as the cause of massive bank failures, the Benston and Cox studies present evidence against this hypothesis.

Despite the Benston and Cox studies, the rationale to maintain ceilings continued to be cited long after 1960. Legislative actions taken after 1960 purported to be under the influence of this rationale. The Heller Commission (1963) and the Hunt Commission (1971) did not include any substantial recommendations as to the removal of ceilings completely. Further, the Financial Institution Act of 1973 and the Financial Reform Act of 1976 were defeated. These Acts would have suspended all ceilings.33
The Mingo-Koehn and Stangle studies, provide new evidence against the belief that deposit-rate ceilings provide a safer banking system. Using data from 1961-1972 period multiple regressions are run to establish a relationship between various risk measures and several accounting and industry variables that are presumed to have an impact on bank risk. However both studies suffer from important methodological problems. An extensive criticism of the methods used in Mingo-Koehn and Stangle studies is given in Smirlock (1984). Smirlock correctly points out that, as used in Mingo, variability of earnings is not a good proxy for bankruptcy risk. Since the value of the deposit-insurance is not reflected in accounting earnings as well as the value of other off-balance sheet transactions, variability of accounting earnings has limited value in estimating the bankruptcy risk. Further, a relationship between interest expense to operating expense ratio (TIE/TOE) and variability of earnings would be observed anyway without implying anything for bank's solvency risk, since TIE/TOE ratio is dependent on a bank's liability composition (Smirlock, 1984, p. 197-198). Koehn and Stangle takes a step further and replaces Mingo's risk proxy with beta. They seek to find whether systematic risk is affected by ceilings. As explained previously, they define a model of the determinants of a bank's market-model beta. However, as indicated in Smirlock (1984), the choice of variables used in the beta equation is ad hoc and far from being complete. Furthermore, it is argued that systematic risk is not a good proxy for solvency risk.
Ahorony, Jones and Swary (1980), AJS, compare the risk characteristics of non-bankrupt firms, prior to actual bankruptcy. They use the least-squares variance partition to infer which risk component best distinguishes between the two groups. AJS find that the sample mean of the unsystematic risk component for the bankrupt group diverge from those of the control group (non-bankrupt firms) in an increasing pattern as the bankruptcy date approaches. No significant shift in the slope term, which captures the systematic risk, is observed. They conclude that "systematic risk (beta) is not a useful indicator of firm deterioration over time".34

Smirlock (1984) is the first to investigate the risk impact hypothesis with capital market information. His method allows him to draw inferences about both systematic and unsystematic risk. However, the method has one major shortcoming. To test the significance of observed shifts in systematic and unsystematic risk around the dates of the ceiling change announcements, he arbitrarily partitions the data set into pre-event event, and post-event periods. His premise is that during the 141 trading days around the announcement of a ceiling change, the assumed return generating process (the market model) follows three regimes. The observations for the first 60 trading days belong to the first regime, the 20 trading days around the announcement day constitute a second regime, and the last 60 trading days belong to a third regime. He implicitly assumes that during the first regime no news leakage concerning ceiling changes to the market occurs, and the
parameters of the market model are stationary. Further, the choice of the cut-off date for the pre-event period (the 60th day) and the 20 days around the announcement day is ad hoc. Also, he hypothesizes that regime changes take place at the assumed dates in an abrupt fashion. By imposing ad hoc dates for each regime switch, a joint hypothesis is being tested. He looks at whether a regime switch occurs at the hypothesized dates. When he observes a significant switch he looks also at whether the parameters of the process are significantly different in the first and the third regimes. But what if he fails to observe a regime switch? Can he rule out the existence of other regimes spanning different time periods? If the regime switched at a date different from the ones hypothesized by Smirlock, or more than one regime existed during the pre-event period, the assumed process would be mis-specified rendering his results unreliable.

Another shortcoming relates to his analysis to investigate the relationship between bank solvency-risk and ceilings. As indicated, he runs the following cross-sectional regressions:

\[ \Delta \text{RISK}_j = a + b \left( \frac{TD}{TA} \right) + u_j, \quad (11) \]

where RISK represents the risk element used in the regression. This ad hoc specification is logically equivalent to

\[ \Delta \text{RISK}_j (TA_j) = a (TA_j) + b (TD_j) + u'_j. \quad (12) \]

He expects to find \( b_1 \) in (11) to be positive and significant if deregulation increases bank risk. In other words, positive and significant \( b_1 \) would indicate that increase in non-passbook time
deposits causes bank risk to increase. However, it is more clear from (12) that risk of a bank's assets has an impact on the risk element used in the cross-sectional regression. Ignoring this effect, means implicitly assuming for all banks to have identical risky assets. However, this assumption is too strong and has no grounds.

Finally, the assumed return generating process in Smirlock (1984), the market model, may not be properly specified. Evidence exists that the common stock returns and interest rates are highly correlated (Flannery and James, 1984). Omitting interest rates as an explanatory variable would cause the estimates of the intercept and the slope of the market model to be biased and inconsistent (Kmenta 1971, p. 394).

3.2 TESTING THE WEALTH IMPACT HYPOTHESIS

James (1983) examines the wealth impact of changes in deposit-rate ceilings on commercial banks in terms of the common-stock price performance of these institutions. He investigates whether these institutions are subsidized by the existence of ceilings and examines the intra-industry effects of changes in ceiling rates. This section summarizes and discusses James's results.
3.2.1 **EMPIRICAL EVIDENCE**

James tests the hypotheses that deposit-rate ceilings provide a subsidy to bank owners by causing a wealth transfer from depositors to owners. He also investigates the possibility of an "intra-industry difference" regarding the impact of ceiling changes. For selected bank stocks, James examines daily common-stock price performance around the dates of four regulatory ceiling changes. For 1973 and 1978 events data for common-stock returns is obtained from Data Resources Incorporated (DRI) Securities Price file. For the 1970 event, price information for over-the-counter stocks is obtained from issues of the *American Banker*. The number of banks used in James (1983) study is given in Table 6. The regulatory events analyzed are the same as those given for Smirlock (1984) in Table 5. Announcement dates are claimed "to represent (the date when) the announced change was first published in *American Banker*". 36

The standard cumulative abnormals returns (CAR) method is utilized to test the hypotheses. Since the CAR method was introduced into the finance literature by Fama, Fisher, Jensen and Roll in 1969 it has been used extensively. Its objective is to detect abnormal returns due to firm-specific information such as stock splits, dividend announcements, or capital-structure changes. An in depth review of the method and problems encountered is given in Brown and Warner (1980) and Warner and

In CAR method two periods are defined: The analysis period and estimation period. The analysis period includes the days which surround the event. In the context of the present study, the event is the announcement date of a ceiling change. The analysis period is also called the event period (Warner and Brown, 1984, p.6). The estimation period is then designated as the days which surround the analysis period. Designation of the location and length of either period is arbitrary. The number of days selected varies in different applications of the method. For example, in their simulation Warner and Brown (1984) use 5 days before and after the event to designate the analysis period (event period) and 239 days before the analysis period to identify the estimation period. James designates the analysis period as 10 days before and after the date of announcement and estimation period as 55 days before and after the analysis period.

James obtains excess return \( e_{pt} \) for each day in the analysis period using the procedure:

\[
e_{pt} = R_{p,t} - \hat{a}_p - \hat{b}_p R_{m,t}, \quad t = -10, +10 \quad (13)
\]

where

\( t \) = day measured relative to an event.

\( R_{p,t} \) = rate of return on equal-weighted portfolio over period \( t \),
\( \hat{a} \) and \( \hat{b} \) = ordinary least square estimates of the intercept and slope of the market model from the estimation period, 

\( R_{m,t} \) = rate of return on the CRSP equal-weighted index on day \( t \).

Prediction errors are utilized to estimate the "abnormal returns to shareholders". This method assumes the market model to be the return generating process. An extensive analysis of market model is given in Fama (1976). The market model posits a linear relationship between security returns \( (\tilde{R}_{it}) \) and the return on the market portfolio \( (\tilde{R}_{mt}) \), where the joint distribution of \( \tilde{R}_{it} \) and \( \tilde{R}_{mt} \) is bivariate normal:

\[
\tilde{R}_{it} = \hat{a}_i + \hat{b}_i \tilde{R}_{mt} + \tilde{e}_{it} \quad .
\]

(14)

Within the context of CAPM coefficients of the market model have the following interpretations: \( \hat{a}_i \) estimates the average movement of the stock price when market returns are unchanged and \( \hat{b}_i \) estimates the market sensitivity of a return on security \( i \). Expected return on security \( i \) is

\[
E(R_{it}) = \hat{a}_i + \hat{b}_i E(R_{mt}) \quad .
\]

(15)

Prediction errors are the differences between actual returns and expected returns which represent deviations in the normal trend of the stock prices given the market conditions. When markets are to be semi-strong efficient security prices reflect all available information. In this case, event-period prediction errors may be interpreted as
evidence of abnormal returns observed due to the new information conveyed by the event under study. Furthermore, if the joint distribution of security returns is assumed to be multivariate normal, then the market model can be used to describe the relation between a portfolio return and market portfolio's return.

To examine the significance of the announcement day prediction errors, James proposes the following test statistic:

$$ t = \frac{e_{pt}}{\sigma_{pt}} $$

(16)

$$ \sigma_{p} = \left[ \frac{1}{19} \sum_{t=10}^{+10} (e_{pt} - APE)^2 \right] $$

(17)

$$ APE = \frac{1}{20} \sum_{t=10}^{+10} PE_{pt} $$

(18)

where

- $\sigma_{pt}$ = prediction error standard deviation,
- $T$ = announcement day,
- $PE_{pt}$ = the prediction error for day $T$.

Statistically significant positive (negative) prediction error is considered as evidence of shareholders' gain (loss) due to the announcement of the regulatory change.

Using his full sample of commercial banks, the only statistically significant announcement-day prediction error James finds is for the 1970 CD event. The abnormal return for this date is positive and significantly different from zero at the 5 percent level.
other events, no significant announcement day prediction errors are reported. James goes on to examine whether an intra-industry difference exists between the announcement-day prediction errors of different classes of commercial banks. Two portfolios are formed using the passbook savings deposit to total deposits ratio (SD/TD). Those banks for which this ratio is less than 10 percent and larger than or equal to 20 percent in 1978 are termed as wholesale banks and retail banks respectively. The findings of intra-industry analysis are as follows:

i. Removing ceilings on large CDs caused statistically significant increases in the market value of wholesale banks. This conclusion is based on the observation that the 1970 CD event resulted in a positive announcement-day prediction error which proved significant at the 1 percent level. Also, wholesale banks experienced about 5 percent abnormal return over the 21-day analysis period for the 1970 CD event.

ii. The market value of retail banks declined "on announcement of elimination or relaxation of ceilings on small denomination consumer accounts". The evidence for this conclusion is the observation that for retail banks, announcement-day prediction error for the 1978 MMC event is negative and significant at the 1 percent level, and that the Wild Card event resulted in a negative abnormal return.

iii. The effects of deposit-rate ceiling changes differ across commercial banks. For three of the four events examined all but the 1970 CD regulatory change, wholesale banks showed positive
announcement-day prediction errors while retail banks experienced negative abnormal returns. For the 1970 CD event, both groups experienced positive abnormal returns. Furthermore, except for the 1973 CD event differences in prediction errors on announcement days of ceiling changes prove statistically significant.

3.2.2 DISCUSSION

Various shortcomings cloud James (1983) findings. First problem is the way the stability of the market model over the analysis and estimation periods is treated. As explained previously the parameters of the market model (intercept and the slope) are estimated from the estimation period and used to obtain the residuals for the analysis period. The implicit assumption in this approach is that the parameters of the market model remain constant over both periods. However, as Brenner (1977) points out, abnormal behavior of the observed residuals may reflect a change in the slope term of the market model interpreted as a measure of systematic risk in a CAPM context. Therefore, positive or negative residual values may trace to an increase or decrease in the risk characteristics of the banks under analysis. In a previous study (James, 1981) James investigates this issue. He uses the following dummy-variable regression:

\[ R_{pt} = a_p + a'_p D + b_p R_{mt} + b'_p R_{mt}D + e_t, \]  

(19)
where D is a zero/one variable, which takes the value of one after the announcement day. This approach allows both the intercept and the slope terms to vary and has been used in various studies (Dodd and Leftwich (1980), Schipper and Thompson (1983), Stillman (1983), Thompson (1983)). A statistically significant $b'_{p}$ coefficient is interpreted as an evidence of a shift in the systematic risk. James (1981) reports no shift and concludes that the observed pattern in residuals is not associated with risk changes. This approach has one important shortcoming. Use of the dummy-variable as zero before the event and one after the event implicitly assumes knowledge of the date on which the risk might change and that the shift is abrupt in nature. Researchers do not have any reason to believe why these assumptions should hold. The risk may have changed prior to the event or gradually, but James (1981) approach is not equipped to detect these alternatives.

The test procedure used in James (1983) is slightly defective. To test whether or not the day-0 prediction errors are statistically significant, James employs the test statistic given in equation 16. The denominator of this test statistic represents the standard deviation of the prediction error. However, the procedure given in equation 17 to estimate the standard deviation of the prediction errors is not an optimal one. As Warner and Brown (1984) indicate, the standard deviation should be adjusted because the excess returns obtained in equation 13 are prediction errors. The total variance of
the prediction error has two parts: one, the variance of the disturbance and the other the variance of the predictor around its mean. The proper formulation of the prediction error standard deviation is as follows:

\[ s_{pt} = \left( \frac{e_p^2}{D-2} \left( 1 + \frac{1}{D} + \frac{(R_{mt} - \bar{R}_m)^2}{\text{Var}(R_m)(D-1)} \right) \right)^{1/2} \]  

(20)

where,
- \( e_p \) = residuals from the market-model regression for the estimation period.
- \( D \) = number of observations during the estimation period.
- \( R_{mt} \) = rate of return on the market index for day \( t \) of the analysis period.
- \( \bar{R}_m \) = mean rate of return on the market index during the estimation period.
- \( \text{Var}(R_m) \) = variance of the mean rate of return on the market index during the estimation period.

One other issue that is overlooked in James (1983) is the content of the 1973 CD announcement. It needs more explanation than given by James. With this announcement, the Fed not only suspended ceilings on longer-term $100,000 CDs but also imposed a supplemental reserve requirement on further increases in CDs of $100,000 or more and proposed a regulatory amendment that would apply reserve requirements.
for the first time to the sale of "finance bills" and reduced to 8% from 20% the reserve requirement on Eurodollar borrowings. The market's response, if any, reflects the net effect of these three distinct events on commercial banks: suspension of ceilings, making banks use Eurodollars more competitively and increasing in reserve requirements on domestic borrowings which raised the opportunity cost of these borrowings. Relying on capital market data alone, it is practically impossible to isolate the effects of these three regulatory changes from one another.

A final minor problem is the contradiction in event dates used by James (1983) and Smirlock (1984). The announcement dates reported in both papers are the same except for 1973 CD event. However, Smirlock claims that the announcement dates represent the Fed's official release dates whereas James claims that the same dates are the dates when these ceiling changes are first published in American Banker. Given that the American Banker is published overnight, it is practically impossible for these two claims to be true at the same time.

3.3 RE-EXAMINATION OF WEALTH EFFECTS OF DEPOSIT-RATE CEILING CHANGES

This section re-examines the wealth effect hypothesis and adjusts the test procedure employed by James(1983), and uses a nonparametric test procedure to make inferences about intra-industry effects of ceiling changes. The stability issue is examined in Chapters 4 and 5.
3.3.1 FULL-SAMPLE RESPONSE

Banks belonging to the Standard Industrial Classification (SIC) Industry Numbers 6022/6025/6711 are selected from the CRSP daily return tapes, constructed by the Center for Research in Security Prices (CRSP) at the University of Chicago. The relevant periods used are 70 days before and after the announcement days used by James for the four regulatory changes. The number of banks which have data for these periods are given in Table 6 for both Smirlock (1984) and James (1983). The analysis period and estimation period are designated as 10 days before and after the date of announcement, and 60 days before and after the analysis period, respectively. Using equation 13, the prediction errors are obtained for the equal-weighted portfolio of banks constructed for each event using the number of banks given in Table 6. To examine whether the prediction errors are significantly different from zero or not, the test statistic given in equation 16 is employed. However, the denominator of this test statistic is defined as in (20). The results are given in Tables 8-11. Announcement-day prediction errors are compared with James' in Table 7.

In examining Table 7 it is interesting to note that for the 1970 CD event, our findings show a significantly positive abnormal return on 6/24. For this day, James reports a negative prediction error for his retail group and an almost-zero prediction error for his wholesale group. If we examine the 6/25 issue of WSJ, we see that 6/24 was a
good trading day for bank stocks. In the "Abreast of the Market" column of WSJ on 6/25 it is explained that on the trading day 6/24 the stock market fell for the fourth time in a row. The plunge was attributed to Penn Central's filing a bankruptcy petition on 6/23 covering its railroad subsidiary and the rumors that Chrysler was caught "in an acute cash bind like the one besetting Penn Central". However, on 6/24 it is indicated that bank stocks made strong advances. Therefore, a negative or an almost-zero prediction error on 6/24 is not consistent with the existing market conditions for bank stocks.

For the 1973 CD event, our results are not consistent with James' either. He reports a positive abnormal return for wholesale group while my findings show that the banks in my sample experienced a negative abnormal return. As indicated earlier the May 17 announcement covers changes in a series of diverse regulations and any market response can not be attributed to deposit-rate ceiling changes only. Furthermore, the package of changes announced by Fed is interpreted as an "act to curb expansion of bank credit". 42 If the market's perception of the whole package was indeed in line with alleged Fed intentions, then abnormal returns found for this day should reflect the impact of the Fed's effort to curb bank credit. Therefore, we claim that the 1973 CD event is difficult to interpret. It is not an unambiguously interpretable regulatory change that can be used to test hypotheses about the effects of deposit-rate ceiling changes.
Our results for 1973 WC event are consistent with James if the announcement date for this event is taken to be July 6. For the previous day, we report a negative abnormal return where James reports a positive abnormal return. The same contradiction is valid for the 1978 MMC event.

The results obtained in our analysis show that for the 1973 CD and 1978 MMC events, banks used in our sample experienced negative announcement-day prediction errors, and for the 1970 CD and 1973 WC events positive abnormal returns. Before reaching any conclusions however, we first examine intra-industry responses.

3.3.2 INTRA-INDUSTRY RESPONSE

Intra-industry response is analyzed by examining the average response of individual banks during the analysis period. The procedure is as follows: Prediction errors for each bank are obtained as in equation 13. Average prediction error (APE) for the analysis period is defined as:

$$APE_i = \frac{1}{21} \sum_{t=-10}^{+10} e_{it}$$  \hspace{1cm} (21)

where $i =$ bank $i$.

The estimated standard deviation of each prediction error during the analysis period is calculated using (20). Average standard deviation is obtained as follows:
The test statistic which has a student-t distribution is:

\[ t = \frac{\text{APE}_1}{AS_1} \]  

The results for t-statistics for each event are given in Table 12.

The banks are then classified into two groups: One, which showed positive (Group 1) and the other negative (Group 2) average prediction errors. For each bank in each group, values of various firm-specific information is obtained from COMPSTAT tapes as end of 1970, 1973 and 1978. These classifying variables are total assets, the breakdown of loan and deposit portfolios, ratio of market value to book value of equity and number of branches. The Mann-Whitney U test is used to test whether the mean sizes of the classifying variables differ between Group 1 and Group 2. This approach to intra-industry analysis differs from James (1983) approach. As explained earlier, James forms two portfolios using SD/TD ratios, names them wholesale and retail banks and examines the prediction errors of these two groups. Here, however, we calculate prediction errors for each bank in the sample, determine whether it is negative or positive on average over the estimation period and investigate whether banks which show positive average prediction errors differ in important characteristics from the banks which show negative average prediction errors. This approach has the potential to give more information than James (1983) approach.
The procedure used to test the null hypothesis of equal population means is the Mann-Whitney U test. To test, for example, that the Group 1 banks tend to have larger asset size than banks in Group 2 the following null hypothesis and alternative hypothesis are defined:

\( H_0 \): Both groups have identical asset size distributions.

\( H_1 \): On average Group 1 tend to have larger asset size than Group 2.

To carry out the test, first a statistic (U) is calculated:

\[
U = n_1n_2 + \frac{(n_1(n_1+1))/2 - R_1}{2} \tag{24}
\]

where \( n_1 \) and \( n_2 \) are the number of observations in Group 1 and Group 2 for the asset sizes. To obtain \( R_1 \), observations on the asset sizes for both groups are merged and arrayed in rank order (the smallest value is assigned a rank of 1). \( R_1 \) is then the sum of the ranks for Group 1.

The value of the U statistic provides evidence on the difference between means of the two population distributions. A very large or very small U value indicates that the sample of observations under investigation come from populations with different means. The mean and the standard deviation of U are as follows:

\[
\mu_u = \frac{n_1n_2}{2} \tag{25}
\]

\[
\sigma_u = \left( \frac{(n_1n_2(n_1+n_2)+1)}{12} \right)^{1/2} \tag{26}
\]
U approaches normal distribution when both $n_1$ and $n_2$ are in excess of about ten observations. Then the standardized normal variate is

$$z = \frac{U - \mu_U}{\sigma_U} \quad (27)$$

Table 13 exhibits the mean values of the classifying variables for each group and Tables 14-15 show the $z$-values calculated for each of the classifying variable for 1973 WC and 1978 MMC events. The findings are as follows:

i. Banks included in our sample exhibit large size, wholesale bank characteristics: Table 13 shows that the mean asset sizes for both group of banks are similar to large bank asset size characteristics. Also, the commercial loan portfolios of both groups is larger than their household loan portfolios.

ii. The increase in passbook rate ceilings and introduction of small denomination ceiling-free certificates caused banks which have smaller asset size and more retail business to experience negative abnormal returns: Table 14 shows that for the 1973 WC event the mean asset size of Group 1 banks is larger than Group 2 banks and this difference is statistically significant. Also, Group 1 banks have significantly more commercial loans than Group 2 banks. The liability-side characteristics support the hypothesis that smaller and retail-business-oriented banks are negatively affected by the 1973 WC event. Group 1 banks have smaller demand deposits, larger time and savings deposits and foreign deposits. The differences are statistically significant. Although
Group 2 banks have a larger mean number of branches this difference is not statistically significant.

iii. Introduction of Money Market Certificates (MMC) caused most banks in the sample to experience negative abnormal returns: Table 15 shows that for this event the asset sizes of Group 1 and Group 2 are not significantly different from each other. However, Group 1 banks have smaller household loans, real estate loans and number of branches. Except for these three characteristics, other classifying variables examined are not significantly different for either groups.

The conclusion of our intra-industry analysis is parallel and complimentary to those of James (1983). For the two deposit-rate ceiling changes examined, banks which are more retail-oriented experienced negative abnormal returns upon announcement of the two ceiling changes. As we emphasized, the sample used in this study consists of large banks. Our data support the conclusion that the larger and the more wholesale oriented banks are not adversely affected by deposit-rate deregulation.

3.3.3 SUMMARY

This section re-examines James (1983) empirical research to highlight potential problems. Our analysis uncovers a significant abnormal return on the day which is one day after the announcement day reported in James (1983). However, for the day on which we find significant abnormal returns, he reports an insignificant result. A
similar situation exists for the 1973 WC event. This day difference is considered to be important because James employs a single-day test. For his conclusions to hold, his selection of announcement days must be correct.

Naturally, this finding first led me to suspect my data. By trying extensive checks, I concluded that no error is made in my effort to compile data. A second finding concerning ceiling-change events is that the 1973 CD event is difficult to interpret and not a good regulatory event for use in testing hypotheses about ceiling changes in deposit-rate ceilings.

It is important to acknowledge the difference between James' sample and the sample used in this dissertation. As shown in Table 5, the number of banks used in this empirical work is considerably smaller than the one James used. The reason for this lies in the different sources used. James uses DRI tapes, which report security price information for over-the-counter as well as NYSE and AMEX stocks. We use CRSP data which cover only NYSE and AMEX stocks. Therefore, James has a larger data base than we do. This difference naturally reduces the power of our tests of the null hypotheses. Also, analyzing intra-industry differences becomes very difficult, because the banks in our sample show common characteristics of large banks. Nevertheless, we carry out intra-industry difference tests using an approach somewhat different from James. We use a multiple-day test approach which de-emphasizes any controversy on announcement-days, and look for common characteristics for banks that experience negative and positive
abnormal returns. This approach provides more information. We find that, within our sample of large banks, the group of banks which experience negative abnormal returns have characteristics common to retail banks, while banks which can be classified as wholesale banks earn positive abnormal returns. Banks that are classified as wholesale banks which experienced positive abnormal returns had more commercial loans, less demand deposits, larger foreign deposits and a smaller number of branches.

Finally, it should be pointed out that throughout this re-examination the parameters of the market model are assumed to be stationary. This assumption, as we noted earlier, has no a priori justification. Positive or negative abnormal returns may trace to shifts in market-model parameters. In particular, if the slope parameter has shifted, an observed abnormal return would be due to a risk shift and would not represent a direct wealth transfer from depositors to stockholders. Unless a model which incorporates the possibility of parameter shifts is used, the results may not be clearly defended as wealth gains.

Chapter 4 and 5 address the stability issue and introduce the switching regression model and its application. The results of applying this method, together with the analysis contained in this chapter should clarify the impact of ceiling-changes.
4.1 SWITCHING REGRESSION MODEL AND EVENT STUDIES

Estimating the parameters of the market model by ordinary least squares (OLS) implicitly assumes that the intercept, the slope and the variance of the error term are stationary throughout the estimation period. The adequacy of this stationarity hypothesis has been examined extensively. Blume (1971, 1975), Levy (1971), Sunder (1980), Hinich and Roll (1981), Chen (1982) and Ohlson and Rosenberg (1982) show that the stationarity assumption is not legitimate and that betas of individual stocks vary significantly across time.

In the event-study literature, other research shows that the variance of a security's rate of return increases around the announcement day of firm-specific information (Beaver (1968), Patell and Wolfson (1979), and Kalay and Lowenstein (1983)). The implications of variance increases for an event study have been examined by Christie (1983), and Warner and Brown (1984). Christie (1983) shows that for some events the variance increases more than a factor of four. Since the total variance of returns can be partitioned into systematic and
unsystematic parts, we should expect these risk components to change with the arrival of information.

Event studies have employed three alternative statistical methods to recognize parameter nonstationarity explicitly and to investigate structural change caused by information arrival. The first is Quandt's switching regression technique (Quandt (1958, 1960)) : Quandt-I. This technique obtains a maximum-likelihood estimate of the location of the unknown change point for a linear regression model obeying two regimes. Collins and Simonds (1979), and Chen and Sanger (1983) apply this technique to determine the point at which beta shifted. The second technique is the Brown-Durbin-Evans (BDE) recursive-residuals approach (BDE, 1975). This approach examines the cumulative sum (CUSUM) or cumulative sum of squares (CUSUMSQ) of recursive OLS residuals and identifies the points of structural breaks by plotting the CUSUM or CUSUMSQ together with significance lines. Morgan and Smith (1983) employ the BDE approach to locate the critical dates of potential shifts in bank stock returns due to DIDMCA. Bey (1983) uses both the BDE and Quandt approaches to analyze the stationarity of a market model for regulated firms. Lee (1983) also applies these two techniques to measure the significance and timing of structural change in the CAPM. Mehta and Beranek (1982) apply these two techniques to determine nonstationarity in one firm's beta and propose a procedure for estimating the number and location of change points when beta is subject to a number of different regimes. A third
procedure Quandt-II, is also due to Quandt (1972). This approach identifies transitions between regimes as a process switches back and forth between two regimes over time. Kon and Jen (1978) apply this technique to the problem of investment performance of mutual funds. Kon and Lau (1979) use the same technique to identify the nonstationary regression parameters of common-stock portfolios and to validate the nonstationarity hypothesis.

The BDE and Quandt-I techniques have the following limitations. In the BDE approach, the shift point cannot be explicitly estimated and the power of the test is quite weak (Garbade, 1977). The Quandt-I approach rules out repeated switching back and forth between two regimes by hypothesis. Also, the possibility that the regime change may depend on the value of some variable which is included in the regression or some extraneous variable not included in the regression is not exploited in these techniques (Goldfeld and Quandt, 1972, p. 261). Although Quandt-II develops an approach which resolves these limitations, all three techniques suffer from a common assumption. In formulating the regime change, it is assumed that the hypothesized structural change is abrupt in nature. However, we typically lack a priori information to support this assumption. Especially in event studies, the speed of adjustment of stock prices to new information, or whether the shift occurs abruptly or gradually should be a major concern. To our knowledge, no study has addressed this issue in a market-model context. Furthermore, in applying these three techniques,
the error structure of the regression implicitly has been assumed to be constant.

The switching regression technique developed by Goldfeld and Quandt (1972, 1973, 1976), avoids the shortcomings of the above methods which deal with parameter nonstationarity. The major strength of this method is that it requires practically no assumption concerning the behavior of the stochastic process. The method is successfully applied by Lin and Oh (1984) to examine the stability of the U.S. short-run money demand function. As indicated earlier, the major shortcomings of the methods used by Smirlock (1981) and James (1983) are ad hoc choices of event days, parameter-stationarity assumptions, and partitioning the analysis period arbitrarily into pre-event and post-event event periods. However, using Goldfeld-Quandt (1972, 1973, 1976) switching regression method, the number of regimes operational during any period, the parameters of the processes in each regime, the switch dates from one regime to another and the type of the regime switch can be simultaneously estimated. This flexibility renders the Goldfeld-Quandt method superior and allows it to provide more information than methods used in other event studies.
4.2 THE SWITCHING REGRESSION MODEL

Goldfeld-Quandt (1972, 1973, 1976) switching regression model can be explained within the context of the market model as follows. The multi-regime market model for $r$ regimes is:

$$ R_{pt} = a_j + b_j R_{mt} + e_{jt}, $$

(28)

where

- $t = \text{observation index, } t = 1, \ldots, T$
- $j = \text{regime index, } j = 1, \ldots, r$
- $R_p = \text{rate of return on a portfolio of assets,}$
- $R_m = \text{rate of return on the market portfolio,}$
- $e_{jt} = \text{regression residual, distributed as } N(0, \sigma^2_j).

The simplest case of multiple regimes is the two-regime model:

$$ R_{pt} = a_1 + b_1 R_{mt} + e_{1t}; \quad t = 1, \ldots, Z^* $$

(29)

$$ R_{pt} = a_2 + b_2 R_{mt} + e_{2t}; \quad t = Z^* + 1, \ldots, T. $$

(30)

In formulating the switching regressions (29) and (30), it is assumed that the parameters of the market-model $(a_j, b_j, \sigma_j)$ are $(a_1, b_1, \sigma_1)$ for some period (regime 1) and that during a transition period they drift from $(a_1, b_1, \sigma_1)$ to $(a_2, b_2, \sigma_2)$, where the shift is governed by an extraneous variable, $Z_t$. In all following periods (regime 2), they stay at $(a_2, b_2, \sigma_2).$ "Regime" is defined as a state of
the parameter vector. The transition between the two regimes is assumed to be deterministic, in the sense that regime state depends on the variable \( Z_t \) with an unknown cutoff value \( Z^* \), where \( Z_t \) is the extraneous classifying variable. If the classifying variable is assumed to be time, the structural change (regime-switch) is time-dependent only. For some unknown specific time, \( Z^* \), when \( Z_t \leq Z^* \) (29) holds and when \( Z_t > Z^* \) (30) holds.

To combine (29) and (30) into a single regression model, a dummy variable \( D_j(Z_t) \) is introduced which is a step function of \( Z_t \).

Abbreviating \( D_j(Z_t) \) by \( D_t \):

\[
D_t = \begin{cases} 
0 & \text{if } Z_t \leq Z^* \\
1 & \text{if } Z_t > Z^* 
\end{cases}
\]  

(31)

Combining (29) and (30), we obtain:

\[
R_{pt}(1-D_t)+R_{pt}D_t = (a_1+b_1R_{mt}+e_{1t})(1-D_t)+(a_2+b_2R_{mt}+e_{2t})D_t
\]

(32)
or

\[
R_{pt} = a_1(1-D_t)+a_2D_t+[b_1(1-D_t)+b_2D_t]R_{mt}+e_{1t}(1-D_t)+e_{2t}D_t
\]

(33)

This specification of \( D_t \) and the relationship (33) imposes prior restraints. Expressing \( D_t \) as a step function assumes an abrupt change at \( Z^* \). In other words, since all observations up to \( Z^* \) belong to regime 1, and the rest to regime 2, the value of \( Z^* \) is presumed to have zero variance. However, we may not have enough \textit{a priori} information to
rule out the possibility of a gradual shift in regimes. In this case, $Z^*$ must be estimated in a way that recognizes the possibility of a positive variance. Another issue is the dimension of the parameter space for the regression (33). As indicated by Goldfeld and Quandt (1972, p. 23) regressions that correspond to all possible divisions of the $T$ observations into two regimes must be found. Thus $T + 6$ parameters, namely, $a_1, b_1, \sigma_1^2, a_2, b_2, \sigma_2^2$ and $D_t$ ($t=1...T$) must be estimated.

An approach, suggested by Goldfeld and Quandt (1972), which may resolve these issues is to approximate $D_t$ by a continuous function as follows: Let $Z_t$ be normally distributed with mean $Z^*$ and variance $\sigma^2$ and let $f(Z_t)$ be the probability density function (pdf) of $Z_t$. Then define $D_t$ to be the cumulative distribution function,

$$D_t = \Pr(Z_t \leq z_t) = \int_{-\infty}^{z_t} f(\xi) \, d\xi,$$

which can also be expressed as in Goldfeld and Quandt (1972):

$$D_t = \int_{-\infty}^{z_t} \left[\frac{1}{2\pi\sigma}\right]^{-1/2} \exp \left\{ -\frac{1}{2} \left( \frac{\xi - Z^*}{\sigma} \right)^2 \right\} \, d\xi.$$

The objective is to find $Z^*$, the unknown cutoff point, and $\sigma^*$. The value of $\sigma^*$ gives information about the smoothness of the structural change. The smaller $\sigma^*$ is, the more sudden the transition
between the two regimes. If \( \sigma^* \) is significantly different from zero, the hypothesis that the structural change is abrupt should be rejected. We may conclude that a gradual change occurs in the vicinity \( Z^* \).

Note that defining \( D_t \) as in (35) reduces the parameter space of (33). There are 8 parameters to estimate instead of \( T+6: a_1, b_1, o_1, a_2, b_2, o_2, Z^* \) and \( o^* \).

The appropriate likelihood function for (33) is obtained in several steps. First, \( R_{pt} \) is assumed to be normally distributed with mean,

\[
\mu_{pt} = \{a_1(1-D_t)+a_2D_t+b_1(1-D_t)+b_2D_t\}R_{mt},
\]

and variance,

\[
\sigma^2_{pt} = \sigma_1^2(1-D_t)^2 + \sigma_2^2D_t^2.
\]

The normal density function for \( R_{pt} \) is

\[
f(R_{pt}) = \left[2\pi\{\sigma_1^2(1-D_t)^2 + \sigma_2^2D_t^2\}\right]^{-1/2} \exp\left[-\frac{1}{2}\left\{\frac{e_{1t}(1-D_t)+e_{2t}D_t}{\sigma_1^2(1-D_t)^2 + \sigma_2^2D_t^2}\right\}^2\right].
\]

Its logarithm is:

\[
\log f(R_{pt}) = -\frac{1}{2} \log \left[2\pi\{\sigma_1^2(1-D_t)^2 + \sigma_2^2D_t^2\}\right] - \frac{1}{2} \left\{\frac{e_{1t}(1-D_t)+e_{2t}D_t}{\sigma_1^2(1-D_t)^2 + \sigma_2^2D_t^2}\right\}^2.
\]
For given values of the vector $R_m = (R_{m1}, \ldots, R_{mT})$, and the parameters $a_1, a_2, b_1, b_2, \theta_1, \theta_2, \omega_1, \omega_2, z^*$ and $\sigma^*$, the joint p.d.f. of $R_{p1}, \ldots, R_{pT}$ (the likelihood function $l$) is:

$$l(R_{p1}, \ldots, R_{pT} | R_m, \theta) = f(R_{p1})f(R_{p2}) \ldots f(R_{pT}),$$

(40)

where $\theta$ represents the parameter space. Its logarithm is

$$L = \sum_{t=1}^{T} \log f(R_{pt}).$$

(41)

Substituting for $\log f(R_{pt})$ yields:

$$L = -\frac{T}{2} \log 2\pi - \frac{1}{2} \sum_{t=1}^{T} \log \left[ \frac{\sigma_1^2 (1-D_t)^2 + \sigma_2^2}{\omega_1^2} \right] - \frac{1}{2} \sum_{t=1}^{T} \frac{(R_{pt} - \mu_{pt})^2}{s_{pt}^2}.$$  

(42)

Maximum-likelihood estimates are obtained by maximizing (42) with respect to the 8 parameters in question, where each value of $D_t$ ($t=1 \ldots T$) is evaluated from (35).

An extension of this model would be to assume the disturbances in (29) and (30) to be autocorrelated. The appropriate likelihood function, assuming a first-order autocorrelated error structure, is derived in Appendix B.
4.3 GENERALIZATION OF THE MODEL

Goldfeld and Quandt's switching regression method can be extended to cope with several regimes. The generalization of the model for \( r \) regimes is given in Goldfeld and Quandt (1976). If the observations come from \( r \) regimes, \( r-1 \) cutoff points exist, where \( r-1 \) sets of variables \( D_{tj} \) must be defined:

\[
D_{tj} = \int_{-\infty}^{\xi} \left[ (2\pi)^{1/2} \sigma_j^* \right]^{-1} \exp \left\{ -\frac{1}{2} \left( \frac{\xi - Z_j^*}{\sigma_j} \right)^2 \right\} d\xi . \tag{43}
\]

where,

\( j = 1, \ldots, r-1 \)

and the definitions, \( D_{tr} = 0 \) and \( D_{tr} = 1 \) are given.

In the multi-regime market model

\[
R_{pt} = a_j + b_j R_{mt} + e_{tj} , ~ j = 1, \ldots, r
\]

the equation representing the \( k \)-th. regime is then multiplied by

\[
\prod_{j=0}^{k-1} D_{tj} \prod_{j=k}^{r-1} (1 - D_{tj}) . \tag{45}
\]

Although not given in Goldfeld and Quandt (1976), the derivation of the likelihood function for \( r \) regimes is very easy. If we define

\[
\gamma_{tk} = \prod_{j=0}^{k-1} D_{tj} \prod_{j=k}^{r-1} (1 - D_{tj}) , \tag{46}
\]

then the equation representing the \( k \) th. regime is

\[
R_{pt} \gamma_{tk} = (a_k + b_k R_{mt} + e_{tk})(\gamma_{tk}) . \tag{47}
\]
The resulting equations for \( r \) regimes are added together to obtain the composite equation to be estimated:

\[
\sum_{k=1}^{r} R_{pt} \gamma_{tk} = \sum_{k=1}^{r} \left\{ (a_k + b_k R_{mt} + e_{tk})(\gamma_{tk}) \right\}.
\]  

(48)

When \( R_{pt} \) is assumed to be normally distributed with mean

\[
\sum_{k=1}^{r} \left\{ (a_k + b_k R_{mt})(\gamma_{tk}) \right\} \quad ,
\]  

(49)

and variance

\[
\sum_{k=1}^{r} \left( o_{tk}^2 \right) (\gamma_{tk}) \quad ,
\]  

(50)

the likelihood function is then,

\[
L = - \frac{T}{2} \log 2\pi - \frac{1}{2} \sum_{t=1}^{T} \sum_{k=1}^{r} \left( o_{tk}^2 \right) (\gamma_{tk})
\]

\[
- \frac{1}{2} \sum_{t=1}^{T} \left[ \sum_{k \neq 1}^{r} R_{pt} \gamma_{tk} - \sum_{k=1}^{r} \left\{ (a_k + b_k R_{mt})(\gamma_{tk}) \right\} \right]^2
\]

\[
- \frac{1}{2} \sum_{t=1}^{T} \left( o_{tk}^2 \right) (\gamma_{tk})^2
\]  

(51)
An illustrative example:

To obtain the likelihood function for a three-regime market model the following steps are followed. The three-regime market model \((r=3)\) using \((28)\) is defined as

\[
R_{pt} = a_1 + b_1 R_{mt} + e_{1t}, \quad t=1, \ldots, Z^*_1
\]

\[
R_{pt} = a_2 + b_2 R_{mt} + e_{2t}, \quad t=Z^*_1 + 1, \ldots, Z^*_2
\]

\[
R_{pt} = a_3 + b_3 R_{mt} + e_{3t}, \quad t=Z^*_2 + 1, \ldots, T
\]

The regime choice depending on a single extraneous classifying variable \((Z_t)\) is defined as:

- if \(Z_t \leq Z^*_1\) regime 1 is chosen,
- if \(Z^*_1 < Z_t \leq Z^*_2\) regime 2 is chosen,
- if \(Z_t > Z^*_2\) regime 3 is chosen.

The variables \(D_{tj}\) \((j=1, \ldots, r-1)\) using \((43)\) are:

\[
D_{t1} = \int_{-\infty}^{Z^*_1} \left[ \left( 2\pi \right)^{1/2} \left( \sigma^*_1 \right) \right]^{-1} \exp \left\{ -\frac{1}{2} \left( \frac{\xi - Z^*_1}{\sigma^*_1} \right)^2 \right\} d\xi.
\]

\[
D_{t2} = \int_{-\infty}^{Z^*_2} \left[ \left( 2\pi \right)^{1/2} \left( \sigma^*_2 \right) \right]^{-1} \exp \left\{ -\frac{1}{2} \left( \frac{\xi - Z^*_2}{\sigma^*_2} \right)^2 \right\} d\xi.
\]
Using (45), the equations (52)-(54) representing the first regime \( k=1 \), the second regime \( k=2 \) and the third regime \( k=3 \) are multiplied by,

\[
D_{t0}(1 - D_{t1})(1 - D_{t2})(1 - D_{t3})
\]

\[
D_{t0}D_{t1}(1 - D_{t2})(1 - D_{t3})
\]

\[
D_{t0}D_{t1}D_{t2}(1 - D_{t3})
\]

respectively. Invoking the definitions \( D_{tr}=0, D_{t0}=1 \) equations (57) to (59) can be simplified as:

\[
(1 - D_{t1})(1 - D_{t2})
\]

\[
D_{t1}(1 - D_{t2})
\]

\[
D_{t1}D_{t2}
\]

The equations,

\[
[(1-D_{t1})(1-D_{t2})] R_{pt} = [a_1 + b_1 R_{mt} + e_{1t}] [(1-D_{t1})(1-D_{t2})]
\]

\[
[D_{t1}(1-D_{t2})] R_{pt} = [a_2 + b_2 R_{mt} + e_{2t}] [D_{t1}(1-D_{t2})]
\]

\[
[D_{t1}D_{t2}] R_{pt} = [a_3 + b_3 R_{mt} + e_{3t}] [D_{t1}D_{t2}]
\]

are added together to form the equation to be estimated:

\[
[1-D_{t2}(1-D_{t1})] R_{pt} = a_1(1-D_{t1})(1-D_{t2})+ a_2(1-D_{t2})D_{t1} + a_3D_{t1}D_{t2}
\]

\[ +[ b_1(1-D_{t1})(1-D_{t2}) + b_2(1-D_{t2})D_{t1} + b_3D_{t1}D_{t2} ] R_{mt} + w_t. \]

The variance of the error term \( w_t \) is:

\[
[(1-D_{t1})(1-D_{t2})]^2 \sigma_1^2 + [(1-D_{t2})D_{t1}]^2 \sigma_2^2 + [D_{t1}D_{t2}]^2 \sigma_3^2.
\]

The likelihood function is then easily formed using (51).
4.4 HYPOTHESIS TESTING

4.4.1 TESTS FOR REGIME CHANGES

As indicated previously, the switching regression model can be used to investigate whether or not a stochastic process has been stationary. During the analysis period, the observations under examination may belong to a single regime or different regimes. Our first concern is to determine the number of regimes operational during the analysis period. This can be accomplished using a nested approach. First, using a likelihood-ratio test (LRT) procedure, the null hypothesis that no regime switch occurs can be tested against the alternative that two regimes (one switch point) exist. The general form of the LRT is as follows (Maddala 1977, p. 44):

\[ \lambda = \frac{\max L(\theta) \text{ over restricted values of } \theta \text{ specified by } H^0}{\max L(\theta) \text{ over all values of } \theta}, \quad (68) \]

where \( L(\theta) \) is the likelihood function. The likelihood-ratio test statistic, \(-2 \ln \lambda\), has asymptotically a chi-square distribution with degrees of freedom (d.f.) equal to the number of restrictions under the null hypothesis. These restrictions for different hypotheses are exhibited in Table 16. When the stochastic process is assumed to be the market model and the null hypothesis that no switch in regime occurs is to be tested against the alternative hypothesis that two regimes exist, then the d.f. is five (Table 16). If the alternative hypothesis is accepted, then the next step is to test for the existence
of three regimes. In this case the null hypothesis is the two-regime process and the alternative is a three-regime process (two switch points.) The likelihood-ratio test statistic is obtained as explained above with d.f. equal to five. The number of regimes is incremented and the likelihood-ratio test re-run until we fail to reject the null hypothesis. To check the robustness of the test results, the null hypothesis of no regime switch can be tested against the alternative of the existence of three regimes. In this case the d.f. freedom becomes ten (see Table 16).

In event-studies, a particularly interesting query is whether any structural shift has occurred on the announcement date. If we conclude that two regimes exist during a given period then this hypothesis can be easily tested using the procedure explained above. Suppose the null hypothesis is that an abrupt or gradual switch occurs on a particular date \( Z_e^* \): \( \phi_e^* = 0 \) if abrupt change is hypothesized and \( \phi_e^* \neq 0 \) if gradual change is hypothesized. Subscript \( e \) denotes the announcement day. The maximum-likelihood value \( (L_e^*) \) is obtained restricting \( Z_e^* \) and \( \phi_e^* \) to equal the hypothesized values. Then the two-regime unrestricted maximum-likelihood value \( (L_2^*) \) is obtained. The likelihood-ratio test statistic \(-2 \ln \lambda\), where

\[
\lambda = \frac{L_e}{L_2}
\]

(69)

with d.f. equal to 2, is used to test the null hypothesis.
4.4.2 TESTS FOR THE PARAMETRIC NATURE OF THE SHIFTS

Once the number of operative regimes during the analysis period is obtained by these procedures, the final hypothesis to be tested concerns the parametric nature of these shifts. In the market-model context, the parameters are the intercept, slope and the variance of the error term. Parameter equality can be tested across different regimes as follows: Suppose, for the analysis period we conclude the existence of two regimes, where the maximum-likelihood value for the two-regime process is $L_2$. Then, the likelihood function for two-regimes is remaximized, subject to the parameter-equality constraint under examination, where the maximum-likelihood value is $L_{2R}$. The likelihood-ratio test statistic $-2 \ln(L_{2R}/L_2)$, which has asymptotically a chi-square distribution with one d.f., is then used to test the parameter equality hypothesis.

This procedure of testing the parametric nature of the shifts, in relation to the regime-switch tests (first stage tests), can be further explained as follows: Suppose, in the first stage, we conclude the existence of a three-regime process. This implies the following null $(H_0)$ and the alternative $(H_1)$ hypotheses:
\[ H_0: a_1 = a_2 = a_3, \text{ and } b_1 = b_2 = b_3, \text{ and } \sigma_1 = \sigma_2 = \sigma_3, \text{ and} \]
\[ z_1^* = z_2^* = 1 \text{ or } T, \text{ and } \sigma_1^* = \sigma_2^* = 0. \]

\[ H_1: \text{not all } a_1 \text{ are equal,} \]
\[ \text{not all } b_1 \text{ are equal,} \]
\[ z_1 \text{ are not equal to } 1 \text{ or } T, \]
\[ \sigma_1 \text{ are not equal to } 0, \]

and we reject the null hypothesis.

Then, in the second stage we test for the equality of \( a_1, b_1 \) and \( \sigma_1 \) to infer the nature of the shifts. For example, in the case of testing the equality of \( a_1 \) the null and the alternative hypotheses are as follows:

\[ H_0: a_1 = a_2 \text{ vs. } H_1: a_1 \neq a_2 \]

and

\[ H_0: a_2 = a_3 \text{ vs. } H_1: a_2 \neq a_3 \]

However, these second stage tests pose a problem similar to the multiple comparisons issue in the analysis-of-variance area. A typical example of multiple comparisons in analysis-of-variance is as follows: If we test the following hypotheses:

\[ H_0: m_1 = m_2 = m_3 = m_4 \text{ vs. } H_1: \text{not all } m_i \text{ are the same} \]

where \( m_i \) are the means of four experiments, and conclude the alternative, then we may wish to know which pairs of means are not
equal. In the above example, six more tests are required. If we conduct the tests at the 5 percent level of significance and carry out all six tests then the probability of rejecting at least one true hypothesis is greater than 5 percent (Daniel and Terrell, 1983). Therefore, care must be exercised in determining the level of significance.

One suggested method in multiple comparisons is the Bonferroni technique. It is considered to be simple and conservative (Madsen and Moeschberger, 1980). According to this method, if we wish to conduct n pairwise tests with an overall significance level of $\alpha$, each of the n tests is made using a single significance level of $\alpha/n$ (Dunn and Clark, 1974). In other words, we maintain an overall significance level of 5 percent but decrease the probability of rejection the true hypothesis when we conduct the n pairwise tests.

Within the context of the multiple comparisons issue the following procedure is adapted in our second stage tests. We set an overall significance level of 5 percent and adjust it with the number of comparisons we make. For example, if we conduct 10 comparisons then the level of significance for each test is 0.5 percent ($0.05/10$). We call 0.5 percent the adjusted significant level.
CHAPTER V

APPLICATION OF SWITCHING REGRESSION MODEL AND
INTERPRETATION OF RESULTS

5.1 NUMERICAL OPTIMIZATION ROUTINE - GQOPT

The GQOPT package was compiled at Princeton University as a program that optimizes nonlinear functions. In this dissertation, it is used to maximize the likelihood functions derived in Chapter 4. Among the many users of GQOPT, Lin and Oh (1984) and Ang and Peterson (1985) exemplify problems that arise in its use in finance. To clarify the program's improper use in these two studies, it is necessary to discuss the characteristics of this package and how it is used in this study.51

Among the various computer routines in the GQOPT package, DFP, GRADX and NMSIMP are the most widely used. However, numerical output from these methods varies significantly, depending on the function to be maximized, the starting points used and the accuracy level specified.52 For example, in maximizing a likelihood function DFP and NMSIMP generally give entirely different maximum-likelihood estimators.
for a given set of starting values and accuracy level. Although both DFP and NMSIMP are search methods, NMSIMP searches a wider range of values than DFP. This means that DFP tends to give results closer to starting values.

Another piece of information that a user often seeks are t-values for estimates of model parameters. Only DFP and GRADX provide t-values. GRADX is an algorithm which uses the quadratic hill-climbing method. The t-values found by these two methods generally differ in magnitude and reliability. In GRADX, the Hessian matrix is calculated at every iteration and t-values for each round of parameter estimates is stored. When the optimization ends, t-values for the last iteration is outputted. This fact makes GRADX very expensive and time-consuming to use. DFP, on the other hand, does not calculate the Hessian matrix at every iteration. When the termination occurs under DFP, the outputted t-values may not belong to the estimators obtained in the last iteration. Therefore, the t-values given by DFP are "reasonably accurate at best and will probably be of very little value when termination occurs in only a few iterations."

To sum up, it is evident that several methods and different starting points must be used to ensure reasonably reliable function evaluations. The best approach seems to be to use the NMSIMP method first to obtain "fairly good starting points", which can be used as input into the GRADX method to produce final estimates and t-values. Lin and Oh (1984) use the DFP method, while Ang and Peterson (1985) do
not indicate what method they use. Although the former study can be criticized for not reporting fully reliable results, the latter omits important information without which the reliability of their results cannot even be assessed.

Due to the sensitivity of the results to the method chosen, we tried to pursue every possible check of the reliability of our results. In using the GQOPT package, regardless of the method chosen, two Fortran programs must be written to access needed routines. The first program calls GQOPT and selects the method. The second embodies the subroutine in which the function to be optimized is defined. The first access program is common to any use of GQOPT. Examples of the relevant statements are given in GQOPT manual.

The first step is to check the correctness of the subroutine in which likelihood functions given in Chapter 4 are defined. The following procedure is followed. We set the shift point, \( Z^* \), equal to 72 and the shift variance close to zero for the 1970 CD event, which implies two regimes and an abrupt switch on the 72nd day. Next, maximum-likelihood estimates of the two-regime market model parameters are obtained using the NMSIMP method. Then, using the SAS computer package, OLS estimates of the market model for the periods covering the first day through 72nd day and 73rd day through 142nd day are obtained separately. Theoretically, under the assumptions we make, parameter estimates given by maximum likelihood and OLS should be the same. Hence, the results of NMSIMP and SAS-OLS may be compared to check for
programming errors. They proved identical, ensuring that no error occurred in writing the subroutine used in GQOPT. A sample program used to obtain the likelihood estimators for the five-regime market model is given in Appendix C.

The second important step is to determine the number of regimes in effect under each of the four events analyzed. We first test for the existence of two regimes. The likelihood function values for one regime and two regimes are obtained using the NMSIMP routine. To ensure a global maximum, we use entirely different sets of starting values. Then the likelihood ratio test is performed. The null hypothesis \( H_0 \) is the existence of one regime and the alternative hypothesis \( H_1 \) is two regimes. As explained before, the ratio of the maximal value of the likelihood function over restricted values of the parameters specified by \( H_0 \) to the maximal value of the likelihood function over all values of the parameters for the two regimes is used as the test statistic. If we reject the null hypothesis, the next step is to introduce the possibility of a three-regime market model, embodying two switch points. Again, entirely different starting values for the three-regime market model likelihood function are first used to ensure the likelihood function extremization captures the function's global maximum. In this case \( H_0 \) is the two-regime market-model and \( H_1 \) is the three-regime market-model. The LRT is performed. If we reject \( H_0 \), we test for the existence of four regimes.
Once the number of operative regimes during the period is determined, then the parameter estimates obtained are used as starting values for the GRADX method. In other words, the function is re-maximized using GRADX with the starting values obtained from NMSIMP. Then parameter estimates with their corresponding t-values are reported. This procedure is applied for the four different ceiling-change events.

Our final step is to test for the nature of the parameter shifts that occur. Our major concern is to infer whether or not the slope term and the regression variance have shifted. A slope shift captures the change in the systematic risk, while variance shifts indicate changes in unsystematic risk. A shift in the intercept term represents changes in portfolio returns independent of systematic and unsystematic risk elements.

5.2 RESULTS

As indicated in the last section, three key steps are traversed in applying the switching regression model to the events under study. First, the appropriate number of regimes in effect for each event is determined with the NMSIMP algorithm. Next, estimates of model parameters and their t-values are obtained using GRADX. Finally, using NMSIMP again, parameter equality constraints are tested. This section summarizes the findings at each of these steps. The chapter's final
section discusses our results and compares them with the findings of previous studies.

In examining the four ceiling changes, the 1973 CD and 1973 WC events raise a special problem. These events occur within 65 trading days of each other. To avoid contaminating parameter estimates, both James (1983) and Smirlock (1984) adopt the following procedure: for the 1973 CD event, the 47 days following the analysis period are the days which follow the 1973 WC analysis period and for the 1973 WC event, the 47 days previous to the analysis period are the days previous to the 1973 CD analysis period. Switching regression does not require any special data ordering or manipulation. As long as enough degrees of freedom exist, periods of any length can be analyzed. For the 1973 CD and 1973 WC events 176 days is the focal period, starting 60 days before the analysis period for the 1973 CD event and 60 days after the analysis period for the 1973 WC event.

Table 17 summarizes the results of tests determining the number of regimes in effect during the three periods analyzed. For the 1970 CD event period, four regimes are indicated. During the period including the 1973 CD and 1973 WC events, three regimes are found. For the 1978 CD event period, at 5 percent significance we cannot reject the null hypothesis that only one regime is in effect.

Tables 18 and 19 present estimates of the parameters of the market model with their t-values during each regime, and the regime-switch dates and types for the 1970 CD and 1973 CD - 1973 WC event periods. For the 1970 CD event the results show that market model switched twice
before the 1970 CD announcement day and once after this day. The first and the second switches are 43 trading days and 12 trading days before the 1970 CD announcement day and the third switch is 48 trading days after this announcement date. The first switch turns out to be gradual, whereas the second and the third switches are fairly abrupt. For the 1973 CD - 1973 WC period, the first switch date is 67 and 101 trading days prior to 1973 CD and 1973 WC announcement days, respectively. The second switch is 39 trading days after the 1973 WC announcement day. Both switches are found to be abrupt.

In the third step we test for the applicability of parameter-equality constraints and identify which parameters change. Table 20 shows that during the 1970 CD event period, the three shifts observed may be attributed to shifts in the regression variance or unsystematic risk. In testing parameter-equality constraints, significance levels are adjusted to accommodate multiple-comparisons problem explained in Chapter 4. The first and the second shifts in unsystematic risk prove significant at 0.5 percent and 1 percent, respectively. The third shift in regression variance is significant at 5 percent. Also, the slope terms, which capture the systematic risk, are not equal between the first regime and the fourth regime. This equality is rejected at 0.5 percent level.

The return-generating process in effect during this period can be explained as follows: The market model follows the first regime for 29 trading days until April 23. Around this date a gradual shift occurs. This shift is due to an increase in unsystematic risk. The second
regime continues until 12 trading days before the 1970 CD event date, which is June 5. On this day, an abrupt switch takes place and the third regime starts. Again, the nature of this shift is a change in unsystematic risk. This time it decreased abruptly. The third regime holds until August 31, when an abrupt switch embodying a further drop in unsystematic risk takes place. During the 1970 CD event period, the slope term, which captures systematic risk (beta), consistently declined. Although this decrease in beta is not significant between consecutive regimes, as indicated above, beta coefficient of the fourth regime is significantly lower than the beta of the first regime.

During the 1973 CD - 1973 WC events period, the two shifts observed are shifts in the intercept term. Table 21 shows that the equality of the intercept terms of the first and the second regimes are rejected at all significance levels. Also equality of intercepts is rejected between the second and the third regimes.

5.3 DISCUSSION

Applying the switching regression to the regulatory events previously analyzed by James and Smirlock shows that, except for the 1970 CD event, neither the systematic risk nor the unsystematic risk changed during the periods when ceiling-change announcements were made. To a large extent, this finding parallels Smirlock (1984) in that his only significant finding is a decrease in unsystematic risk during the 1970 CD event. However, the switching regression approach helps us to
observe the behavior of systematic as well as unsystematic risk during the period analyzed. We find that for the 1970 CD event the unsystematic risk first increased in the beginning of the period and started to decrease in two stages. Also, the systematic risk significantly decreased over the period. For the 1973CD - 1973 WC period, we observe two shifts in the intercept term. These findings were not observed either by Smirlock or James.

It is appropriate at this point to move our analysis beyond the statistical to the substantive realm. What new information developed during these two periods? Were the ceiling-change announcements the only information events that took place in these periods? Can any shift or abnormal return observed be associated with the event under analysis? These questions need to be answered properly before reaching any conclusions about the impact of any event. We have offered the criticism that the majority of the traditional event studies do not concern themselves with these questions. Because, as explained previously, a period is specified which surrounds the event under analysis, and either risk shifts or abnormal returns are sought. The underlying assumption is that the one and only concern that the market had at the time of the event or over the whole period was the information event under analysis.

We, however, adopt a different approach. The switching regression method indicates that switches occur at times other than the ceiling-change announcements. Therefore, as a final step, we go back to the WSJ to infer what other events might have taken place that could be
associated with the observed findings. A **caveat** applies. The danger of establishing **ad hoc** causal relations exists in any event study. This in our opinion is the "dilemma" of event study research.

What follows is merely an attempt to lay out an inventory of news flows that took place during the two ceiling change periods. We intend to show that the "no other news other than the event under analysis" assumption is unrealistic. We offer evidence that the assumption of "expecting a stationary return generating process during a given period" is far from realistic. Finally, we closely examine news flows around the shift points we have determined statistically. With caution, we discuss whether a "causal relation" can be established between particular information events and the switches we observe.

We start with the 1970 CD event. The period analyzed for this event starts on March 13, 1970 and ends on October 1, 1970. There are 142 trading days in this period. Appendix D lists significant news published in the **WSJ** which concerns the banking industry. These information flows are obtained from the **WSJ** Index. The list is by no means exhaustive. The selection of "relevant" news is judgemental. However, the list is comprehensive enough to provide a fair description of events reaching the expectations of market participants.

A quick glance at this list shows that the market's "one and only" concern during this period was not the ceiling-change announcements. Further, as explained below, events exist other than ceiling-changes that may justify completely different event studies. Finally, with some reservation, the news around the shift points that we observe, may
be considered significant enough to expect the kind of changes that we find from our statistical analysis.

We first examine the news around the shift date of April 23 and the period covering the second regime (4/23 - 6/5). We may recall that the observed shift was an increase in unsystematic risk. One important news event that was published on 5/20 issue of WSJ, indicated that Nixon Administration "quietly decided to eventually suspend all deposit interest-rate ceilings." Furthermore, soon after the switch to the third regime (6/5) we read in the WSJ (6/12) that "cash shortage causes worry big firms could face collapse; Penn Central's ills point up dangers to economy." Following this news in the WSJ (6/12) Penn Central filed a bankruptcy petition on 6/21.

Could these information flows which took place in the beginning of the third regime cause the increase in bank unsystematic risk that we observe in the second regime? The kind of the events just indicated are not completely "surprise-shocks." We may assume that events of this kind develop through time before they become publicly known. The market may broadly anticipate the event, but the timing, extent, and character of the event may or may not be fully known. Uncertainty about the event may or may not be high. Under the circumstances indicated, market participants' trust in the vulnerable commercial paper market may be adversely affected. We find confirming news in the WSJ after the switch day. Further, such circumstances could force companies to seek more short-term funds from banks. We claim that, stock-market participants ought to have foreseen that banks could be
facing a sharp surge in credit demands before this fact became news in the WSJ. Such circumstances would have diverse effect on banks. The weakness in the commercial paper market would strengthen banks' deposit-gathering capacity. Also pressure would develop on federal authorities to permit banks to raise more deposits. We argue that these facts are sufficient to explain the increase in bank unsystematic risk during the regime just before the ceiling change announcement.

Next we look at the regime in which the ceiling announcement is made. This regime includes the days between 6/5 - 8/31. With this announcement, most of the uncertainty concerning banks that existed in the previous regime should have been cleared. The stated reason for the ceiling suspension was "to aid banks in meeting loan demand after Penn Central filing." Furthermore, this announcement is particularly important, because it allowed banks for the first time since 1933 to offer no-ceiling certificates. Also, for the first time since 1950 they faced lessened competition from an important ceiling-exempt deposit substitute. Later in the third regime (on 8/18), banks' reserves on time deposits lowered to 5 percent. Thus, the observation that unsystematic risk dropped during the third regime may be interpreted as according with this regime's characteristics.

Why do we observe another shift after the ceiling-suspension announcement? To answer this question we look for news in the vicinity of the third shift, which occurs 8/31. Right after this date we read in the WSJ (on 9/3) that "financial crisis fades as money supply gains." Further, on 9/4, it is reported that "the assets of overseas
branches of U.S. banks jumped to record levels." Also, on 9/17 we read that Senate approved a weaker plan than House bill to place curbs on one-bank holding companies. The first two information flows suggest a gradual rather than an abrupt shift, but all three are consistent with the observed shift on 8/31 and further decline in unsystematic risk in the fourth regime? We have emphasized that we have no way of confirming just which information events shift what parameters. The most we can say is that these information flows are consistent with the direction in which unsystematic risk moves.

Our next analysis pertains to the 1973CD - 1973WC announcement. The period analyzed for this event starts on February 2, 1973 and ends October 12, 1973. There are 176 trading days in this period. Appendix E lists significant news published in the WSJ concerning the banking industry. We again wish to point out that during this period the ceiling change announcements were neither the only nor the most important news reaching the market.

The first shift during the 1973CD - 1973WC event takes place early in the period and occurs in the intercept term. The median switch date is 2/8 and the period starts on 2/2. Examining news flows around the switch date as tabled in Appendix E we see that one of the most significant economic events in the 1970s took place on February 3, 1971. On this date, the U.S. devalued the dollar 10 percent by raising price of gold. Such an important action could strongly affect the profitability of international banking. It is beyond the scope of this dissertation to speculate about possible impacts of U.S. dollar's
devaluation on banks' profits. Our major concern is to investigate whether bank risk elements have changed during this period. We observe that neither the systematic risk nor the unsystematic risk has shifted. The second shift also occurs in the intercept term. Thus we conclude that during the 1973 CD and 1973 WC period bank risk remained stationary.

It is difficult to associate either shifts with the 1973 ceiling changes under analysis. In contrast, in analyzing the 1970CD event, we saw that the observed decrease in unsystematic risk could easily be attributed to the ceiling suspension. It is useful to examine the news around the 1973 CD and 1973 WC events to compare the environment of these changes with 1970 CD event. Both ceiling changes in 1973 occurred in an environment when market interest rates were rising. News flows prior to these ceiling changes made increases in short-term rates and the federal funds rate as well as a "prime-rate boost" headline events. Indeed, on May 16, one day before the 1973 WC change is announced, federal funds rate jumped to 15 percent which was the highest level since the 1920s. In 1973, banks were facing strong competition from money market instruments. Our findings suggest that the announced 1973 ceiling changes were not sufficiently large for market participants to alter markedly their expectations of aggregate deposit flows. On the other hand, during the 1970 CD change, the effect of the Penn Central bankruptcy adversely affected the commercial paper market and created a macro-policy need for policymakers to pave the way for banks to increase their deposits. Macroeconomic policy
during the 1973 CD and 1973 WC events aimed at maintaining a climate of overall monetary restraint.

5.4 SUMMARY

In any event study, special care should be given to other events that take place during the period under analysis. Ignoring these "additional information flows" means assuming that the event under study is the market's "one and only concern." Our analysis shows that many other events took place during the periods of important changes in deposit-rate ceilings. Some of these events seem important enough to be themselves the subject of completely different "event studies".

Our findings uncover significant shifts during the 1970 CD and the 1973 CD - 1973 WC periods. We fail to observe any shift during the 1978 CD period. Only in one case, the 1970 CD change, can we attribute the shift to ceiling changes. In this case, the shift involves a decrease in unsystematic risk, and systematic risk decreased significantly over the period. The 1970 CD announcement is a particularly promising event to use to measure the impact of ceilings; both systematic and unsystematic risk components decreased significantly. This evidence confirms findings about the risk impact hypotheses in the previous literature in that the null hypothesis that ceilings decrease bank risk is rejected.

By not requiring choice of ad hoc days for any event, the switching regression method demands users to look for news flows other than those
of primary interest. Our results give new force to Brown and Warner's final comment on event studies:

"... even if the researcher doing an event study has a strong comparative advantage at improving existing methods, a good use of his time is still in reading old issues of the Wall Street Journal to more accurately determine event dates."\textsuperscript{57}
CHAPTER VI

SUMMARY

The primary objective of this dissertation is to apply the switching regression model developed by Goldfeld and Quandt in an event study. This major objective is achieved. It is shown that, compared with traditional methods, this technique yields more information about the financial impact of regulatory events without requiring as many ad hoc assumptions. This accomplishment has extensive implications. Since much of the empirical literature in finance concerns the market's reaction to information flows, the Goldfeld-Quandt technique is potentially useful in a wide range of areas.

Our findings show that special care must be given in associating statistical evidence of abnormal returns or parameter variation with the events under analysis. Such evidence may reflect the impact of entirely different events. Ignoring this problem threatens to result in unreliable conclusions. The strength of the switching regression method is reflected in the fact that it forces the researcher to make extensive reading to determine event dates accurately.

In this dissertation, the events to which the switching regression technique is applied are changes in deposit-rate ceilings. Parameter variation around four regulatory changes is examined. For each change
we test hypotheses concerning the impact of deposit ceilings on bank risk. We conclude that for the sample of banks examined, which are primarily large banks, ceilings are burdensome and the market's reaction to suspension of ceilings is favorable. The dissertation also replicates James' (1983) tests on our data, to explore shortcomings in the methods traditionally used in event studies.

Research is seldom final. Important caveats almost always apply. This dissertation is no exception. First, the sample used in this dissertation is far from representative of the U.S. banking industry as a whole. This limits the applicability of the results and makes it impossible to undertake a satisfactory intra-industry analysis. Second, the assumed return-generating process—though widely used in event studies—is severely criticized in the literature. In particular, adding interest rates as a second explanatory variable to the market model yields better results (Flannery and James, 1984). Third, the number and character of the events used to evaluate the impact of deposit-rate ceilings on banks is neither large enough nor diverse enough to determine whether or not recent acts of deregulation have made banks riskier.

These caveats identify avenues for future research. This dissertation features a technique which can easily be used either with more-advanced return-generating models or with broader samples. It would be useful to investigate how stock in thrift institutions performed when ceiling rates changed. Also, using a different data set, (e.g. the DRI data base), the sample of banks should be extended
to include small banks to permit a more meaningful intra-industry analysis to be accomplished. With a broader data set, the common stock price performance of thrift institutions and commercial banks could be analyzed to determine whether or not these institutions have become riskier during the last 25 years.
FOOTNOTES


5. "Deposit Interest Rate Ceilings and Housing Credit", *The Report of the President's Inter-Agency Task Force on Regulation Q*, Department of the Treasury, August 1979, p. 35.

6. Ibid., p. 40.


12. "Deposit Interest Rate Ceilings and Housing Credit", Ibid., p. 44.


17.  AB, June 18, 1979.
20.  AB, November 2, 1979
22.  Ibid. p. 106
28.  Benston (1964) points out the belief among bankers that maximizing deposits is synonymous with wealth maximization.
32.  The market model is explained in Chapter 3.
34.  Aharony, Jones and Swary (1980), p. 1006.
35.  Dann and James (1982) focus on savings and loan institutions and examine the same issue using a similar method as in James (1983).
37. Banks which have SD/TD ratio between 10 percent and 20 percent are implicitly assumed to have wholesale/retail bank characteristics and excluded from the "intra-industry difference" analysis.

38. For a discussion of this point and derivation of the formula see Kmenta (1971), pp. 239-241.

39. Both James (1983) and Smirlock (1984) exclude from their samples firms which have zero trading volume to reduce biases in the parameter estimates caused by infrequent trading. (See Scholes and Williams (1977) and Dimson (1979)). A better way to adjust for this problem would have been to use either Scholes/Williams procedure or the Dimson aggregated coefficients method in estimating the parameters of the market model. However, Warner and Brown (1984) show that these methods "convey no clear-cut benefit in an event study". In this replication no adjustment is made for infrequent trading problem.

40. The 1973 CD and 1973 WC events were within 65 trading days of each other. The procedure used by James and Smirlock to avoid any contamination of parameter estimates is employed here (i.e., for the 1973 CD event the 47 days which follow the analysis period are the days which follow the 1973 WC analysis period and for the 1973 WC event the 47 days previous to the analysis period are the days previous to 1973 CD analysis period).

41. It is best to compare our results with James' results for wholesale banks since the average asset size of the banks used in our sample in James' wholesale group is similar.


44. 1970 CD and 1973 CD events are not included in the intra-industry analysis. Only three of banks showed negative abnormal returns for the 1970 CD change. Also, there is not sufficient balance-sheet information for 1970 in bank COMPSTAT tapes. The 1978 CD event is excluded because the 1978 CD announcement covered two other regulatory changes in addition to the ceiling change announcement.

45. For a complete description of the test see Daniel (1978) and Hogg and Craig (1978).


47. See Hogg and Craig (1978) for a derivation of the mean and the standard deviation.


50. For a review of these techniques see Ashley (1984).

51. I am indebted to Fusun Gonul for showing me how to use the GQOPT and discussing the results of the computer runs.

52. GQOPT manual, section 10.

53. For a description of the algorithm see Goldfeld and Quandt (1972), pp. 5-9.

54. GQOPT manual, section 10.

55. ibid.
56. I wish to thank Randall Ohlson for suggesting this check.

### APPENDIX A

**DEPOSIT - RATE CEILINGS APPLICABLE TO**

**TIME AND SAVINGS ACCOUNTS AT**

**COMMERCIAL BANKS (1933 - 1984)**

<table>
<thead>
<tr>
<th>Date</th>
<th>Ceiling change/New instrument</th>
<th>Old</th>
<th>New</th>
<th>Other Announcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 1, 1933</td>
<td>Savings and Time Deposits:</td>
<td>n.c.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All maturities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb. 1, 1935</td>
<td>Savings and time deposits:</td>
<td>3</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All maturities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan. 1, 1936</td>
<td>Time Deposits</td>
<td>2.5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 - 180 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less than 90 days</td>
<td>2.5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Jan. 1, 1957</td>
<td>Savings Deposits</td>
<td>2.5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All maturities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Deposits</td>
<td>2.5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>101 days or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 - 180 days</td>
<td>2</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Jan. 1, 1962</td>
<td>Savings Deposits</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 year or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less than 1 year</td>
<td>3</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Deposits</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 year or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>180 days - 1 year</td>
<td>3</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>July 17, 1963</td>
<td>Time Deposits</td>
<td>3.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>181 days - 1 year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 - 180 days</td>
<td>2.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Nov. 24, 1964</td>
<td>Savings Deposits</td>
<td>3.5</td>
<td>4</td>
<td>Discount rate raised to 4% from 3%</td>
</tr>
<tr>
<td></td>
<td>Less than 1 year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Deposits</td>
<td>4</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 days or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 - 89 days</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Dec. 6, 1965</td>
<td>Time Deposits</td>
<td>4.5</td>
<td>5.5</td>
<td>Discount rate raised to 4.5% from 3.5%</td>
</tr>
<tr>
<td></td>
<td>90 days or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 - 89 days</td>
<td>4</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>July 16, 1966</td>
<td>Time Deposits:</td>
<td>5.5</td>
<td>5</td>
<td>Fed. decided against a boost in discount rate; proposed amending to distinguish more clearly between savings and time deposits.</td>
</tr>
<tr>
<td></td>
<td>Multiple Maturity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 days or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 - 89 days</td>
<td>5.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sept. 26, 1966</td>
<td>Time Deposits:</td>
<td>5.5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single Mat., Less than $100,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 days or more</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Discount rate raised to 4% from 3%*
April 19, 1968

**Time Deposits:**
- Single Mat., $100,000 or more
  - 180 days or more: 5.5
  - 90 - 179 days: 5.5
  - 60 - 89 days: 5.5

Jan. 21, 1970

**Savings Deposits:**
- All maturities: 4

**Time Deposits:**
- Multiple Maturity
  - 30 - 89 days: 4

**Time Deposits:**
- Single Mat., Less than $100,000
  - 2 years or more: 5
  - 1 - 2 years: 5

**Time Deposits:**
- Single Mat., $100,000 or more
  - 1 year or more: 6.25
  - 180 days to 1 year: 6.25
  - 90 - 179 days: 6
  - 60 - 89 days: 5.75
  - 30 - 59 days: 5.5

March 4, 1970

**Time Deposits:**
- Multiple Maturity
  - 1 - 2 years: 5
  - 2 years or more: 5

June 24, 1970

**Time Deposits:**
- Single Mat., $100,000 or more
  - 60 - 89 days: 6.5
  - 30 - 59 days: 6.25

May 17, 1973

**Time Deposits:**
- Single Mat., $100,000 or more
  - 1 year or more: 7.5
  - 180 days to 1 year: 7
  - 90 - 179 days: 6.75

July 6, 1973

**Savings Deposits:**
- All maturities: 4.5

**Time Deposits:**
- Less than $100,000
  - 2.5 - 4 years: 5.75
  - 1 - 2.5 years: 5.5
  - 2.5 - 4 years: 5.75

Oct. 18, 1973

**Time Deposits:**
- Minimum $1000
  - 4 years or more: n.c.

Dec. 10, 1973

**MMD Accounts:**
- Ceiling introduced: n.c.
**Nov. 27, 1974**

*Time Deposits: $100,000 or more*  
**Governmental Units**  
Discount rate increased to 7% from 6.5%). The yield on MIC pegged to six-month U.S. Treasury bills.

**Governmental bodies are permitted to open savings accounts at commercial banks.**

**Dec. 9, 1974**

*Time Deposits: Minimum $1,000*  
6 year maturity  
**7.5**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**April 8, 1977**

*IRA and Keogh*  
**7.5**  
**7.75**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**May 12, 1978**

*Time Deposits: $1,000 min. den.*  
8 years or more  
**7.75**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

*Time Deposits: $10,000 min. den.*  
6 month: variable, change weekly  
**n.c.**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**May 9, 1979**

Money Market Certificates (MIC)  
**7.5**  
**8**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**May 31, 1979**

*Time Deposits: 4 year - variable ceiling*  
**5**  
**5.25**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**July 31, 1979**

Time Deposits: Less than $100,000  
30 to 69 days  
**5**  
**5.25**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**Dec. 17, 1979**

*Time Deposits: No min. denonin.*  
2.5 year - variable, change monthly (SSC)  
**n.c.**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

Time Deposits:  
30 days - 1 year  
**5.5**  
**5.75**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**Feb. 28, 1980**

Time Deposits:  
Small saver cert. (SSC)  
**n.c.**  
**11.75**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**May 29, 1980**

Time Deposits:  
MIC - minimum ceiling  
**7.75**  
**9.25**  
**12.24**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**

**Discount rate increased to 7% from 6.5%. The yield on MIC pegged to six-month U.S. Treasury bills.**
<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 10, 1980</td>
<td>MW accounts</td>
</tr>
<tr>
<td>Sept. 4, 1981</td>
<td>*All-savers' certificates: 1 year, tax-free, fixed rate</td>
</tr>
<tr>
<td>Sept. 23, 1981</td>
<td>Savings Deposits</td>
</tr>
<tr>
<td>March 23, 1982</td>
<td>*Savings certificate - min. $7500</td>
</tr>
<tr>
<td>June 30, 1982</td>
<td>*Savings account - min. $20000</td>
</tr>
<tr>
<td>Nov. 16, 1982</td>
<td>*Money Market Deposit account - min. 2500</td>
</tr>
<tr>
<td>Dec. 7, 1982</td>
<td>*Super - MW accounts min. $2500</td>
</tr>
<tr>
<td>July 1, 1983</td>
<td>All time deposits:</td>
</tr>
</tbody>
</table>

Premiums to be paid for deposits are defined: advance payment of interest is barred; finders' fees are considered interest payments.

DDIC approved a plan to phase out ceilings on all time deposits during the next four years. Except for passbook savings, all ceilings will be removed on time deposits by August 1, 1985.

Sept. 23, 1981 *IRA and Keogh - min. mat. 1.5 yrs
5.25 5.75

An alternative way to calculate the maximum allowable rate for MMGs is introduced.

March 23, 1982 *Savings certificate - min. $7500
91-day: variable

Yield on the new savings account is tied to the discount rate or 13-week Treasury bills. DDIC created a new group of savings deposit accounts with declining maturities.

June 30, 1982 *Savings account - min. $20000
7 days to 31 days: variable

Yield on the new savings account is tied to a 3-month Treasury bill.

Nov. 16, 1982 *Money Market Deposit account - min. 2500

Six transfers, including the checks, from this account a month is permitted.

Dec. 7, 1982 *Super - MW accounts min. $2500

Unlimited number of checks can be written on Super-MW accounts. Minimum denomination on various accounts are decreased.

July 1, 1983

All remaining ceilings on SMS deposits are eliminated effective October 1, 1983.

---

a. Dates indicated are the publication of the corresponding events in the WSJ.

n.c. denotes no ceiling.

* denotes introduction of a new instrument.
APPENDIX B

THE GOLDFELD–QUANDT MODEL WITH SERIAL CORRELATION OF DISTURBANCES

In (29) and (30), the disturbances are assumed to be uncorrelated. If a first-order autocorrelated error structure is assumed, the switching regression model can be written as:

\[
R_{pt} = a_1 + b_1 R_{mt} + e_{1t} \quad (70)
\]

\[
R_{pt} = a_2 + b_2 R_{mt} + e_{2t} \quad , \quad (71)
\]

where

\[
e_{1t} = \rho_1 e_{1t-1} + u_{1t} \quad (72)
\]

\[
e_{2t} = \rho_2 e_{2t-1} + u_{2t} \quad , \quad (73)
\]

and \( \rho_1 \) and \( \rho_2 \) are the autocorrelation coefficients associated with regime 1 and regime 2, respectively. Then,

\[
R_{pt} = a_1 + b_1 R_{mt} + \rho_1 e_{1t-1} + u_{1t} \quad ; \quad i = 2,...,Z^* \quad (74)
\]

\[
R_{pt} = a_2 + b_2 R_{mt} + \rho_2 e_{2t-1} + u_{2t} \quad ; \quad i = Z^* + 1,...,T. \quad (75)
\]

In (73) \( \rho_2 \) is associated with regime 2 and applied to the error of the previous period, \( e_{t-1} \). If in period \( t \) regime 2 operates and in period \( t-1 \) regime 2 operated as well, the error term follows the usual Markov process. However, if in period \( t-1 \) regime 1 operated (a switch
took place), then the behavior of the error structure at the time of the switch has to be defined. In combining (74) and (75) within the switching framework, assumptions must be made regarding the impact of regime-switching on autocorrelation coefficients. One alternative is to disregard the impact of the regime change on the error structure. Another alternative is to assume that a nonautocorrelated error is generated when a switch takes place. The likelihood functions corresponding to these two alternatives are derived in Goldfeld and Quandt (1976, pp. 15-18).

A third alternative for the error-generating mechanism is to build into the model of equations (74) and (75) a transition in error structure (Goldfeld and Quandt, 1976, p. 31-32). If in periods t and t-1 regime 2 is in effect, then

$$e_{2t-1} = R_{pt-1} - a - b R_{mt-1}$$

(76)

However, if regime 2 was not operative in period t-1, then (76) does not apply. The error sequence is assumed to be reinitialized when the regime changes. Since,

$$\text{Var}(e_{2t}) = \rho^2 \text{Var}(e_{2t-1}) + \text{Var}(u_{2t})$$

(77)

$$\text{Var}(e_{2t}) - (1 - \rho^2) = \text{Var}(u_{2t})$$

(78)

$$\text{Var}(e_{2t}) = \frac{\text{Var}(u_{2t})}{(1 - \rho^2)}$$

(79)

an attractive approximation, suggested by Goldfeld and Quandt (1976), p. 31), for $e_{2t}$ is,
Then if regime 2 is operative in periods \( t \) and \( t-1 \), (76) holds; otherwise (80) holds. Substituting (76) and (80) into (74) and (75) yields:

\[
R_{pt} = a_1 + b_1 R_{mt} + \{\rho_1 (R_{pt-1} - a_1 - b_1 R_{mt-1}) + u_{1t}\} \\
R_{pt} = a_2 + b_2 R_{mt} + D_{t-1} \{\rho_2 (R_{pt-1} - a_2 - b_2 R_{mt-1}) + u_{2t}\} + \\
\left(1 - D_{t-1}\right) u_{2t} / \left(1 - \rho_2^2\right)^{1/2} .
\]

Combining (81) and (82) in a manner similar to (27) gives

\[
R_{pt} = f_t + w_t ,
\]

where

\[
f_t = (1-D_t) \left[ a_1 + b_1 R_{mt} + \{\rho_1 (R_{pt-1} - a_1 - b_1 R_{mt-1})\} \right] \\
+ D_t \{a_2 + b_2 R_{mt} + D_{t-1} [\rho_2 (R_{pt-1} - a_2 - b_2 R_{mt-1})]\} \\
w_t = (1-D_t) u_{1i} + D_{t-1} [D_{i-1} + \left(1 - D_{i-1}\right) / (1 - \rho_2^2)^{1/2}] u_{2i} .
\]

Equation (83) is a two-regime market model with a first-order Markov process for the error structure.

To derive the likelihood function, we first state the normal conditional density function for \( R_{pt} \) as

\[
f(R_{pt} | R_{pt-1}) = \left\{ (2\pi)^{1/2} \sigma_{wt} \right\}^{-1} \exp\left\{ - \sigma_{wt}^{-2} (R_{pt} - f_t)^2 \right\} .
\]

The variance of the combined error \( w_t \) is defined as
which is heteroscedastic unless $\sigma_1^2 = \sigma_2^2$. The logarithm of (86) is:

$$\log f(R_{pt} | R_{pt-1}) = -\frac{1}{2} \log (2\pi \sigma_{wt}^2) - \frac{(R_{pt} - f_t)^2}{2\sigma_{wt}^2}.$$  \hspace{1cm} (88)

The log-likelihood function is

$$L = \sum_{t=2}^{T} \log f(R_{pt} | R_{pt-1}).$$  \hspace{1cm} (89)

Substituting for $\log f(\cdot)$ yields:

$$L = -\frac{T-1}{2} \log 2\pi - \frac{1}{2} \sum_{t=2}^{T} \left[ \log \sigma_{wt}^2 + \frac{(R_{pt} - f_t)^2}{\sigma_{wt}^2} \right].$$  \hspace{1cm} (90)

To obtain maximum-likelihood estimates of $a_1, b_1, a_2, b_2, \sigma_1^2, \sigma_2^2, Z^*, \sigma^*$, (90) is maximized with respect to these 10 parameters substituting (85), (87) and (28) in (90) for $\omega_t^2, \sigma_{wt}^2$ and $D_t$ wherever they occur.
APPENDIX C

SAMPLE PROGRAM TO USE THE GQOPT ROUTINE

1. // JOB,
2. // TIME=2,REGION=2000K
3. /*JOBPARM LINES=9999,DISKIO=10000,TAPEIO=500
4. /*SETUP UNIT=TAPI9,ID=(CC2053,C146,READ)
5. /*PROCLIB DD DSN=CKAO30.PROCLIB,DISP=SHR
6. // EXEC GQOPT,PARM='GOSTMT'
7. //FORT.SYSIN DD *
8. IMPLICIT REAL*8 (A-H,O-Z)
9. EXTERNAL SUB
10. EXTERNAL NMSIMP
11. DIMENSION XD(23),ALABEL(23)
12. COMMON/SWITCH/V(142,4)
13. COMMON/BSTACK/aint(800)
14. COMMON/BSTAK/NQ,NSTOP
15. COMMON/BSTOP/NVAR1,ISTOP(3)
16. COMMON/MYBLOCK/ND(23),MOBS,IW
17. COMMON/BOPT/IVER,LT,IFP,ISP,NLOOP,IST,ILoop
18. COMMON/BFIDIF/FDFRAC,PDIM
19. COMMON/BLNSR/STEP1,STPACC,NLNSR
20. COMMON/BDIS/PSTEPMIN,FOPT
21. COMMON/BINPUT/INFILG
22. COMMON/BNEL/STP1,VAR,KONVGE,NRST
23. NW=0
24. MAX=1
25. NQ=800
26. NRST=1
27. ISTOP(1)=1
28. ISTOP(2)=1
29. ITRFLG=1
30. READ(5,*)NP,ITERL,ACC,NV,MOBS
31. READ(5,*) (XD(K),K=1,NP)
32. READ(5,*) (ZD(I),I=1,NP)
33. WRITE(6,50)
34. FORMAT('STARTING VALUES')
35. WRITE(6,*) (XD(K),K=1,NP)
36. WRITE(6,*) (ZD(I),I=1,NP)
37. DO 60 IKL=1,MOBS
38. READ (10,500) (V(IKL,KK),KK=1,NV)
39. FORMAT(F3.0,F5.0,F10.6,F10.5)
40. CONTINUE
41. WRITE(6,*)NP,ITERL,ACC,NV,MOBS,V(1,1)
42. CALL OPT(XD,NP,FLNL,NMSIMP
43. $ ,ITERL,MAX,IER,ACC,SUB,ALABEL)
CALL PUNCH (XD, NP)
CALL OPTOUT(0)
IW=1
CALL SUB(XD, NP, FLNL, DUMMY)
CALL SUB(XD, NP, FLNL, DUMMY)
STOP
END
SUBROUTINE SUB(XD, NP, FLNL, DUMMY)
IMPLICIT REAL*8(A-H, O-Z)
DOUBLE PRECISION XD(NP), FLNL
COMMON/MYBLOK/ZD(23), MOBS, IW
COMMON/SWITCH/V(142, 4)
DIMENSION D(200), Z(200), F(200), RP(200), RM(200), VAR(200)
$ , XMEAN(200), E(200), H(200), T(200), U(200), B(200), C(200), G(200)
FLNL=0.0D0
PI=(22./7.)*1.D0
PDAYS=142.0
Z0=XD(1)*ZD(1)
Z1=Z0+ZD(2)*DABS(XD(2))
Z2=Z1+ZD(3)*DABS(XD(3))
Z3=Z2+ZD(4)*DABS(XD(4))
S0=DABS(XD(5))*ZD(5)
S1=DABS(XD(6))*ZD(6)
S2=DABS(XD(7))*ZD(7)
S3=DABS(XD(8))*ZD(8)
A1=XD(9)*ZD(9)
B1=XD(10)*ZD(10)
SIGMA1=DABS(XD(11))*ZD(11)
A2=XD(12)*ZD(12)
B2=XD(13)*ZD(13)
SIGMA2=DABS(XD(14))*ZD(14)
A3=XD(15)*ZD(15)
B3=XD(16)*ZD(16)
SIGMA3=DABS(XD(17))*ZD(17)
A4=XD(18)*ZD(18)
B4=XD(19)*ZD(19)
SIGMA4=DABS(XD(20))*ZD(20)
A5=XD(21)*ZD(21)
B5=XD(22)*ZD(22)
SIGMA5=DABS(XD(23))*ZD(23)
DO 100 I=1, PDAYS
RP(I)=V(I, 3)
RM(I)=V(I, 4)
CONTINUE
DO 200 I=1, PDAYS
Z(I)=I*1.0
YYY=(Z(I)-Z0)/S0
CALL MDNOR(YYY,D(I))
XXX=(Z(I)-Z1)/S1
CALL MDNOR(XXX,E(I))
WWW=(Z(I)-Z2)/S2
CALL MDNOR(WVV,G(I))
H(I)=(1.-G(I))*(1.-F(I))*(1.-E(I))*(1.-D(I))
T(I)=(1.-G(I))*(1.-F(I))*(1.-E(I))*D(I)
U(I)=(1.-G(I))*(1.-F(I))*E(I)*D(I)
B(I)=(1.-G(I))*F(I)*E(I)*D(I)
C(I)=G(I)*F(I)*E(I)*D(I)
VAR(I)=(H(I)**2)*(SIGMA1**2)+(T(I)**2)*(SIGMA2**2)+
$(U(I)**2)*(SIGMA3**2)+(B(I)**2)*(SIGMA4**2)+
$(C(I)**2)*(SIGMA5**2)
XMEAN(I)=((H(I)+T(I)+U(I)+B(I)+C(I)))*RP(I)
$-B1*H(I)+B2*T(I)+B3*U(I)+B4*B(I)-B5*C(I)*RM(I)**2
FLNL=FLNL+DLOG(DSQRT(2.*PI*VAR(I)))- (0.5*(XMEAN(I)/
$VAR(I))))

IF(IW.EQ.1)WRITE(6,*) Z0, S0
IF(IW.EQ.1)WRITE (6,*) Z1, S1
IF(IW.EQ.1)WRITE(6,*) Z2, S2
IF(IW.EQ.1)WRITE(6,*) Z3, S3
IF(IW.EQ.1)WRITE(6,*) A1, B1, SIGMA1
IF(IW.EQ.1)WRITE(6,*) A2, B2, SIGMA2
IF(IW.EQ.1)WRITE(6,*) A3, B3, SIGMA3
IF(IW.EQ.1)WRITE(6,*) A4, B4, SIGMA4
IF(IW.EQ.1)WRITE(6,*) A5, B5, SIGMA5

RETURN
END

GO.SYSIN DD *
23
100
1.0D-05
4
142
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
26. 9. 25. 59. 1.7 1.1 1.1 1.4 .000065 .73 .0033 -.0024 .53 .0057
.00028 .72 .0079 .00087 .58 .0047 -.0011 .36 .0033
GO.FT10001 DD DSN=EV.ONE,UNIT=TAPE9,
// DISP=(OLD,KEEP),VOL=SER=CC2053,LABEL=(4,SL)
/*
//
## APPENDIX D

**SIGNIFICANT NEWS AROUND THE 1970 CD ANNOUNCEMENT**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/18</td>
<td>House Banking &amp; Currency Committee passed bill to curb use of secret foreign bank accounts for illegal purposes.</td>
</tr>
<tr>
<td>3/24</td>
<td>Supreme Court held, in effect, by backing lower-court decision, that travel agents have legal standing to challenge right of national banks to diversify into the travel business.</td>
</tr>
<tr>
<td>3/26</td>
<td>Major banks cut prime rates to 8% from 8 1/2% their first cut in 18 months; Irving Trust Co. of New York leads move followed by some reluctantly.</td>
</tr>
<tr>
<td>4/13</td>
<td>Savings banks face heavy April outflow; maturing Treasury bills may ease drain.</td>
</tr>
<tr>
<td>4/15</td>
<td>Dual system of reporting bank earnings raising fears that public may be misled.</td>
</tr>
<tr>
<td>4/15</td>
<td>Bank giveaways to long-term depositors are interest income and fully taxable in year received, IRS ruled.</td>
</tr>
<tr>
<td>4/21</td>
<td>Bill to regulate one-bank holding concerns likely to get hearing before Senate Banking &amp; Currency Committee in May.</td>
</tr>
<tr>
<td>4/21</td>
<td>Banks may deal in issues guaranteed by GNMA, Currency Comptroller rules.</td>
</tr>
<tr>
<td>4/22</td>
<td>Bankers said IRS could decide to move against entire industry.</td>
</tr>
<tr>
<td>5/13</td>
<td>Senate Banking &amp; Currency Committee found House bill too tough on one-bank holding firms, Sen. Sparkman said.</td>
</tr>
<tr>
<td>5/20</td>
<td>Nixon Administration quietly decided to eventually suspend all deposit interest-rate ceilings, putting them on standby basis, K.A. Randall, former chairman of FDIC said.</td>
</tr>
<tr>
<td>5/26</td>
<td>American Bankers Association asked delay in legislation on holding companies; Association's head told Senate Banking &amp; Currency Committee Congress should wait for Presidention commission study.</td>
</tr>
</tbody>
</table>
Empty Coeffers: Cash shortage causes worry big firms could face collapse; Penn Central's ills point up dangers to exonomy; 'ripple' effect feared.

Pressure on FRB to ease credit increased by Penn Central Transportation Co.'s misfortunes.

FRB suspended interest limits on some big deposit certificates; move intended to aid banks in meeting loan demand after Penn Transportation Co. filing.

Some major banks lifted CD rates sharply after FRB suspended ceilings.

Chairman Patman's probe of Penn Central's ills will concentrate on banks' role.

FRB put new restrictions on bank capital notes; maturity boosted for exclusion from interest-rate ceilings, reserve requirements.

Major banks' net turned sluggish in second period; drop in prime rate blamed.

House Banking & Currency Committee voted to authorize use of subpoenas to investigate banking industry's role in financial collapse of Penn Central Transportation Co.

Senate Banking & Currency subcommittee approved tougher bill on secret foreign bank accounts: added three disclosure provisions to measure passed by House; bill goes to full Banking Committee.

Senate Banking & Currency Committee approved bill to curb secret foreign bank accounts; measure, tougher than version passed by House, would require listing of certain transactions.

Banks' reserves on time deposit lowered to 5%; FRB adopted rule making commercial paper more expensive to banks; actions effective Sept. 17.

Banks seen shuffling dependence on sources of funds for lending; FRB moves expected to lead to more Eurodollar borrowing from units abroad.

Demand-deposit reserve rule applied to banks under-30-day commercial paper.
Several banks reduced rates on big deposits due in 30 to 89 days; Chase Manhattan Bank, First National City Bank among those cutting quotes on certificates 1/8 percentage point.

IRS plans to tax interest when earned on long-term bank and savings & loan deposits.

Banking officials rap IRS plan to end tax deferrals on accounts; said proposal will hurt housing and educational loans, and savers near retirement.

Easing the Squeeze, Financial crisis fades as money supply gains, interest rates decline; Penn Central collapse called factor in averting woes by spotlighting problems; Will the prime rate be cut?

Assets of overseas branches of U.S. banks jumped 79%, or $18.1 billion, in 1969 to record $41.1 billion at year-end.

Senate approved bill placing curbs on one-bank holding firms; plan weaker than House bill.

Senate passed bill aimed at curbing use of secret foreign bank accounts for illegal purposes.

Prime rate is cut to 7 1/2% from 8% by major banks across the country; others expected to follow as competitive pressure grows on money market.

First National City Bank lowered to 6 3/4% from 7% rate it pays on large denomination certificates of deposit due in 30 to 89 days.

Compromise neared on bill to regulate one-bank holding firms; House-Senate conferees agree tentatively on several items, breaking previous impasse.
### APPENDIX E

**SIGNIFICANT NEWS AROUND THE 1973 ANNOUNCEMENTS**

<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/1</td>
<td>Several finance companies boosted rates they will pay on commercial paper, or short-term IOUs.</td>
</tr>
<tr>
<td>2/2</td>
<td>Dollar drops further in European markets despite central banks' propping efforts.</td>
</tr>
<tr>
<td>2/6</td>
<td>Dollar remains weak on currency markets but trading diminishes; gold price rises.</td>
</tr>
<tr>
<td>2/8</td>
<td>Wilbur Mills urged further devaluation of dollar; Rep. Henry Reuss suggested asking Bonn to float mark.</td>
</tr>
<tr>
<td>2/8</td>
<td>Dollar is driven below base rate in West Germany; drop follows Bonn report that a two-tier system for mark isn't ruled out.</td>
</tr>
<tr>
<td>2/13</td>
<td>U.S. devalued dollar 10% by raising price of gold; Japan agreed to let yen float; President Nixon plans trade legislation, end to equalization levy and to rein on investment.</td>
</tr>
<tr>
<td>2/16</td>
<td>FRB goes limit in pumping funds into bank system; banks reserve position was slimmest on record; currency turmoil blamed.</td>
</tr>
<tr>
<td>2/26</td>
<td>Banks set to lobby for the right to join securities exchanges; sources say they want to use this as leverage to force down commission charges.</td>
</tr>
<tr>
<td>3/5</td>
<td>Federal Reserve's rate ceiling on CDs vex banks, may boost short-term scale.</td>
</tr>
<tr>
<td>3/6</td>
<td>Some New York banks boosted loan rates to brokers by quarter-point or more.</td>
</tr>
<tr>
<td>3/7</td>
<td>Interest rates for short term continued to rise; CDs of 30 days lifted to 6 5/8%; competition on 89-day issue called stiff.</td>
</tr>
</tbody>
</table>
FRB to hold hearings on applications by 22 bank holding companies to engage in certain insurance agency activities.

New York State's savings banks registered a net deposit inflow of $168 million in February, down from $277 million in January, $421.4 million in February 1972.

House Banking & Currency Subcommittee received diverse views on bill curbing savings banks; law would ban paying interest on accounts basically similar to checking accounts of others.

Battle by banks for cash to lend pushes rates up; they have to pay as much as 6.85% for 30-day CDs to lure investor money.

Bank regulatory overhaul won't be part of President Nixon's plan to revise financial system.

FRB asked Congress to allow all banking institutions to offer their customers checking services on savings accounts.

Pressure grows for rise in discount rates as banks' borrowings from the Fed soar.

Three New York banks have foreign trade net after currency crisis; J.P. Morgan & Co., Charter New York Corp., Chemical New York Corp. report to annual meetings they were in Treasury Dept. asked Congress to extend for two years the authority of Federal Reserve banks to purchase U.S. securities directly from the Treasury.

Checking-type accounts at savings banks would be barred by House panel's measure.

Short-term interest rates climbed in reaction to meat-price ceilings; Treasury bills jump 1/8 point; fees banks pay to raise funds through sale of CDs also rise.

President Nixon might veto a price-interest freeze, Treasury Secy. George Shultz warned House Banking & Currency Committee.

High interest rates in the money market pinch savings banks; New York City's thrift units had net outflow of deposits in March, first since 1970.
House Banking & Currency Committee approved checking-type accounts for savings banks, overruling a unit.

Senate Banking & Currency Committee voted to let depositors of mutual savings banks continue writing checks on interest-paying accounts, but moved to place the interest rates under federal ceilings.

Citibank reinstates a floating prime rate, which is set at 6 3/4% but probably will lift.

Supreme Court upheld FRB rule designed to prevent evasion of the consumer-credit disclosure requirements of the 1968 Truth-in-Lending Act.

FRB expanded regional banks' power in bank holding cases; granted authority to approve formation of multibank firms, more acquisitions and mergers.

FRB chairman Arthur Burns urges extending of Reserve rules to savings banks, non-members of Fed.

FRB to consider whether to allow bank holding companies to enter the growing mortgage-insurance business.

Several dealers boosted to 7 1/4% from 7 1/8% offering rates to investors on high-grade commercial paper due in 90 days.

Interest rates on federal funds jumped to 15% at one point May 16, the highest level since at least the 1920s, according to some specialists.

FRB acted to curb expansion of bank credit; series of moves included removal of lid on CD rates; increase in interest costs of business borrowers seen; boost in 'prime' probable.

Rules to curb expansion of bank credit outlined by FRB.

Short-term rates surge as Fed continues its tighter credit stance in open market.

Senate voted to limit special interest-paying checking service to the two states where it's currently in use.
Two banks announced plans for offering customers an automatic stock purchase program through deductions from their checking accounts.

House-Senate conference committee agreed to a 19-month extension of federal banking agencies' authority to control interest rates paid depositors.

Interest-rate ceilings covering banks savings and loan associations expired midnight May 31; House-Senate conferees fail to act on bill extending control, but no real effect is expected.

Short-term fees jump still higher in money market; rates on three-month CDs rise to 8%.

Banks in New York City and other major financial centers asked for interstate bank branching; curb on federal rules for foreign banks.

Short-term rates rise in key areas of money market; increases add to pressure for industry-wide boost in prime rate to 7 3/4%.

FHLBB is considering lifting the 5% interest ceiling on passbook savings accounts at federally insured savings and loan associations.

FRB may allow bank holding companies to perform management consulting services for non affiliated banks.

Prime-rate boost to at least 8% is likely to spread as FRB lifts discount rate and reserve requirements; loans to member banks will cost record 7%; bid to curb money supply seen.

Congress passed authority for the federal banking regulatory agencies to control interest rates paid depositors until Aug. 1.

Rep. Henry Reuss (D., Wis.) asked inquiry into foreign banking operations in the U.S.

Savings rate ceiling to be raised 1/2 point in Joint regulatory move likely in week ended July 7.

FRB to ease limits on trust units of bank holding firms; proposal, which would permit acceptance of certain deposits, spurred by New York situation.
FRB moved to impose penalties when a bank depositor changes the terms of a certificate of deposit.

Regulation by U.S. of stock processing cleared by Senate Banking & Currency Committee; bill give SEC authority to set standards and enforce them for all bodies except banks.

House-Senate conference committee reached compromise permitting interest-paying checking accounts to continue to be offered in the two states where they currently exist.

Major New York banks' trust departments had operating profit in 1972; it was the first since 1968 for 10 banks in Fed survey; gains are shown in four broad areas.

Philadelphians snap up savings certificates paying higher rates; Western Savings' 'super eights' sold out, other institutions are reaching federal ceiling.

President Nixon's proposed banking overhaul to trigger long fight in Congress; White House package likely to foster heavy lobbying by major groups affected.

Gov. Cahill signed bill permitting statewide branch banking in New Jersey and providing for gradual elimination of so-called home-office protection.

Relaxed limit on bank time deposits outside rate ceilings; change will permit 8,000 banks not tied to Reserve System to convert some till Sept. 8.

FDIC relaxed limit on bank time deposits outside rate ceilings; change will permit 8,000 banks not tied to Reserve System to convert some funds till Sept. 8.

FRB adopted new regulations to discourage bank depositors from switching their old certificates of deposit to the new, higher-paying ones.

Savings & Loan Associations had $313 million savings outflow; FHLBB increases amount savings & loan associations may have in CDs to help them get deposits.

Banks paid as much as 20% annual interest Aug. 29 to borrow overnight funds from each other.
9/4  Heard on Street item on merits of theory that when interest rates go up, banks should make lots of money lending funds at high returns.

9/6  More banks offer customers stock market investment plans.

9/10 Rise to 11% in reserves needed on big CDs underscores FRB's restrictive money policy.

9/11 Savings banks in New York State had a net deposit outflow of $311 million in August following a record $472 million outflow in July.

9/17 Prime rate of 10% is expected to spread rapidly despite rumblings in Washington.

9/18 Regulation of banks' securities services by SEC is urged by agency's chairman.

9/19 Prime rate rise to 10% takes hold throughout U.S.; Bank of America and others increase fee; other money costs show sharp drops.

10/2 Senate voted to outlaw the newly authorized certificates of deposit that are free from federal interest-rate ceilings.

12/17 Insured-deposit limit would go to $50,000 under a bill approved by House Banking Committee.
### Table 1: Selected Ceiling Rates and Market Rates (in percent), 1933-1979

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<th>Long-Term Savings Deposits</th>
<th>Long-Term Time Deposits</th>
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- a. Passbook Savings
- b. 30-69 days
- c. 1 year or more

Source: Appendix A; Ibbotson and Sinquefield (1982); Various issues of Federal Reserve Bulletin; Annual Report, 1944, Office of the Comptroller.
### Table 2: Average Annual Yield on Deposits of Savings Associations and Commercial Banks, 1933–1979.

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Table 3: Growth in Total Assets of Savings and Loan Associations 1933-1979.

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<td>5875</td>
<td>(8.3)</td>
</tr>
<tr>
<td>1936</td>
<td>5772</td>
<td>(1.8)</td>
</tr>
<tr>
<td>1937</td>
<td>5682</td>
<td>(1.6)</td>
</tr>
<tr>
<td>1938</td>
<td>5632</td>
<td>(0.9)</td>
</tr>
<tr>
<td>1939</td>
<td>5597</td>
<td>(0.6)</td>
</tr>
<tr>
<td>1940</td>
<td>5738</td>
<td>2.4</td>
</tr>
<tr>
<td>1941</td>
<td>6049</td>
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</tr>
<tr>
<td>1942</td>
<td>6150</td>
<td>1.7</td>
</tr>
<tr>
<td>1943</td>
<td>6604</td>
<td>7.4</td>
</tr>
<tr>
<td>1944</td>
<td>7458</td>
<td>12.9</td>
</tr>
<tr>
<td>1945</td>
<td>8747</td>
<td>17.3</td>
</tr>
<tr>
<td>1946</td>
<td>10202</td>
<td>16.6</td>
</tr>
<tr>
<td>1947</td>
<td>11087</td>
<td>14.6</td>
</tr>
<tr>
<td>1948</td>
<td>13028</td>
<td>11.5</td>
</tr>
<tr>
<td>1949</td>
<td>14622</td>
<td>12.2</td>
</tr>
<tr>
<td>1950</td>
<td>16893</td>
<td>15.5</td>
</tr>
<tr>
<td>1951</td>
<td>19222</td>
<td>13.8</td>
</tr>
<tr>
<td>1952</td>
<td>26733</td>
<td>18.0</td>
</tr>
<tr>
<td>1953</td>
<td>31633</td>
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</tr>
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<td>1954</td>
<td>37656</td>
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<td>1955</td>
<td>42875</td>
<td>13.9</td>
</tr>
<tr>
<td>1956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1957</td>
<td>48338</td>
<td>12.3</td>
</tr>
<tr>
<td>1958</td>
<td>55139</td>
<td>14.5</td>
</tr>
<tr>
<td>1959</td>
<td>61530</td>
<td>15.2</td>
</tr>
<tr>
<td>1960</td>
<td>71476</td>
<td>12.5</td>
</tr>
<tr>
<td>1961</td>
<td>82135</td>
<td>14.9</td>
</tr>
<tr>
<td>1962</td>
<td>93605</td>
<td>14.0</td>
</tr>
<tr>
<td>1963</td>
<td>107559</td>
<td>14.9</td>
</tr>
<tr>
<td>1964</td>
<td>119355</td>
<td>11.0</td>
</tr>
<tr>
<td>1965</td>
<td>129380</td>
<td>8.6</td>
</tr>
<tr>
<td>1966</td>
<td>133933</td>
<td>3.4</td>
</tr>
<tr>
<td>1967</td>
<td>143534</td>
<td>7.2</td>
</tr>
<tr>
<td>1968</td>
<td>152890</td>
<td>6.5</td>
</tr>
<tr>
<td>1969</td>
<td>162149</td>
<td>6.1</td>
</tr>
<tr>
<td>1970</td>
<td>176183</td>
<td>8.7</td>
</tr>
<tr>
<td>1971</td>
<td>206033</td>
<td>16.9</td>
</tr>
<tr>
<td>1972</td>
<td>243127</td>
<td>18.0</td>
</tr>
<tr>
<td>1973</td>
<td>271905</td>
<td>11.8</td>
</tr>
<tr>
<td>1974</td>
<td>295545</td>
<td>8.7</td>
</tr>
<tr>
<td>1975</td>
<td>338243</td>
<td>14.4</td>
</tr>
<tr>
<td>1976</td>
<td>459241</td>
<td>17.2</td>
</tr>
<tr>
<td>1977</td>
<td>529542</td>
<td>14.0</td>
</tr>
<tr>
<td>1978</td>
<td>579307</td>
<td>10.7</td>
</tr>
</tbody>
</table>

a. Parentheses denote negative growth

Source: Savings and Loan Fact Book, 1970 and 1980, Tables 84 and 72, respectively.
Table 4: Maximum Interest Rate Payable On Time and Savings Deposits as of December 31, 1984.

<table>
<thead>
<tr>
<th>Type and maturity of deposit</th>
<th>Commercial banks</th>
<th>Savings and loan associations and mutual savings banks (thrift institutions)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In effect Dec. 31, 1984</td>
<td>In effect Dec. 31, 1984</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>Effective date</td>
</tr>
<tr>
<td>Savings</td>
<td>5½%</td>
<td>1/1/84</td>
</tr>
<tr>
<td>Negotiable order of withdrawal accounts</td>
<td>5½%</td>
<td>12/31/80</td>
</tr>
<tr>
<td>Negotiable order of withdrawal accounts of $2,500 or more</td>
<td>1%</td>
<td>1/2/83</td>
</tr>
<tr>
<td>Money market deposit account</td>
<td>(‘)</td>
<td>12/14/82</td>
</tr>
<tr>
<td>Time accounts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-31 days of less than $2,500</td>
<td>5½%</td>
<td>1/1/84</td>
</tr>
<tr>
<td>7-31 days of $2,500 or more</td>
<td>1%</td>
<td>1/2/83</td>
</tr>
<tr>
<td>More than 31 days</td>
<td></td>
<td>10/1/83</td>
</tr>
</tbody>
</table>

1. Effective Oct. 1, 1983, restrictions on the maximum rates of interest payable by commercial banks and thrift institutions on various categories of deposits were removed. For information regarding previous interest rate ceilings on all categories of accounts, see earlier issues of the Federal Reserve Bulletin, the Federal Home Loan Bank Board Journal, and the Annual Report of the Federal Deposit Insurance Corporation.

2. Effective Dec. 1, 1983, IRA/Keogh (H.R. 10) Plan accounts are not subject to minimum deposit requirements.

3. Effective Dec. 14, 1982, depository institutions are authorized to offer a new account with a required initial balance of $2,500 and an average maintenance balance of $2,500 not subject to interest rate restrictions. No minimum maturity period is required for this account, but depository institutions must reserve the right to require seven days' notice before withdrawal. When the average balance is less than $2,500, the account is subject to the maximum ceiling rate of interest for negotiable order of withdrawal accounts; compliance with the average balance requirement may be determined over a period of one month. Depository institutions may not guarantee a rate of interest for this account for a period longer than one month or condition the payment of a rate on a requirement that the fund remain on deposit for longer than one month.

4. Deposits of less than $2,500 issued to governmental units continue to be subject to an interest rate ceiling of 8 percent.

Table 5: The four Regulatory Ceiling Changes Analyzed During the 1970-1980 period

<table>
<thead>
<tr>
<th>Announcement Date</th>
<th>Regulatory change</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/23/1970 (1970 CD)</td>
<td>Suspension of ceilings on $100,000 or more certificates of deposits (large CD's) maturing 30 through 89 days.</td>
</tr>
<tr>
<td>5/16/1973 (1973 CD)</td>
<td>Suspension of ceilings on large CD's maturing 90 days or more.</td>
</tr>
<tr>
<td>7/5/1973 (1973 WC)</td>
<td>Removal of ceilings on CD's of 1000 or more. Passbook savings rates are increased 1/4 of a point to 5 1/4 percent.</td>
</tr>
<tr>
<td>5/11/1978 (1978 MMC)</td>
<td>Variable rate Money Market Certificate (MMC) is introduced. In addition, an 8-year certificate with a fixed 8-percent ceiling is introduced.</td>
</tr>
</tbody>
</table>

b. The indicated date for 1973 WC event in Smirlock (1984) is 7/1/1973
Table 6: Number of sample banks used in the three empirical studies

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1970 CD</td>
<td>61 (18,30)</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>1973 CD</td>
<td>70 (23,35)</td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>1973 WC</td>
<td>70 (23,35)</td>
<td>29</td>
<td>45</td>
</tr>
<tr>
<td>1978 MMC</td>
<td>81 (24,37)</td>
<td>29</td>
<td>45</td>
</tr>
</tbody>
</table>

a. Source for data is DRI and American Banker  
b. Source for data is CRSP  
c. Source for data is CRSP  
d. Numbers in parenthesis are number of banks in wholesale and retail portfolios respectively.
Table 7: Day(0) and Day (+1) prediction errors for the four ceiling change events.

<table>
<thead>
<tr>
<th>Event</th>
<th>Day</th>
<th>All Banks</th>
<th>All banks</th>
<th>Wholesale</th>
<th>Retail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970 CD</td>
<td>6/23</td>
<td>1.08</td>
<td>-0.22</td>
<td>2.21</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>6/24</td>
<td>-0.58</td>
<td>1.71</td>
<td>0.02</td>
<td>-0.78</td>
</tr>
<tr>
<td>1973 CD</td>
<td>5/16</td>
<td>-0.20</td>
<td>0.05</td>
<td>0.01</td>
<td>-0.37</td>
</tr>
<tr>
<td></td>
<td>5/17</td>
<td>0.24</td>
<td>-0.39</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>1973 WC</td>
<td>7/5</td>
<td>-0.12</td>
<td>-0.41</td>
<td>0.38</td>
<td>-0.50</td>
</tr>
<tr>
<td></td>
<td>7/6</td>
<td>0.01</td>
<td>0.22</td>
<td>0.16</td>
<td>-0.10</td>
</tr>
<tr>
<td>1978 MMC</td>
<td>5/11</td>
<td>-0.21</td>
<td>-0.12</td>
<td>0.18</td>
<td>-0.99</td>
</tr>
</tbody>
</table>

a. Prediction errors reported in James (1983)

b. Prediction errors calculated for the sample of banks used in this dissertation.
TABLE 8: Daily prediction errors(\%), cumulative prediction errors(\%), and t-values for 1970 CD event for all banks.

<table>
<thead>
<tr>
<th>DAY</th>
<th>PE</th>
<th>CPE</th>
<th>T</th>
<th>T*</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>0.09808</td>
<td>0.09808</td>
<td>0.1750</td>
<td>0.1898</td>
</tr>
<tr>
<td>-9</td>
<td>0.53947</td>
<td>0.63755</td>
<td>0.9624</td>
<td>1.0411</td>
</tr>
<tr>
<td>-8</td>
<td>0.04336</td>
<td>0.68091</td>
<td>0.0774</td>
<td>0.0835</td>
</tr>
<tr>
<td>-7</td>
<td>-0.07951</td>
<td>0.60140</td>
<td>-0.1419</td>
<td>-0.1538</td>
</tr>
<tr>
<td>-6</td>
<td>0.12849</td>
<td>0.72989</td>
<td>0.2292</td>
<td>0.2487</td>
</tr>
<tr>
<td>-5</td>
<td>-0.54901</td>
<td>0.18089</td>
<td>-0.9795</td>
<td>-1.0469</td>
</tr>
<tr>
<td>-4</td>
<td>0.15781</td>
<td>0.33869</td>
<td>0.2815</td>
<td>0.3054</td>
</tr>
<tr>
<td>-3</td>
<td>-0.41434</td>
<td>-0.07565</td>
<td>-0.7392</td>
<td>-0.8012</td>
</tr>
<tr>
<td>-2</td>
<td>0.62580</td>
<td>0.55015</td>
<td>1.1164</td>
<td>1.2097</td>
</tr>
<tr>
<td>-1</td>
<td>-0.42003</td>
<td>0.13012</td>
<td>-0.7493</td>
<td>-0.8120</td>
</tr>
<tr>
<td>0</td>
<td>0.22291</td>
<td>0.35303</td>
<td>0.3977</td>
<td>0.4241</td>
</tr>
<tr>
<td>+1</td>
<td>1.71326</td>
<td>2.06629</td>
<td>3.0565</td>
<td>3.3034</td>
</tr>
<tr>
<td>+2</td>
<td>-0.23804</td>
<td>1.82825</td>
<td>-0.4247</td>
<td>-0.4607</td>
</tr>
<tr>
<td>+3</td>
<td>0.38280</td>
<td>2.21105</td>
<td>0.6829</td>
<td>0.7396</td>
</tr>
<tr>
<td>+4</td>
<td>-0.84793</td>
<td>1.36313</td>
<td>-1.5127</td>
<td>-1.6379</td>
</tr>
<tr>
<td>+5</td>
<td>0.75212</td>
<td>2.11524</td>
<td>1.3418</td>
<td>1.4555</td>
</tr>
<tr>
<td>+6</td>
<td>0.43390</td>
<td>2.54915</td>
<td>0.7741</td>
<td>0.8396</td>
</tr>
<tr>
<td>+7</td>
<td>0.48445</td>
<td>2.99380</td>
<td>0.7933</td>
<td>0.8606</td>
</tr>
<tr>
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<td>0.44586</td>
<td>3.43966</td>
<td>0.7954</td>
<td>0.8569</td>
</tr>
<tr>
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<td>0.19996</td>
<td>3.54962</td>
<td>0.1962</td>
<td>0.2124</td>
</tr>
<tr>
<td>+10</td>
<td>-0.20391</td>
<td>3.34570</td>
<td>-0.3638</td>
<td>-0.3885</td>
</tr>
</tbody>
</table>

For Tables 8 - 11:

T = t-values as formulated in James (1983).

T* = In calculating these values the standard deviation used is the one given in equation (13).
TABLE 9: Daily prediction errors(\%), cumulative prediction errors(\%), and t-values for 1973 CD event for all banks.

<table>
<thead>
<tr>
<th>DAY</th>
<th>PE</th>
<th>CPE</th>
<th>T</th>
<th>T*</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>-0.44863</td>
<td>-0.4486</td>
<td>-1.2569</td>
<td>-1.0812</td>
</tr>
<tr>
<td>-9</td>
<td>-0.11240</td>
<td>-0.5610</td>
<td>-0.3149</td>
<td>-0.2693</td>
</tr>
<tr>
<td>-8</td>
<td>0.20967</td>
<td>-0.3514</td>
<td>0.5874</td>
<td>0.5086</td>
</tr>
<tr>
<td>-7</td>
<td>0.12070</td>
<td>-0.2307</td>
<td>0.3381</td>
<td>0.2938</td>
</tr>
<tr>
<td>-6</td>
<td>0.20281</td>
<td>-0.0279</td>
<td>0.5682</td>
<td>0.4926</td>
</tr>
<tr>
<td>-5</td>
<td>0.20391</td>
<td>0.1761</td>
<td>0.5712</td>
<td>0.4960</td>
</tr>
<tr>
<td>-4</td>
<td>0.18572</td>
<td>0.3618</td>
<td>0.5203</td>
<td>0.4512</td>
</tr>
<tr>
<td>-3</td>
<td>0.22350</td>
<td>0.5853</td>
<td>0.6261</td>
<td>0.5402</td>
</tr>
<tr>
<td>-2</td>
<td>-0.16962</td>
<td>0.4157</td>
<td>-0.4752</td>
<td>0.4022</td>
</tr>
<tr>
<td>-1</td>
<td>-0.43580</td>
<td>-0.0201</td>
<td>-1.2209</td>
<td>-1.0596</td>
</tr>
<tr>
<td>0</td>
<td>0.05273</td>
<td>0.0326</td>
<td>0.1477</td>
<td>0.1284</td>
</tr>
<tr>
<td>+1</td>
<td>-0.38925</td>
<td>-0.3567</td>
<td>-1.0905</td>
<td>-0.9443</td>
</tr>
<tr>
<td>+2</td>
<td>-0.57859</td>
<td>-0.9352</td>
<td>-1.6209</td>
<td>-1.3804</td>
</tr>
<tr>
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<td>-0.86464</td>
<td>-1.7999</td>
<td>-2.4223</td>
<td>-2.0819</td>
</tr>
<tr>
<td>+4</td>
<td>0.19828</td>
<td>-1.6016</td>
<td>0.5555</td>
<td>0.4810</td>
</tr>
<tr>
<td>+5</td>
<td>-0.00543</td>
<td>-1.6070</td>
<td>-0.0152</td>
<td>-0.0132</td>
</tr>
<tr>
<td>+6</td>
<td>-0.54101</td>
<td>-2.1481</td>
<td>-1.5157</td>
<td>-1.2507</td>
</tr>
<tr>
<td>+7</td>
<td>0.22556</td>
<td>-1.9225</td>
<td>0.6319</td>
<td>0.5454</td>
</tr>
<tr>
<td>+8</td>
<td>0.48003</td>
<td>-1.4425</td>
<td>1.3448</td>
<td>1.1690</td>
</tr>
<tr>
<td>+9</td>
<td>0.04244</td>
<td>-1.4000</td>
<td>0.1189</td>
<td>0.1020</td>
</tr>
<tr>
<td>+10</td>
<td>0.02606</td>
<td>-1.3740</td>
<td>0.0730</td>
<td>0.0632</td>
</tr>
</tbody>
</table>
TABLE 10: Daily prediction errors(%, cumulative prediction errors(%), and t-values for 1973 WC event for all banks.

<table>
<thead>
<tr>
<th>DAY</th>
<th>PE</th>
<th>CPE</th>
<th>T</th>
<th>T*</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>-0.22001</td>
<td>-0.22001</td>
<td>-0.6704</td>
<td>-0.5680</td>
</tr>
<tr>
<td>-9</td>
<td>0.27912</td>
<td>0.05911</td>
<td>0.8506</td>
<td>0.7158</td>
</tr>
<tr>
<td>-8</td>
<td>0.10333</td>
<td>0.16244</td>
<td>0.3149</td>
<td>0.2668</td>
</tr>
<tr>
<td>-7</td>
<td>0.35437</td>
<td>0.51681</td>
<td>1.0799</td>
<td>0.9058</td>
</tr>
<tr>
<td>-6</td>
<td>-0.55015</td>
<td>-0.03334</td>
<td>-1.6765</td>
<td>-1.4137</td>
</tr>
<tr>
<td>-5</td>
<td>-0.02423</td>
<td>-0.05758</td>
<td>-0.0738</td>
<td>-0.0626</td>
</tr>
<tr>
<td>-4</td>
<td>0.08233</td>
<td>0.02475</td>
<td>0.2509</td>
<td>0.2114</td>
</tr>
<tr>
<td>-3</td>
<td>0.42752</td>
<td>0.45227</td>
<td>1.3028</td>
<td>1.1045</td>
</tr>
<tr>
<td>-2</td>
<td>0.55332</td>
<td>1.00558</td>
<td>1.6861</td>
<td>1.4179</td>
</tr>
<tr>
<td>-1</td>
<td>0.13298</td>
<td>1.13856</td>
<td>0.4052</td>
<td>0.3421</td>
</tr>
<tr>
<td>0</td>
<td>-0.40666</td>
<td>0.73190</td>
<td>-1.2392</td>
<td>-1.0512</td>
</tr>
<tr>
<td>+1</td>
<td>0.21666</td>
<td>0.94856</td>
<td>0.6602</td>
<td>0.5595</td>
</tr>
<tr>
<td>+2</td>
<td>0.10949</td>
<td>1.05805</td>
<td>0.3337</td>
<td>0.2817</td>
</tr>
<tr>
<td>+3</td>
<td>0.09885</td>
<td>1.15690</td>
<td>0.3012</td>
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Table 12: t-values for average abnormal returns around each event for each bank.

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Table 13: Mean values for the balance-sheet items

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<th>Item</th>
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<th>1976 MC</th>
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<tr>
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<tr>
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<tr>
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<td>818.5</td>
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<td>Demand Deposits</td>
<td>3117.7</td>
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<td>Time and Savings</td>
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<td>Deposits</td>
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<td>Foreign Deposits</td>
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<td>-</td>
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<tr>
<td>NH + R.E.L/TA (%)</td>
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<tr>
<td>CL/TA (%)</td>
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<tr>
<td>DD/TD (%)</td>
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<td>FD/TD (%)</td>
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Source: Bank CONDUSTAT
Table 14: Mann-Whitney tests of differences between the balance sheet items for 1973 WC event.

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<th></th>
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<td>N Avg Rank</td>
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<tr>
<td>Comm. Loans</td>
<td>17 13.24</td>
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<td>Real Est. Loans</td>
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<tr>
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<td>-0.4089</td>
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<td>HIL + REL/TA</td>
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<td>8 17.25</td>
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<tr>
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* Significant at 5%
Table 15: Mann-Whitney tests of differences between the balance-sheet items for 1978 MMC event

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<td>Avg Rank</td>
<td>N</td>
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<td>Corn. Loans</td>
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<tr>
<td>Real Est. Loans</td>
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<td>DO/TD</td>
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<td>20.80</td>
<td>22</td>
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<tr>
<td>T &amp; S/TD</td>
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* Significant at 5%
Table 16: Number of Restrictions Under Different Hypotheses Testing.

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<th>$H_0: EDR$</th>
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<td>$a_1 = a_2$</td>
<td>$* \sigma_1 = 0$ or any value</td>
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<td>$a_2 = a_3$</td>
<td>$* Z_1 = \text{event day}$</td>
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<tr>
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<td>$b_1 = b_2$</td>
<td>$* b_2 = b_3$</td>
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<tr>
<td>$H_1: R_2$</td>
<td>$* o_1 = 0$</td>
<td>$b_2 = b_3$</td>
<td>$* Z_2 = 1$ or $T$</td>
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</tbody>
</table>

5 | 10 | 2
Table 17: Likelihood-Ratio Test to Determine the Number of Regimes
In Effect In The Vicinity of the Ceiling-Change Events.

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<thead>
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<th>Event/Regime</th>
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<th>$-2\ln(L^*/L)$a</th>
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<tr>
<td>$R_2$ vs. $R_3$</td>
<td>554.45/561.35</td>
<td>13.8</td>
</tr>
<tr>
<td>$R_3$ vs. $R_4$</td>
<td>561.35/567.23</td>
<td>11.76</td>
</tr>
<tr>
<td>$R_4$ vs. $R_5$</td>
<td>567.23/569.96</td>
<td>5.46b</td>
</tr>
<tr>
<td>2. 1973 CD and 1973 WC Events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_1$ vs. $R_2$</td>
<td>722.92/739.12</td>
<td>32.4</td>
</tr>
<tr>
<td>$R_2$ vs. $R_3$</td>
<td>739.12/748.93</td>
<td>19.62</td>
</tr>
<tr>
<td>$R_3$ vs. $R_4$</td>
<td>748.93/750.0</td>
<td>2.14b</td>
</tr>
<tr>
<td>3. 1978 CD Event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_1$ vs. $R_2$</td>
<td>609.9/615.14</td>
<td>10.48c</td>
</tr>
</tbody>
</table>

a. Critical value for 5 d.f. at 5% significance level = 11.07.
   Critical value for 5 d.f. at 1% significance level = 15.09.

b. Rejected at all significance levels.

c. Rejected at 5% significance level.
Table 18: Maximum-Likelihood Estimates of Regime Parameters for 6/23/1970 CD Event (a)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Regime 1</th>
<th>Regime 2</th>
<th>Regime 3</th>
<th>Regime 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting/switch Dt.</td>
<td>3/13</td>
<td>4/23</td>
<td>6/5</td>
<td>8/31</td>
</tr>
<tr>
<td>Intercept ($10^{-3}$)</td>
<td>0.1909</td>
<td>-0.267</td>
<td>0.819</td>
<td>1.038</td>
</tr>
<tr>
<td></td>
<td>(2.612)</td>
<td>(-3.654)</td>
<td>(3.361)</td>
<td>(3.757)</td>
</tr>
<tr>
<td>Slope</td>
<td>0.737</td>
<td>0.683</td>
<td>0.588</td>
<td>0.358</td>
</tr>
<tr>
<td></td>
<td>(7.988)</td>
<td>(8.809)</td>
<td>(10.206)</td>
<td>(4.829)</td>
</tr>
<tr>
<td>Regr. St.D. ($10^{-2}$)</td>
<td>0.322</td>
<td>0.833</td>
<td>0.464</td>
<td>0.325</td>
</tr>
<tr>
<td></td>
<td>(6.926)</td>
<td>(8.37)</td>
<td>(11.227)</td>
<td>(7.137)</td>
</tr>
<tr>
<td>Switch Point</td>
<td>28.78</td>
<td>59.83</td>
<td>119.98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(20.28)</td>
<td>(20.87)</td>
<td>(38.87)</td>
<td></td>
</tr>
<tr>
<td>Switch St.D</td>
<td>11.54</td>
<td>0.23</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(23.17)</td>
<td>(0.65)</td>
<td>(8.439)</td>
<td></td>
</tr>
<tr>
<td>Switch/End Date</td>
<td>4/23</td>
<td>6/5</td>
<td>8/31</td>
<td>10/1</td>
</tr>
</tbody>
</table>

(a) t-values in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>Regime 1</th>
<th>Regime 2</th>
<th>Regime 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start/Switch Date</strong></td>
<td>2/2</td>
<td>2/8</td>
<td>8/29</td>
</tr>
<tr>
<td><strong>Intercept (10^{-2})</strong></td>
<td>-0.917</td>
<td>-0.035</td>
<td>0.282</td>
</tr>
<tr>
<td></td>
<td>(7.087)</td>
<td>(1.215)</td>
<td>(3.557)</td>
</tr>
<tr>
<td><strong>Slope</strong></td>
<td>0.867</td>
<td>0.432</td>
<td>0.330</td>
</tr>
<tr>
<td></td>
<td>(2.751)</td>
<td>(13.97)</td>
<td>(3.015)</td>
</tr>
<tr>
<td><strong>Regr.St.D.(10^{-2})</strong></td>
<td>0.207</td>
<td>0.338</td>
<td>0.406</td>
</tr>
<tr>
<td></td>
<td>(2.859)</td>
<td>(16.75)</td>
<td>(7.808)</td>
</tr>
<tr>
<td><strong>Switch Point</strong></td>
<td>4.87</td>
<td>145.36</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(18.91)</td>
<td>(142.19)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Switch St.D</strong></td>
<td>0.20</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.492)</td>
<td>(14.032)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Implied Switch Date</strong></td>
<td>2/8</td>
<td>8/29</td>
<td>10/12</td>
</tr>
</tbody>
</table>

_t-values in parentheses_
Table 20: Test of Parameter Equality Constraints For the 1970 CD Event

<table>
<thead>
<tr>
<th>Parameter Restriction</th>
<th>$\ln (L^*/L)$</th>
<th>$-2 \ln (L^*/L)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 = A2</td>
<td>(567.145/567.23)</td>
<td>0.17</td>
</tr>
<tr>
<td>B1 = B2</td>
<td>(567.008/567.23)</td>
<td>0.44</td>
</tr>
<tr>
<td>S1 = S2</td>
<td>(561.485/567.23)</td>
<td>11.49</td>
</tr>
<tr>
<td>A2 = A3</td>
<td>(566.761/567.23)</td>
<td>0.94</td>
</tr>
<tr>
<td>B2 = B3</td>
<td>(566.809/567.23)</td>
<td>0.84</td>
</tr>
<tr>
<td>S2 = S3</td>
<td>(563.682/567.23)</td>
<td>7.10</td>
</tr>
<tr>
<td>A3 = A4</td>
<td>(565.45/567.23)</td>
<td>3.56</td>
</tr>
<tr>
<td>B3 = B4</td>
<td>(565.76/567.23)</td>
<td>2.94</td>
</tr>
<tr>
<td>S3 = S4</td>
<td>(564.94/567.23)</td>
<td>4.58</td>
</tr>
<tr>
<td>B1 = B4</td>
<td>(561.88/567.23)</td>
<td>10.70</td>
</tr>
<tr>
<td>B2 = B4</td>
<td>(563.65/567.23)</td>
<td>7.16</td>
</tr>
</tbody>
</table>

a. AX, BX, SX denote the intercept, slope, and the regression variance of the market model respectively, where X shows the regime number.

b. Critical value for 1 d.f. at 5% significance level = 3.841
   Critical value for 1 d.f. at 1% significance level = 6.635
   Adjusted critical value at adjusted significance level (.05/10 = 0.005) for 1 d.f. at 5 percent overall significance level = 7.88.
   Adjusted critical value at adjusted significance level (.10/10 = 0.01) for 1 d.f. at 10 percent overall significance level = 6.635.

c. Significant at adjusted 0.5% critical value.

d. Significant at adjusted 1% critical value.
Table 21: Test of Parameter Equality Constraints for the 1973 CD and 1973 WC Events

<table>
<thead>
<tr>
<th>Parameter Restriction</th>
<th>$\ln (L^*/L)$</th>
<th>$-2 \ln (L^*/L)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1 = A_2$</td>
<td>(743.21/748.93)</td>
<td>11.44&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>$B_1 = B_2$</td>
<td>(748.12/748.93)</td>
<td>1.62</td>
</tr>
<tr>
<td>$S_1 = S_2$</td>
<td>(748.17/748.93)</td>
<td>1.52</td>
</tr>
<tr>
<td>$A_2 = A_3$</td>
<td>(742.86/748.93)</td>
<td>12.14&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>$B_2 = B_3$</td>
<td>(748.53/748.93)</td>
<td>0.80</td>
</tr>
<tr>
<td>$S_2 = S_3$</td>
<td>(748.02/748.93)</td>
<td>1.82</td>
</tr>
<tr>
<td>$B_1 = B_3$</td>
<td>(747.49/748.93)</td>
<td>2.88</td>
</tr>
</tbody>
</table>

a. $A_X$, $B_X$, $S_X$ denote the intercept, slope, and the regression variance of the market model respectively, where $X$ shows the regime number.

b. Critical value for 1 d.f. at 5% significance level = 3.841

Critical value for 1 d.f. at 1% significance level = 6.635

Adjusted critical value at adjusted significance level (.05/10 = 0.005) for 1 d.f. at 5 percent overall significance level = 7.88.

Adjusted critical value at adjusted significance level (.10/10 = 0.01) for 1 d.f. at 10 percent overall significance level = 6.635.

c. Significant at all levels.
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Kane, E.J., "Good Intentions ad Unintended Evil: The Case Against Selective Credit Allocation", Journal of Money, Credit, and Banking, February 1977.


U.S. Treasury Department, Deposit Rate Ceilings and Housing Credit:The Report of the President's Inter-Agency Task Force on Regulation Q,July 1979.