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**Mark Carlson and David C. Wheelock**

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# Near-Money Premiums, Monetary Policy, and the Integration of Money Markets: Lessons from Deregulation

Mark Carlson and David C. Wheelock*

The 1960s and 1970s witnessed rapid growth in the markets for new money market instruments, such as negotiable certificates of deposit (CDs) and Eurodollar deposits, as banks and investors sought ways around various regulations affecting funding markets. In this paper, we investigate the impacts of the deregulation and integration of the money markets. We find that the pricing and volume of negotiable CDs and Eurodollars issued were influenced by the availability of other short-term safe assets, especially Treasury bills. Banks appear to have issued these money market instruments as substitutes for other types of funding. The integration of money markets and ability of banks to raise funds using a greater variety of substitutable instruments has implications for monetary policy. We find that, when deregulation reduced money market segmentation, larger open market operations were required to produce a given change in the federal funds rate, but that the pass through of changes in the funds rate to other market rates was also greater.

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* Carlson: Bank for International Settlements and Board of Governors of the Federal Reserve System, Mark.a.carlson@frb.gov. Wheelock: Federal Reserve Bank of St. Louis, David.C.Wheelock@stls.frb.org. We are grateful for valuable comments from Ingo Fender, Robert McCauley, Patrick McGuire, Christopher Neely, Andreas Schrimpf, and Jeremy Stein. The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the Bank for International Settlements, the Federal Reserve Bank of St. Louis, the Board of Governors of the Federal Reserve System, or their staffs.

The money market landscape has changed dramatically in recent decades. Easy access to short-term funding markets fueled the growth of the shadow banking sector, and these markets proved to be particularly vulnerable during the recent financial crisis. Subsequently, new regulations were introduced for important players in the money markets. For example, new liquidity rules encourage commercial banks to rely less on short-term financing and money market mutual funds to reduce the average maturity of the securities in which they invest.[1] Monetary policy developments have also affected money markets. In the United States, banking system reserves have grown enormously since December 2008, when the Federal Reserve lowered its federal funds rate target effectively to zero and subsequently engaged in large-scale asset purchases. Trading in the federal funds market has since diminished substantially and the counterparties most active in the market have changed. Market participants and policymakers are uncertain how a tightening of monetary policy and higher short-term interest rates might affect the federal funds market, or how closely linked the fed funds market will be to other money markets. This uncertainty is particularly great in light of other changes in the regulatory environment, such as the payment of interest on reserves, which influence the incentives of banks to borrow or lend in the federal funds market.

For insights into how money markets and the implementation of monetary policy are affected by changes in the regulatory environment, this paper examines bank funding markets in the 1960s and 1970s. This period witnessed considerable changes in regulation as well as an expansion in the types of securities available to market participants. Both Regulation Q, which put ceilings on the interest rates that banks could pay on deposits raised in the United States, and reserve requirements, which mandated that banks hold cash or balances at the Federal Reserve in proportion to certain types of liabilities, were changed multiple times during the 1960s and 1970s. Partly in response to these regulations, new money market instruments, such as negotiable certificates of deposit (CDs) and Eurodollars were introduced and their use grew rapidly.[2] These new instruments allowed banks to circumvent regulations and access new wholesale funding markets, and thereby reduce their dependence on the federal funds market and domestic deposits for short-term funding.

This paper tests various hypotheses about the impact of changes in regulation and the availability of new funding sources. Money market instruments offered by the largest banks would be attractive to investors looking for safe, short-term securities. Hence, we test whether

[1] Some of the new regulation reference particular maturity points, for example by differentiating securities with maturities of more or less than 30 days. These reference maturity points could potentially create kinks in the money market yield curve.

[2] Our definition of Eurodollars follows BIS reporting. In particular, we focus on US dollar-denominated external liabilities of banks in countries that report statistics to the BIS.

the pricing and growth of negotiable CDs and Eurodollars reflected changes in the availability of safe, short-term public securities.[3] We then examine whether banks adjusted their funding structures by substituting among different instruments in response to shifts in relative funding costs, at least to the extent permitted by extant regulations. Deregulation gave banks more flexibility to shift among alternative funding sources and promoted the integration of the various short-term funding markets. We test whether the integration of markets, in turn, affected the Federal Reserve's ability to influence the federal funds rate and thereby implement monetary policy.

We begin by investigating whether the new money market instruments displayed the characteristics of safe, near-money instruments as described in Gorton, Lewellen, and Metrick (2012); Krishnamurthy and Vissing-Jorgensen (2012, 2013); Carlson, Duygan-Bump, Natalucci, Nelson, Ochoa, Stein, and Van den Heuval (2014); Gorton (2015); Greenwood Hanson and Stein (2015); and Sunderam (2015). This literature argues that investors have a preference, and will pay a "near money" premium, for assets that are safe, liquid, and easily convertible to cash. When the supply of risk-free and liquid public securities is insufficient to satisfy the demand for safe assets, private issuance of close substitutes will increase. Under this hypothesis, a decline in U.S. Treasury issuance reduces the yields on Treasury securities and close substitutes, but also tends to increase spreads between yields on privately-issued money market instruments and Treasury securities. Despite larger spreads, private firms will issue more securities because of the general decline in market rates. Thus, changes in the supply of Treasury securities should influence both the issuance of private money market securities and the spreads between those instruments and comparable maturity Treasury securities. Following Greenwood et al. (2015) and Carlson et al. (2014), we test whether the supply of Treasury bills in particular affected the use and pricing of negotiable CDs and Eurodollars. We find that increases in the supply of Treasury bills reduced the spreads between the yields on private instruments and Treasury bills. Further, we find that issuance of negotiable CDs and Eurodollars grew more rapidly when Treasury bills were relatively scarce.. Thus, even in the early years of these markets, pricing and volumes responded similarly to what the literature has found for money markets in more recent times.

Our research also finds that banks responded to incentives affecting their use of private money market securities by altering their issuance of other types of liabilities. Specifically, we find that changes in the supply of Treasury bills, as well as other factors influencing the issuance

[3] In addition to new funding sources for banks and other money market borrowers, this period also saw innovations on the part of suppliers of funds. One such innovation was the money market mutual fund which invests exclusively in money market instruments while also offering investors liquidity services.

of CDs and Eurodollars also caused banks to adjust the composition of their liabilities, but did not affect the growth of total bank liabilities. Thus, at least in the short run, banks responded to developments in money markets by changing the composition of their liabilities but not their total leverage. This evidence is consistent with Gorton, Lewellen, and Metrick's (2012) description of how wholesale funding instruments and demand deposits have generally been substitutes in the post-war period.

Finally, we investigate how money market developments affected the implementation of monetary policy.[4] The development of the new marginal sources of funding may have made the demand for federal funds more elastic with respect to price, which would have affected the Federal Reserve's ability to influence the federal funds rate.[5] Further, because regulations affected the degree to which banks could substitute new funding sources for federal funds, we conjecture that changes in regulation likely affected both the impact of the Fed's open-market operations on the federal funds rate, and how tightly the federal funds rate and other money market rates were linked. We focus in particular on the impact of the permanent suspension of Regulation Q for negotiable CDs and Eurodollars with a maturity of 90 days or more in mid-1973, and the relaxation and eventual abolition of a variety of "voluntary" controls related to foreign transactions that restricted borrowings from foreign branches (Kreicher 1982). We also examine whether these relationships differed during periods when regulations were more binding, either because Regulation Q was constraining money market rates or because reserve requirements related to money market instruments were higher.

We find evidence that when regulations were tighter, the federal funds rate was more sensitive to action by the Federal Reserve—measured either as the change in the holdings of government securities or changes in non-borrowed reserves. Moreover, when Regulation Q was binding, Federal Reserve actions had an especially strong impact on the federal funds rate. However, stronger impact did not necessarily translate into greater control; deviations of the market funds rate from the Fed's target rate were higher in the early period, particularly when Regulation Q was binding. We speculate that a binding Regulation Q disrupted the normal

[4] Discussion about the impact of these markets on monetary policy effectiveness have been around almost as long as the markets themselves. Frydl (1979/1980) discusses some of the earlier debates about whether the Eurodollar market in particular might undermine the monetary control exercised by central banks. Ways in which the Eurodollar market and other financial innovations are related to monetary policy and financial stability are also discussed in an early report of the Committee on the Global Financial System (1986).

[5] It should be remembered that during this period the Federal Reserve was much more opaque about its preferences for monetary policy and its target for the federal funds rate. Communication was much less important in shaping monetary policy, and open market operations that changed the level of bank reserves were more important in managing the federal funds rate.

supply and demand relationships in the federal funds market by cutting off certain types of money market funding.

After regulations were relaxed, arbitrage between markets became easier and banks were better able to substitute one form of funding for another.[6] We find that by the mid-1970s, larger open-market operations were required to effect a given change in the federal funds rate. However, changes in the federal funds rate also passed through to other markets to a greater extent so that the Federal Reserve was able to more directly influence general funding conditions.

Our findings have important policy implications. In finding that government issuance of money market securities influences the premiums on and volumes of money market securities issued by private firms, our results suggests that the Federal Reserve, which provides short-term safe assets (reserves) in exchange for longer-term safe assets (typically Treasury securities) through its conduct of monetary policy, could impact money market premia and the volume of private activity in money markets.[7] Conversely, we also find that the integration of private money markets affects the ability of the Federal Reserve to implement monetary policy. Thus, regulations affecting the evolution of money markets have implications for both financial stability and the efficacy of monetary policy.

The paper proceeds as follows: Section 2 describes the key regulations and developments in money markets in the 1960s and 1970s, and discusses some previous literature on arbitrage between those funding markets. Section 3 reports our investigation of the pricing of money market instruments and issuance volumes. Section 4 discusses the impact of regulation on bank liability structures. Section 5 examines the responsiveness of the federal funds rate to actions by the Federal Reserve, and how the pass through from changes in the federal funds rate to other money market rates changed over time. Section 6 concludes.

## Section 2. Background

In this section, we first review the regulatory environment, and then discuss the early development and use of the new money market instruments. We then describe the growth of these markets in the 1960s and 1970s that bear on our empirical analysis.

[6] Interestingly, Kreicher, McCauley, and McGuire (2013) find that some recent regulatory developments, such as the shift in the FDIC deposit insurance assessment fee from being based on insured deposits to being based on total liabilities, made banks less willing to arbitrage between the federal funds market and other wholesale funding markets.

[7] See also the discussion in a 2015 report by the Committee on the Global Financial System.

*2.1 Regulation*

The Banking Acts of 1933 and 1935 required U.S. bank regulators to impose ceilings on the interest rates that banks pay on time and savings deposits. Interest rates on demand deposits were set to zero by statute. Regulation Q covered most other types of liabilities. The intent of rate ceilings was to keep banks from engaging in "destructive interest rate competition" for funding, which in turn might lead them to make riskier loans (Ruebling 1970). The Federal Reserve established ceilings for commercial banks that were members of the Federal Reserve System while the FDIC set them for non-member commercial banks. The ceilings were made applicable to savings and loan associations that were members of the Federal Home Loan Bank system in 1966. Collectively, the structure of deposit rate ceilings was referred to as Regulation Q.

Initially, deposit interest rate ceilings were set well above the prevailing level of market interest rates, and they did not become binding until the late 1950s when market rates rose with rising inflation and economic growth (Ruebling 1970). The rules pertaining to Regulation Q were initially simple, but became more complicated over time. For example, by the 1970s, the ceilings on time deposits varied by deposit maturity and size. Notably for our purposes, the ceilings applied to deposits of more than $100,000 with maturities typical of money market securities—which would include most negotiable CDs—were distinct from those on other time deposits. Ceiling rates were also adjusted over time, particularly when policymakers became concerned that banks might be at a competitive disadvantage for funds.[8]

Market interest rates continued to rise in the 1960s, causing Regulation Q ceilings to bind more frequently. Figure 1 shows the level of interest rates in the secondary market for 3-month negotiable CDs and the applicable Regulation Q ceiling. The regulation was binding during periods when the interest rate (blue line) exceeded the ceiling (red line).

Notably, Regulation Q did not apply to Eurodollar deposits, i.e., dollar-denominated deposits in both non-U.S. banks and overseas branches of U.S. banks. Thus, U.S. banks with offshore subsidiaries or branches could raise funds in money markets at competitive rates even when Regulation Q limited their ability to obtain funds by offering domestic deposits.

Interest rate ceilings remained in place on most deposits throughout the 1960s and 1970s. However, ceilings on negotiable CDs were first suspended and then eliminated in the 1970s. The first change occurred in 1970, following the bankruptcy of Penn Central Company.

[8] Cook (1978) argues that about 90 percent of banks were paying rates at or near the regulation Q ceilings on their savings and small time deposits for much of the mid-1970s.

Penn Central had been a major issuer of non-financial commercial paper and the market reaction to its bankruptcy prevented other firms from issuing commercial paper. In response, the Federal Reserve suspended interest rate ceilings on large time CDs with maturities of less than 90 days to enable banks to raise funds to meet the liquidity needs of their business customers that were suddenly shut out of the commercial paper market (Carlson and Wheelock 2015). The ceiling was never reinstated. The Federal Reserve subsequently suspended Regulation Q for large time CDs with longer maturities in May 1973 (Cook 1978). Interest rate ceilings were phased out for other types of savings and time deposits in the 1980s.

Whereas Regulation Q limited the rates that banks could pay for domestic deposits, reserve requirements forced banks to hold reserves equal to a fraction of their deposit liabilities. The requirements imposed on Federal Reserve member banks were generally higher than those imposed on non-member banks and thrifts.[9] The reserve requirement, which creates a demand for reserve balances, and open market operations, by which the Federal Reserve controls the stock of reserves, are basic elements of the Federal Reserve's implementation of monetary policy. [10]

Prior to 2008, banks earned no interest on their reserves held at the Fed.[11] Therefore, as market interest rates rose during the 1960s, banks increasingly sought to minimize their reserve balances by substituting away from domestic deposits toward liabilities that were subject to lower or no reserve requirements. Originally, Eurodollar deposits were not subject to reserve requirements. In October 1969, the Federal Reserve placed an indirect reserve requirement on Eurodollar deposits by requiring banks to hold reserves against amounts due to their foreign branches and agencies.[12] Reserve requirements on both Eurodollar deposits and negotiable CDs were changed multiple times throughout the 1960s and 1970s. At various times, the Fed lowered requirements on member banks to discourage banks from leaving the Federal Reserve System (Feinman 1993). Other changes in reserve requirements, such as adding the

[9] State-chartered non-member banks also faced reserve requirements, but often less stringent ones than Fed members. The Monetary Control Act of 1980 subjected all depository institutions to the reserve requirements imposed by the Fed on member banks.
[10] See Carlson and Wheelock (2014) for a discussion of the use of reserve requirements as a monetary policy tool from the 1930s through the 1950s.
[11] Congress authorized the Federal Reserve to pay interest on reserve deposits under the Emergency Economic Stabilization Act of 2008, and the Fed's ability to vary that interest rate has become an important tool for influencing the federal funds rate (see Chen, Clouse, Ihrig, and Klee 2014).
[12] See Federal Reserve (http://www.federalreserve.gov/monetarypolicy/reservereq.htm). The Federal Reserve imposed reserve requirements on balances due from foreign branches in part to moderate the flows of foreign funds between U.S. banks and their foreign branches that affected the balance of payments, and to remove a special advantage to member banks that had been able to use Eurodollars as a means of avoiding credit restraints (for further detail see the *Annual Report of the Board of Governors of the Federal Reserve System* for 1969).

reserve requirement on Eurodollars, were intended to influence the relative attractiveness of different types of liabilities. We control for these changes in our empirical analysis.[13]

*Section 2.2 Money Market Innovations*

The two most important money market innovations in the 1960s were the Eurodollar market and negotiable certificates of deposit (CD's). Schenk (1998) argues that the Eurodollar market originated from interest rate arbitrage, and reports that Midland Bank found that bidding for dollar funding in London, selling dollars in the spot market and buying them back in the forward market, provided a comparatively cheap source of funding. Other banks soon began bidding for these deposits as well. Both Schenk (1998) and Ferras (1969) noted that U.K. regulations helped spur the development of the market as prohibitions imposed in 1957 on the use of sterling to finance non-sterling-area trade encouraged British banks to obtain dollar funding in the Eurodollar market to finance their dollar based activities. American banks had also become quite active in the market by the early 1960s (Schenk 1998). Although Eurodollars and other Eurocurrencies were present in a number of countries, the London market remained the largest.

U.S. bank regulations also contributed to the growth of the Eurodollar market. U.S. banks found Eurodollars a desirable source of funding because at first Eurodollar deposits were subject to neither reserve requirements nor Regulation Q ceilings. Eurodollar deposits proved to be a more dependable source of funds than domestic deposits when interest rate ceilings bound and domestic wholesale funding options dried up (Friedman 1971). The Eurodollar market was further spurred by the presence of a clientele that was particularly interested in holding dollars and investing in dollar assets outside the United States, such as eastern European governments that feared confiscation if they purchased assets in the United States (Friedman 1971). Kreicher (1982) reports that members of OPEC also generally preferred to place funds in the Eurodollar market, and that a large amount of petro-dollars flowed to the market in 1973 and again in the late 1970s. Nevertheless, Gilbert (1966) reports that, at least in the early years of the market, non-bank business corporations were both the largest suppliers and largest demanders of Eurodollar funds.

The Eurodollar market quickly became an important source of funds for many banks. Gilbert (1966) reports that U.S. banks were actively competing for funds in the market by 1966

[13] Shortly before our sample period starts, in December 1959, the Fed began to count a bank's vault cash toward its required reserves. This change did have an important impact on the scarcity, and thus price, of reserves but mostly for small banks which were less likely to use the wholesale funding instruments studied here.

and that Eurodollars were becoming an important source of their money market funding. Nevertheless, he notes that interest rates in the Eurodollar market and in New York would occasionally diverge, indicating that the markets were not completely integrated. Ferras (1969) points to the continued importance of Regulation Q as a wedge preventing full arbitrage. However, contemporaries observed that banks increasingly were able to substitute across different types of liabilities. Similarly, Ferras (1969) notes that when the Federal Reserve attempted to tighten policy in the late 1960s, U.S. banks turned to the Eurodollar market to maintain their borrowing. He reports that large U.S. money center banks in particular took advantage of their access to the Eurodollar market to relieve funding constraints. Ferras notes that regulators subsequently took steps to limit banks use of Eurodollar funding, such as the placement of reserve requirements on the liabilities of banks to their foreign branches, which included their Eurodollar funding.

Negotiable CDs were first issued in 1961 by First National City Bank of New York, and Discount Corporation, a Government securities dealer, agreed to make a market for these CDs (Ruebling 1970). The existence of a secondary market made negotiable CDs more viable as a money market security. The innovation was successful, and other banks began issuing the securities. Larger banks in particular found these instruments to be an attractive funding source. By mid-1965, negotiable CDs funded about 7 percent of the balance sheets of large U.S. banks; by 1975, it had risen to over 17 percent (based on data reported in *Banking and Monetary Statistics* and subsequent Federal Reserve statistical volumes). As noted previously, unlike Eurodollar deposits, negotiable CDs were subject to Regulation Q ceilings until 1970, when the ceilings on short-term CDs were suspended, and 1973, when ceilings on all other negotiable CDs were lifted. Negotiable CDs were also subject to reserve requirements throughout the period.

By 1980, the Eurodollar and negotiable CD market—both wholesale funding markets—had become quite integrated. Kreicher (1982) describes how banks could arbitrage differences between rates in these two markets and the evolution of some of the regulatory wedges that allowed interest rate differentials to persist. He notes that by the middle of 1975, the remaining wedge was quite small.

*Section 2.3 Other important background information*

The Herstatt bank failure in June 1974 had a notable impact on money market rates. The bank was closed while it had an open position in the foreign exchange market (it had received funds as part of the transaction, but had not yet delivered funds). This failure made banks and

regulators much more aware of, and concerned about, settlement risk in foreign exchange markets. While Herstatt did not have any Eurodollars and the Eurodollar market was not implicated in any way, heightened concerns about all types of foreign currency transactions caused Eurodollar contract rates to surge. It was not until the end of the year that rates and spreads on Eurodollar contracts returned to more normal levels (Kreicher 1982). The stress in the Eurodollar market is obvious and we need to account for this episode in our empirical analysis.

The Bretton Woods exchange rate regime ended in the early 1970s and the dollar began to float against other currencies in 1973. Efforts to prop up the Bretton Woods regime included a number of voluntary and less-voluntary capital regulations and controls, some of which placed restrictions on banks (see Neely 1999, Sylla 2002). Once these restrictions were lifted, also around 1973-1974, banks were further able to arbitrage differences in funding markets, especially the Eurodollar market. (See Bordo and Humpage (2014) for a further discussion of the decline of the Bretton Woods regime.) These changes occurred close to the other financial deregulation we discuss and supports this period as a break.

## Section 3. Pricing and Issuance of Money Market Instruments

In this section, we test various hypotheses about the pricing and issuance volumes of Eurodollars and negotiable CDs when those markets were becoming important components of bank funding markets in the 1960s-70s. As the previous sections describe, the emergence of those markets reflected the interaction of regulation and macroeconomic outcomes, especially rising inflation and interest rates. We seek to discern how closely the early Eurodollar and negotiable CD markets conformed to the predictions of recent studies on money markets, and the extent to which market pricing and issuance volumes reflected the effects of regulation and deregulation.

### *3.1 Pricing of Private Money Market Instruments*

Our research contributes to a recent but rapidly growing body of work that examines the role that safe assets play in the financial system and how the supply of government-issued securities affects the pricing of close substitutes issued by the private sector (e.g., Gorton, Lewellen, and Metrick 2012; Gorton 2015; Krishnamurthy and Vissing-Jorgensen 2012, 2013; Greenwood, Hanson and Stein 2015; Sunderam 2015; Carlson, et al. 2014).[14] This work argues

[14] Studies of the relationship between Eurodollar rates and Treasury yields are almost as old as the Eurodollar market. Herdershott (1967), for example, examines the response of Eurodollar rates to changes in Treasury bill yields and to other stock and flow effects between the late 1950s and mid-1960s.

that the demand for safe liquid assets is fairly constant, at least in the short run, and that changes in the availability of publicly-issued securities will affect incentives for private parties to issue close substitutes. When the supply of risk-free, liquid government securities falls, for example, the yields on those securities decline both absolutely and relative to yields on the closest substitutes issued by the private sector.

Following this literature, we estimate an empirical pricing model to investigate how changes in the supply of risk-free, liquid government securities and other market and regulatory conditions affected pricing of Eurodollars and negotiable CDs when those securities were first coming into widespread usage during the 1960s and 1970s. Following Greenwood et al. (2015) and Carlson et al. (2014), we use U.S. Treasury bills (T-bills) for the alternative, safe asset, and estimate models of the spreads between market interest rates on Eurodollars and CDs and T-bill yields. T-bills are very liquid and have short maturities and duration, which makes them particularly advantageous to investors seeking to hold safe liquid assets. Short-term negotiable CDs, commercial paper, and other short-term privately-issued securities have similar characteristics, but by being exceptionally liquid and default-risk free, T-bills command a "near-money" premium over such instruments. We expect that increases (decreases) in the supply of Treasury bills increased (reduced) spreads between interest rates on Eurodollars and negotiable CDs and bill yields.

Whereas spreads are likely affected by the changes in the volume of risk-free liquid securities, Nagel (2014) argues that the spreads also depend on the opportunity cost of holding money or non-interest bearing liquid assets. An increase in the opportunity cost of money (reflected in the level of very short-term interest rates) will increase the demand for the next least risky/most liquid interest earning assets (e.g., Treasury bills in our case), and result in a larger spread between interest rates on privately issued money market securities (Eurodollars and negotiable CDs) and T-bill yields. We include the overnight federal funds rate in our model to test whether changes in the opportunity cost of money influenced yield spreads and issuance volumes of Eurodollars and negotiable CDs. We expect that increases (decreases) in the funds rate increased (decreased) yield spreads.

More recently, the pricing of money market instruments has been considered in various contexts. For example, various studies find that the spread between the rates on Eurodollars and Treasury bills (the TED spread) reflected financial market stress during the recent financial crisis (see for instance Stock and Watson 2012). The spread also widened during earlier episodes of stress, such as the Herstatt crisis. However, here we are more interested in the lower-frequency, longer-term determinants of these spreads.

Eurodollars and negotiable CDs were innovations driven by regulation, and it is likely that regulation and changes in regulation strongly influenced market pricing for those instruments. Regulation Q limited the extent to which the interest rates on CDs could rise with market rates on alternative assets. We exclude periods when Regulation Q ceilings were binding, i.e., when secondary market rates on negotiable CDs exceeded the applicable Regulation Q ceilings on large value CDs, from our pricing regressions for CDs. We expect, however, that Regulation Q influenced the Eurodollar market. By limiting the usefulness of negotiable CDs as a funding source, we expect that binding rate ceilings led to increased Eurodollar volumes and yields relative to T-bills.

Market pricing of Eurodollars and negotiable CDs were also likely affected by reserve requirements. Reserve requirements acted as a tax on negotiable CDs and other deposits to which they were applied. Increases in requirements thus reduced banks' willingness to offer CDs and likely narrowed their spread relative to T-bills. At the same time, an increase in reserve requirements on CDs would encourage banks to offer more Eurodollar deposits, which might increase their price relative to T-bills. By the same token, an increase in reserve requirements that applied to Eurodollars—in this case reserve requirements on balances due to foreign branches—should have increased the issuance of negotiable CDs and pushed up their spreads against T-bills. Similar reasoning applies for the way a change in the reserve requirements on deposits due *from* branches of U.S. banks would have affected the negotiable CD market. An increase in this reserve requirement would have made issuing CDs more attractive, increased supply, and therefore increased the spread to T-bills. However, the effect of an increase in the reserve requirement on deposits due from branches of U.S. banks on Eurodollar pricing is uncertain for reasons that reflect the specifics of that market. A higher reserve requirement would have made it less attractive for U.S. banks to issue Eurodollar liabilities which, following the reasoning above, would reduce supply and likely the spread relative to T-bills. However, there is another factor at play. U.S. banks generally paid lower rates to borrow in the Eurodollar market than banks of other countries (Clarke 1983). Thus, if U.S. banks reduced their Eurodollar deposits, the market rate spread could still rise, so the effect of an increase in reserve requirements applicable to deposits due from foreign branches on the spread between market Eurodollar rates and T-bill yields is ambiguous.

To test the hypotheses described above we estimate regressions that use as dependent variables the spreads between the 3-month Eurodollar rate and the yield on 3-month T-bills and between the 3-month negotiable CD rate and the yield on 3-month T-bills. Rates for negotiable CDs and T-Bills are secondary market rates, Eurodollar rates are the going market rates. We calculate the spreads by first calculating the average weekly rate from daily data for each

instrument and then subtracting the weekly T-bill rate from the weekly rate on the private security. See Appendix 1 for additional details about the data.

We regress the money market spreads in week *t* on the federal funds rate prevailing in that week, the ratio of T-bills outstanding to GDP in the previous month *m–1*, the regulations prevailing in week *t*, and an indicator for the Herstatt crisis.[15] The Herstatt crisis was a substantial shock to both the Eurodollar and the negotiable CD markets, boosting risk premiums during the period from when Herstatt Bank failed until the end of the year (June 1974 – December 1974). We deal with the episode in two ways: one specification includes a dummy variable for the crisis period (*Herstatt*) while an alternative specification omits the period from the sample altogether.

$$Spread_t = \alpha + \beta_1 \begin{pmatrix} Fed \\ funds \\ rate_t \end{pmatrix} + \beta_2 \begin{pmatrix} TBills \\ to \\ GDP_{m-1} \end{pmatrix} + \beta_3 Regulations_t + \beta_4 Herstatt_t + \varepsilon_t \quad (1)$$

Regulations include an indicator for whether Regulation Q was binding and the contemporaneous levels of the reserve requirements for large time deposits and deposits due to foreign branches (see Appendix A for details).[16] We estimate the regressions using ordinary least squares. The standard errors are robust and adjusted for serial correlation assuming that errors follow a first-order autoregressive process. The estimation period is from July 1963 to October 1979, which results in approximately 800 observations.

Tables 1 and 2 report the results for Eurodollar and negotiable CD spreads, respectively. We find support for both the hypotheses that spreads increased in response to a higher level of money market rates and fell with greater supply of T-bills. (Though the coefficient on the impact of the supply of T-bills on the spread between negotiable CDs and T-bills is not statistically significant when the Herstatt crisis period is included in the estimation period.) In the Eurodollar spread regression, the coefficient on the (lagged) ratio of T-bills outstanding to GDP of –3.1 implies that a one standard deviation increase in the ratio would narrow the spread between rates on Eurodollars and T-bills by 10 basis points. Similarly, the coefficient of –1.3 on the ratio in specification 2 of Table 2 indicates that a one standard deviation increase in T-bills

[15] Gorton, Lewellen, and Metrick (2012) argue that the demand for safe assets relative to the size of the economy is constant over time. Hence, we scale Treasury bills by GDP. Data on Treasury bills are monthly, i.e., month-end, while nominal GDP is quarterly. We also tried scaling by a narrow money stock measure (M1), which might better reflect the general size of the financial factor. The results of our empirical analysis were similar, if not stronger.

[16] Our indicator for whether Regulation Q was binding is that the secondary market rate for negotiable CDs exceeds the Reg. Q ceiling for the primary market for these securities. Recall that Regulation Q was suspended for negotiable CDs of 90 days or more after May 1973.

to GDP narrows the spread between negotiable CDs and T-bills by 5 basis points. As the spreads typically were about 130 basis points and 70 basis points, respectively, the reductions are modest but economically meaningful. Similarly, the coefficient on the federal funds rate is approximately 0.1 in all specifications, and implies that a one standard deviation decrease in the federal funds rate (about 2 percentage points in this period) would result in a decline in the Eurodollar to T-bill spread and negotiable CD to T-bill spread of about 22 basis points and 18 basis points, respectively. These effects are also clearly economically meaningful. These results are also similar to the finding of Greenwood, Hanson, and Stein (2015) who find similar impacts of changes in the volume of T-bills on the premiums investors are willing to pay to hold four-week T-bills.

As expected, we also find that the Eurodollar to T-bill spread widened when Regulation Q was binding. We do not find a statistically significant relationship between reserve requirements and spreads, however, though all the coefficients have the expected signs. Spreads were decidedly wider during the Herstatt crisis period.

*3.2 Eurodollar and CD Volumes*

We expect that the factors affecting the Eurodollar and CD yield spreads also affected the volumes that banks issued. The literature argues that a reduction in the stock of T-bills outstanding should cause spreads to widen, but also increase issuance of private securities. Increased issuance occurs because increased demand for money market securities pulls down the front end of the yield curve, making it still more attractive for banks to issue at short maturities than at longer ones. Similarly, when the opportunity cost of holding money is higher, the demand for interest-earning safe private money market securities might still be sufficient to induce increased issuance.

Our regressions for Eurodollar and CD volumes include the same regulatory and interest rate variables as in Equation (1). The data on issuance of these instruments are the outstanding amounts of negotiable CDs at large U.S. banks as reported by the Federal Reserve, and amounts of Eurodollar deposits in the United Kingdom and elsewhere in Europe as reported by the Bank for International Settlements (BIS).

We measure issuance as the change in the ratio of the outstanding value of Eurodollar deposits or negotiable CDs relative to U.S. GDP over particular windows. For negotiable CDs, we consider one-month changes in the outstanding amount of negotiable CDs on the last Wednesday of the month for large weekly reporting banks, so that changes are month-end to month-end. Given the relatively high frequency of these data, we examine how conditions at

time *t* affected the change in negotiable CDs between time *t* and time *t+1*. For Eurodollars, we only have quarterly data. We consider several measures of the size of the Eurodollar market. First, we examine changes in the ratio of the dollar liabilities of banks to non-bank entities for nine large European countries relative to U.S. GDP.[17] This series on bank to non-bank liabilities is available quarterly from 1968 to 1979. We also consider the total dollar liabilities of banks in these nine European counties and, as it was the largest market, just in the United Kingdom. These totals are available for a longer period. As with negotiable CDs, we examine how conditions at time *t* affected the change in the ratio of Eurodollars to U.S. GDP between time *t* and time *t+1*.

We expect that regulations reduced the use of affected securities and provided a boost to alternatives. When Regulation Q was binding, outstanding amounts of negotiable CDs likely fell and the amount of Eurodollars issued rose. Given that we are uncertain whether our Regulation Q indicator fully captures the impact of rate ceilings on the use of negotiable CDs, we estimate two specifications: one with an indicator for when Regulation Q was binding, and another that excludes such periods from the estimation. Increases in reserve requirements on a particular type of money market instrument should have put downward pressure on issuance of that type of instrument and lifted amounts issued of the alternative. The effects of Regulation Q and reserve requirements should be less obvious for Eurodollar rates and volumes than for negotiable CDs as the regulations affected only U.S. banks and not other banks that issued Eurodollar deposits.

We also include macroeconomic controls in our regressions. In the case of negotiable CDs, where banks were likely seeking funds to lend to U.S. firms and households, we include a measure of the slope of the shorter end of the yield-curve—specifically, the yield on three-year Treasury securities minus the federal funds rate. Most bank funding is fairly short-term so we focus on the shorter-maturity part of the yield curve. We also include two lags of the growth of industrial production and two lags of the inflation rate. For Eurodollars, the relevant economy is less clear, and so we include year fixed effects rather than U.S. variables as controls. We continue to include a dummy for the Herstatt crisis period.

The regression is then slightly different for Eurodollars, where we use year dummies, than for negotiable CDs, where use economic variables. Otherwise they have the same form:

[17] These countries are West Germany, France, Netherlands, Belgium, Luxembourg, Switzerland, the United Kingdom, Italy, and Sweden.

$$\Delta\left(\frac{Eurodollars}{GDP}\right)_{t-(t-1)} = \alpha + \beta_1\begin{pmatrix} Fed \\ funds \\ rate_{t-1}\end{pmatrix} + \beta_2\begin{pmatrix} TBills \\ to \\ GDP_{t-1}\end{pmatrix} + \beta_3 Regulations_{t-1} + \beta_4 Herstatt_t + \gamma * years + \varepsilon_q \quad (2)$$

$$\Delta\left(\frac{CDs}{GDP}\right)_{t-(t-1)} = \alpha + \beta_1\begin{pmatrix} Fed \\ funds \\ rate_{t-1}\end{pmatrix} + \beta_2\begin{pmatrix} TBills \\ to \\ GDP_{t-1}\end{pmatrix} + \beta_3 Regulations_{t-1} + \beta_4 Herstatt_t + \gamma Economic\ controls_{t-1,t-2} + \varepsilon_t \quad (3)$$

Eurodollar data are quarterly while the negotiable CD data are monthly. For the federal funds rate, we use the average rate over the relevant period. Regulatory controls include whether Regulation Q was binding and the average levels of the reserve requirements. We use ordinary least squares to estimate the regressions. The standard errors are robust and adjusted for serial correlation assuming that the errors follow a first-order autoregressive process. The estimation period for Eurodollars is from either 1964q1 or 1968q4 to 1979q3, while the estimation period for negotiable CDs is from 1965m7 to 1978m12.

Tables 3 and 4 report the results for Eurodollars and negotiable CDs, respectively. We find evidence that a reduction in the outstanding volume of Treasury bills resulted in greater issuance of both money market instruments, which is consistent with previous work on the impact of safe assets on issuance of private securities (Sunderam 2015; Carlson, et al. 2014). The coefficient relating changes in Eurodollars outstanding to the ratio of T-bills to GDP is –69.5 (first column of Table 3), which implies that a one standard deviation decrease in the amount of Treasury bills outstanding relative to GDP caused an increase in the ratio of Eurodollars issued to non-banks relative to U.S. GDP of 0.2 percentage points over the next quarter. For our sample period, the typical quarterly change was 0.15 percentage points and the average ratio of Eurodollars to GDP was 5.2 percent. Thus, the response of banks to shifts in the availability of Treasury bills appears to have been economically meaningful. The corresponding coefficient of –92.9 for negotiable CDs shown in Table 4 implies that a one standard deviation decrease in the amount of Treasury bills outstanding caused an increase in the ratio of negotiable CDs (to quarterly GDP) of 0.3 percentage points over the next month. The typical monthly change was 0.05 percentage points, so the response here was quite large as well. We find that the federal funds rate also affected the issuance of negotiable CDs. The coefficient of 1.2 in specification 1 of Table 4 means that a one standard deviation increase in the federal funds rate (about 2 percentage points) led to an increase in the ratio of negotiable CDs to GDP over the next month of 0.34 percentage points, or about the same size as the impact of one-standard deviation

decrease in T-bills outstanding. These findings are similar to those of Sunderam (2015) who studies the impact of changes in T-bill supply on issuance of the asset-backed commercial paper. Thus, we find that pricing and outstanding volumes of Eurodollars and negotiable CDs in the early years of these markets responded similarly to changes in the relative availability of safe assets as has been found for modern money markets.

We find that regulations affected the issuance of the money market instruments as well. When Regulation Q was binding for negotiable CDs, Eurodollar issuance was larger.[18] The issuance of negotiable CDs tended to increase more rapidly and Eurodollars more slowly when reserve requirements were relatively high for balances due to foreign branches of U.S. banks. We find some indication that increases in reserve requirement on CDs caused declines in Eurodollar issuance relative to U.S. GDP, though the reason for this is not clear. With respect to the macroeconomic variables, we detect no consistent impact of industrial production growth on CD issuance, but that issuance tended to respond negatively to rising inflation.

**Section 4. Changes in Bank Liability Structure**

In the previous section, we found that that issuance of both negotiable CDs and Eurodollars rose when T-bills became relatively scarce. In this section, we examine other parts of bank liability structures to determine whether the increased use Eurodollars and negotiable CDs was part of a general expansion of bank balance sheets or simply a substitution away from other liabilities. This distinction has important financial stability implications as it indicates whether changes in the supply of public short-term securities affect bank preferences for leverage or the maturity profile of their liabilities and, hence, the potential for maturity mismatches.[19] Given available data, we focus more on how parts of bank balance sheets moved with respect to changes in the volume of negotiable CDs; since negotiable CDs were *de facto* unavailable as a funding source when regulation Q was binding, we drop those periods from the analysis.

We first investigate whether total bank liabilities responded to changes in T-bill supply, controlling for the level of the federal funds rate, reserve requirements, and macroeconomic conditions. As shown in Table 5, we find little evidence that changes in the volume of T-bills

[18] Evidence suggesting an ability to use alternative sources of funds when Regulation Q was binding is consistent with Koch (forthcoming), who finds that the effects of Regulation Q interest rate ceilings were smaller, though still important, for larger banks.

[19] Stein (2012) makes a similar argument in the context of monetary policy. He notes that when the Federal Reserve purchases large amounts of longer-maturity Treasury securities and provides the financial system reserves that trade in short-term markets then term premia can fall and encourage banks to rely more on longer-term financing. He argues that this shift should promote financial stability.

outstanding (relative to GDP) affected total bank liabilities (also scaled by GDP). Further, we find no statistically significant effect from any other of our explanatory variables. Of course, total bank liabilities may have respond over a longer horizon than is captured by our short-run model.

If banks issued more negotiable CDs when T-bills were scarce and their total liabilities were unchanged, then banks must have reduced other types of liabilities. To explore how the structure of bank liabilities changed in response to changes in the volume of T-bills, we consider four liability categories: i) negotiable CDs; ii) demand deposits of individuals, partnerships and corporations, savings banks, and foreign banks, as well as federal funds bought; iii) other demand deposits (largely of governments and other commercial banks); and iv) time deposits other than negotiable CDs. We examine whether the ratios of these liability categories to total bank liabilities responded to either the level of interest rates or supply of T-bills. The results, reported in Table 6, indicate that negotiable CDs declined as a share of total bank liabilities when the supply of T-bills rose, while other categories of liabilities increased.

These movements are consistent with the conclusion of Gorton, Lewellen, and Metrick (2012) that since the 1950s, demand deposits at banks and money market instruments have been substitutes (although that study focuses on longer-run trends in annual data rather than the shorter-run responses noted here). The evidence from Section 3 suggests that changes in the supply of safe short-term public debt affected the pricing and supply of Eurodollars and negotiable CDs. Here we find that changes in the supply of T-bills had a stronger influence on the composition of bank liabilities, and thus on the amount liquidity risk, than on total bank liabilities or leverage. We also find that banks issued more negotiable CDs and fewer other time deposits when short-term interest rates rose. Finally, we find some indication that the structure of bank liabilities responded fairly quickly to economic activity. CDs became a smaller portion of banks' liability base when inflation rose. By contrast, negotiable CDs rose but other time deposits declined when the growth of industrial production increased.

## Section 5. Money Market Integration and Monetary Policy

In this section we consider how interest rates in the negotiable CD market and the Eurodollar market were linked to the effective federal funds rate. We start by examining the extent to which changes in the federal funds rate were co-integrated with changes in the other market rates during our sample period. We then consider the implications for the size of Federal Reserve (Fed) actions and associated changes in the federal funds rate.

### *5.1. Correspondence of changes in the federal funds rate and other rates*

We expect that the removal of interest rate ceilings and the adoption of more uniform reserve requirements reduced many of the wedges between the federal funds market and other money markets in which banks were active borrowers. We thus examine whether changes in the rates on Eurodollars and negotiable CDs were more closely linked to changes in the federal funds rate after Regulation Q ceilings on negotiable CDs were removed in May 1973.

The explanatory power of the first principal component of changes in the three interest rates provides a measure of market integration. We find that the first principal component explains 48 percent of the variance of week-to-week changes in the rates in the early period and 64 percent in the later period. That a single factor explains more of the changes in the different interest rates suggest that the markets increasingly moved together.

Co-integration tests provide additional evidence of the relationship between rates on Eurodollars, negotiable CDs, and federal funds. Following Engle and Granger (1987), we estimate a long-run equilibrium equation, test for stationarity of the residuals, and then estimate an error-correction model. Over the longer-run, interest rates in these markets should behave similarly as they are all short-term bank funding instruments; however, there may be short-run market specific factors that lead to temporary deviations. The error correction analysis indicates the degree to which changes in the federal funds rate explain changes in the other interest rates and the pace of convergence to the longer run relationship.[20] For the long-run relationship, we estimate:

$$\begin{pmatrix} money \\ market \\ rate \end{pmatrix}_t = \alpha_1 + \beta_1 \begin{pmatrix} fed \\ funds \\ rate \end{pmatrix}_t + \mu_t \qquad (4)$$

The error correction model is then:

$$\Delta \begin{pmatrix} money \\ market \\ rate \end{pmatrix}_{t-(t-1)} = \alpha_2 + \delta_1 \Delta \begin{pmatrix} money \\ market \\ rate \end{pmatrix}_{(t-1)-(t-2)} + \delta_2 \Delta \begin{pmatrix} fed \\ funds \\ rate \end{pmatrix}_{(t-1)-(t-2)} + \delta_3 * (\mu)_{t-1} + \varepsilon_t \qquad (5)$$

We perform the co-integration tests using weekly interest rates for two periods: i) June 1963 to May 1973 and ii) May 1973 to October 1979 (before and after deregulation). As before, for the negotiable CD rate, we exclude periods when Regulation Q was binding.

[20] One might also expect that the Fed discount rate strongly influences the relationship. To control for any such impact, we created adjusted rates by subtracting the discount rate from the federal funds rate, the Eurodollar rate, and the CD rate. Repeating the analysis here using these adjusted rates produced similar results.

The results, shown in Table 7, indicate that the markets were co-integrated in both periods. We are interested in whether the impact of changes in the federal funds rate on changes in the Eurodollar rates and negotiable CD rates increased after May 1973. The error correction model estimates indicate that the impact was, indeed, stronger in the later period, as the coefficient on lagged changes in the federal funds rate increases from –.03 to .23 for Eurodollars and from .02 to .16 from negotiable CDs. The coefficient on the lagged error term also increases in magnitude from the first period to the second period, indicating that convergence toward the long-run relationship was faster after deregulation. Like the principal component analysis, these results suggest that the markets were more integrated after deregulation.[21]

Our finding that Eurodollar rates were more closely integrated with the federal funds rate after 1973 is consistent with assertions of contemporary observers and earlier researchers who described the federal funds market as actively anchoring the Eurodollar market by the mid-1970s. The results also support Kreicher (1982), who argues that the corridor in which the Eurodollar rate could fluctuate without resulting in arbitrage opportunities between Eurodollars and CDs narrowed substantially in 1973-74.[22]

*5.2 Open Market Operations and changes in the Federal Funds rate*

Next we investigate how deregulation may have affected the relationship between changes in the supply of bank reserves and the federal funds rate. Consider the following simplistic scenario: If the Fed sought to tighten policy, it could do so by engaging in open market operations, such as selling Treasury securities, to reduce the supply of bank reserves. With a smaller supply of reserves, banks that routinely borrowed in the federal funds market would compete more for those funds and push up the federal funds rate. If money markets become more integrated, allowing banks to more easily turn to a different funding market, then a larger reduction in the supply of reserves would be required to produce a given size response in the federal funds rate.

There is some question about the degree to which the Fed targeted the federal funds rate in the 1960s and 1970s. Early in the period, the Fed may have used the funds rate more as a

[21] As yet another indicator of the integration of markets, we conducted Granger causality tests of changes in the federal funds rate and the money market rates for our two sub-periods. In this approach, which allows the federal funds rate to both affect and be affected by other rates, we again find that the relationships between different interest rates was much stronger in the later period than in the earlier period.

[22] Interestingly, Duffee (1996) finds that in the early 1980s, shortly after our sample period ends, yields on Treasury-bills begin to move more idiosyncratically and becomes less connected to the rest of the Treasury yield curve.

guidepost, along with other interest rates and qualitative indicators, than as a formal target. However, by the 1970s, the federal funds rate was clearly among the Fed's main targets, if not the only target. According to Meek and Thunberg (1971, p. 80), the FOMC's directives "meant that the Manager [of the open market desk] would begin by seeking to hold mainly the following within ranges designated by the Committee: the federal funds rate, member bank borrowings from the Reserve Banks, and free or net borrowed reserves…." Similarly, Axilrod (1971, p. 10) argues that the framework in place since the late 1960s meant that open market operations were importantly connected to the federal funds rate: "The net reserve position and the federal funds rate are basic elements of money market conditions influencing the Manager's day-to-day decisions as to whether to buy or sell securities." For the first part of our analysis, we are interested in the impact of Fed operations on the federal funds rate, regardless of whether it was the Fed's target or a merely a guidepost in achieving goals. In subsequent analysis below, however, we are decidedly interested in the federal funds rate specifically as a target.

First, we test whether the federal funds rate was less responsive to Fed actions after markets became more integrated in the 1970s. We estimate the impact of the Fed's open market operations on the federal funds rate using, alternatively, changes in the Fed's government securities holdings (both outright and via repurchase agreements) and changes in non-borrowed reserves as the measure of open market operations. (See, for instance, Christiano and Eichenbaum (1991) for evidence linking changes in non-borrowed reserves to changes in the federal funds rate.) For each, we use changes from week *t-1* to week *t* divided by the average amounts in weeks *t-5* to *t-2;* this procedure adjusts for growth in the balance sheet of the Fed over time.[23] We estimate separate regressions for June 1963 to May 1973 and June 1973 to October 1979 to account for the suspension of Regulation Q ceilings on large CDs in May 1973. The change in Fed operating procedures in October 1979 provides an obvious end point for our analysis. Our regressions control for a variety of other factors that might affect the federal funds rate, such as changes in the Fed's discount rate, whether Regulation Q was binding, and changes in the reserve requirements applicable to negotiable CDs and to balances due from foreign branches. We include contemporaneous changes in the discount rate as these should have had an immediate effect on pricing (in part because of the signal they provided about monetary policy intentions). It may take a few days for banks to react to changes in reserve requirements, so we used lagged changes (by one week) in these variables. For the early period, we also interact our measure of open-market operations with the indicator for whether Regulation Q was binding. If our hypothesis is correct, when Regulation Q was binding and the ability of the

[23] Alternatively, using log differences in holdings of government securities or in non-borrow reserves yields similar results.

banks to substitute into negotiable CDs was reduced, the Fed's actions should have had a stronger impact on the federal funds rate. The regression then takes the form:

$$\Delta\begin{pmatrix} fed \\ funds \\ rate \end{pmatrix}_{(t+1)-t} = \alpha + \beta_1 \Delta \begin{pmatrix} Disc \\ rate \end{pmatrix}_{(t+1)-t} + \beta_2 \Delta(OMO)_{t-(t-1)} + \beta_3 \Delta(regulations)_{t-(t-1)} + \beta_4 \left(\Delta OMO_{t-(t-1)} * \Delta regulations_{t-(t-1)}\right) + \varepsilon_t \quad (6)$$

We estimate the regression using ordinary least squares with robust standard errors.

In testing for differences in the responsiveness of the federal funds rate to actions by the Fed, we benefit from the fact that in the 1960s and 1970s the Fed did not announce changes in its target for the federal funds rate. Thus, changes in the funds rate were driven by the Fed's actual open market operations more than they might be now that FOMC communications and market expectations about policy play a large role in the implementation of monetary policy.

The results, reported in Table 8A (government securities holdings) and Table 8B (non-borrowed reserves), suggest that larger open-market operations were required to induce a given size change in the federal funds rate after money markets had become more integrated following deregulation. For instance, when looking at the impact of a change in the Fed's government securities holdings on changes in the federal funds rate, the coefficient declines in absolute value from –9.9 before deregulation to –1.3 after deregulation, which implies that a given change in securities holdings resulted in a change in the federal funds rate roughly 1/8$^{th}$ the size as before. Moreover, we find some evidence that open market operations had an even greater impact on the federal funds rate at times when Regulation Q was binding during the earlier period. Our control variables also behave as expected. When reserve requirements were increased (decreased), which would have affected the incentives for banks to substitute into other money markets, there was an associated increase (fall) in the federal funds rate.

Next, we investigate whether the magnitude of the impact of open market operations on the funds rate depended on the prevailing levels of reserve requirements. When reserve requirements on various money market instruments were higher, a larger change in the federal funds rate was likely required before a bank that typically borrowed in the federal funds market would find it attractive to turn to an alternative funding source. Thus, when reserve requirements were higher and there was less substitutability across markets, a given size open-market operation would induce a larger change in the federal funds rate than when reserve requirements were lower.

To test whether the impact of open market operations on the federal funds rate depended on the level of reserve requirements, we must account for the fact that the reserve requirements applicable to negotiable CDs and to balances due to foreign branches differed in levels and were sometimes changed in opposite directions. Thus, we construct time period dummies for different levels of the relevant reserve requirements and interact open-market operations with these dummies. This procedure allows open-market operations to affect the federal funds rate differently in each period while the coefficients on the other independent variables are constrained to be constant over time.

The results, shown in Table 9, indicate that that the funds rate did respond more strongly to the Fed's actions when reserve requirements were higher. For instance, when both the reserve requirement applicable to negotiable CDs and the reserve requirement applicable to due to foreign branches were set at 8 percent, or when reserve requirements on balance due to foreign branches were high, the federal funds rate was very responsive to open-market operations (the coefficients are relatively large in absolute value at –5.8 and –9.7, respectively). By contrast, when reserve requirements on negotiable CDs and due to foreign branches were 6 and 4 percent, respectively—relatively low compared to other periods—the federal funds rate was less responsive to open-market operations (the coefficients are notably smaller in magnitude at –1.0 and –0.47, and are not statistically different than zero).

*5.3 Deviations from Target*

It is worth noting that a greater impact of open market operations on the federal funds rate does not necessarily mean that the Fed was better able to hit its target for the funds rate. We reviewed the historical record to determine the Federal Open Market Committee's intended target for the federal funds rate.[24] Starting in 1967, the Memoranda of Discussion refer to specific levels of the federal funds rate that FOMC members viewed as consistent with their desired amount of restraint or ease on money market conditions. We take these references as indicating that policymakers viewed the funds rate as an instrument for implementing policy, rather than merely an indicator of market conditions. We do not find the same degree of specificity in the record before 1967, and so do not include those years in our comparison of the actual or "effective" funds rate with the FOMC's desired rate.

[24] Specifically, we reviewed the "Memoranda of Discussion" and meeting transcripts for descriptions by the Manager of the System Open Market Account of the funds rate target and the preferences of the Open Market Committee about the target. In some cases the Committee members refer to the alternatives suggested by the staff rather than stating numbers themselves; in this case we use the targets provided in the Bluebook. Where a range for the funds rate is provided, we use the mid-point for the range unless the Committee members specified clearly that they preferred a particular point in that range.

The difference between the effective funds rate in the market and the Fed's target rate is shown in Figure 3. As shown in Table 10, the average absolute difference between the effective funds rate and the target rate was higher in the earlier period (21 basis points) than in the later period (15 basis points). The larger average deviations in the early period are due entirely to months when Regulation Q was binding; outside those periods the average deviations were similar in the two periods. This is apparent in Figure 3, where shaded regions indicate months when Regulation Q was binding. The bulk of the deviations between the actual and intended rate occurred in late 1969 and early 1970 when Regulation Q was particularly binding.

A possible reason for the larger deviations when Regulation Q was binding is that the reduced ability to use the negotiable CD market as a marginal source of funding meant that banks had to rely more on the federal funds market, causing the regular relationships between excess reserves and the federal funds rate to break down. For example, Axilrod (1971) notes that Federal Reserve actions to influence bank reserves and interest rates caused larger and more immediate adjustments of bank balance sheets than usual when Regulation Q ceilings were binding. Conceivably, the more intense response could have made calibrating the appropriate size of Federal Reserve operations more difficult which might explain why deviations between the effective and intended funds rate were larger at those times. [25]

**Section 6. Conclusion**

Regulations on bank liabilities, such as reserve requirements and interest rate ceilings, strongly influenced the development of new money market instruments and the composition of bank liabilities in the 1960s and 1970s. In this paper we investigate the behavior of these new instruments, including the responsiveness of their market pricing and issuance volumes to changes in regulation, the supply of Treasury bills, and the opportunity cost of holding money. Further, we examine how the presence of these markets and their regulation affected the Fed's ability to influence the federal funds rate.

We find that the pricing and use of the new instruments were strongly related to other drivers of near-money premiums. Similar to the work of Greenwood, Hanson, and Stein (2015) and Carlson et al. (2014), we find that reduced availability of short-term safe public assets, specifically Treasury bills, increased the spreads between the rates on the new instruments and

[25] Of course, the FOMC may have been less concerned about hitting a particular funds rate target at different times, especially early in the sample period when it was first starting to discuss specific target values in its meetings. Nonetheless, our findings show that deviations from target were similar outside of months when Regulation Q was binding. For whatever reason, the FOMC was either unable or unwilling to take actions to control the funds rate as tightly during those months.

Treasury bill yields, but at the same time tended to boost their issuance. We also find, similar to Nagel (2014), that spreads increased when short-term interest rates rose. Thus, even when the Eurodollar and negotiable CD markets were in their infancy, they behaved as predicted by modern theories of financial market pricing.

These findings have important lessons for financial stability and monetary policy. The shadow banking system relies substantially on near-money instruments, such as asset-backed commercial paper and financial commercial paper, as a source of funding. Factors that affect the use and pricing of these near-money securities thus matter for financial stability and the distribution of risks across the financial system. We find that the level of the short-term interest rates affects near-money premia. Thus, when interest rates are low, financial system regulators should be most alert to increased reliance on near-money instruments and the potential for that to increase maturity mismatches. We also find that the supply of high-quality short-term securities, in particular Treasury bills, affects the pricing and use of money market instruments. As it explores options for an exit from exceptionally low interest rates, the Federal Reserve has experimented with offering term deposits to banks and overnight reverse repurchase agreements (ON-RRPs) to banks and non-bank counterparties (Ihrig, Meade, and Weinbach 2015). Extensive use of such instruments, which are risk-free short-term securities, could substantially affect near-money premia, and thus private sector issuance of money market securities (Stein 2012).

We also find that development of new funding market instruments can affect the implementation of monetary policy. When regulations created greater segmentation of money markets, the Federal Reserve could influence the federal funds rate with smaller balance sheet adjustments, but at the same time, the Fed's operations had less pass through to other funding markets (as shown in Tables 7 – 10). When the regulations were lifted, larger balance sheet adjustments by the Federal Reserve were required to influence the federal funds rate but these effects had greater impact on other funding markets.

These latter findings suggest that the central bank's ability to control a particular interest rate is affected both by the depth of the market in which it seeks to operate and the integration of that market with other financial markets. Further, regulations that place a wedge between different segments of the money market can reduce the ability of the monetary authority to influence funding conditions.

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**Appendix A: Data and sources**

Data on interest rates include the effective federal funds rate, the secondary market rate for 3-month negotiable CDs, the rate in secondary markets for 3-month T-bills, and the rate on Eurodollar deposits, and the yield on the 3-year constant maturity Treasury. Where possible, we use daily data on interest rates and average available observations for the week (ending Wednesday) to come up with our weekly series. In some cases, such as for the negotiable CD data in the early part of the sample, only one observation is available per week; in those cases that observation comprises our weekly average. Data on 3-month negotiable CD rates, 3-month T-bill yields, the yield on the 3-year constant maturity Treasury security, and the Federal Reserve discount rate are from the Federal Reserve's H.15 statistical release. Eurodollar rates are from the BIS.

Information on the target federal funds rate comes from the FOMC's "Memoranda of Discussion" and Bluebooks (http://www.federalreserve.gov/monetarypolicy/default.htm).

Data on the volume of Eurodollars outstanding are from BIS international banking statistics as reported in the BIS Annual Report or "Statistics of Euro-Currencies" releases. We use total U.S. dollar liabilities and liabilities to the non-bank sector of banks located in the U.K. or in other selected European countries.

Data on balance sheets of large U.S. banks are from the Federal Reserve's *Banking and Monetary Statistics*. Data are available for "Large Commercial Banks" on a weekly basis starting in July 1965. Large negotiable CDs are a memo item that is a subset of time deposits. Demand deposits and due to banks include total demand deposits, federal funds bought, and "other borrowings." The remaining category, other liabilities, is comprised mainly of time deposits.

Federal Reserve balance sheet data, data on required and excess reserves, and data on end of month Treasury bills outstanding are from the Federal Reserve's *Banking and Monetary Statistics* and subsequent statistical annuals.

Data on quarterly GDP and M1 are from Federal Reserve Economic Data (FRED). For M1, we use the non-seasonally adjusted series.

Information on Regulation Q is from Ruebling (1970) for the period until 1970. We use the ceiling on single maturity deposits of $100,000 or more with a maturity of 90-179 days (or of the category that would include such a liability). After 1970, we follow the description in Cook (1978). We consider regulation Q to be binding if the rate in the secondary market on three-month negotiable CDs equals or exceeds the regulation Q ceiling.

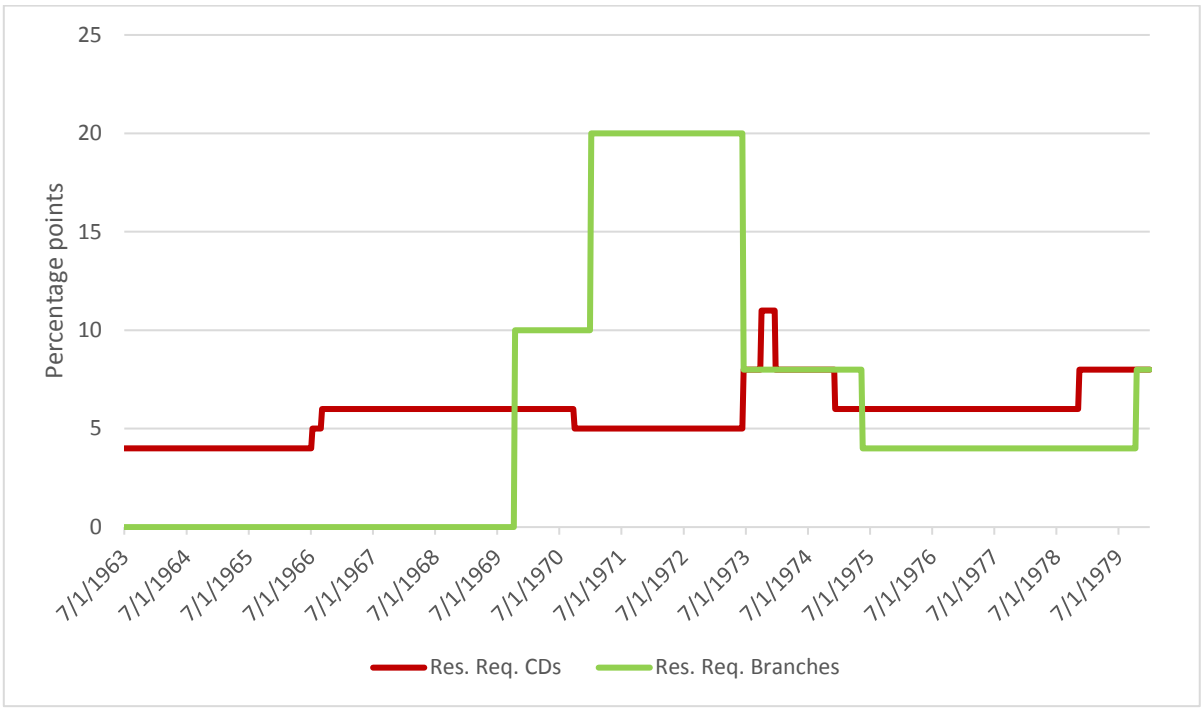
Information on reserve requirements are from Feinman (1993), Kreicher (1982), and the Federal Reserve (http://www.federalreserve.gov/monetarypolicy/reservereq.htm). For reserve requirements on negotiable CDs, we use the series for time deposits of more than $5 million with a maturity of 30-179 days (where applicable). Reserve requirements on "due from foreign branches" were uniform for all such liabilities.

The Herstatt crisis period lasts from June 26, 1974 until Dec. 31, 1974.

Figure 1
Interest rates and the Regulation Q ceiling

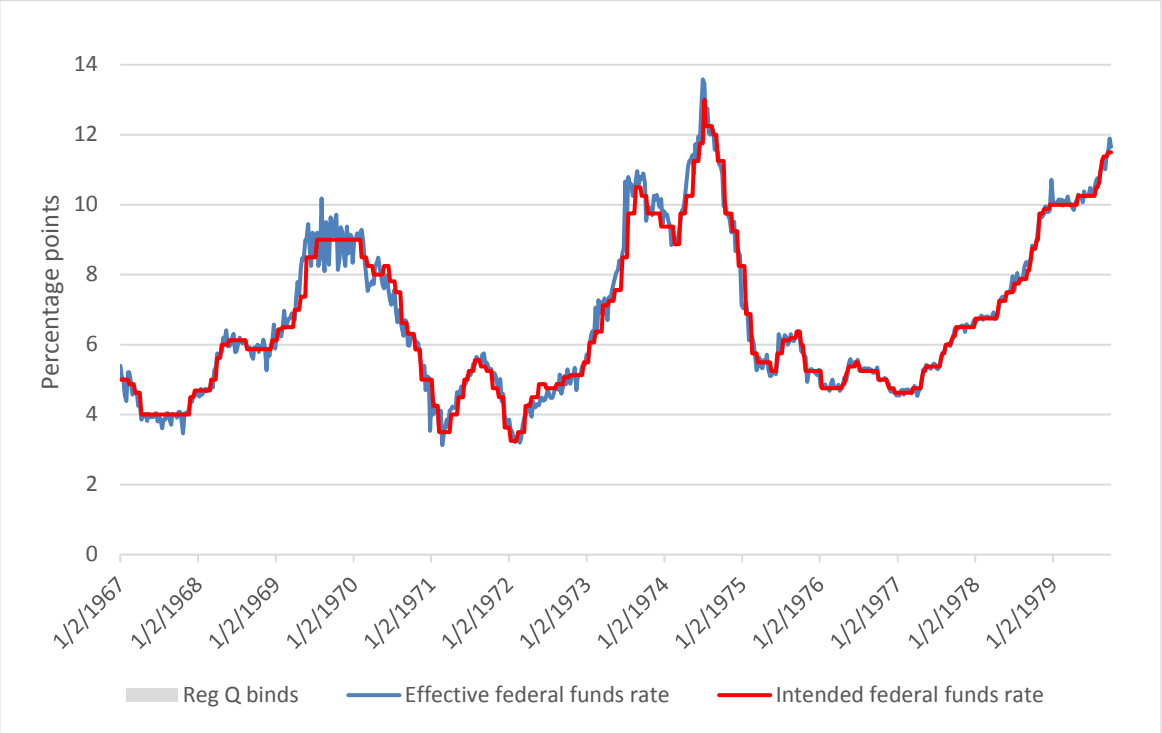

Source: see Appendix A.

Figure 2
Evolution of reserve requirements affecting CDs and Eurodollars




Source: see Appendix A

Figure 3
Actual and intended federal funds rates




Source: see Appendix A

Table 1
Factors affecting the Eurodollar spread

Dependent variable: spread between the interest rates for 3-month Eurodollars and for 3-month T-bills

| | Specification 1<br><br>(Herstatt crisis period included) | Specification 2<br><br>(Herstatt crisis period excluded) |
|---|---|---|
| Federal funds rate | .11***<br>*(.03)* | .10***<br>*(.03)* |
| Ratio T-bills to GDP (lagged) | -3.10***<br>*(1.18)* | -3.57***<br>*(1.09)* |
| Reg. Q binds | .15**<br>*(.08)* | .15**<br>*(.07)* |
| Reserve Req. on CDs | .04<br>*(.04)* | .05<br>*(.04)* |
| Reserve Req. on due from branches | .01<br>*(.01)* | .01<br>*(.01)* |
| Herstatt crisis | .59***<br>*(.19)* | |
| Constant | 1.59***<br>*(.55)* | 1.72***<br>*(.53)* |
| Rho (serial correlation coef.) | .94 | .94 |
| Observations | 800 | 773 |
| F-stat | 7.32 | 9.25 |
| Adjusted $R^2$ | .04 | .05 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are weekly and cover the period from July 1963 to October 1979; data on T-Bills outstanding are available monthly and divided by quarterly GDP. See the Appendix 1 for data sources.

Table 2
Factors affecting the Negotiable CD spread

Dependent variable: spread between the interest rates for 3-month negotiable CDs and for 3-month T-bills

| | Specification 1<br><br>(Herstatt crisis period included) | Specification 2<br><br>(Herstatt crisis period excluded) |
|---|---|---|
| Federal funds rate | .09***<br>*(.02)* | .08***<br>(.02) |
| Ratio T-bills to GDP (lagged) | -.80<br>*(.83)* | -1.28*<br>(.70) |
| Reserve Req. on CDs | -.01<br>*(.03)* | .02<br>(.03) |
| Reserve Req. on due from branches | .002<br>*(.009)* | .005<br>(.007) |
| Herstatt crisis | .41***<br>*(.12)* | |
| Constant | .56<br>*(.40)* | .56*<br>(.33) |
| Rho (serial correlation coef.) | .95 | .94 |
| Observations | 634 | 607 |
| F-stat | 7.5 | 12.8 |
| Adjusted $R^2$ | .05 | .07 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are weekly and cover the period from June 1964 to October 1979; data on T-Bills outstanding are available monthly and divided by quarterly GDP. Periods when Regulation Q was binding are excluded from the analysis. See the Appendix 1 for data sources.

Table 3
Factors affecting size of the Eurodollar market (relative to US GDP)

Dependent variable: change in the ratio of the size of the Eurodollar market to US GDP

| | European Eurodollar market (due to non-banks) | European Eurodollar market (all liabilities) | UK Eurodollar market (all liabilities) |
|---|---|---|---|
| Average Federal funds rate | .2<br>*(.6)* | .1<br>*(2.6)* | -1.6<br>*(1.3)* |
| Ratio T-bills to GDP | -69.5*<br>*(38.4)* | -446.5***<br>*(124.2)* | -141.7**<br>*(67.0)* |
| Reg. Q was binding during the quarter | 8.4*<br>*(5.4)* | -6.9<br>*(7.1)* | .5<br>*(3.6)* |
| Average reserve Req. on CDs | -3.2*<br>*(1.6)* | -.2<br>*(6.5)* | 4.5<br>*(3.4)* |
| Average reserve Req. on due from branches | -.4*<br>*(.2)* | -1.5<br>*(1.1)* | .2<br>*(.6)* |
| Herstatt crisis | -20.0<br>*(7.1)* | -65.4**<br>*(27.6)* | -27.9*<br>*(15.1)* |
| Constant | 34.4**<br>*(16.8)* | 150.4***<br>*(51.3)* | 102.3<br>*(24.4)* |
| Year dummies | Yes | Yes | Yes |
| Rho (serial correlation coef.) | -.66 | -.16 | -.48 |
| Observations | 44 | 62 | 62 |
| F-stat | 4.5 | 2.7 | 4.0 |
| Adjusted $R^2$ | .56 | .37 | .51 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are quarterly and cover the period from December 1968 (column 1) or March 1964 (columns 2 and 3) to October 1979. See the Appendix 1 for data sources.

Table 4
Factors affecting the growth of the negotiable CD market

Dependent variable: change in the ratio of the size of negotiable CDs to US GDP

| | Specification 1<br><br>(Includes periods when Reg. Q was binding) | Specification 2<br><br>(Excludes periods when Reg. Q was binding) |
|---|---|---|
| Average Federal funds rate | 1.2*<br>*(.66)* | 1.4**<br>*(.72)* |
| Ratio T-bills to GDP | -92.9***<br>*(34.5)* | -98.4***<br>*(34.0)* |
| Reg Q binds | -2.3*<br>*(1.4)* | |
| Average reserve Req. on CDs | .58<br>*(.84)* | -.25<br>*(.92)* |
| Average reserve Req. on due from branches | .21**<br>*(.09)* | .09<br>*(.10)* |
| Herstatt crisis | -.03<br>*(3.2)* | -.38<br>*(3.1)* |
| Short-term yield curve (lagged 1 month) | 1.3<br>*(.99)* | .77<br>*(1.1)* |
| Growth in IP (lagged 1 month) | -.18<br>*(.41)* | -.35<br>*(.43)* |
| Growth in IP (lagged 2 months) | .49<br>*(.41)* | .64<br>*(.44)* |
| Inflation rate (lagged 1 month) | -4.2*<br>*(2.1)* | -5.0**<br>*(2.3)* |
| Inflation rate (lagged 2 months) | -4.1*<br>*(.41)* | -4.3*<br>*(2.3)* |
| Constant | 27.5**<br>*(12.5)* | 35.6***<br>*(12.3)* |
| Month dummies | Yes | Yes |
| Rho (serial correlation coef.) | .22 | .13 |
| Observations | 161 | 123 |
| F-stat | 7.0 | 7.3 |
| Adjusted $R^2$ | .45 | .52 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are monthly and cover the period from July 1965 to December 1978. See the Appendix 1 for data sources.

Table 5
Factors affecting the growth of total bank liabilities

Dependent variable: change in the ratio of the size of bank liabilities to US GDP

| | Change in all bank liabilities |
|---|---|
| Average Federal funds rate (lagged) | -.69<br>*(1.65)* |
| Ratio T-bills to GDP (lagged) | -8.6<br>*(72.2)* |
| Average reserve Req. on CDs | .28<br>*(2.3)* |
| Average reserve Req. on due from branches | -.09<br>*(.21)* |
| Herstatt crisis | -9.6<br>*(6.9)* |
| Short-term yield curve (lagged 1 month) | -3.0<br>*(2.7)* |
| Growth in IP (lagged 1 month) | 1.4<br>*(1.4)* |
| Growth in IP (lagged 2 months) | -2.0<br>*(1.4)* |
| Inflation rate (lagged 1 month) | 1.3<br>*(7.9)* |
| Inflation rate (lagged 2 months) | -7.8<br>*(7.3)* |
| Constant | 28.1<br>*(26.1)* |
| Month dummies (January omitted) | Yes |
| Rho (serial correlation coef.) | -.41 |
| Observations | 123 |
| F-stat | 15.1 |
| Adjusted $R^2$ | .71 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are monthly and cover the period from July 1965 to December 1978. See the Appendix 1 for data sources.

Table 6
Factors affecting distribution of bank liabilities

Dependent variable: change in the ratios of different bank liabilities to total bank liabilities

| | Change in CDs | Change in selected demand deposits | Chang in other demand deposits | Change in time deposits (ex. CDs) |
|---|---|---|---|---|
| Average Federal funds rate (lagged) | .12** *(.05)* | -.03 *(.06)* | -.02 *(.06)* | -.08* *(.05)* |
| Ratio T-bills to GDP (lagged) | -6.1*** *(2.4)* | 4.5* *(2.4)* | .76 *(2.8)* | 4.7** *(2.1)* |
| Average reserve req. on CDs | -.09 *(.07)* | .06 *(.08)* | -.02 *(.09)* | .04 *(.07)* |
| Average reserve req. on due from branches | .003 *(.007)* | .01 *(.007)* | -.004 *(.008)* | -.003 *(.006)* |
| Herstatt crisis | .05 *(.22)* | -.24 *(.23)* | -.14 *(.27)* | .25 *(.20)* |
| Short-term yield curve (lagged 1 month) | .03 *(.08)* | -.02 *(.09)* | -.01 *(.11)* | -.05 *(.08)* |
| Growth in IP (lagged 1 month) | -.03 *(.03)* | .11** *(.04)* | .02 *(.05)* | -.07* *(.04)* |
| Growth in IP (lagged 2 months) | .06* *(.03)* | -.07 *(.05)* | -.08 *(.05)* | -.02 *(.04)* |
| Inflation rate (lagged 1 month) | -.34* *(.18)* | .16 *(.26)* | .15 *(.31)* | -.008 *(.23)* |
| Inflation rate (lagged 2 month) | -.32* *(.17)* | .02 *(.24)* | .08 *(.29)* | .16 *(.21)* |
| Constant | 2.4*** *(.86)* | -3.4*** *(.88)* | -.40 *(1.01)* | -.02 *(.78)* |
| Month dummies | Yes | Yes | Yes | Yes |
| Rho (serial correlation coef.) | .03 | -.37 | -.44 | -.45 |
| Observations | 123 | 123 | 123 | 123 |
| F-stat | 3.1 | 7.3 | 1.2 | 7.1 |
| Adjusted $R^2$ | .26 | .52 | .04 | .50 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. January is omitted from the month dummies. Data are monthly and cover the period from July 1965 to December 1978. Selected demand deposits include demand deposits by individuals, partnerships, and corporations, demand deposits by foreign banks, demand deposits by savings banks, federal funds purchased, and "other borrowings." See the Appendix 1 for other information regarding the data sources.

Table 7
Co-integration tests of the federal funds rate and other interest rates

| | Eurodollar rates | | Negotiable CD rates | |
|---|---|---|---|---|
| | Before May 1973 | After May 1973 | Before May 1973 | After May 1973 |
| Long run relationship: dependent variable is the level of the interest rate | | | | |
| Federal funds rate | 1.03***<br>*(.018)* | .99***<br>*(.01)* | .78***<br>(.02) | .92***<br>(.01) |
| Constant | .98***<br>(*.10)* | .70***<br>*(.10)* | 1.38***<br>(.09) | .75***<br>(.08) |
| Observations | 468 | 332 | 302 | 332 |
| Adjusted $R^2$ | .87 | .95 | .82 | |
| Augmented Dickey-Fuller Test statistics (using MacKinnon critical values) | | | | |
| | -7.4**** | -6.2*** | -6.6*** | -11.7*** |
| Error correction model: dependent variable is the change in the money rate | | | | |
| Change in dependent variable (lagged) | .25***<br>*(,04)* | .28***<br>(.05) | .51***<br>(.05) | .45***<br>(.05) |
| Change in the federal funds rate (lagged) | -.03<br>*(.03)* | .23***<br>(.05) | .02<br>(.02) | .16***<br>(.04) |
| Error term from long run (lagged) | -.10***<br>*(.02)* | -.16***<br>(.03) | -.07***<br>(.02) | -.11***<br>(.02) |
| Constant | .007<br>*(.01)* | .009<br>(.01) | .004<br>(.005) | .01<br>(.01) |
| Observations | 468 | 332 | 302 | 332 |
| F-stat | 19.7 | 40.4 | 47.1 | 55.7 |
| Adjusted $R^2$ | .11 | .26 | .32 | .33 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Regressions involving negotiable CD rates exclude periods in which Regulation Q was binding. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are weekly and cover the period from July 1963 (Eurodollars) or June 1964 (negotiable CDs) to October 1979. See the Appendix 1 for data sources.

Table 8A
Factors affecting the federal funds rate

Dependent variable: change in the federal funds rate (in basis points)

| | Prior to May 1973 | | After May 1973 |
|---|---|---|---|
| Change in discount rate | 1.0***<br>*(.24)* | 1.0***<br>*(.24)* | .58***<br>*(.13)* |
| Change in securities holdings | -9.9***<br>*(1.9)* | -7.4***<br>*(2.3)* | -1.3**<br>*(.7)* |
| Change in whether Reg. Q binds | .11<br>*(.09)* | .12<br>*(.09)* | |
| Interaction changes in securities * Reg Q binds | | -6.9*<br>*(3.8)* | |
| Reserve Req. on CDs (lagged 1 week) | .11<br>*(.19)* | .15<br>*(.19)* | .13**<br>*(.05)* |
| Reserve Req. on due from branches (lagged 1 week) | -.003<br>*(.02)* | -.003<br>*(.02)* | .03<br>*(.02)* |
| Constant | .02<br>*(.02)* | .02<br>*(.02)* | 1.72***<br>*(.53)* |
| Observations | 468 | 468 | 306 |
| F-stat | 9.6 | 8.6 | 7.6 |
| Adjusted $R^2$ | .08 | .09 | .08 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are weekly and cover the period from July 1963 to October 1979. See the Appendix 1 for data sources.

Table 8B
Factors affecting the federal funds rate

Dependent variable: change in the federal funds rate (in basis points)

| | Prior to May 1973 | | After May 1973 |
|---|---|---|---|
| Change in discount rate | 1.03***<br>*(.24)* | 1.04***<br>*(.24)* | .57***<br>*(.12)* |
| Change in non-borrowed reserves | -4.9***<br>*(1.2)* | -3.9**<br>*(1.6)* | -1.6**<br>*(.7)* |
| Change in whether Reg. Q binds | .09<br>*(.09)* | .09<br>*(.09)* | |
| Interaction changes in NBR * change in Reg Q binding | | -2.5<br>*(2.5)* | |
| Change in reserve req. on CDs (lagged 1 week) | .22<br>*(.20)* | .22<br>*(.20)* | .14***<br>*(.05)* |
| Change in reserve req. on due from branches (lagged 1 week) | .005<br>*(.03)* | .007<br>*(.02)* | .03<br>*(.02)* |
| Constant | .008<br>*(.02)* | .009<br>*(.02)* | .02<br>*(.02)* |
| Observations | 468 | 468 | 306 |
| F-stat | 7.0 | 6.0 | 8.1 |
| Adjusted $R^2$ | .06 | .06 | .-8 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are weekly and cover the period from July 1963 to October 1979. See the Appendix 1 for data sources.

Table 9
Factors affecting the federal funds rate

Dependent variable: change in the federal funds rate (in basis points)

| | Federal Reserve operations measured by: | |
|---|---|---|
| | Change in non-borrowed reserves | Change in government securities holdings |
| Change in discount rate | .74***<br>*(.13)* | .69***<br>*(.12)* |
| Impact of Fed operations when RRCD=5 or 6 and RRDTFB=0 | -4.6***<br>*(.17)* | -5.7**<br>*(2.0)* |
| Impact of Fed operations when RRCD=5 or 6 and RRDTFB=10 | -7.00**<br>*(2.8)* | -25.2***<br>*(4.8)* |
| Impact of Fed operations when RRCD=5 and RRDTFB=20 | -2.3<br>*(1.7)* | -11.6***<br>*(3.5)* |
| Impact of Fed operations when RRCD=8 and RRDTFB=8 | -5.8**<br>*(2.5)* | -9.7***<br>*(3.4)* |
| Impact of Fed operations when RRCD=6 and RRDTFB=4 | -1.0<br>*(.9)* | -.47<br>*(.82)* |
| Change in whether Reg. Q binds | .13<br>*(.08)* | .1<br>*(.08)* |
| Interaction changes in NBR * change in Reg Q binding | -10.6***<br>*(2.9)* | -2.6<br>*(1.9)* |
| Change in reserve req. on CDs (lagged 1 week) | .14**<br>*(.06)* | .10*<br>*(.05)* |
| Change in reserve req. on due from branches (lagged 1 week) | .01<br>*(.02)* | .005<br>*(.017)* |
| Constant | .02<br>*(.01)* | .02<br>*(.01)* |
| Observations | 753 | 753 |
| F-stat | 8.4 | 10.4 |
| Adjusted $R^2$ | .09 | .11 |

Note. The symbols ***, **, and * indicated statistical significance at the 1, 5, and 10 percent levels respectively. RRCD is the reserve requirement on negotiable CDs and RRDTFB is the reserve requirement on due to foreign branches. Standard errors in parentheses and italics. Regressions control for serial correlation assuming that errors follow a first-order autoregressive process. Data are weekly and cover the period from July 1963 to October 1979. See the Appendix 1 for data sources.

Table 10
Differences between the target federal funds rates and effective federal funds rate
(percentage points)

| | Early period | | | Late period |
|---|---|---|---|---|
| | All times | Regulation Q binds | Reg. Q does not bind | |
| Average absolute value of differences | .21 | .28 | .16 | .15 |
| Lowest quartile | .05 | .07 | .05 | .04 |
| Median | .15 | .22 | .10 | .09 |
| Top quartile | .30 | .40 | .22 | .20 |
| *Observations* | *334* | *137* | *197* | *332* |

Note. Data are weekly. The early period lasts from January 1967 to May 1973. The late period starts in June 1973 and ends in October 1979. See the Appendix 1 for data sources