Liquidity, Uncertainty, and the Declining Predictive Power of the Paper-Bill Spread

by

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Abstract

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This paper addresses two questions. First, what causes the paper-bill spread to vary over time in anticipation of income fluctuations? Second, why has the predictive power of the spread declined in recent years?

Consistent with previous empirical work, the paper provides evidence for the default-risk, monetary, and cash-flow hypotheses. Moreover, new evidence is provided for the liquidity hypothesis by showing that uncertainty has a strong impact on the paper-bill spread. This finding holds for two different approaches used to measure uncertainty — financial market volatility and forecaster discord — and for uncertainty about five different variables: the federal funds rate, the Treasury bill rate, the long-term corporate bond rate, stock returns, and industrial production.

Using a Kalman filter to recursively estimate the reduced-form model for the paper-bill spread, the paper shows that the impact of monetary policy and uncertainty on the spread declined during the 1980s, while the impact of default risk increased. These findings are explained by two financial market developments occurring during the 1980s: 1) the rapid growth in the volume and liquidity of the commercial paper market, and 2) increased financial fragility of commercial paper issuers.

I. Introduction

Figure 1 shows the spread between interest rates on six-month commercial paper and Treasury bills (the paper-bill spread) along with shaded regions that denote recessions dated by the National Bureau of Economic Research. The paper-bill spread has received a great deal of attention recently because several researchers have shown that it provides — at least until the mid-1980s — considerable predictive power for fluctuations in several different measures of macroeconomic activity.[1] These finding have raised two related questions. First, what causes the paper-bill spread to vary over time in anticipation of macroeconomic fluctuations? Second, why has the predictive power of the spread declined in recent years? This paper addresses both of these questions.

Four hypotheses have been put forth to explain the strong predictive performance of the paper-bill spread. First, the default-risk hypothesis argues that the paper-bill spread rises prior to contractions in economic activity because investors anticipate that contractions will limit the ability of firms to generate cash flow necessary to service their debts and thus demand a default premium to hold commercial paper. Second, the monetary hypothesis posits that the spread has strong predictive power because it accurately measures the stance of monetary policy which is an important determinant of economic activity. Third, the cash-flow hypothesis asserts that the spread rises prior to and during recessions because depressed product demand forces firms to finance inventory accumulation by issuing increased quantities of commercial paper. Finally, the liquidity hypothesis argues that the spread provides strong predictive power because recessions are associated with increased uncertainty that induces investors to raise their demand for liquid assets, such as Treasury bills, while reducing their demand for relatively illiquid assets, such as commercial paper.

As we discuss below, empirical support has been provided for the default-risk, monetary, and cash-flow hypotheses. In contrast, little empirical work has addressed the liquidity hypothesis. We fill this void in the literature by examining the impact that uncertainty has on the paper-bill spread. To do this, we use measures of financial market volatility and forecaster discord from the Blue Chip survey to construct uncertainty proxies for five different variables: the federal funds, Treasury bill, and long-term corporate bond rates; stock returns and industrial production. We show that each of these uncertainty measures has a significant impact on the paper-bill spread even after controlling for the influence of other determinants. These findings have important policy implications because they suggest that the Federal Reserve can influence the paper-bill spread (and the cost of non-bank credit) not only by changing the stance of its policy, but also by limiting the risk injected into financial markets by federal funds rate volatility.

To explain the diminished predictive power of the paper-bill spread, we focus on two major developments in U.S. financial markets during the 1980s: 1) the rapid growth in the volume and liquidity of the commercial paper market, and 2) the increased financial fragility of U.S. corporations.[2] The tremendous development of the secondary market for commercial paper has been noted by Stigum (1990, p. 1051) who observes that, "More than any other aspect of the commercial paper market, it is the secondary market that has, in recent years, been developed." Moreover, Bernanke and Campbell (1988) observe that the financial structure of U.S. corporations became increasingly fragile in the 1980s. They conclude that, "...after growing more slowly than income during 1969-80, debt and debt service expanded much more quickly than income and sales in the eighties..." (p. 84).

Section III of the paper constructs a theoretical model to examine how these developments affect the reduced-form relationship between the paper-bill spread and its determinants. Three important predictions emerge from the model. First, the impact of uncertainty on the paper-bill spread declines when the relative liquidity of paper increases and paper and bills become closer substitutes in investors' portfolios. Second, default risk has a greater impact on the spread when the liquidity or solvency of paper issuers declines. Finally, monetary policy has a diminished effect on the spread if the increased liquidity of the paper market raises the substitutability of paper and bills more than increased financial fragility reduces it.

The last section of the paper evaluates the theoretical predictions by using a Kalman filter model to estimate the reduced-form parameters linking the paper-bill spread to its determinants. Consistent with the predictions of the model, we show that the uncertainty coefficient declined throughout the 1980s while the default-risk coefficient increased. Also, the coefficients linking the paper-bill spread to various measures of monetary policy declined precipitously during the 1980s. Taken together, these findings explain the declining predictive power of the paper-bill spread. That is, increased liquidity of the commercial paper market reduced the ability of the spread to embody important information about monetary policy and uncertainty. While the spread has become more sensitive to changes in default risk, this information is less useful as an indicator of future economic activity.

The outline of the paper is as follows. The next section provides a brief discussion of the hypotheses and existing empirical evidence. The theoretical model is presented in Section III. Section IV discusses data and measurement issues. Section V explores whether the spread between yields on medium and high-grade commercial paper measures default risk exclusively or also contains a liquidity premium. Section VI examines the full-sample empirical relationship between the paper-bill spread and its determinants.

Section VII examines the time-varying influence of the various determinants on the spread. The final section concludes the paper and discusses the policy implications.

II. Hypotheses and Evidence

1. The Default-Risk Hypothesis

The default risk hypothesis argues that the paper-bill spread contains a default premium which is correlated with future economic activity. While Treasury bills are a default-free asset backed by the U.S. government, commercial paper is a private debt subject to potential default. Because recessions limit the ability of firms to generate the cash flow necessary to service their debt, forward-looking investors demand compensation for holding commercial paper when a decline in economic activity is anticipated. To the extent that these anticipations are accurate, on average, the paper-bill spread should be highly correlated with future movements in real income.

There is mixed evidence about the empirical relevance of the default-risk hypothesis. First, it is difficult to reconcile large swings (up to 300 basis points) in the paper-bill spread with the fact that defaults on prime commercial paper are infrequent. For example, Fons and Kimball (1992) estimate the dollar amount of default as a percentage of total volume issued for the 1989 to 1991 period to be only .004 percent.[3] Moreover, Bernanke (1990) shows that the empirical relationship between the paper-bill spread and the spread between yields on low (BAA) and high (AAA) grade long-term bonds — a measure of default risk — is weak. By comparison, Friedman and Kuttner (1993) show that there is a relatively strong positive relationship between the paper-bill spread and default risk measured by the spread between medium- and high-grade commercial paper yields.

2. The Monetary Hypotheses

There are two versions of the monetary hypothesis. The first is the credit crunch hypothesis and is due primarily to Cook (1981). The credit crunch hypothesis posits that the paper-bill spread was a good monetary policy indicator during the 1960s and 1970s because of the pre-1980s regulatory environment and two characteristics which differentiate bills from paper: divisibility and the nonpecuniary services they provide.[4] During the pre-1980 period, restrictive monetary policy caused wealth to flow out of bank time deposits and into money market instruments when market rates rose above ceiling rates on time deposits imposed by Regulation Q. Greater divisibility of Treasury bills implied that relatively more wealth flowed into the bill market, thus raising the paper-bill spread. Moreover, banks and other large investors not constrained by minimum denomination restrictions did not arbitrage away the spread because of the nonpecuniary services that Treasury bills provided. Thus a tightening of monetary policy and disintermediation were associated with an increased spread between paper and bill yields.

The second version of the monetary hypothesis focuses on the imperfect substitutability between bills and paper in investors portfolios.[5] According to this hypothesis, tight monetary policy causes borrowers to be turned away from the loan market. When borrowers turn to the commercial paper market and issue increased quantities of paper, upward pressure is exerted on the paper rate and the paper-bill spread. If investors view paper and bills as imperfect substitutes — due to differential taxation, default risk, liquidity and nonpecuniary services provided by bills — then arbitrage across markets by investors is limited and the paper rate rises relative to the bill rate.

There are three potential problems with the imperfect substitutability hypothesis. First, in addition to putting upward pressure on the paper rate, restrictive monetary policy should also manifest itself in higher bill rates. Two additional arguments have been put forth to explain why the paper-bill spread should continue to rise in response to tighter monetary policy. First, Cook (1981) and Friedman and Kuttner (1993) discuss how the paper-bill spread is positively correlated with the level of interest rates when interest earned on paper and bills is taxed at differential rates or default risk is non-zero. Thus to the extent that restrictive monetary policy raises all market rates, it should exert upward pressure on the paper bill spread. Second, monetary tightening increases the paper rate relative to the bill rate if the borrowers forced into the paper market are less credit worthy or are small borrowers whose paper is less liquid. In this case, the composition of outstanding commercial paper changes and the market-average commercial paper rate rises to reflect the higher likelihood of default or decreased liquidity of representative issues.[6]

The second potential problem with the imperfect substitutability hypothesis is that banks may undertake other adjustments rather than reducing loan supply in response to monetary tightening. For example, banks might issue certificates of deposits (CDs) and other managed liabilities or sell Treasury bills. However, Bernanke (1990) argues that banks must offer higher rates on CDs to induce investors to hold them and this leads to a rise in the paper-bill spread because CDs and paper are closer substitutes in investors portfolios than CDs and bills. If banks liquidate Treasury bills instead, downward pressure is exerted on both the bill rate and the paper-bill spread. However, Bernanke argues that the nonpecuniary services provided to banks by Treasury bills limits this particular reaction.

The third potential problem with the imperfect substitutability hypothesis is that it presumes there is a large number of firms which have the ability to obtain credit through bank loans or commercial paper. However, there is evidence that this set of firms is small.[7]

Two studies have provided evidence for the monetary hypotheses. First, Bernanke (1990) shows that the paper-bill spread is positively related to: 1) dummy variables for the six post-war periods, identified by Romer and Romer (1989), characterized by tight monetary policy, 2) the federal funds rate target for the September 1974 to September 1979 period, and 3) the level of the federal funds rate (and the spread between the federal funds rate and the long-term bond rate). Second, Kashyap et al. (1993) investigate an indirect link between monetary policy and the paper-bill spread. They show that a "mix" variable which measures the volume of bank loans as a fraction of total short-term external finance falls (and paper issuance rises) following monetary contractions.

One attractive feature of both monetary hypotheses is that they can explain the diminished predictive power of the paper-bill spread observed in recent years. With the removal of interest rate ceilings under deregulation of the late 1970s and early 1980s, tightening of monetary policy no longer produced widespread disintermediation out of time deposits into other money market instruments.[8] Moreover, Kashyap et al. (1993) argue that the impact of monetary policy on the spread should weaken as the commercial paper market "deepens" over time. Thus, while monetary policy may still have a strong impact on economic activity, the link between monetary policy and the paper-bill spread should have diminished in the 1980s. In fact, Bernanke (1990) shows that the impact of monetary policy on the spread weakens but does not disappear after 1978. He argues that this finding provides evidence for the imperfect substitutability hypothesis over the credit crunch hypothesis because the latter suggests the link between the paper-bill spread and monetary policy should have been completely broken following the removal of

Regulation Q in the late 1970s.

3. The Cash-Flow Hypothesis

A third explanation for the strong performance of the paper-bill spread as a predictor of economic activity is that the spread responds to cyclical cash flow needs of corporations. According to Friedman and Kuttner (1993), the spread may rise at cyclical peaks and remain high during recessions because contractions in product demand associated with recessions cause inventories to accumulate, thus increasing firms' operating costs and reducing their cash flow. As firms turn to the credit markets to finance the cash flow shortage, upward pressure is placed on both loan and commercial paper rates.

Friedman and Kuttner provide evidence for the cash-flow hypothesis. They show that the paper-bill spread is positively correlated to lagged growth in the proportion of commercial paper to the total amount of paper and bills outstanding and negatively correlated to the proportion of Treasury bills outstanding. These findings suggest that investors regard commercial paper and Treasury bills as imperfect portfolio substitutes, providing support for the cash-flow and monetary hypotheses. However, they also show that the paper-bill spread is positively correlated with both the percentage change in a) commercial paper issued by the nonfinancial corporate sector, and b) bank loans to the nonfinancial corporate sector. The monetary hypotheses predict only that the first correlation will be positive, while the cash-flow hypothesis predicts that both will be positive.

4. The Liquidity Hypothesis

Both the monetary and cash-flow hypotheses emphasize the role of paper supply in determination of the paper-bill spread. The liquidity hypothesis is similar to the default-risk hypothesis in that it focuses on the demand side of the paper and bill markets. According to Friedman and Kuttner (1993), the paper-bill spread may rise prior to and during recessions because economic contractions lead to increased investor uncertainty about cash flow which, in turn, causes them to value liquidity more highly. In essence, their argument implies a causal mechanism running from the real economy, to uncertainty, to the paper-bill spread.[9]

A microeconomic foundation for the liquidity hypothesis is provided by Jones and Ostroy (1984). Employing a sequential decision model, they show that an asset's liquidity (defined as the inverse of the cost of switching from that asset to another asset) provides value to risk-neutral investors because it permits them to profitably exploit new information. In addition, they demonstrate that increases in uncertainty about factors that influence the relative yields of assets raise the demand for liquid assets relative to illiquid ones. When uncertainty increases, the information content of future news rises and investors attempt to increase the liquidity of their portfolio to take advantage of the accelerated pace of learning expected to occur in the near-term.

In the context of the portfolio decision involving paper and bills, the Jones-Ostroy model predicts that increased uncertainty will raise the paper-bill spread as long as Treasury bills have greater liquidity than commercial paper. In fact, bills have been much more liquid than paper over most of the post-war period. For instance, bid-ask spread for bills, a common measure of liquidity,[10] has been very low; reaching levels of around two to four basis points during the early and mid 1980s.[11] In contrast, very little commercial paper was traded in the secondary market until recently. Instead, liquidity in the paper market has been provided by arrangements which allow investors to sell paper back to dealers or the direct issuer if a sudden need for funds arises. However, dealers and direct issuers have no legal obligation to buy back paper and the cost charged for this service — the bid premium — has been approximately 12 basis points. This state of affairs has changed in recent years with the development of an active secondary market for commercial paper and bid premia falling to about five basis points.[12]

The only direct empirical evidence for the liquidity hypothesis is Friedman and Kuttner's finding that there is a negative and significant time trend in regression equations for the paper-bill spread. This finding suggests that the paper-bill spread has fallen over time in response to the increasing relative liquidity of the commercial paper market.

III. A Simple Model for the Paper-bill Spread

In this section we construct a reduced-form model for the paper-bill spread using the four hypotheses to guide us in the specification of supply and demand for paper and bills. By modeling the paper-bill spread this way we can formulate predictions about the impact that changes in the liquidity and default characteristics of commercial paper have on the responsiveness of the spread to its determinants. Two important findings emerge. First, growing insolvency or illiquidity of borrowers in the paper market should strengthen the relationship between the spread and default risk. Second, increases in the relative liquidity of paper should decrease the sensitivity of the spread to changes in monetary policy or uncertainty.

The supply and demand for Treasury bills are expressed, respectively, as

(1) $$\mathbf{B}^s_t = a_0 - a_1\mathbf{r}_{B,t} + \varepsilon_t$$

(2) $$\mathbf{B}^d_t = b_0 + b_1\mathbf{r}_{B,t} - b_2\mathbf{r}_{P,t} + b_3\mathbf{NBR}_t + b_4\mathbf{DRISK}_t + b_5\sigma_t + u_t$$

where $\mathbf{r}_{B,t}$ is the Treasury bill yield; $\mathbf{r}_{P,t}$ is the commercial paper rate; $\mathbf{NBR}_t$ is nonborrowed reserves (a potential measure of monetary policy); $\mathbf{DRISK}_t$ is default risk; σ_t is uncertainty; a_o, a_1, b_o,..., b_5 are parameters; and ε_t and u_t are disturbance terms. Bill supply is expressed as a function of the bill rate to allow for the possibility that the supply of the government's debt is not strictly exogenous. Bill demand is influenced by the commercial paper rate because bills and paper are substitutes in investors portfolios. The greater the substitutability between paper and bills, the larger is b_2. Both default risk and uncertainty have a positive impact on bill demand. Bill demand is a positive function of nonborrowed reserves because bills are purchased by the Federal Reserve during open market operations. This specification is chosen to explore the theoretical possibility — discussed in the previous section — that policy does not have and unambiguous impact on the paper-bill spread.

Supply and demand for commercial paper are expressed, respectively, as

$$(3) \qquad \mathbf{P}^s_t = c_0 - c_1 \mathbf{r}_{P,t} - c_2 \mathbf{NBR}_t + c_3 \mathbf{INV}_t + \xi_t$$

$$(4) \qquad \mathbf{P}^d_t = d_0 + d_1 \mathbf{r}_{P,t} - d_2 \mathbf{r}_{B,t} - d_3 \mathbf{DRISK}_t - d_4 \sigma_t + \eta_t$$

where $\mathbf{INV}_t$ is the level of inventories; c_o,..., c_3, d_o,..., d_4 are parameters; and ξ_t and η_t are disturbance terms. Nonborrowed reserves have a negative impact on paper supply due to the monetary channel emphasized by Kashyap et al. (1993). Inventories have a positive effect on paper supply according to the cash flow hypothesis of Friedman and Kuttner (1993). Once again, the substitutability between paper and bills is modeled by including the bill rate as a determinant of paper demand. Finally, both default risk and uncertainty have a negative impact on paper demand.

Setting supply equal to demand in each market, we get the following two equations

$$(5) \quad r_{B,t} = \frac{a_0 + b_0}{a_1 + b_1} + \left(\frac{b_2}{a_1 + b_1}\right) r_{P,t} - \left(\frac{b_3}{a_1 + b_1}\right) \mathbf{NBR}_t - \left(\frac{b_4}{a_1 + b_1}\right) \mathbf{DRISK}_t - \left(\frac{b_5}{a_1 + b_1}\right) \sigma_t + \left(\frac{1}{a_1 + b_1}\right) (\varepsilon_t - u_t)$$

$$(6) \quad r_{P,t} = \frac{c_0 + d_0}{c_1 + d_1} + \left(\frac{d_2}{c_1 + d_1}\right) r_{B,t} - \left(\frac{c_2}{c_1 + d_1}\right) \mathbf{NBR}_t + \left(\frac{c_3}{c_1 + d_1}\right) \mathbf{INV}_t + \left(\frac{d_3}{c_1 + d_1}\right) \mathbf{DRISK}_t + \left(\frac{d_4}{c_1 + d_1}\right) \sigma_t + \left(\frac{1}{c_1 + d_1}\right) (\xi_t - \eta_t)$$

Substituting (6) into (5), we obtain the bill rate consistent with simultaneous equilibrium in the bill and paper markets. This rate can then be inserted into either (5) or (6) to solve for the equilibrium paper rate. The equilibrium bill rate is then subtracted from the equilibrium bill rate to produce the following reduced-form equation for the paper-bill spread

$$(7) \quad r_{P,t} - r_{B,t} = \alpha + \lambda \cdot \mathbf{DRISK}_t + \gamma \cdot \mathbf{INV}_t - \beta \cdot \mathbf{NBR}_t + \pi \cdot \sigma_t + z_t$$

where z_t is an amalgamation of the structural shocks. If we assume that the exogenous variables affect the markets in a symmetric fashion (i.e., $b_4 = d_3$, $b_5 = d_4$ and $b_3 = c_2$), and that the bill (paper) rate elasticity of bill (paper) demand is equal to the bill (paper) rate elasticity of paper (bill) demand (i.e., $b_1 = d_2$ and $b_2 = d_1$),[13] then the reduced-form parameters can be written as:

$$\alpha = \frac{c_0 - d_0}{c_1 + d_1} + \left(\frac{(a_0 - b_0)(c_1 + d_1) + b_2(c_0 - d_0)}{(a_1 + b_1)(c_1 + d_1) - b_2 d_2}\right)\left(\frac{d_2 - c_1 - d_1}{c_1 + d_1}\right)$$

$$\lambda = d_3 \cdot \left(\frac{a_1 + c_1}{a_1 \cdot c_1 + a_1 \cdot b_2 + c_1 \cdot d_2}\right) > 0$$

$$\gamma = c_3 \cdot \left(\frac{a_1 + b_1}{a_1 \cdot c_1 + a_1 \cdot b_2 + c_1 \cdot d_2} \right) > 0$$

$$\beta = c_2 \cdot \left(\frac{a_1 - c_1 + 2(d_2 - b_2)}{a_1 \cdot c_1 + a_1 \cdot b_2 + c_1 \cdot d_2} \right) \gtreqless 0$$

$$\pi = d_4 \cdot \left(\frac{a_1 + c_1}{a_1 \cdot c_1 + a_1 \cdot b_2 + c_1 \cdot d_2} \right) > 0$$

Each slope parameter is unambiguously positive with the exception of the parameter for nonborrowed reserves. In the context of the model, the sufficient conditions for restrictive monetary policy to have a positive impact on the paper-bill spread in this model is for substitutability to be symmetric (i.e., $b_2 = d_2$) and for paper supply to be less elastic than bill supply (i.e., $a_1 > c_1$). Of course, if monetary policy actions do not affect bill demand directly (e.g., the discount rate is changed), Fed tightening unambiguously increases the paper-bill spread.

From the investors perspective, two of the primary characteristics which distinguish paper from bills is their relative liquidity and default risk. As these two characteristics change, the responsiveness of the paper-bill spread to the exogenous factors also changes. For example, consider what happens when the relative illiquidity of paper falls. Increased liquidity of paper lowers the parameter π in (7) because investors view paper and bills as closer substitutes and thus their demand for the two assets becomes less sensitive to uncertainty (i.e., b_5 and d_4 fall). Also, b_2 and d_2 both rise as paper and bills become closer substitutes. This also reduces π as can be observed by assuming symmetric substitutability and considering the following derivative:

$$\frac{\partial \pi}{\partial d_2} = \frac{-d_4(a_1 + c_1)^2}{[a_1 c_1 + (a_1 + c_1) d_2]^2} < 0$$

Thus greater substitutability between paper and bills increases the arbitrage activity across the markets and reduces the impact that uncertainty has on the paper-bill spread.

Next, consider what happens to the reduced-form parameters when the default risk of paper rises. There are two principal sources of default risk. First, the probability that the typical firm will default rises when product demand and revenue is expected to fall. This is the source of default risk focused on in the literature (and embodied in **DRISK**) because it explains the predictive power of the paper-bill spread. Second, given a fixed level of expected demand, the probability of default increases with a firm's leverage ratio and the percentage of its cash flow committed to interest rate payments. Thus, investors will view the substitutability of paper and bills to be lower if the financial fragility of firms increases. If **DRISK** only measures the first source of default risk, then increased financial fragility causes b_4 and d_3 to rise which increases the reduced-form parameter λ in (7). Moreover, b_2 and d_2 both fall — in contrast to what we observed in the previous example — as the substitutability of bills and paper declines. This raises the value of λ further as we see from the following derivative:

$$\frac{\partial\lambda}{\partial d_2} = \frac{-d_3(a_1 + c_1)^2}{[a_1c_1 + (a_1 + c_1)d_2]^2} < 0$$

Thus greater financial fragility of firms in the aggregate reduces arbitrage activity across markets and increases the impact that default risk has on the paper-bill spread.

Finally, increases in the relative liquidity of paper and greater financial fragility of firms have offsetting effects on the responsiveness of the paper-bill spread to changes in monetary policy and inventories. A rise in d_2 causes β and γ to fall if the sufficient conditions for $\beta > 0$ are met. However, increases in the liquidity of paper make paper and bills closer substitutes, while greater financial fragility has the opposite effect. Thus it is not clear what impact these changes will have on d_2 and thus β and γ.

IV. Measurement Issues

To measure default risk, we follow the existing literature and use the difference between yields on medium (A-2 and P-2) and high-grade (A-1 and P-1) commercial paper.[14] This quality spread (**QUALITY**) is shown in Figure 2. The assumption made when using the quality spread to measure default risk is that new information about business cycle conditions is reflected in investor demand for medium- and high-grade paper before rating agencies can down- or upgrade firms. In contrast, the quality spread does not reflect changes in the level of financial fragility if the rating agencies can identify firms with changing financial structure so that the relative strength of balance sheets for high- and medium-grade borrowers does not change over time.[15]

Bernanke and Blinder (1992) have argued that the federal funds rate (**ff**) was a good indicator of monetary policy prior to October 1979 when the Federal Reserve was targeting this rate. The Federal Reserve allowed the funds rate to adjust to demand shocks in the market for reserves between October 1979 and October 1982, and thus it may not provide an accurate gauge of monetary policy for this period. Presumably, the funds rate was a better indicator of policy in the post-November 1982 period when the Federal Reserve returned to a policy of smoothing short-term interest rate movements.[16] An alternative measure of the monetary policy is the level of nonborrowed reserves (**NBR**). Unlike the funds rate, nonborrowed reserves are under the direct control of the Federal Reserve.[17]

To measure inventories, we use the level of end-of-month manufacturing and trade inventories in 1982 dollars (**INV**). This is the broadest measure of inventories available on a monthly basis.

Two different approaches are employed to measure uncertainty. The first uses the volatility of daily interest rate changes and stock price returns over the month. Following Roley and Troll (1983), interest rate volatility is estimated by the root mean squared error for the yield

(8) $$\mathbf{RMSE}_t = \left(\frac{1}{N_t} \sum_{j=1}^{N_t} \Delta i_{jt}^2 \right)^{1/2}$$

where Δi_{jt}^2 is the squared change in the yield between day j and day j-1 of month t and N_t is the number of trading days in month t. Two different yields are considered: the federal funds rate and the yield on three-month Treasury bills. The first provides us with a rate that the Federal Reserve has some control over, while the second is an open market rate that is influenced by inflationary expectations. The root mean squared errors for the federal funds and Treasury bill rate are denoted by **FFRMSE** and **TBRMSE** respectively and are shown in Figures 3.

Following Merton (1980), and French, Schwert and Stambaugh (1987), we use daily returns on the New York Stock Exchange value-weighted Index (inclusive of distributions) to estimate monthly standard deviations of stock market returns. In particular, we estimate

(9) $$\mathbf{NYSESD}_t = \left(\frac{1}{N_t - 1} \sum_{i=1}^{N_t} r_{it}^2 \right)^{1/2}$$

where r_{it} is the return for day i of month t. This measure is illustrated in Figure 4.[18] The extremely high level of volatility in October 1987 has been removed from the Figure — but not from the series used in the analysis — so that fluctuations in the series can be better visualized.

The second set of uncertainty measures are constructed using survey data on macroeconomic forecasts. According to Zarnowitz and Lambros (1987), the dispersion of forecasts across a group of forecasters — forecaster discord — provides a good estimate of the collective level of uncertainty experienced by the group. We use forecasts made each month by a group of economists who participate in a survey conducted by the Blue Chip Economic Indicator forecasting service to estimate forecaster discord.[19]

The discord measures are constructed by estimating the cross-forecaster standard deviation of point forecasts made each month for the *i*) AAA corporate bond rate, and *ii*) industrial production growth rate. Because the forecast target date changes only once a year, the length of the forecast horizon changes each month.[20] Given this feature of the data, the standard deviations of point forecasts should be higher, on average, in months where the forecast horizon is further into the future. To remove this source of discord variability, the standard deviation of forecasts in each month is divided by the average value of the standard deviation for that particular month taken over the entire sample period.

Long-term interest rate discord (**LTRDISC**) and industrial production discord (**IPDISC**) are illustrated in Figures 5 and 6. Note that interest rate discord, as well as interest rate volatility illustrated in Figure 3, reached high levels between the end of 1979 and 1982. A broad consensus has emerged among researchers that the nonborrowed reserve operating procedure employed by the Federal Reserve during this period contributed to the interest rate uncertainty.[21]

V. Is the Quality Spread Measuring Default Risk Exclusively?

Before proceeding to examine the determinants of the paper-bill spread, it is important to consider whether the quality spread responds exclusively to perceived default risk. This examination is motivated by two observations. First, the volume of high-grade commercial paper outstanding was about four times the volume of medium-grade paper as of the mid-1980s, thus suggesting that high-grade paper is more liquid than medium-grade paper.[22] Second, the liquidity hypothesis suggests that the spread between yields on any two assets should be sensitive to uncertainty if the liquidity of these assets differs to a significant degree. Thus it is possible that a part of the commercial paper quality spread is actually a liquidity premium that responds to fluctuations in uncertainty.

To investigate this hypothesis, the quality spread was regressed on the five uncertainty proxies. The results from these regressions are presented in Table 1. They demonstrate that each of the uncertainty measures has a positive and statistically significant impact on the quality spread. In fact, the R-squareds exceed 30 percent in three out of the five regressions. This finding suggests that a significant proportion of the quality spread's variation over time can be explained by an uncertainty-driven liquidity premium.[23]

To purge the quality spread of the liquidity premium and obtain a measure of default risk, we use the residuals from the regressions in Table 1. Figure 2 illustrates the residual from model 2. The quality spread and the residual are highly correlated with some notable exceptions. For instance, it appears that the quality spread is driven by uncertainty and a liquidity premium in the period from mid-1980 through 1981, while its rise in 1974 and 1982 is attributable mainly to increases in default risk.

VI. The Paper-Bill Spread and Its Determinants

Tables 2 through 4 present estimates for the reduced-form models for the paper-bill spread. The regressions in Table 2 employ nonborrowed reserves to measure the stance of monetary policy, while regressions in Tables 3 and 4 use, respectively, the 6-month Treasury bill rate (and nonborrowed reserves) and the federal funds rate. Each Table contains five different regressions, one for each of the uncertainty measures discussed above. The sample periods are dictated by data availability.

Because the error terms from the models estimated with ordinary least squares exhibit significant first-order autocorrelation, generalized least squares was employed. In particular, the Beach-MacKinnon Maximum likelihood procedure was used to simultaneously estimate the autocorrelation coefficient, ρ, and the models' other parameters. Each Table contains several diagnostic statistics. The Ljung-Box statistic, Q(12), tests the hypothesis that the first 12 autocorrelation coefficients for the estimated residuals are jointly equal to zero. This statistic has a chi-squared distribution with 12 degrees of freedom. WHITE(k) is the statistic suggested by White (1980) to test the null hypothesis of a homoskedastic error process. It is also distributed as a chi-squared and has k degrees of freedom. When autocorrelation and/or heteroskedasticity is present in the error process, the t-statistics were constructed using White's (1980) and Hansen's (1982) heteroskedasticity- and autoregressive-consistent standard errors, with 4 lags of the residuals and a dampening factor of 1.0.

To facilitate comparison of the coefficients, each variable was standardized by adding it to the negative of its sample mean and then dividing by the sample standard deviation. Thus the resulting parameter estimates are beta coefficients; they show the number of standard error changes in the dependent variable resulting from a one standard error change in an explanatory variable.

A. Policy Measured by Nonborrowed Reserves

The results in Table 2 do not provide uniform support for the four hypotheses discussed above. Of the three that have already been examined empirically in the literature (i.e., the default-risk, monetary and cash-flow hypotheses), the strongest support is provided for the cash flow hypothesis.

This conclusion is based on the finding that inventories have a significant positive impact on the paper-bill spread in each of the five specifications and the beta coefficients are well above one in each case.

Support is also provided for the default-risk hypothesis. The coefficient on the quality spread, purged of the liquidity premium, is consistently positive and significantly different from zero in each model. However, the relatively small coefficients on the quality spread (i.e., they are approximately one-fifth the size of the those on inventories) suggest that the impact of default risk is less powerful than the impact of inventory movements.

Table 2 provides little support for the monetary hypothesis. While the coefficients on nonborrowed reserves are generally negative as the hypothesis predicts, they are far from significant. Moreover, the parameters are unstable across the models, ranging from -1.007 to .097. Either nonborrowed reserves do not reflect the stance of monetary policy, or the latter does not have a strong impact on the paper-bill spread.

The most novel finding presented in Table 2 is the strong relationship documented between the uncertainty proxies and the paper-bill spread. Each of the uncertainty proxies has a positive coefficient that is significant at the one percent level or better. In addition, coefficients on the three interest rate uncertainty proxies are larger than those for the quality spread. The fact that these results hold when uncertainty is measured by both financial market volatility and forecaster discord suggests that the evidence for the liquidity hypothesis is robust.

B. Policy Measured by Nonborrowed Reserves and the Level of Market Rates

As discussed in section II, the paper-bill spread should be positively correlated with the level of market rates when interest earned on paper and bills is subject to differential taxation. To the extent that restrictive monetary policy raises all market rates, the finding of a positive link between the level of rates and the paper-bill spread provides support for the monetary hypotheses. To examine this issue empirically, models in Table 2 were re-estimated with the level of the 6-month Treasury bill rate (**TB6**) included as an additional determinant.[24] The results are shown in Table 3.

In several respects, the results in Table 3 are consistent with those in Table 2. Inclusion of the interest rate level does not greatly alter the magnitude or statistical significance of the quality spread coefficient, while the size and statistical significance of the coefficient on inventories falls by a relatively small amount. In contrast, the coefficient on nonborrowed reserves switches sign and in three cases (models 2, 4 and 5) is statistically significant. This result contradicts the monetary hypothesis and is difficult to explain. Interestingly, the 6-month Treasury bill rate has a significant positive effect on the paper-bill spread in each of the models. This result provides support for the monetary hypothesis. Finally, the uncertainty proxies continue to have a significant positive impact on the paper-bill spread in each of the models except model 4. The latter result may be due to multicollinearity between interest rate discord and the level of the 6-month Treasury bill rate. Nevertheless, the results confirm the earlier conclusion that uncertainty is an important determinant of the paper-bill spread.

C. Policy Measured by the Federal Funds Rate

Given the conflicting findings about the empirical relevance of monetary policy, we consider one final measure of policy: the federal funds rate. Table 4 provides results for models that use this variable. The Table shows that inventories and default risk play a somewhat diminished role in explaining the paper-bill spread when the federal funds rate is included in the models. Moreover, the magnitude of the coefficients on the uncertainty proxies declines somewhat in Table 4, although each remains significant at the five percent level or higher. Finally, note that the federal funds rate has a positive impact on the paper-bill spread in each of the models and that its coefficient is highly significant. To the extent that the federal funds rate is an accurate indicator of monetary policy, the results in Table 4 provide strong evidence in favor of the monetary hypotheses.

The finding that federal funds rate volatility affects the paper-bill spread in Tables 2 through 4 has important policy implications. It is well understood that the Federal Reserve influences the costs firms ultimately pay for bank credit by impacting the price for reserves. However, the results presented above suggest that the Federal reserve can also affect the cost of non-bank credit by stabilizing the federal funds rate and reducing financial market risk. As we have seen over the past 20 years, the Federal Reserve is capable of dramatically reducing federal funds rate volatility by targeting the funds rate. By limiting financial market risk, the Fed reduces the incentive for investors to hold liquid assets and thus lowers the liquidity premium firms must pay to access capital in the open market.

VII. Has the Relationship Between the Paper-Bill Spread and its Determinants changed in Recent Years?

As many commentators have noted, several major developments in U.S. financial markets occurred during the 1980s. For the purpose of explaining the changing relationship between the paper-bill spread and its determinants, we focus on two of these developments. The first is the dramatic growth of the commercial paper market. This growth can be seen in Figure 7 which shows the ratio of total commercial paper outstanding to outstandings of Treasury securities with less than one year to maturity. One important implication of this growth is that the relative illiquidity of paper has — from the investor's perspective — declined.[25]

The second feature of U.S. financial markets that has received attention is the deteriorating balance sheets of corporations during the 1980s. For example, Bernanke and Campbell (1988) point out that corporate debt burdens, measured on a current basis, rose sharply during the 1980s as a larger proportion of firms' cash flows were committed to interest payments. This secular rise in debt burdens is illustrated in Figure 8 which shows the ratio of net interest payments to profits.[26] One important implication of this rise in financial fragility is that a given negative economic shock should have been expected to produce a greater level of commercial paper defaults in the 1980s than in earlier periods.

The theoretical model constructed in Section III suggests that the reduced-form relationship between the paper-bill spread and its determinants should have been altered by these developments. In particular, increased relative liquidity of paper causes investors to view paper and bills as closer substitutes and weakens the impact that uncertainty has on the paper-bill spread. On the other hand, greater financial fragility of commercial paper issuers reduces the substitutability of paper and bills and makes the spread more sensitive to changes in default risk. How the impact of monetary policy and inventories changes depends on the net effect of these two developments on the substitutability between paper and bills.

To determine whether there has been a structural shift in the relationship between the paper-bill spread and its determinants, Chow tests were performed on the models presented in Tables 2 through 4. The test statistics was constructed in the following manner. First, the sample period was divided into two equal-sized (approximately) sub-samples; the first runs from January 1974 to December 1982 and the second runs from January 1983 to June 1991. Then a dummy variable was created that takes on values of zero in the first sub-sample and one in the second. Next, this dummy variable was multiplied by each of the models' explanatory variables and these interacted variables were introduced into the specifications. Evidence for structural change is obtained if we can reject the null hypothesis that the coefficients on the dummy and interacted variables are jointly equal to zero. The last row of Tables 2 through 4 shows chi-squared statistics, denoted by CHOW(k) where k is the degrees of freedom, used to test the joint significance of these coefficients.

A striking finding presented in Tables 2 through 4 is that the Chow statistics are significantly different from zero at the five percent level or better in each of the models estimated with the exception of model 5 in Table 4. These results allow us to reject the hypothesis of parameter stability, suggesting that the relationship between the paper-bill and its determinants changed over the sample period.

To investigate how the relationship between the paper-bill spread and its determinants has changed, we employ the Kalman filter to estimate the reduced-form parameters from (7). The Kalman filter is an algorithm for sequentially updating parameter estimates and provides us with the flexibility to specify different transition processes for the parameter vector. We chose a general specification with random walk parameter variation. Given the findings of heteroskedasticity in the previous section, the variance of the regression disturbance term is also allowed to vary over time. Initial estimates for the parameters were obtained by estimating the models over the 1974 to 1976 period. The Kalman filter was then used to recursively estimate the parameters for the remainder of the sample. The relative tightness on time variation is set equal to one so that all past data is given equal weight in the parameter estimation.

Figure 9 shows the behavior of the four key parameters from model 1 of

Table 2. Panel C shows that the coefficient on nonborrowed reserves takes on large negative values in the early part of the sample, but converges to zero by 1987. This finding provides evidence that the influence of monetary policy on the paper-bill spread diminished greatly over the 1980s. Interestingly, the rapid decline in the absolute size of this coefficient subsides temporarily between the end of 1979 and 1983; the period when the Federal Reserve used nonborrowed reserves as its primary policy instrument. This finding suggests that a partial explanation for the finding of a weak relationship between nonborrowed reserves and the paper-bill spread observed in Table 2 is that nonborrowed reserves are not a precise indicator of monetary policy for the full sample period.[27]

Panel D shows the evolution of the coefficient for federal funds rate volatility. Note that the absolute size of this coefficient also declines dramatically over the sample period. The coefficient initially has a value of .57, falls somewhat between 1978 and 1979, increases slightly in 1981, and then declines precipitously beginning in 1986. Overall, the downward path of this coefficient provides evidence that uncertainty had an increasingly smaller impact on the paper-bill spread over the 1980s. This finding is consistent with the theoretical prediction that increased liquidity of the paper market should attenuate the link between uncertainty and the spread.[28]

Unlike the nonborrowed reserve and uncertainty coefficients, the default risk coefficient in panel A rose by a considerable amount over the sample period. This finding is consistent with the observation that the financial fragility of commercial paper issuers increased over the 1980s so that the substitutability between paper and bills declined along this dimension.

The behavior of the coefficient on inventories in panel B is more difficult to account for, although, as we see below, the behavior of this coefficient, unlike the other ones, is not stable across the models.

Also, it is possible that the recent advent of just-in-time inventory control methods has obviated the link between inventories and commercial paper issuance.

Figures 10 through 12 illustrate the robustness of these results across the different specifications. Figure 10, which is from model 3 of Table 2, shows several interesting results. First, the coefficients on nonborrowed reserves and default risk continue to maintain the general pattern observed in Figure 9. Second, the coefficient on inventories follows a steep downward path over the sample and, unlike what is observed in Figure 9, does not have a large spike in 1987 and 1988. Finally, the coefficient on stock return volatility declines by a considerable amount during the 1980s. In contrast to the coefficient on federal funds rate volatility, however, the coefficient on stock return volatility experiences most of its decline in 1982.

Figure 11 shows the coefficients from model 1 of Table 4. Similar to what we observed for the nonborrowed reserves coefficient, the coefficient on the federal funds rate declines a great deal over the sample. In contrast to the coefficient on nonborrowed reserves, however, the decline in the federal funds rate coefficient is much sharper and takes place between 1979 and 1981. It could be argued that this decline simply reflects the diminished ability of the federal funds rate to capture the monetary policy stance following the change in operating procedures in 1979. However, if this were the case then the coefficient should rise after 1982 when the Federal Reserve returned to a policy of targeting the federal funds rate. This does not occur. Figure 11 also shows the instability of the inventory coefficient; it rises over the sample period rather than falling as we observed in Figures 9 and 10. Finally, note that the coefficient on federal funds rate volatility falls over the sample period as we saw earlier.[29]

Figure 12 shows the coefficients from model 3 of table 4. The patterns displayed in this Figure are generally consistent with what we observed in the previous three Figures.

Overall, the results suggest that the influence of monetary policy and uncertainty on the paper-bill spread weakened considerably over the 1980s.[30] This finding is consistent with the observation that the relative liquidity of paper rose during the 1980s with the dramatic increase in the volume of paper traded on the secondary market. In contrast, the paper-bill spread has become more sensitive to changes in default risk during this time. This finding is consistent with the increasing financial fragility of commercial paper issuers during the 1980s. To the extent that information in the paper-bill spread concerning the stance of monetary policy and uncertainty is more informative about future economic activity than is information about default risk, these findings explain the recent decline in the predictive power of the spread.

VIII. Conclusion and Policy Implications

This paper examined the determinants of the paper-bill spread. In addition, it explored the role that major financial market developments occurring during the 1980s play in explaining the declining predictive power of the spread observed in recent years. The paper provides three main findings.

First, consistent with previous empirical work we find evidence for the default-risk, monetary and cash-flow hypotheses. We show that the commercial paper quality spread (purged of its liquidity premium component), various measures of monetary policy, and manufacturing inventories impact the paper-bill spread in a manner consistent with these three hypotheses.

Second, we provide new evidence that uncertainty is an important force driving the paper-bill spread. This result holds using two different methods to measure uncertainty: financial market volatility and forecaster discord from the Blue Chip survey. Moreover, it holds for uncertainty measures for five different variables: the federal funds rate, three-month Treasury bill rates, long-term bond rates, stock returns, and industrial production. These findings provide support for the liquidity hypothesis which argues that the paper-bill spread provides strong predictive power for economic activity because it reflects, in part, the level of uncertainty in the economy.

Third, the paper shows that the impact of the determinants on the paper-bill spread is not time-invariant. In particular, we use a Kalman filter model to show that the paper-bill spread became less sensitive to movements in monetary policy and uncertainty over the 1980s, while default risk had a greater impact on the spread during this period. This finding is explained by two developments occurring in U.S. financial markets during the 1980s: 1) the rise in the volume and liquidity of the commercial paper market, and 2) the increased financial fragility of U.S. corporations. Moreover, this finding helps us to understand why the predictive performance of the paper-bill spread has deteriorated in recent years. That is, changing financial structure has reduced the ability of the spread to embody important information about monetary policy and uncertainty.

Two policy implications can be drawn from the analysis. First, policy-makers should be cautious about using the paper-bill spread as an instrument of monetary policy given the sensitivity of its ability to embody important information to changing financial market structure. Nevertheless, it is possible that other yield spreads may continue to serve as useful policy instruments. As established security markets become deeper and yields in these markets are driven less by liquidity considerations, yields on assets traded in new and less liquid markets (e.g., the junk bond market) may contain liquidity premia that provide useful information about the economy. This is an important empirical issue that should be explored in future research.

Second, the paper provides evidence of an additional channel — one that has received little attention in the literature — through which monetary policy affects the economy. That is, monetary policy regimes that do not offset demand shocks to reserves and allow the federal funds rate to fluctuate are an important source of financial market uncertainty. As we have seen, this uncertainty affects the non-bank cost of finance by driving a wedge between yields on relatively illiquid open market credit instruments such as commercial paper and rates on liquid assets. By targeting the federal funds rate and limiting this uncertainty, the Federal Reserve can reduce the cost of credit and stimulate investment spending.

Data Appendix

Quarterly Data

1. Profits before taxes, GDP of nonfinancial corporations, SAAR (Citibase: GJPBT), 1974:Q1- 1991:Q2.
2. Net Interest, GDP of nonfinancial corporations, SAAR (Citibase: GJINT), 1974:Q1- 1991:Q2.
3. Capital Consumption Allowances, GDP of nonfinancial corporations, SAAR (Citibase: GJCCAA), 1974:Q1- 1991:Q2.

Monthly Data

1. Six-month commercial paper rate, bank discount basis, NSA (Citibase: FYCP), 1974.1-1991.6.
2. Six-month Treasury bill rate, secondary market, NSA (Citibase: FYGM6), 1974.1-1991.6.
3. Federal funds effective rate, NSA (Citibase: FYFF), 1974.1-1991.6.
4. Nonborrowed reserves adjusted for extended credit, SA (Citibase: FMRNBC), 1974.1-1991.6.
5. Inventories: Manufacturing and Trade, book value, eom, 1982 dollars, SA (Citibase: IVMT82), 1974.1-1991.6
6. A-2/P-2 and A-1/P-1 rated commercial paper yields, composite of 30 day rates provided by commercial paper dealers to the Board of Governors on each Wednesday, NSA (Board of Governors of the Federal Reserve System), 1974.1-1991.6.
7. Volume outstanding of total commercial paper (Board of Governors of the Federal Reserve System), 1974.1-1991.6.
8. Volume outstanding of Treasury securities with less than one year to maturity (*Treasury Bulletin*), 1974.1-1991.6.
9. AAA Corporate bond rate forecasts, (*Blue Chip Economic Indicators*, Eggert Economic Enterprises, Inc.), 1976.8-1991.6.
10. Industrial production growth forecasts, (*Blue Chip Economic Indicators*, Eggert Economic Enterprises, Inc.), 1977.9-1991.6.

Daily Data

1. Secondary market yield on three-month Treasury bills, discount basis (*Federal Reserve Bulletin*, Table H.15, distributed by National Technical Information Services: GFSM03), 1974.1-1991.6
2. Federal funds effective rate (*Federal Reserve Bulletin*, Table H.15, distributed by National Technical Information Services: PFF), 1974.7-1991.6
3. Returns, including all distributions, on the value-weighted NYSE index (CRSP: VWRETD), 1962.7-1991.6

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Figure 1

Six-Month Paper-Bill Spread

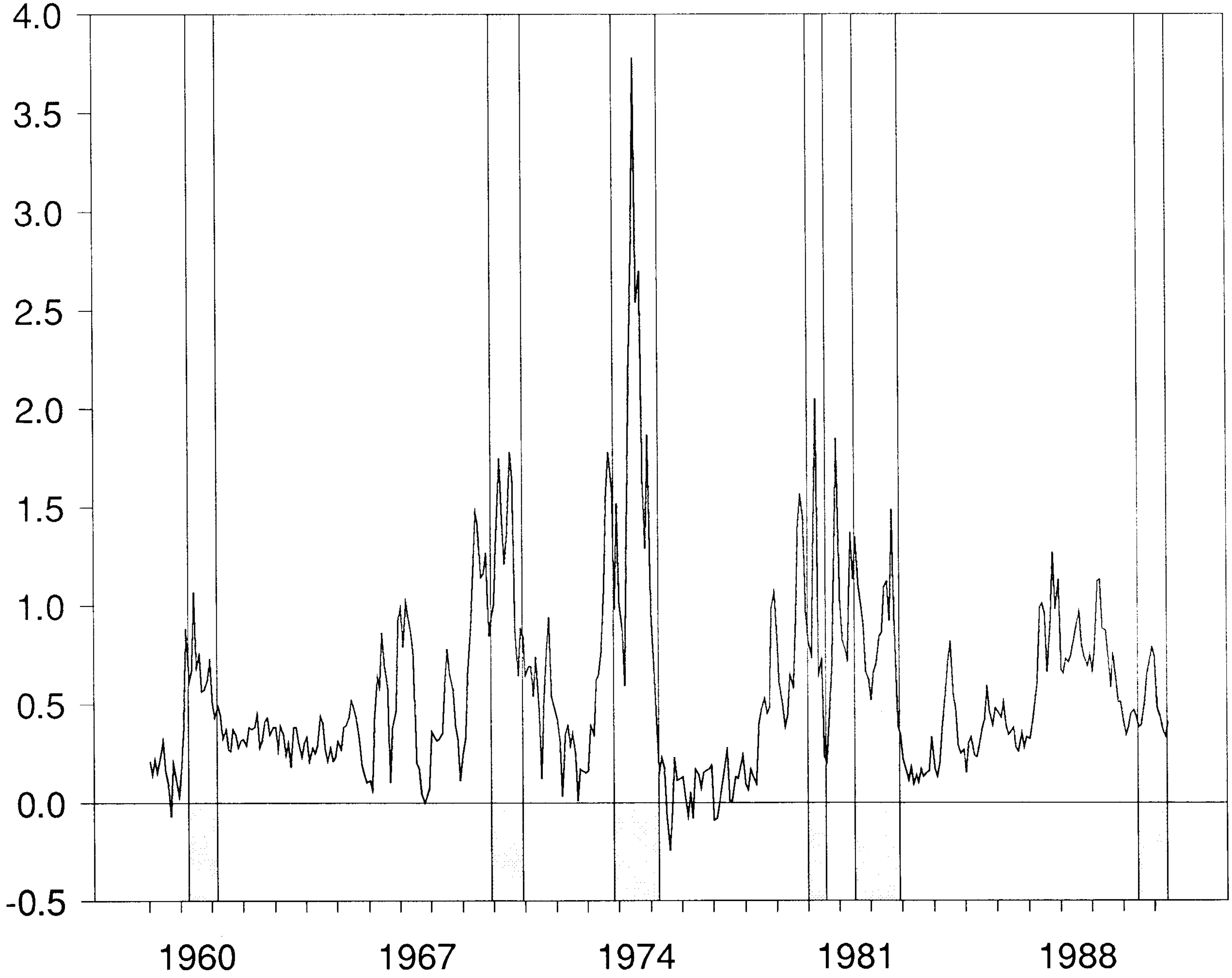


Figure 2

Default Risk

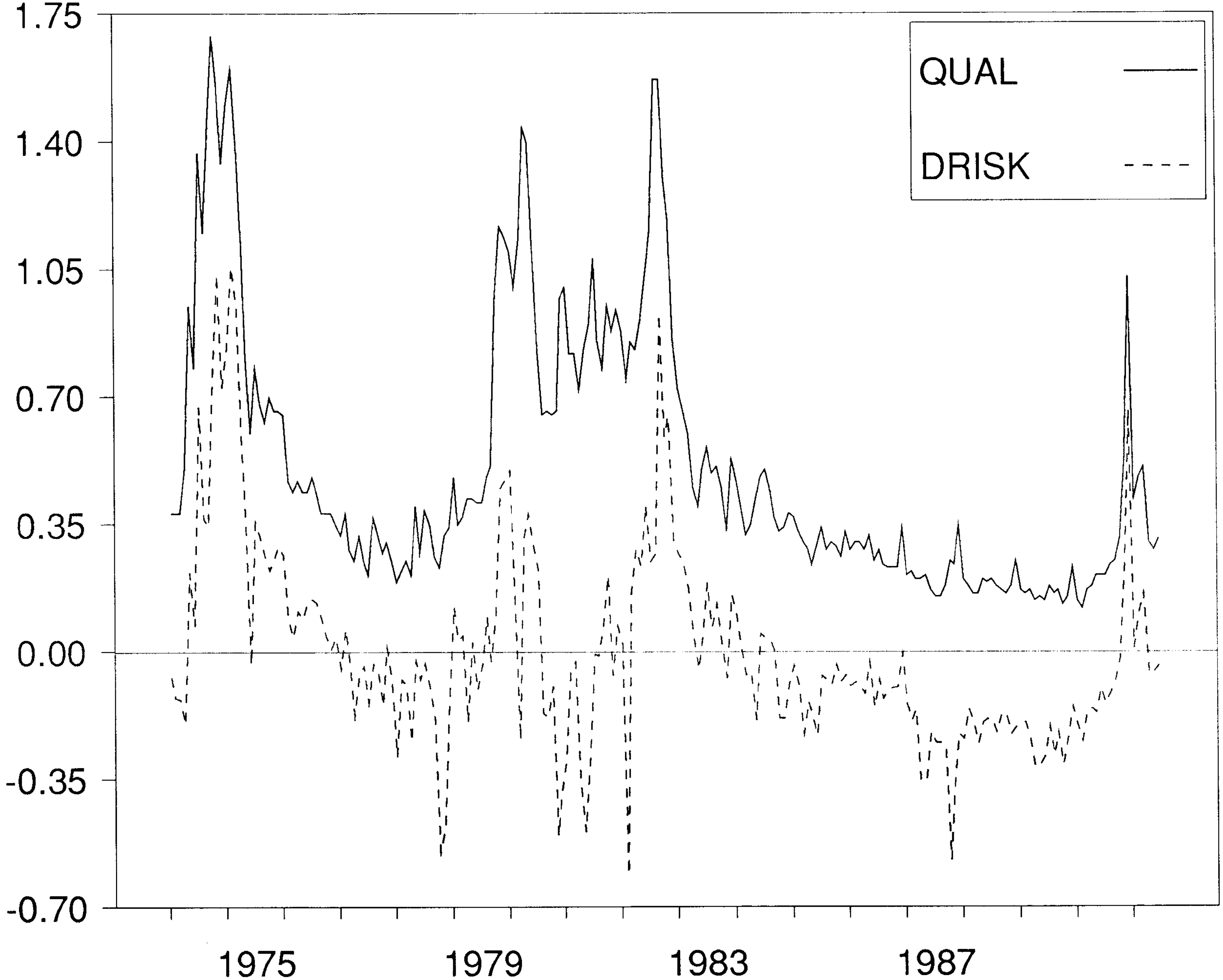


Figure 3

Interest Rate Volatility

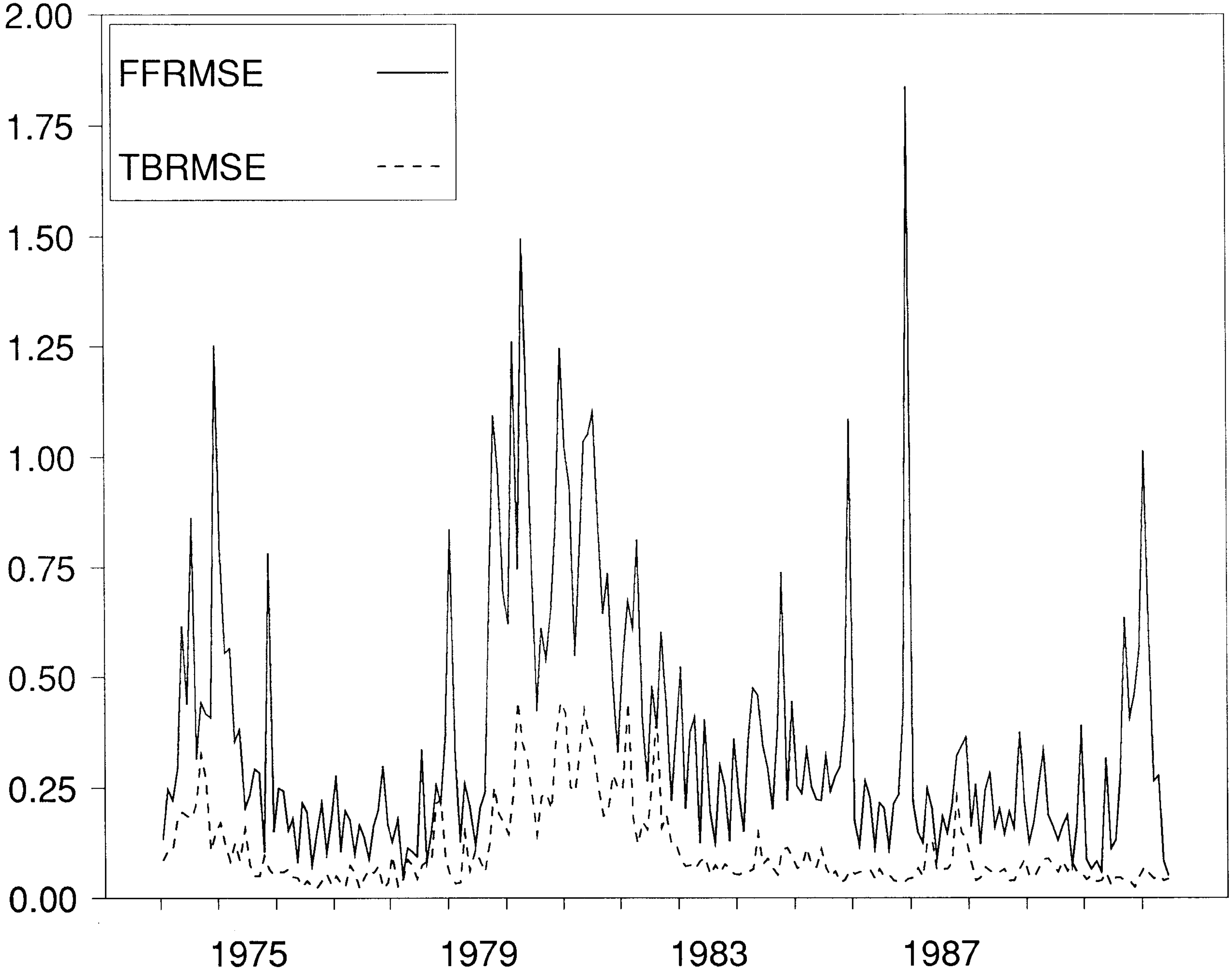


Figure 4

Stock Return Volatility

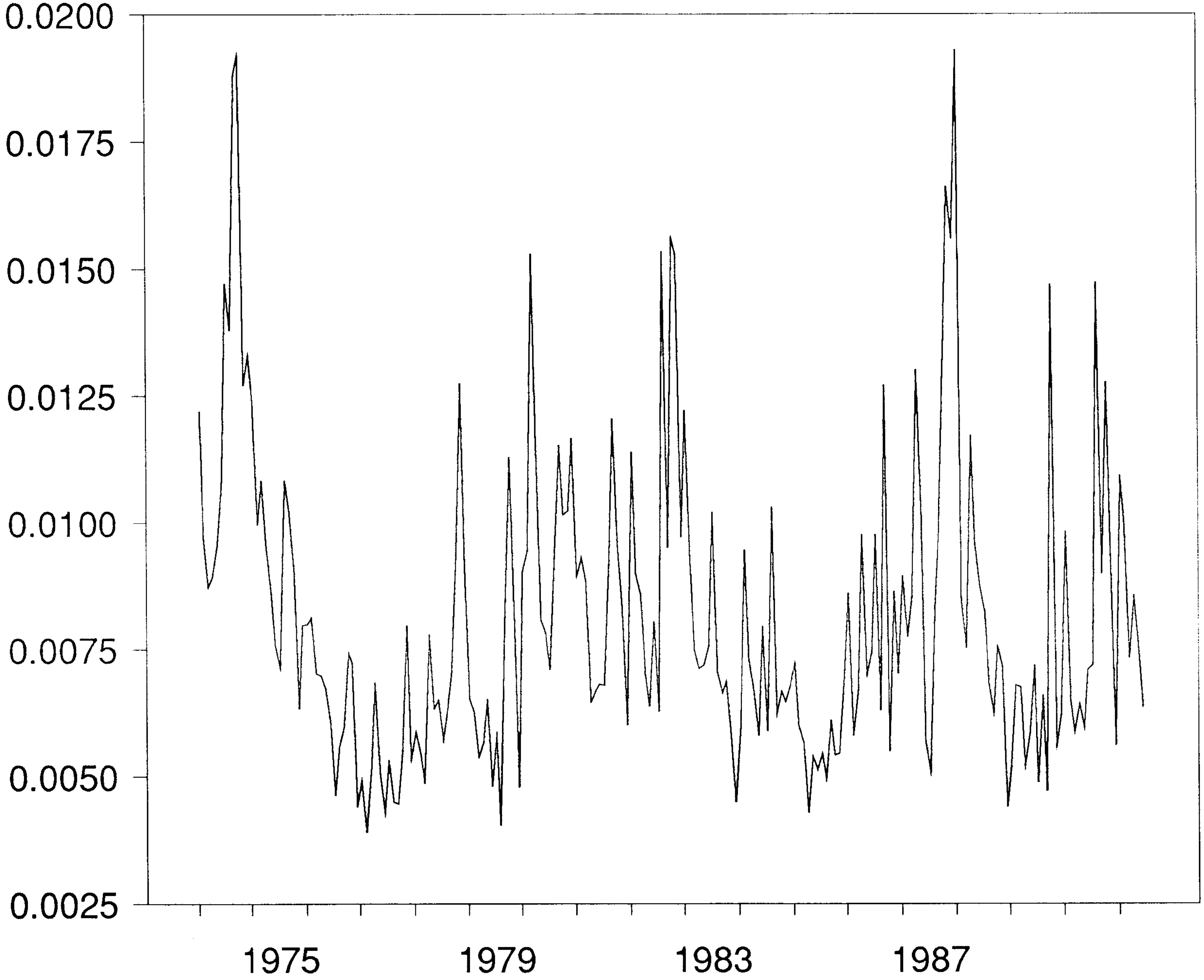


Figure 5

Long-term Interest Rate Discord

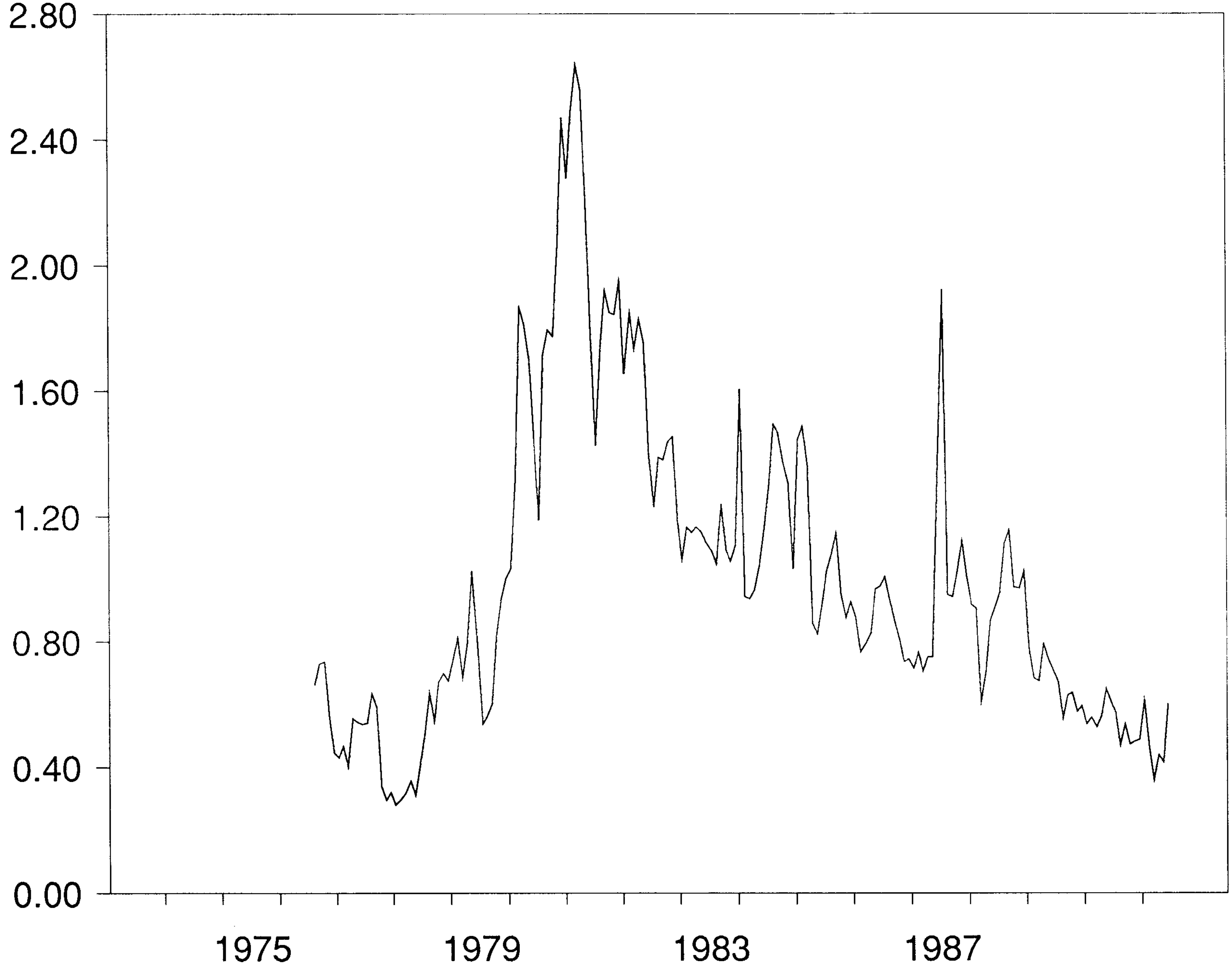


Figure 6

Industrial Production Discord

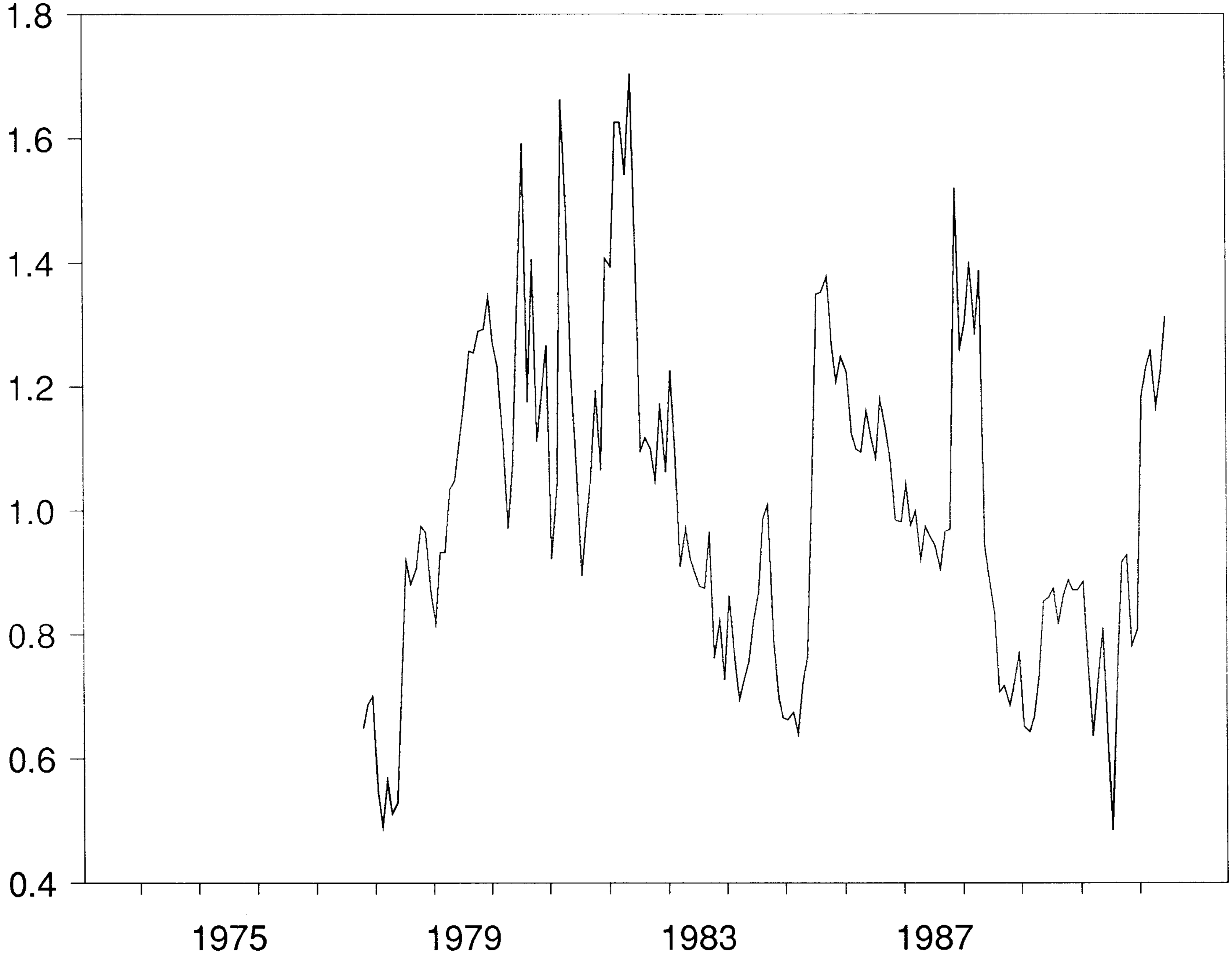


Figure 7

Ratio of Paper to Short-term Government Securities Outstanding

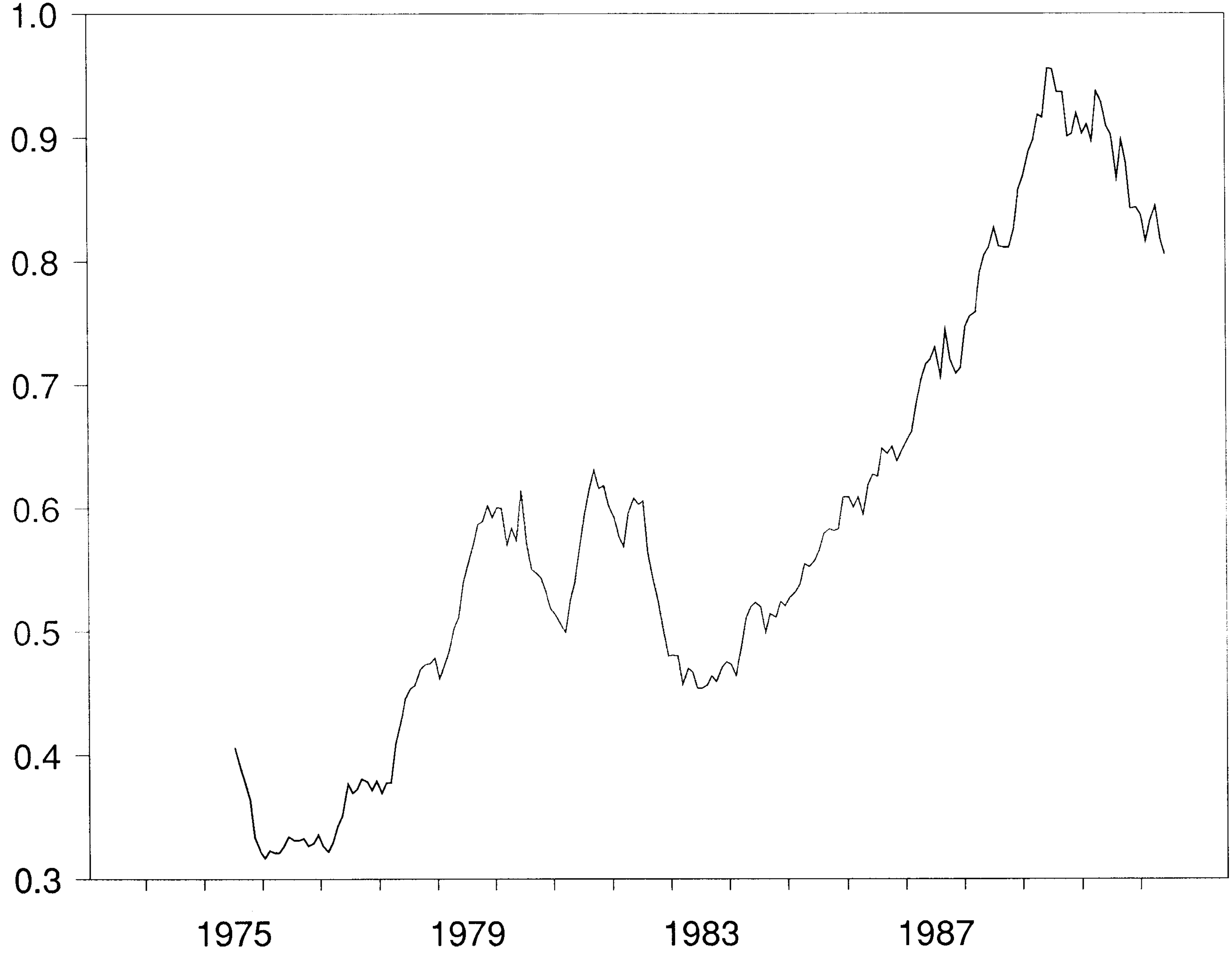
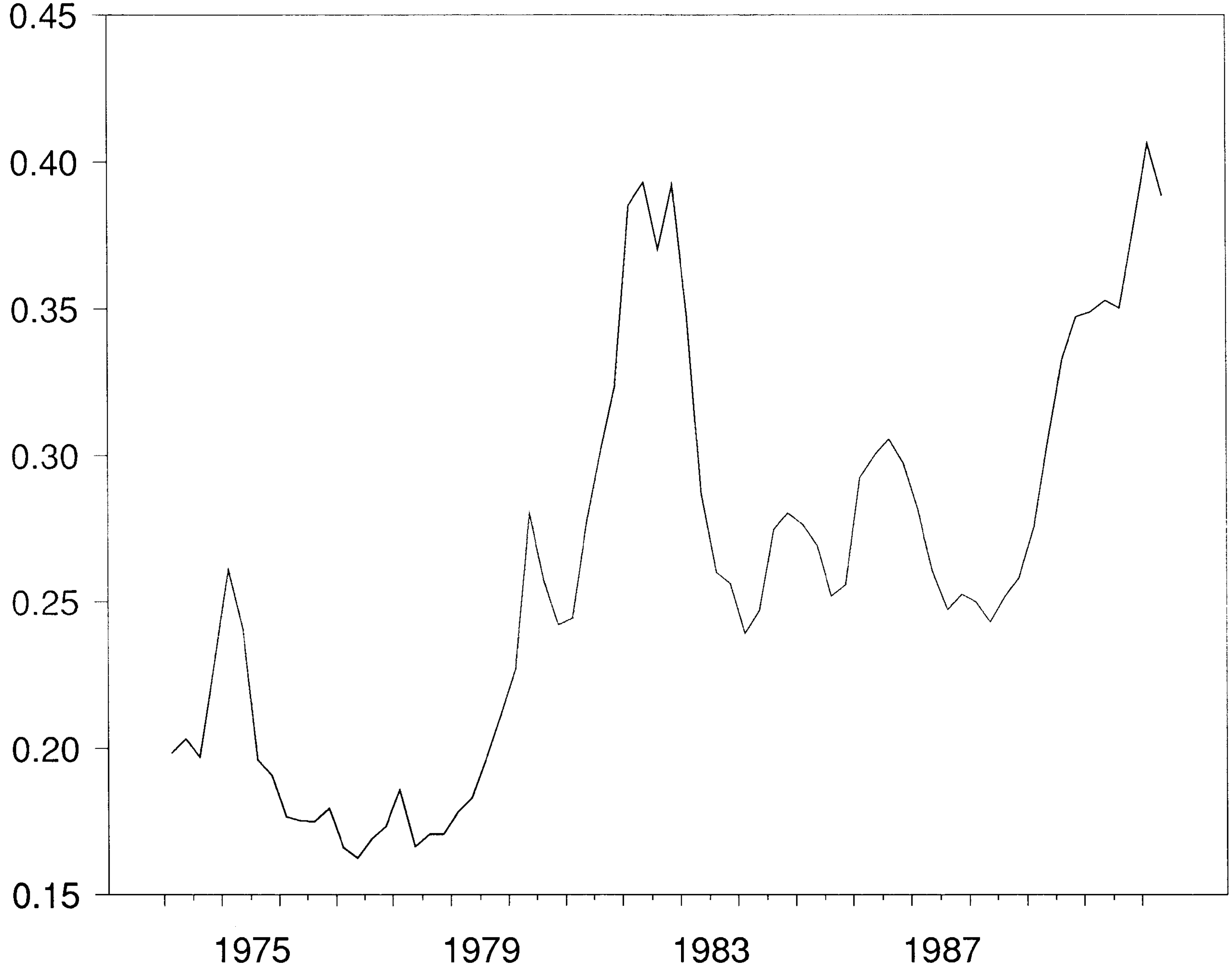


Figure 8

Ratio of Interest Payments to Profits



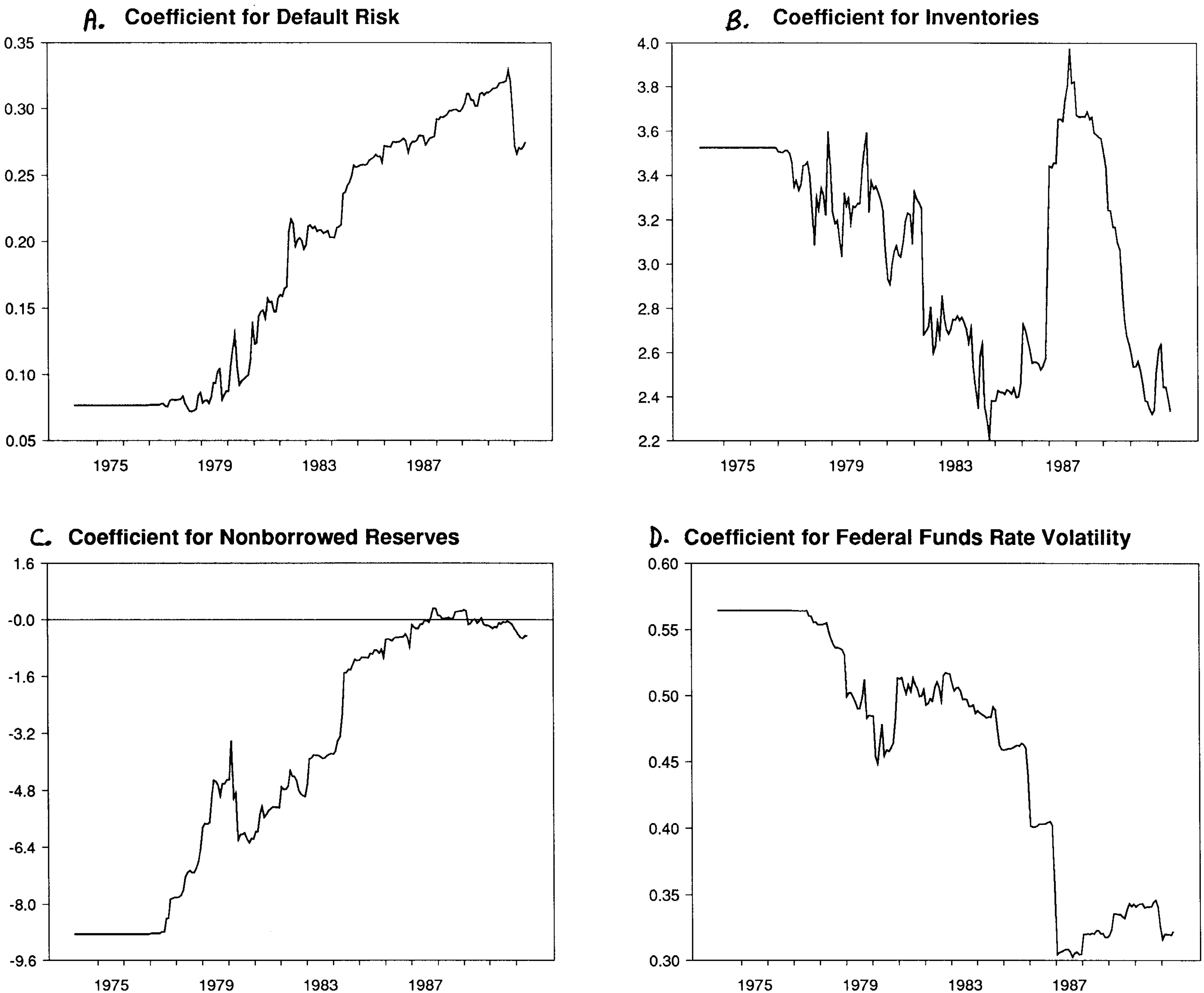
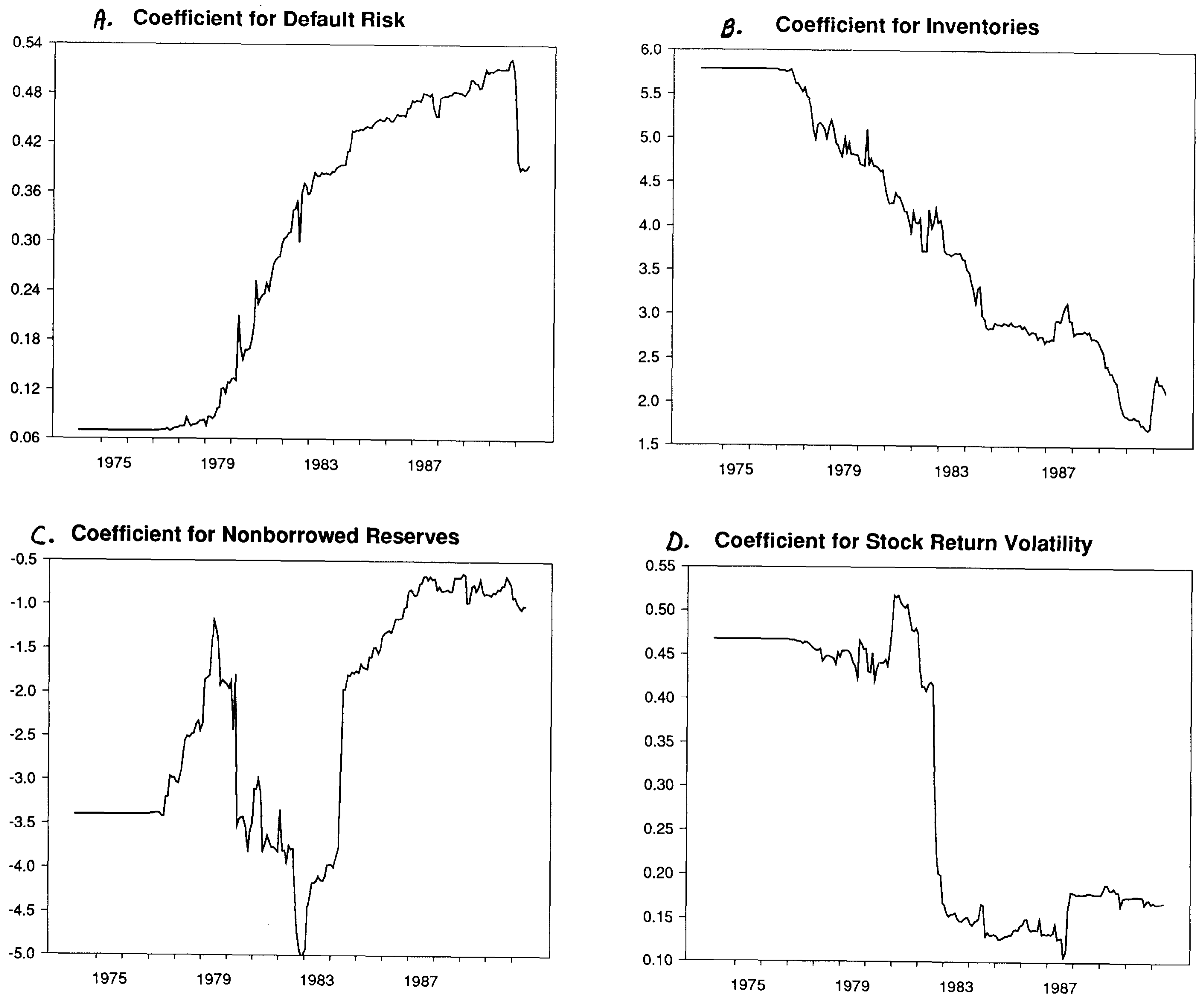

A. Coefficient for Default Risk
0.35
0.30
0.25
0.20
0.15
0.10
0.05
1975
1979
1983
1987
B. Coefficient for Inventories
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
1975
1979
1983
1987
C. Coefficient for Nonborrowed Reserves
1.6
-0.0
-1.6
-3.2
-4.8
-6.4
-8.0
-9.6
1975
1979
1983
1987
D. Coefficient for Federal Funds Rate Volatility
0.60
0.55
0.50
0.45
0.40
0.35
0.30
1975
1979
1983
1987

Figure 9

Figure 10



A. Coefficient for Default Risk
0.54
0.48
0.42
0.36
0.30
0.24
0.18
0.12
0.06
1975
1979
1983
1987
B. Coefficient for Inventories
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1975
1979
1983
1987
C. Coefficient for Nonborrowed Reserves
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
1975
1979
1983
1987
D. Coefficient for Stock Return Volatility
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
1975
1979
1983
1987

Figure 11

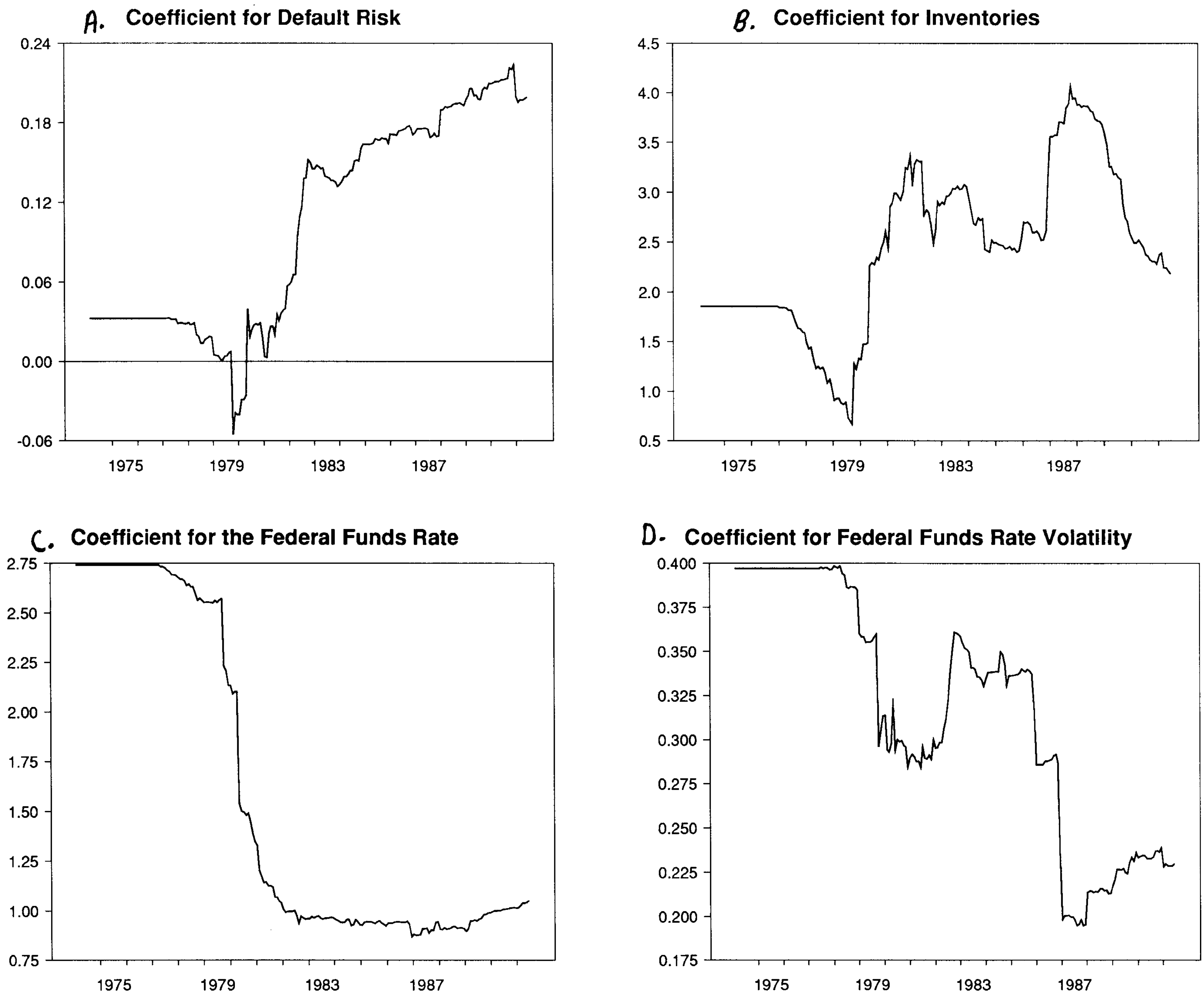

A. Coefficient for Default Risk
0.24
0.18
0.12
0.06
0.00
-0.06
1975
1979
1983
1987
B. Coefficient for Inventories
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1975
1979
1983
1987
C. Coefficient for the Federal Funds Rate
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
1975
1979
1983
1987
D. Coefficient for Federal Funds Rate Volatility
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
1975
1979
1983
1987

Figure 12

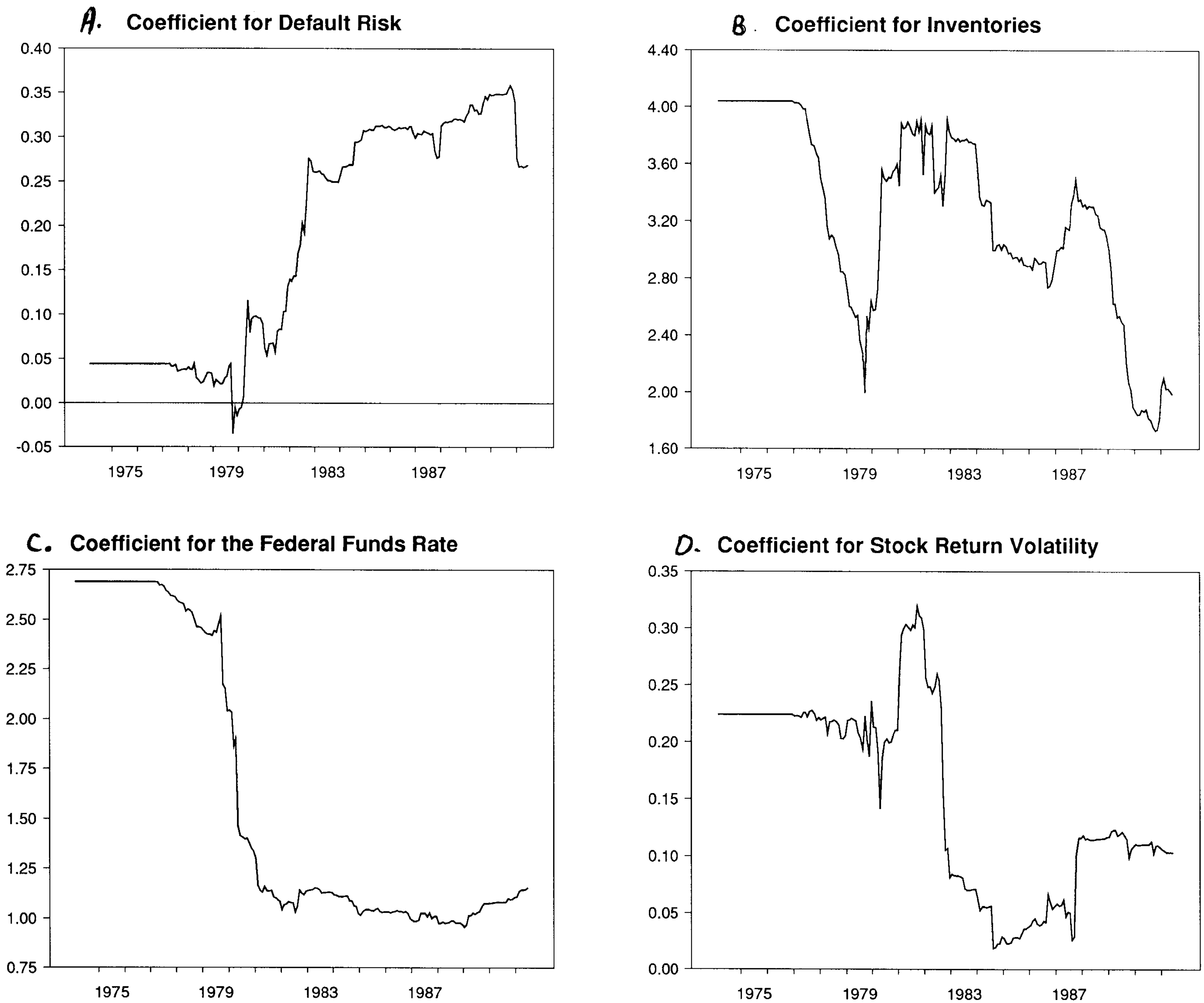

A. Coefficient for Default Risk
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
1975
1979
1983
1987
B. Coefficient for Inventories
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1975
1979
1983
1987
C. Coefficient for the Federal Funds Rate
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
1975
1979
1983
1987
D. Coefficient for Stock Return Volatility
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1975
1979
1983
1987

TABLE 1

Explaining Fluctuations
in the Commercial Paper Quality Spread

Sample	(1) 74:1-91:6	(2) 74:1-91:6	(3) 74:1-91:6	(4) 76:8-91:6	(5) 77:10-91:6
Constant	.251	.233	.308	.500	.482
	(4.76)[a]	(4.11)[a]	(2.04)[b]	(24.38)[a]	(20.45)[a]
FFRMSE	.718	...	...	...	...
	(10.31)[a]				
TBRMSE	...	2.55	...	...	...
		(12.22)[a]			
NYSESD	...	...	24.69	...	...
			(4.24)[a]		
LTRDISC	...	...	...	.372	...
				(9.15)[a]	
IPDISC	...	...	...	...	.546
					(6.16)[a]
$\bar{R}^2$	.33	.42	.07	.32	.18
DW	.51	.44	.24	.25	.26
Q(12)	625.1[a]	541.4[a]	1004.6[a]	617.5[a]	585.0[a]
WHITE(1)	21.8[a]	7.2[a]	80.8[a]	1.5	6.4[b]

Note: The dependent variable is the spread between yields on low and high grade commercial paper (**DRISK**). **FFRMSE** and **TBRMSE** are root mean squared errors of changes in daily federal funds and 3-month Treasury bill rates, respectively; **NYSESD** is monthly standard deviation of daily value-weighted returns on the New York Stock Exchange index; **LTRDISC** and **IPDISC** are long-term bond rate and industrial production discord measures, respectively, from the Blue Chip survey.

T-statistics are in parentheses. $\bar{R}^2$ is the adjusted coefficient of determination, DW is the Durbin-Watson statistic, Q(12) is the Ljung-Box Q-statistic estimated with 12 autocorrelations, and WHITE(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of a homoskedastic errors process.

Significance at 1% and 5% levels given by a and b respectively.

TABLE 2

Paper-bill Spread Equations:
Monetary Policy Measured by Nonborrowed Reserves

Sample	(1) 74:2-91:6	(2) 74:2-91:6	(3) 74:2-91:6	(4) 76:9-91:6	(5) 77:10-91:6
Trend	-.002	-.012	-.007	-.019	-.015
	(0.11)	(0.80)	(0.38)	(2.11)[b]	(1.56)
DRISK	.270	.298	.397	.268	.334
	(2.17)[b]	(2.34)[b]	(2.48)[b]	(2.91)[a]	(3.01)[a]
NBR	-1.007	-.351	-.741	.097	-.142
	(1.20)	(0.53)	(0.99)	(0.24)	(0.32)
INV	1.393	1.376	1.436	1.470	1.535
	(2.24)[b]	(3.03)[a]	(2.40)[b]	(5.14)[a]	(5.00)[a]
FFRMSE	.352	...	...	...	...
	(3.70)[a]				
TBRMSE	...	.390	...	...	...
		(2.91)[a]			
NYSESD	...	...	.176	...	...
			(3.19)[a]		
LTRDISC	...	...	...	.311	...
				(3.51)[a]	
IPDISC	...	...	...	...	.181
					(2.76)[a]
ρ	.86	.82	.83	.61	.64
$\bar{R}^2$	.78	.77	.77	.72	.68
DW	2.01	2.04	2.01	1.86	1.88
Q(12)	16.77	23.02[b]	20.80	17.39	13.44
WHITE(15)	54.31[a]	65.37[a]	60.83[a]	40.99[a]	32.29[a]
CHOW(6)	19.86[a]	14.08[b]	16.08[b]	16.65[a]	17.50[a]

Note: **TREND** is a time trend; **DRISK** is the adjusted spread between yields on medium- and high-grade paper; **NBR** is the log of non-borrowed reserves; **INV** is the log of real manufacturing and trade inventories; **FFRMSE** and **TBRMSE** are root mean squared errors of changes in daily federal funds and 3-month Treasury bill rates, respectively; **NYSESD** is monthly standard deviation of daily value-weighted returns on the New York Stock Exchange index; **LTRDISC** and **IPDISC** are long-term bond rate and industrial production discord measures, respectively, from the Blue Chip survey.

When diagnostic statistics suggest that serial correlation and/or heteroskedasticity are present, then t-statistics are constructed from White's (1980) and Hansen's (1982) heteroskedasticity- and autoregressive-consistent standard errors, with 4 lags of the residuals and a dampening factor of 1.0. (See RATS manual Version 4.0 for details). $\bar{R}^2$ is the adjusted coefficient of determination, DW is the Durbin-Watson statistic, Q(12) is the Ljung-Box Q-statistic estimated with 12 autocorrelations, WHITE(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of a homoskedastic errors process, CHOW(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of no structural change in model between the pre-1983 and post-1983 (inclusive of 1983) periods, ρ is the autocorrelation coefficient.

Significance at 1% and 5% levels given by a and b respectively.

TABLE 3

Paper-bill Spread Equations:
Monetary Policy Measured by Nonborrowed Reserves
and the Level of Market Interest Rates

Sample	(1) 74:2-91:6	(2) 74:2-91:6	(3) 74:2-91:6	(4) 76:9-91:6	(5) 77:10-91:6
Trend	-.022 (1.37)	-.029 (2.45)[b]	-.028 (2.35)[b]	-.030 (4.63)[a]	-.029 (4.11)[a]
DRISK	.274 (2.23)[b]	.296 (2.31)[b]	.385 (2.47)[b]	.233 (2.65)[a]	.264 (2.48)[b]
NBR	.465 (0.73)	1.013 (2.01)[b]	.926 (1.85)	1.364 (3.69)[a]	1.241 (3.44)[a]
INV	1.134 (1.87)	1.051 (2.53)[b]	1.053 (2.48)[b]	.874 (2.60)[a]	1.051 (3.32)[a]
TB6	.511 (2.60)[a]	.525 (3.27)[a]	.549 (3.71)[a]	.529 (3.27)[a]	.563 (3.69)[a]
FFRMSE	.332 (3.36)[a]	...	...	...	...
TBRMSE	...	.329 (2.68)[a]	...	...	...
NYSESD	...	...	.157 (2.77)[a]	...	...
LTRDISC	...	...	...	.126 (1.18)	...
IPDISC	...	...	...	...	.144 (2.51)[b]
ρ	.85	.81	.81	.59	.62
$\bar{R}^2$	.80	.79	.80	.77	.74
DW	2.06	2.06	2.04	1.92	1.94
Q(12)	17.95	24.94[b]	23.83[b]	16.84	14.28
WHITE(15)	84.09[a]	98.64[a]	97.62[a]	76.60[a]	70.15[a]
CHOW(7)	21.40[a]	30.15[a]	16.75[b]	34.71[a]	24.29[a]

Note: **TB6** is the 6-month Treasury bill rate. See the notes to Table 2 for a description of the other variables.

When diagnostic statistics suggest that serial correlation and/or heteroskedasticity are present, then t-statistics are constructed from White's (1980) and Hansen's (1982) heteroskedasticity- and autoregressive-consistent standard errors, with 4 lags of the residuals and a dampening factor of 1.0. (See RATS manual Version 4.0 for details). $\bar{R}^2$ is the adjusted coefficient of determination, DW is the Durbin-Watson statistic, Q(12) is the Ljung-Box Q-statistic estimated with 12 autocorrelations, WHITE(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of a homoskedastic errors process, CHOW(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of no structural change in model between the pre-1983 and post-1983 (inclusive of 1983) periods, ρ is the autocorrelation coefficient.

Significance at 1% and 5% levels given by a and b respectively.

TABLE 4

Paper-bill Spread Equations:
Monetary Policy Measured by the Federal Funds Rate

Sample	(1) 74:2-91:6	(2) 74:2-91:6	(3) 74:2-91:6	(4) 76:9-91:6	(5) 77:10-91:6
Trend	-.015	-.015	-.014	-.004	-.003
	(1.38)	(1.43)	(1.35)	(0.40)	(0.35)
DRISK	.182	.198	.250	.166	.207
	(1.68)	(1.84)	(1.92)	(2.97)[a]	(3.18)[a]
FF	.922	.979	.973	.827	.848
	(6.09)[a]	(6.20)[a]	(6.56)[a]	(9.35)[a]	(6.17)[a]
INV	1.272	1.297	1.198	.880	1.084
	(2.10)[b]	(2.11)[b]	(2.00)[b]	(1.48)	(2.03)[b]
FFRMSE	.228	...	...	...	...
	(2.80)[a]				
TBRMSE	...	.182	...	...	...
		(2.21)[b]			
NYSESD	...	...	.109	...	...
			(2.53)[b]		
LTRDISC	...	...	...	.163	...
				(2.08)[b]	
IPDISC	...	...	...	...	.156
					(2.85)[a]
ρ	.92	.92	.92	.89	.87
$\bar{R}^2$	.84	.83	.83	.79	.77
DW	2.17	2.20	2.21	2.23	2.21
Q(12)	24.69[b]	33.78[a]	33.64[a]	16.54	13.97
WHITE(15)	44.37[a]	39.95[a]	36.87[a]	14.06	30.38
CHOW(6)	22.92[a]	23.89[a]	24.66[a]	22.72[a]	9.93

Note: **ff** is the federal funds interest rate. See the notes to Table 2 for a description of the other variables.

When diagnostic statistics suggest that serial correlation and/or heteroskedasticity are present, then t-statistics are constructed from White's (1980) and Hansen's (1982) heteroskedasticity- and autoregressive-consistent standard errors, with 4 lags of the residuals and a dampening factor of 1.0. (See RATS manual Version 4.0 for details). $\bar{R}^2$ is the adjusted coefficient of determination, DW is the Durbin-Watson statistic, Q(12) is the Ljung-Box Q-statistic estimated with 12 autocorrelations, WHITE(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of a homoskedastic errors process, CHOW(k) is a chi-squared statistic with k degrees of freedom used to test the null hypothesis of no structural change in model between the pre-1983 and post-1983 (inclusive of 1983) periods, ρ is the autocorrelation coefficient.

Significance at 1% and 5% levels given by a and b respectively.

End Notes

[1]See Stock and Watson (1989), Bernanke (1990), Bernanke and Blinder (1992), Friedman and Kuttner (1992, 1993). Bernanke (1990) and Kuttner (1992) show that the predictive power of the spread has declined in recent years.

[2]Kashyap, Stein and Wilcox (1993) also point to the development of the paper market as a potential source for the spread's diminished predictive power. They speculate that the link between monetary policy and the paper-bill spread will deteriorate because "as the commercial paper market deepens, the price pressure generated by Fed tightening should decline" (p. 80).

[3]Between 1969 and 1988 there were only two major defaults on commercial paper: The Penn Central default in 1970 and the Manville Corporation default in 1982.

[4]Commercial paper is generally issued in minimum amounts of $25,000 while Treasury bills can be purchased in $10,000 allotments. Also, banks and other investors can use bills to post margin requirements, collateralize overnight repurchase agreements, and satisfy bank capital requirements. Commercial paper cannot be used for these purposes.

[5]See Bernanke (1990), Friedman and Kuttner (1993), and Kashyap et al. (1993).

[6]See Friedman and Kuttner (1993) for a discussion of this point.

[7]See Kuttner (1992) for a discussion of this point.

[8]Also, rapid growth of money market mutual funds has made divisibility less of an issue for investors.

[9]It is also possible that exogenous changes in uncertainty lead to both a rise in the paper-bill spread and a decline in aggregate economic activity. This view is consistent with recent theoretical and empirical work which suggests that uncertainty plays an important causal role in the business cycle. See Pindyck (1991) and Ferderer (1993).

[10]Amihud and Mendelson (1986) provide a good discussion of the link between bid-ask spreads, transactions costs and liquidity.

[11]See Cook (1986, pp. 84-85).

[12]See Stigum (1990) p. 1051.

[13]This last condition must hold if investors only hold bills and paper.

[14]See Hahn (1993, p. 54) for a discussion of the rating system.

[15]Kaufman (1986) discusses the widespread downgrading of U.S. firms during the 1980s in response to the dramatic deterioration of firms' balance sheets.

[16]Balke and Emery (1994) discuss problems associated with using the federal funds rate as an indicator of monetary policy in the post-1982 period. They conclude that "vector autoregression evidence on the federal funds rate as an indicator of monetary policy weakens when the period since 1982 is examined."

[17]We also examined the explanatory power of real (deflated by CPI) nonborrowed reserves, nonborrowed reserves unadjusted for extended credit, and reserve growth. In all cases, the results were essentially the same.

[18]In his analysis of equity market risk premia, Merton focuses on contemporaneous stock return volatility. By comparison, French *et al.* (1987) decompose volatility into expected (*ex ante*) and unexpected volatility. Given the difficulty of estimating expected volatility, we restrict our analysis to contemporaneous volatility.

[19] One advantage to using the Blue Chip survey for this purpose is that members of the Blue Chip group (economists working in nonfinancial corporations, financial institutions, and professional forecasting firms) have strong financial incentives to exploit available information when making forecasts because their forecasts are used either for internal planning purposes or are sold to organizations that use them for this purpose. Moreover, forecasts made by members of the Blue Chip group are available to the public so that historical success of individual forecasters can be gauged. A second advantage of using the Blue Chip forecasts is that they allow us to construct discord measures with monthly frequencies. The group had thirty members in August 1976 when the survey began and fifty in June 1991, the last month of the sample.

[20] The Blue Chip group predicts the average interest rate over the current year in the months January through June and the average of this rate over the following year in months July through December. Similarly, industrial production growth is forecasted over the current year in January through June and over the following year in July through December.

[21] See Roley and Troll (1983).

[22] See Rowe (1986, p. 114)

[23] One possible object to this conclusion is that the diagnostic statistics in Table 1 suggest that there is considerable autocorrelation in the residuals and that this autocorrelation invalidates statistical inferences based on OLS. However, the residuals reflect variations in default risk which should exhibit considerable persistence since default risk is correlated with movements in economic activity which are highly persistent. Standard procedures to correct for autocorrelated disturbances cannot be justified if the autocorrelation arises from this source.

[24] Also, by including the interest rate level in the regressions we are able to check whether the interest rate volatility series are significant determinants of the spread only because they proxy for the level of market rates.

[25] The ideal way to measure the relative liquidity of the commercial paper and Treasury bill markets is to compare the bid-ask spreads prevailing in each. Unfortunately, data on commercial paper bid-ask spreads is not publicly available. Nevertheless, Stoll (1985) has shown empirically that bid-ask spreads for different assets are negatively correlated with trading volume.

[26] Profits are before tax profits plus capital consumption allowances, plus net interest payments.

[27] In fact, the coefficients on nonborrowed reserves became more significantly negative when the dummy and interaction terms were included in the models to obtain the Chow statistics.

[28] Interestingly, the timing of the uncertainty coefficient decline corresponds roughly with the sharp rise in the relative liquidity of paper suggested by Figure 7.

[29] The fact that the coefficient temporarily falls during the 1980 to 1982 period may reflect the fact that there is a concave nonlinear relationship between the paper-bill spread and federal funds rate volatility. That is, the coefficient may have declined somewhat in this period due to the high levels of federal funds rate volatility.

[30] It is difficult, however, to distinguish between the two versions of the monetary hypothesis based on these results. Recall that the credit crunch hypothesis predicts that the relationship should have disappeared immediately following the removal of Regulation Q in the late 1970s. In contrast, the imperfect substitutes hypothesis suggests that the deterioration of the relationship should be slower, reflecting the gradual development of the secondary market for paper. Results using nonborrowed reserves to measure the stance of policy favor the imperfect substitutability hypothesis, while results using the federal funds rate support the credit crunch hypothesis.