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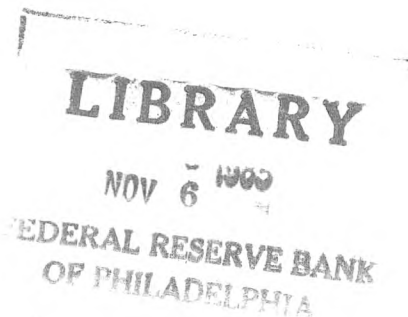
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The Regulation of Bank Entry

Michael C. Keeley*

This paper analyzes the regulation of entry into banking through government chartering. Entry regulations are shown to be necessary for other anticompetitive regulations to succeed in raising industry profits to above-normal levels. Empirically, we find that although regulation reduced entry during the 1936–1962 period, entry restrictions appear to have been relaxed since then. If entry has been unrestricted for some time, the deregulation of deposit rates or other forms of banking deregulation are unlikely to affect the aggregate profits of the banking industry, at least in the long-run.

Commercial banking in the United States is a highly regulated industry. Banking regulations pervade almost every aspect of the business, including whether, how and where a bank can do business. Ostensibly, the primary rationale for banking regulation is to protect and promote the safety and soundness of the financial system. Indeed, recently, as bank failures have mounted, some have called for increased regulation.

As a legacy of the 1930s, many banking regulations were implemented that did not deal directly with safety and soundness issues, but instead, restricted competition among banks themselves and between banks and other financial institutions. For example, various restrictions on entry, such as government control of chartering, geographic restrictions on branching, and product-line restrictions, at least have the potential to reduce competition.

Other regulations that do not deal with entry, such as consumer deposit rate ceilings, also have the potential to lessen competition. In fact, some economists have argued that the regulation of entry as well as other anti-competitive measures reflect the “capture” of the regulators by the regulated firms. Since banks as

a group have an interest in restricting competition (and thereby generating economic rents), they would promote regulations that would eliminate or reduce interbank competition or reduce competition from nonbank firms that provide substitute services.

Currently, many of these restrictions on bank competition are breaking down. Deposit-rate ceilings essentially have been eliminated on all but business checking accounts. Geographic restrictions are diminishing through the liberalization of branching laws and through regional interstate compacts. They are also being evaded through various legal loopholes such as “nonbank” banks.¹ Product-line distinctions between banks and nondepository financial firms also are blurring. What will be the impacts of these changes? Is banking becoming more competitive and less profitable, and will bank failures consequently mount as profits decline?² Or, will deregulation merely change the way banks compete with each other rather than increase the overall degree of competition?

The answers to these questions depend in large part on how effective entry regulations have been in actually reducing entry.³ In general, anticompetitive regulations that fix prices would be effective in reducing the degree of competition only if entry also were restricted. This is because if entry is not limited, the regulation of prices will not be able to suppress nonprice competition by new entrants. Con-

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versely, if entry is restricted, the degree of competition generally will be reduced even without other anticompetitive restrictions.

Purpose and Organization

The objectives of this paper are threefold. First, we analyze, in general, the effects of the government regulation of entry into an industry and the interaction of entry regulation with other types of regulation. We show that without entry restrictions, other regulations seeking to limit competition will be ineffective in the creation of economic rents. However, anticompetitive regulations may very well alter the form of competition. Conversely, effective entry regulations generally will limit competition and

thereby create economic rents even in the absence of other anticompetitive restrictions. Second, we apply this general analytic framework to the banking industry. We analyze empirically how regulation has affected the rate of entry into banking and whether entry restrictions have been relaxed recently. Finally, the implications of the current deregulatory trend in banking are explored in light of our findings about the regulation of bank entry.

Section I examines how entry restrictions alone or in conjunction with other regulations in theory would affect competition in banking. Then, in Section II, data on bank entry are analyzed to assess whether actual entry has been limited. Section III presents the summary and conclusions.

I. The Theory of Entry and Competition

Entry plays a prominent role in the economic theory of competition. Free entry is the key economic force that ensures that there are an optimal number of firms (from society's viewpoint) in a particular industry and that individual firms charge competitive prices and operate at optimum scales.⁴

In an industry in which individual firms operate independently (that is, they do not collude), the short-run supply curve is the (horizontal) sum of the marginal cost curves of the firms in the industry (at a particular moment in time). If, at the price determined by supply and demand, price is above each firm's average cost (because individual firms have increasing marginal costs), new firms will be attracted to the industry until price is forced down to equal average cost. Thus, in long-run equilibrium, the entry of new firms ensures that price equals (minimum) average cost (which also equals marginal cost), that an optimal number of firms are in the industry, and that profits are normal.

If, however, entry were restricted at less than the socially optimal number of firms, firms would produce at levels above their minimum average costs, prices would exceed average costs, and firms would enjoy above-normal

profits (even in the absence of collusion) unless firms were able to produce at constant costs. If firms could produce at constant costs, so that marginal and average costs were equal, then restrictions on the number of firms in an industry would have no effects on prices or profits as long as the firms did not collude. Thus, constant costs of production are equivalent in a sense to unrestricted entry.

Although there is an empirical literature that suggests that banking is characterized by constant costs, at least for banks above some minimum size, these econometric results are inconsistent with a wide range of other evidence.⁵ First, the new theory of firm size, developed by Rosen (1982), Oi (1983) and others, argues that each firm may have a U-shaped cost function even though firms of widely differing sizes appear to have similar measured average costs.⁶ According to this theory, any given firm will be subject to increasing average (and marginal) costs if it expands output beyond its equilibrium level, holding managerial talent constant. The apparent equality of average costs of firms of different sizes is due to higher levels of managerial talent at larger firms and greater compensation of more able managers.

Second, there is anecdotal evidence that

there are very strong economic forces propelling the nation toward interstate banking. This suggests that there must be important scale economies, at least in banking. Finally, if banking were characterized by constant costs, it seems unlikely that such a wide variety of regulations regarding the scale of their operations, such as merger regulation, chartering, and geographic restrictions would exist since such regulations would have no effect on competition, interest rates, or the pricing of bank services. Thus, it seems likely that, in banking, firms do have U-shaped cost functions.

Entry and the threat of entry are also strong forces that tend to eliminate cartels. For example, if the firms in an originally competitive industry (where price equaled average cost) succeeded in forming a successful cartel that restricted industry output by allocating output to members (and consequently raising prices), new firms would have a strong incentive to enter because of the above-normal profits to be earned. New firms would continue to enter until price equalled average cost and profits returned to normal levels. Since potential cartel members are aware of the incentives for entry caused by a cartel, cartels rarely form if entry is unrestricted. Thus restrictions on entry are a necessary precondition for other restrictions on competition to succeed in raising firms' profits to above-competitive levels.

Regulation and Entry Restrictions

A large number of government regulations are either intended to restrict competition and thereby raise the regulated firms' profits or have that effect. However, just as private restrictions on competition (for example, cartels) will be unsuccessful in restricting competition unless entry is limited, so will government regulations. Despite the much stronger enforcement tools at the government's disposal, competition can take place along so many dimensions that it is virtually impossible to prevent it by regulation.

For example, suppose the government attempts to restrict competition in an industry by imposing a minimum price above the competi-

tive level. Such an above-competitive price (relative to costs) would make an industry highly profitable and thus attractive to enter. If price cutting were permitted, new firms would enter and force down prices and profits to competitive levels by increasing the quantity of the product and cutting prices.

However, even if price cutting were prohibited, new firms would still enter and compete along various nonprice dimensions. As George Stigler stressed in his classic 1968a article, "When a uniform price is imposed upon, or agreed to by, an industry, some or all of the other terms of sale are left unregulated". For example, competition through quality, advertising, convenience and by providing additional nonpriced or underpriced services may all be viable forms of nonprice competition.

Unless nonprice competition is also fully prohibited, something virtually impossible to do without assuming full control of an industry (for example, nationalizing it), new firms will enter and existing firms will expand their level of nonprice competition until average costs are driven up to equal price. Thus, without entry restrictions, firms will compete away any potential economic rents due to regulation through nonprice competition. With entry restrictions, however, things are much different.

First, consider the effects of entry restrictions alone. If there were fewer than the socially optimal number of firms in an industry, then firms would price competitively (price would equal marginal cost) but price would exceed average cost and the firms would earn above-normal profits. If a regulation, such as a minimum price, were then imposed on the industry (set to equate industry marginal revenue with industry marginal cost), then the industry would have the potential to earn even larger (above-normal) profits depending on whether the potential economic rents were entirely competed away through nonprice competition. Thus, regulation has the potential to reduce competition and increase profits only in an industry in which entry is restricted.

But will economic rents be competed away through nonprice competition even in an industry in which entry is restricted?

With restricted entry, only existing firms would expand the level of nonpriced services (and goods). Assuming such firms face increasing marginal costs of nonprice competition (as is likely), existing firms would expand output to the point where the total marginal cost of the product plus the nonpriced services equals demand. Thus, with entry restrictions, above-normal profits would not be competed away unless nonprice competition can occur at constant costs—something that seems highly unlikely. Thus, regulation has the potential to increase the profits of the regulated firms to above-normal levels, but only if entry is also limited. Moreover, nonprice competition alone is unlikely to lead to competitive profit levels.

Entry and Deposit Ceilings

As an example of how entry restrictions interact with other regulations, consider the effects of the regulation of deposit interest rates on consumer accounts. Initially, if a deposit-rate ceiling were imposed below the market rate, existing banks would earn supranormal profits by having lower costs of deposits. This above-normal level of profits would provide strong incentives for both new banks to enter and existing banks to increase levels of convenience or nonpriced services until (average) deposit costs were bid up to competitive levels and profits returned to normal levels. The effects of the ceilings, however, would differ if entry also were restricted.

First, consider the case where entry is unrestricted. As long as new banks could enter at no cost disadvantage to existing banks, any excess profits would be eliminated in the long-run. This is because firms would continue to enter and provide various forms of underpriced conveniences until any excess profits were eliminated. However, such non-priced services would be expanded beyond the level they would have attained in the absence of regulation and, consequently, average (and marginal) deposit costs would be higher because consumers value these services at less than their costs (that is, from a consumer's viewpoint, services and interest are not perfect substitutes).⁷

If existing banks could not provide such services and conveniences at constant costs (that is, if existing firms face increasing marginal costs of expanding the provision of such services so that marginal costs exceed average costs), new firms would be attracted to such a regulated industry. Thus, binding deposit ceilings, as well as other forms of anticompetitive restrictions, may attract new entrants. Counterbalancing this force would be the overall decline in the industry caused by its increased costs compared to industries providing substitute products that are not subject to regulation. With unrestricted entry, deposit ceilings may affect the type of competition and the number of firms, but they will not affect the degree of competition or the profitability (aggregate economic rent) of the industry.

The effects of deposit interest ceilings generally will be very different with restricted entry. First, entry restrictions alone reduce the demand for deposits so that rates paid on deposits would be below levels that would prevail in the absence of entry restrictions. Thus, if the number of banks were limited by entry restrictions, this alone would cause deposit costs to be lower, loan rates to be higher and, consequently, profits to be higher than normal. Second, if binding ceilings were then imposed on such an industry, limiting deposit rates to below the (already low) levels the firms would set through competition with one another, the existing banks would then expand nonpriced services up to the point where interest plus marginal service costs of deposits equaled their marginal revenue products.

If individual banks faced increasing marginal costs of providing nonpriced services, additional services would be provided up to the point where marginal deposit costs equaled the value of deposits' marginal products, but average deposit costs would be less. Thus, with entry restrictions, consumer deposit ceilings may confer economic rents on existing banks.

Since the effects of (nonentry) regulation and hence deregulation on industry profitability depend in large degree on whether entry was limited, we now turn to an empirical analysis of the effects of chartering regulation on entry into banking.

II. Empirical Analysis of Chartering Restrictions

The United States has a "dual" banking system. Currently, persons wishing to start a bank can apply for a federal charter from the Comptroller of the Currency or apply to the appropriate state banking agency for a state charter. However, to obtain federal deposit insurance, newly chartered state banks must either receive approval directly from the Federal Deposit Insurance Corporation (FDIC) or become members of the Federal Reserve System. (Federally chartered banks are all members of the Federal Reserve System and all have federal deposit insurance.)

In general, competition among chartering agencies would seem to limit any single agency's power to restrict entry. This is because if one agency restricted entry severely, firms seeking charters would go to another agency. Over time, an agency with an overly restrictive chartering policy would find itself with few firms to regulate.

Prior to the creation of the FDIC and the passage of the Banking Act of 1935, which set up a federally administered "needs" criteria for chartering federally insured banks, there was active competition between the states and the federal government for chartering banks. However, with the creation of the FDIC, the competition for the chartering of *insured* banks was probably reduced since the owners of state-chartered banks had to apply either to the FDIC or the Federal Reserve to obtain federal deposit insurance. Thus, the federal government could control the number of (federally) insured banks, although the power to do so was diffused through three agencies.

As thrifts have gained more bank powers recently, thrift charters may be becoming good substitutes for bank charters. If so, competition from the Federal Home Loan Bank Board (FHLBB), which controls the chartering of federally insured savings and loans, may be introducing a new element of competition among federal agencies for the chartering of depository institutions.

Although the diffusion of chartering powers

through several federal agencies may have introduced a significant degree of interagency competition and made entry regulation relatively ineffective in actually restricting entry, it is an empirical question whether and/or to what degree entry has been limited.

Previous Studies

In a classic study (1965) dealing with the effects of chartering on the rate of bank entry, Sam Peltzman concluded that chartering reduced the rate of bank entry by at least 50 percent compared to what would have occurred without such restrictions. His finding is based on a comparison of the rate of entry prior to the passage of the Banking Act of 1935 and the creation of the FDIC, which he characterizes as the "free-banking" era, to the 1936-1962 period, during which he argues federal-state competition for the chartering of insured banks was effectively eliminated.

In conducting a study to determine what the effects of the 1935 Banking Act were, ideally one would want to control for all factors other than the passage of the Act that might affect entry. Especially important would be the profitability of the industry because increased profitability would lead to greater entry (and lower profitability would lead to less entry) all other things equal. However, to control for variations in profitability properly is difficult because profitability itself depends on entry restrictions (that is, it is endogenous). (In fact, the whole point of entry restrictions is to increase profitability.)

Although Peltzman included profitability as a control variable, he ignored its endogeneity. Thus, his estimates may have been less reliable than estimates that ignored potential (exogenous) changes in profitability altogether. By neglecting the fact that limited entry itself would increase profitability, he likely overestimated the effect of the Act on deterring entry.

A more recent (1974) re-analysis of Peltzman's data by Linda and Franklin Edwards tries to address the endogeneity of profitability.⁸ They argue that although Peltzman overstated

the effects of chartering restrictions, his conclusion that chartering restrictions substantially limited the rate of entry is valid.

Below, I take another look at these data and extend the analysis from 1962 through 1983, the last year for which complete data are currently available. I do not attempt to control for the effects of varying profitability on entry because of the difficulty in properly controlling (statistically) for the effect of regulation on profitability.

A Further Analysis

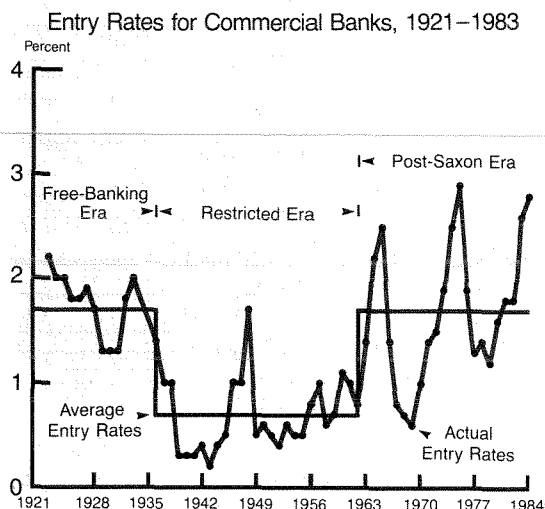
Although the Banking Act of 1935 did apparently substantially lessen state-federal competition for the chartering of insured banks during the 1936–1962 period, there was still interagency competition between the FDIC, the Comptroller, and the Federal Reserve.⁹

More recently, as S&Ls have gained more and more bank-like powers, the FHLBB may have increased the degree of competition among federal agencies for chartering. Because of this actual and potential competition among chartering agencies, it may well be that chartering would become a less and less *effective* restriction to entry over time. Below, we look at entry rates during the post-1962 period in addition to those during the 1921–1962 period analyzed by Peltzman to see whether entry rates have remained low or increased.

Entry rates (the number of banks opening in year t divided by the number of existing banks at year $t-1$) are plotted in Chart 1. The sources of the data used to calculate entry rates are the same as those used by Peltzman and are described in the Data Appendix. For the free-banking period, 1921–1935, it is somewhat difficult to define entry properly because of the relatively large number of reopenings of previously suspended banks and the difficulty in distinguishing new openings from re-openings. The re-openings of suspended banks was especially high during the 1931–1935 period before FDIC insurance reduced the number of bank failures.

I have chosen to define entry as simply the number of banks opening regardless of whether they were new openings or re-openings, partly

Chart 1



because this is the only consistent definition in the published data across the whole 1921–1983 period, and partly because re-openings also represent a new source of competition. Because entry rates might be somewhat overstated by this procedure, especially during 1933 and 1934 when the number of re-openings was very large, I have excluded data for these years from the analysis. This has the effect of reducing the average entry rate during the free-banking period.

For the period 1921–1935, the average rate of entry was about 1.7 percent per year. In contrast, during the 1936–1962 period, the average rate of entry declined to only .7 percent a year, a statistically significant decline (see Chart 1). This decline of approximately 50 percent is approximately the same magnitude found by Peltzman using his more complex but flawed statistical procedure. Thus, the evidence supports the notion that there was a significant decline in the rate of bank entry during the period following the passage of the Banking Act of 1935 until 1962.

On November 15, 1961, James Saxon was appointed Comptroller of the Currency. He was widely regarded as a proponent of the national banking system and was viewed as being much more liberal than his predecessors in his chartering policies. The data in Chart 1 suggest that initially his policies did have a significant effect

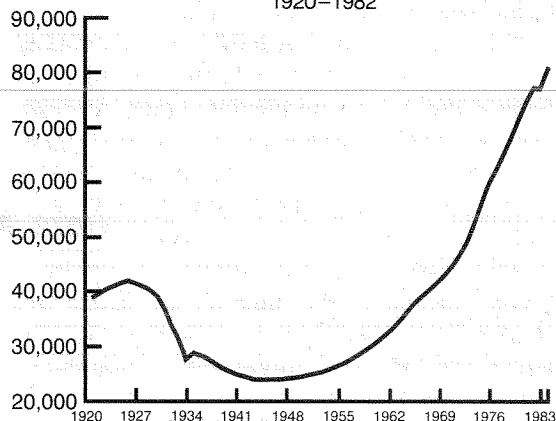
on raising entry rates. However, by the last year of his tenure (1966), entry rates had fallen back to the pre-Saxon level. Then, beginning in 1968, entry rates again began a sharp upward rise and continued to follow a cyclical pattern unique to the post-1962 period.

Looking at the 1962–1983 period as a whole, entry rates averaged essentially the same as during the 1921–1935 period. Thus, it appears that Saxon began an era where entry into banking was no more difficult than during the “free-banking” era. If correct, this means that banking has been a more competitive industry, at least since 1962.¹⁰ However, another interpretation of the data in Chart 1 would be that entry restrictions were gradually relaxed beginning perhaps as early as 1950 since the data would not be inconsistent with an upward trend in entry rates starting then. In either event, entry now does not appear to be significantly restricted, at least compared to the free-banking era.

Looking at entry in banking only in terms of entry by new banking organizations probably understates entry because of the possibility of entry through branching, entry by S&Ls, and increased competition by nondepository institutions (such as Merrill Lynch). For example, although the total number of banking and S&L offices was relatively constant from 1934 to the early 1950s, the number of offices has almost tripled since then (see Chart 2), and the number of offices per real deposit dollar has shown an upward trend since 1962 (although it has not reached anywhere near the level of the 1920s and 1930s).

The recent deregulation of banking, specifically the removal of consumer deposit-rate ceilings, appears to be taking place in an environ-

Chart 2
Total Banking & Savings Association Offices,
1920–1982



ment in which entry restrictions have been effectively eliminated or at least have been substantially relaxed. If so, deposit-rate deregulation should have little or no long-run effects on the profitability of the banking industry as a whole because free entry ensures that, in the long-run, profitability will be at normal, competitive levels.

However, individual banks may have different experiences as they make the transition from nonprice to price competition.¹¹ Further, if entry restrictions had been effectively removed prior to deregulation, then deregulation, by eliminating the inefficiencies inherent in nonprice competition, should have led to an expansion of the banking industry relative to its nonbank competitors and this in turn would increase incentives for entry. The effects of deregulation may explain the very high entry rates of the last few years shown in Chart 1. They are also consistent with anecdotal evidence that there has been a recent surge in new bank start-ups (see Brannigan 1985).

III. Conclusions

The data on bank entry suggest that the regulation of entry through chartering has been much less restrictive in the post-Saxon era. Since 1962, entry rates have on average been equal to those before 1936, a period during which, it is argued, entry was relatively unrestricted.

If, in fact, bank entry has been unrestricted since 1962, then various anticompetitive regulations, such as deposit rate ceilings, would not have been effective in reducing the degree of competition in banking. (They would, however, have made the banking industry less efficient.) This in turn means that bank profits were

not enhanced (or at least are not currently being enhanced) by these anticompetitive restrictions.

If the degree of competition and banking profits have been at the level they would have been without entry restrictions, then deregulation of consumer deposit rates is unlikely to af-

fect banking profits or the degree of competition, at least in the long-run. Thus, the current calls to reregulate banking—to reduce competition and bolster bank profits—to stem the recent spate of bank failures are not focusing on the real causes of these failures.

Data Appendix

All commercial banking data except those so noted, including the number of banks and branches¹ in existence in a given year, the number of new “primary” organizations and the total deposits data², come from publications of the Board of Governors (BOG) of the Federal Reserve System (FRS).

Series for the 1921–1940 period³ come from the U.S. BOG of the FRS, *Supplement to Banking and Monetary Statistics*, Section I, 1962. (Note: This supplement was originally released in Sections in 1943 as a revised version of available data from the period 1914–1941. It was published in 1962.)

The 1941–1970 series are from the U.S. BOG of the FRS. *Banking and Monetary Statistics*, 1941–1970, 1976.

Data for the 1970–1979 period were taken from the *Annual Statistical Digest*, 1970–1979, published in 1981 by the BOG.

Since 1979, the *Annual Statistical Digest* has been published yearly, and they were used on a yearly basis from 1980 through 1982.

Data for 1983 for commercial banks, branches, new openings, and total deposits were obtained directly from the BOG; 1983 data on savings and loans was obtained directly from the FHLBB.

Although these data are from several different publications (of primarily the same sources), all series are consistently defined, with the exception of those indicated.

¹ Commercial bank branch data for the year 1920–1934 were obtained from the *Historical Statistics of the United States*, Colonial Times to 1970, Part 2, U.S. Department of Commerce, Bureau of the Census, 1975.

Branch data for thrifts was collected from the *Savings and Home Financing Source Book*, 1952–1955, U.S. Federal Home Loan Bank Board, and the *Savings and Loan Fact Book*, 1962, 1965, 1980, U.S. League of Savings Association, and represent total insured (federal- and state-chartered) savings and loan associations.

² Total deposits data for savings and loan associations were taken from the *Source Book* (see above citing), 1955, Federal Home Loan Bank Board, for the years prior to 1955. Citibase was used from 1955 to 1983 (actually from BOG FRB Table 1.7).

Total Real Deposits were calculated using an implicit price deflator (wholesale) from the *Historical Statistics of the United States, Colonial Times to 1957* (see above).

Total offices per real deposit dollar was calculated by dividing total bank and thrift offices by the sum of their total real deposits.

³ The 1921–1940 portion of the total number of commercial banks in existence (at year-end) series was multiplied by a factor of 1.003919373 to correct for a change in the series definition from “All Incorporated” to “All Commercial” banks after 1940.

FOOTNOTES

1. The legal status of nonbank banks was unclear at the time this article went to press.
2. Failures are less likely in an industry where firms are earning above normal profits (economic rents). In such industries, it takes a larger random shock to reduce demand or increase costs to make earnings (or net worth) negative and drive the firm out of business.
3. Chartering regulation, branching restrictions, and product-line regulation are all forms of entry regulation.
4. Throughout this paper, I use the definition of a barrier to entry that was first formulated by George Stigler (1968b): "A barrier to entry may be defined as a cost of producing (at some or every rate of output) which must be borne by a firm which seeks to enter an industry but is not borne by firms already in the industry."
Free or unrestricted entry means there are no barriers to entry. This concept of a barrier to entry contrasts sharply with the view that any cost of doing business is a cost of entry. That is, I do not view capital requirements (or land or labor requirements for that matter) as costs of entry per se, as opposed to costs of doing business.
5. See Gilbert (1984) for a review of this literature.
6. See Keeley (1984) for evidence supporting this notion.
7. See Keeley and Zimmerman (1985) for an elaboration of this argument.
8. However, they do not employ a simultaneous equations technique. Thus, one may also question the validity of their estimates.
9. See Kenneth Scott (1979).
10. An alternative hypothesis consistent with these data is that some other force, such as an exogenous increase in banking profitability, caused the rate of entry to increase during these years. However, it seems unlikely that an increase in profitability would persist over a 20-year period.
11. It is conceivable that deregulation might have a short-run negative effect on profitability as specific capital used to support nonprice competition depreciates in value. However, this factor would have no lasting effect if entry had been unrestricted prior to deregulation.

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Savings and Loan Asset Composition and the Mortgage Market

Frederick T. Furlong*

Over the past several years, savings and loan associations have diversified their asset portfolios by increasing the share of non-mortgage investments. New asset powers, along with poor earnings and deposit deregulation, have provided the impetus for this change with its important implications for the survival of savings and loans as effective competitors in financial markets. However, contrary to the concerns of some, savings and loans have not diversified their portfolios to the detriment of the mortgage market.

Savings and loan associations traditionally have been highly specialized financial institutions.¹ As they entered the 1980s, they held over 85 percent of their assets in mortgage loans and mortgage-backed securities. This concentration of assets in mortgages stemmed not only from regulations restricting investment activities but also from the tax benefits available to thrifts from holding mortgages. In such an environment, asset management for savings and loans primarily entailed using liquid assets as a buffer against fluctuations in flows to deposit accounts subject to interest rate ceilings.

In more recent years, expanded asset powers have opened new opportunities for thrifts to invest in nonmortgage assets, while the extremely poor performance of earnings among thrifts has diluted the appeal of the tax incentives attached to mortgage lending. In addition, factors affecting liabilities at savings and loans have led to changes in the composition of their assets. As a result, savings and loans have increased substantially the share of their funds allocated to nonmortgage assets.

The greater use of asset management and the diversification into nonmortgage activities by savings and loans is seen by many as necessary

for them to survive in today's interconnected financial system. However, the apparent reduced emphasis on mortgage lending also has raised some concerns. One of these is that more aggressive pursuit of nonmortgage activities by savings and loans will curtail the flow of funds to finance housing.² This concern is related to the longstanding belief that the volume of mortgage credit is tied to deposit flows at thrifts. Much of the public policy regarding savings and loans has been founded on this belief, including the differential on interest rate ceilings which for many years allowed thrifts to pay a higher explicit return on deposits than commercial banks.

This paper provides a perspective on the reasons for the increased asset portfolio diversification at savings and loans and the implications greater diversification may have for the mortgage market. The section, "Asset Diversification," examines how and why the mix of savings and loan assets has changed during the past several years. It argues that, while the easing of asset restrictions has had some bearing on changes in asset mix, tax effects and factors affecting liabilities management also have been instrumental in determining the asset composition at thrifts. The second section investigates whether the move to nonmortgage investments by savings and loans has affected mortgage interest rates and the allocation of funds to mort-

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gages. The findings in that section do not support the view that the change in asset mix at savings and loans has had a noticeable impact

on the mortgage market. General comments and conclusions are presented in the last section.

I. Asset Diversification

Historically, regulations have limited the options for savings and loans to invest directly in nonmortgage assets. The regulatory restrictions have been effectively reinforced by a tax code that provides strong incentives for thrifts to hold residential mortgages in the form of loans and mortgage-backed securities. By holding at least 60 percent of its assets in specified categories, a depository institution qualifies as a thrift and is eligible for special tax benefits.³ Among the "qualifying assets," mortgages are generally the highest yielding since most of the other qualifying assets are government obligations. Once meeting the test of a savings and loan, an institution can defer taxes on a portion of its income by placing retained earnings in special loan loss reserve accounts.⁴ The maximum proportion of income that can be sheltered in this way is 40 percent. To protect the maximum amount of income possible, a savings and loan has to hold at least 82 percent of its assets in qualifying assets.

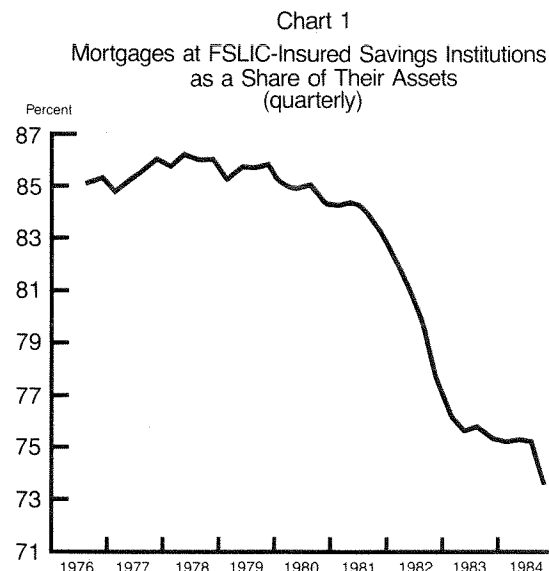
These regulatory "restrictions" and tax benefits clearly determined the choice of assets for savings and loans. Nevertheless, within these constraints, the asset composition for savings and loans also has been affected by limitations they faced in managing liabilities. Having relied heavily on small-denomination deposits subject to interest rate ceilings and limited access to "purchased" funds, savings and loans generally were not active liability managers. Consequently, asset management at these thrifts consisted mainly of a "passive" adjustment of short-term asset holdings to absorb swings in small-denomination deposits.

Through the late 1970s, the interplay of forces determining the asset composition of savings and loans resulted in an industry that held a more or less stable proportion of its assets in mortgages. Over the past several years, however, the asset mix at savings and loans has changed dramatically. Combined, mortgages

and mortgage-backed securities at FSLIC-insured savings institutions fell from 85½ percent of total assets at the end of 1979 to a little more than 73 percent in December 1984. As Chart 1 shows, the drop in the ratio of mortgages to assets at savings and loans was particularly pronounced between mid-1981 and mid-1983.

Asset Restrictions

A natural starting point for explaining this marked portfolio shift is the change in regulations governing the investment options for savings and loans. In 1980, the Depository Institutions Deregulation and Monetary Control Act (MCA) broadened asset powers for thrift institutions, widening their scope to invest in nonmortgage assets.⁵ Under the Act, federally chartered savings and loans were permitted to allocate up to 20 percent of assets to consumer loans, commercial paper, and other corporate securities. Federally chartered savings and loans were allowed to invest in shares of certain open-end investment companies, to issue credit



cards, to exercise trust and fiduciary powers similar to those of nationally chartered commercial banks, and to invest up to 5 percent of assets in education loans and community development and unsecured construction loans.⁶

For the most part, this set of new asset powers for savings and loans was adopted to complement the deposit interest rate deregulation called for in MCA. The decision to phase out rate ceilings on deposits, rather than to remove them immediately, was intended mainly to allow thrifts time to diversify and to shorten the effective maturity of their asset portfolios by using their new powers.

These regulatory changes were necessary conditions for meaningful asset diversification for many savings and loans. However, given the importance of the tax incentives associated with mortgage lending, the regulatory measures were probably not sufficient conditions. In the past, the ability to make deferred contributions to reserves provided a compelling incentive for savings and loans to hold mortgage-related assets irrespective of other regulations. For example, long before MCA, some state-chartered

savings and loans had considerably broader powers to engage in nonmortgage lending than their federally chartered counterparts. They did not exploit this apparent advantage to any real extent, however, mainly because the tax benefits associated with residential mortgage lending overwhelmed the gains associated with diversifying into nonmortgage assets.

Particularly weak earnings in recent years have diluted the appeal of the special tax treatment connected with mortgage lending. In the latter part of 1981 and the first part of 1982, over three-fourths of the federally insured savings institutions had negative net income. It was during this period that the most dramatic asset portfolio adjustments took place. In the last two years, lower market interest rates have allowed the savings and loan industry as a whole to post positive net earnings. Nevertheless, by mid-1984, the proportion of savings institutions insured by the Federal Savings and Loan Insurance Corporation posting losses still was about one out of four.

With both the regulatory and tax constraints to asset diversification relaxed, it is not sur-

TABLE 1
Portfolio Changes at FSLIC-Insured Savings Institutions

	Percent of assets as of December						Change in share of assets from 1979 to 1984 (percentage points)
	1979	1980	1981	1982	1983	1984	
<i>Assets</i>							
Mortgages and mortgage-backed securities	85.4	84.0	82.8	77.5	75.2	73.3	-12.1
Cash and securities	8.9	9.8	10.1	12.0	13.4	13.3	4.4
Consumer and commercial loans	2.8	3.0	2.8	2.9	3.4	4.5	1.7
Other assets	2.9	3.2	4.3	7.6	8.0	8.9	6.0
<i>Liabilities</i>							
Managed liabilities ¹	14.4	16.8	20.9	22.3	21.9	26.0	11.6

¹ Include large-denomination CDs, Federal Home Loan Bank advances and other borrowed funds.

prising that we saw a change in the asset composition of savings and loans. Indeed, from Chart 1, it might appear that the easing of “constraints” on assets was the dominant influence on the portfolio changes. However, further analysis suggests a somewhat more temperate assessment of the importance of the change in asset powers and the decline in earnings.

First, only a small portion of the drop in the ratio of mortgages to assets at savings and loans was related to an increase in nonmortgage loans. From 1979 to December 1984, consumer and commercial loans accounted for only 1.7 percentage points of the 12.1 percentage rise in the ratio of nonmortgage assets to total assets at FSLIC-insured institutions (Table 1).⁷ Moreover, the ratio of consumer and commercial loans to total assets was virtually unchanged from 1979 to 1982; it rose in 1983 and 1984 after most of the adjustment in the ratio of mortgages to assets had already taken place.

Special factors also account for much of the change in “other assets” shown in Table 1. For example, included in “other assets” is “goodwill and other tangible assets.” The value of this asset category was boosted considerably through the purchase accounting procedures used in savings and loan mergers. About 2.3 percentage points of the rise in “other assets” as a share of total assets from 1979 to 1984 can be attributed to the rise of goodwill alone. Of the remaining 3.7 percentage points rise in the ratio of “other assets,” about one-third can be explained by the increase in FSLIC-insured institutions’ equity investments in their service corporations, something they were allowed to do before MCA.⁸

Increased Liquidity

The growth in “cash and securities” over the past several years also indicates that the relaxation of asset restrictions was not the only influence on the asset mix at thrifts. The bulk of these assets are federal government or federally sponsored agency securities, bank CDs and federal funds, which savings and loans were empowered to hold even before MCA. And, as mentioned earlier, some of these securities can

be used by thrifts to qualify for special tax treatment.

The increase in the relative holdings of “cash and securities” could reflect factors affecting small-denomination deposits at thrift institutions. A possible connection is that the assets in cash and securities were accumulated in the face of deposit-rate deregulation which stimulated strong small-denomination deposit flows. Such a response by savings and loans would be in keeping with their traditional passive approach to managing liquid assets.

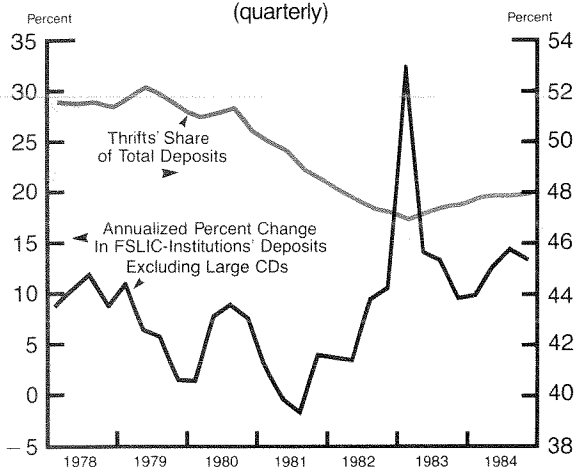
In this context, the quantity of these so-called “core deposits,” which represent the main source of funding for savings and loans, is difficult to control in the short-run. With limited use of managed liabilities (which include Federal Home Loan Bank advances, large-denomination CDs, RPs, and mortgage-backed bonds), most savings and loans have relied to a large extent on liquid assets, such as those included in cash and securities, as a buffer for variations in small-denomination deposit flows. Under this passive asset and liability management arrangement, there tends to be a positive correlation between changes in liquid asset holdings and core deposit flows at savings and loans.

This characterization of savings and loan management of liquid assets would seem to be particularly appropriate in the post-1982 period. Chart 2 shows that with the onset of full deposit deregulation—the introduction of the ceiling-free money market deposit account (MMDA) in late 1982—flows of deposit excluding large CDs surged in early 1983 and remained relatively strong through 1984.⁹

Savings and loans responded to a flood of core deposits in early 1983 by building up their holdings of cash and securities. In fact, virtually all of the rise in the ratio of cash and securities to total assets in 1983 (shown in Table 1) occurred in the first half of the year.¹⁰ After mid-1983, that ratio varied some from quarter to quarter, but on balance did not change much through the end of 1984.

The changes in managed liabilities at savings and loans in early 1983 mirrored that of liquid assets. Following the introduction of the

Chart 2
Thrift Deposits
(quarterly)



MMDA, savings and loans ran off a considerable volume of managed liabilities. This is reflected in Table 1 as a decline in the ratio of managed liabilities to total assets for 1983. However, the upward trend in savings and loan reliance on managed liabilities before 1983, which continued in 1984, suggests that thrifts may not have been reacting only to strong core deposit flows over the past several years. Indeed, Chart 2 indicates that, from 1979 through 1982, the growth of core deposits was relatively weak despite the introduction of market-rate deposit accounts.

One reason that core deposits did not perform "better" prior to 1983 is that, during the phase-out of deposit ceilings, deregulation represented a two-edged sword for savings and loans. The six-month money market certificate (MMC), for example, allowed thrifts to compete more effectively with issuers of nondeposit instruments and dampened for a while the impact of higher market interest rates on flows to thrifts. (This account was introduced in mid-1978 and had a variable-ceiling indexed to the six-month Treasury bill rate.) However, with the other edge of the sword, the effectiveness of the MMC as an instrument for thrifts to compete against commercial banks was reduced considerably in March 1979. At that time, the 25 basis point differential on the ceiling rate for

thrifts over that for commercial banks was removed whenever the six-month Treasury bill rate was 9 percent or higher. The impact of the loss of the differential on the popular MMC is illustrated in Chart 2. The purple line shows that, after the loss of the differential on the MMC, savings and loans and other thrifts lost ground to commercial banks during the phase-out of deposit ceilings. Thrifts' share of total deposits fell more or less steadily between mid-1979 and the end of 1982, and the drop was reflected in generally weak core deposit flows.

On balance then, the deregulation of deposit interest rate ceilings, with its impact on flows to core deposits, probably contributed to the rise in the holdings of cash and securities at savings and loans. However, the observation that reliance on both liquid assets and managed liabilities has increased, suggests that the increase in liquid assets at savings and loans probably reflected a higher demand of thrifts for liquidity rather than only strong flows of small-denomination deposits.

During the phase-out of deposit interest rate ceilings, which was marked by the loss of the bank/thrift differential on the popular MMC as well as high and variable market interest rates, the increased demand for liquid assets probably was due to a deterioration in the outlook for the stability and the overall availability of small-denomination deposit balances at savings and loans. The persistence of a relatively high ratio of cash and securities to total assets more recently may have two causes: a continued demand for liquidity in the face of the shortening overall maturity of core deposits that has accompanied deposit deregulation, and/or the greater amount of intermediation carried out through savings and loans in recent years.¹¹

Conclusion

The decline in the relative importance of mortgages at savings and loans in recent years has been the result of several factors in addition to the provisions of the MCA. These include the methods used by regulators to manage thrift crises, increased equity investments in thrifts' service corporations, and a dramatically changed financial environment.

In the future, some savings institutions probably will further diversify given the virtually unlimited scope of activities now open to them. They will be able to compete on a broader basis

in financial markets, and will probably tend to hold relatively more risky assets. Over time, however, earnings should improve and the improvement should reduce the impetus to move away from mortgage assets.

II. Implications for the Mortgage Market

This section examines the implications that the changes in savings and loan asset composition have for the mortgage market. The proposition that a link exists between the asset mix of savings and loans and the allocation of credit to housing is a variant of the one that ties the volume of mortgage credit to deposit growth at thrifts. Presumably, in the latter case, for a given volume of total credit, the larger the share of the funds channeled through thrifts, the higher the proportion of credit allocated to mortgages. If this were true, it follows that if thrifts reduce their propensity to invest in mortgage-related assets, then, all else equal, a smaller fraction of credit will go to mortgages and mortgage rates will rise relative to other market rates.

For deposit flows at thrifts and their mix of assets to have an impact on the allocation of credit to the mortgage market requires not only some separation of the mortgage market from the rest of the capital market, but also some segmentation within the mortgage market itself. That is, changes in mortgage lending by savings and loans, owing to developments specific to those institutions, must not be offset by other lenders.

Some degree of separation in financial markets might be expected in the short-run if institutional arrangements for channeling funds in the credit market are costly to adjust and the market disruptions are viewed as only temporary. However, it seems reasonable to expect that a permanent change in the propensity of thrifts to extend mortgage loans would induce adjustments by other lenders. This is particularly true given the increased importance of mortgaged-backed securities. In evaluating the impact of deposit interest rate ceilings, King (1979) suggests that regulation of thrifts is likely to affect the channels for mortgage credit rather

than the volume of such credit. This holds as well for regulations affecting the composition of assets at savings and loans.

The plausibility of the assumption that other participants in the capital market would adjust is only one reason that a changing asset mix at thrifts should not affect the allocation of credit. The idea that the asset mix at thrifts affects housing credit also is based on the questionable presumption that thrifts merely substitute non-mortgage assets for mortgages. This presumption ignores the fact that asset management should be related to liability management and the deregulation of deposits, which together affect the overall flow of funds to savings and loans.

In the previous section, it was pointed out that deposit deregulation contributed to the rebound of savings institutions as intermediaries. This has been particularly evident in the past couple of years, during which the strong performance of savings and loans was tied to the re-intermediation of small-denomination deposits following the lifting of deposit ceilings. The removal of deposit ceilings lowered the overall cost of deposits, making intermediation more efficient. To the extent that funds acquired by thrifts had been allocated to non-mortgage uses, such as in commercial paper held by money market mutual funds, the investment of those funds by thrifts in similar instruments would have no impact on the allocation of credit.

In addition, as discussed above, intermediation carried out by savings and loans in recent years has been boosted by their increasing reliance on large-denomination deposits and other nondeposit funds. This has been particularly true in the past couple of years. After the initial surge in small-denomination deposit growth following the introduction of MMDAs,

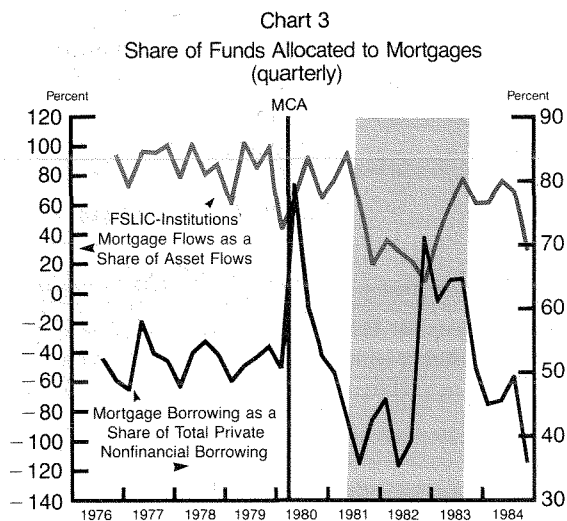
FSLIC-insured savings institutions once again picked up their issuance of managed liabilities. Some institutions have been particularly aggressive in issuing large CDs, apparently as part of a strategy to use liability management to increase asset growth.¹²

As a result of stronger managed liabilities, savings and loans have been able to extend a large volume of mortgage credit and simultaneously increase their relative holdings of non-mortgage assets. In 1984, for example, their mortgage holdings increased by about 15½ percent and total assets expanded by almost 20 percent. Thus, since the changing mix of assets was accompanied by rapid growth in assets, the nonmortgage activity at thrifts has complemented, rather than substituted for, mortgage lending.

Chart 3 provides evidence that is consistent with the view that changes in the mix of assets at FSLIC-insured savings institutions have not affected the allocation of funds to mortgages. The purple line in the chart represents the quarterly change in mortgages at FSLIC-insured institutions as a percent of the change in their assets, while the black line shows total mortgages flows—that is, net extensions of mortgages by all lenders, including households—as a share of private domestic nonfinancial borrowing.

The shaded region in the chart sets off the period in which the shift to nonmortgage assets at savings and loans was most pronounced. During that period, the ratios of mortgages to private domestic nonfinancial borrowing varied but, on balance, tended to rise, not fall. The movement of the ratio of total mortgage lending to private borrowing in the early 1980s appears to reflect changes in interest rates rather than portfolio adjustments at savings institutions. The peak in the 1980 credit control period aside, the ratio of mortgages to private borrowing fell in late 1980 and early 1981 as market interest rates rose. The ratio remained low, relative to the late 1970s, until the second half of 1982 when market rates began falling sharply.

As net mortgage flows at FSLIC-insured institutions (measured as a share of the change in



assets) stabilized between mid-1983 and the third quarter of 1984, the ratios of total mortgages to the volume of aggregate private borrowing fell. The two ratios did decline in the last quarter of 1984. However, on balance, it does not appear that there has been a consistent positive (or negative) relation between changes in the relative allocation of funds to mortgages by savings institutions and the share of aggregate borrowing accounted for by mortgages.

Another way of investigating the impact of the change in the asset mix at savings institutions on the mortgage market is to examine the behavior of mortgage interest rates. In keeping with several past studies on the determination of mortgage interest rates (see for example Jaffee and Rosen, 1979; Pyle, 1982; Anoako-Ada and Ben-Zion, 1983), it is assumed that mortgage rates can be modeled as a partial adjustment process such that,

$$R_t - R_{t-1} = \lambda(R_t^* - R_{t-1}). \quad (1)$$

In equation 1, R is the actual mortgage rate, R^* is the equilibrium mortgage rate, and λ measures the speed at which the mortgage rate adjusts to its equilibrium value. The equilibrium mortgage rate is assumed to be determined by the marginal cost of funds at savings institutions (C).¹³ For the purpose of this paper, the marginal cost is taken to be the rate on a 10-year Treasury bond.

To test whether changes in the composition of assets at savings and loans affect the rate on mortgages, the share of the flow of funds at FSLIC-insured savings institutions allocated to mortgages (M) is included as a determinant of the equilibrium mortgage rate. Also, to allow for the possibility that the flow of funds to savings and loans has repercussions on the mortgage rate, the equilibrium mortgage rate is expressed as a function of the percent change in small-denomination deposits at savings and loans (D).¹⁴

With these assumptions, the change in the mortgage rate can be expressed as a linear function:

$$R_t - R_{t-1} = \lambda[\alpha_0 + \alpha_1 C_t + \alpha_2 M_t + \alpha_3 D_t - R_{t-1}] \quad (2)$$

This can be restated in the standard regression form:

$$R_t = \beta_0 + \beta_1 C_t + \beta_2 M_t + \beta_3 D_t + \beta_4 R_{t-1} + \varepsilon_t \quad (3)$$

Based on portfolio theory, the use of simple regression analysis and equation 3 to investigate the relation between the mortgage rate and the asset mix at savings and loans may be unsatisfactory. Within a simple portfolio model, the fraction of funds allocated to mortgages by savings and loans would be expected to be pos-

itively related to the spread between the mortgage rate and the marginal cost of funds. This positive relation is just the opposite of what would be predicted under the "supply shock" hypothesis being tested in equation 3. Under that hypothesis, a greater allocation of funds to mortgages would tend to narrow the spread between the mortgage rate and the marginal cost of funds.

If both of these channels of influence come into play (the mortgage rate being affected by the flow of funds at savings and loans allocated to mortgages and vice versa), a single equation approach to estimating equation 3 would generate a biased estimate of β_2 . Accordingly, a two-stage estimation approach is used. In the first stage, an instrumental variable is derived for M.¹⁵ The second stage involves an ordinary least squares estimation of equation 3 in which the instrumental variable values for M are included.

The estimation results for equation 3 (with the instrumental variables included) are reported in Table 2.¹⁶ Equation I in the table is estimated using the commitment rate on mortgages from a survey conducted by the U.S. Department of Housing and Urban Development (HUD). In that equation, the estimated coefficient for M is not significantly different from zero. This result does not support the hypoth-

TABLE 2
Coefficients and Statistics for the Mortgage Rate Equation
(quarterly, 1978:2-1984:4)

Dependent Variable	Independent Variables					\bar{R}^2	SE	DW	ρ
	Constant	C_t	M_t	D_t	R_{t-1}				
I. HUD Commitment Rate	1.26	0.57 (3.90)*	-0.11 (-0.14)	-0.10 (-1.37)	0.45 (3.23)*	0.87	0.66	1.95	-0.32 (-1.60)
II. GNMA Rate	1.63	0.88 (15.05)*	-0.06 (-0.13)	-0.04 (-1.48)	0.08 (0.99)	0.99	0.23	1.92	0.79 (6.54)*

t-statistics in parentheses.

*Significantly different from zero at the one percent level.

esis that changes in the asset mix at FSLIC-insured institutions have had any significant contemporaneous impact on the primary mortgage market interest rate in recent years. The findings are confirmed when equation 3 is estimated using the actual values of M instead of the values of the instrumental variable.¹⁷

The results for equation I in Table 2 also show that the estimated coefficient for D is not statistically different from zero at the conventional levels of significance, although the t-statistic for the coefficient for D is larger than that for M.¹⁸ This finding suggests that, in the primary mortgage market, the growth rate of small-denomination deposits at savings institutions has not had an impact on mortgage rates in recent years. Jaffee and Rosen (1979), in contrast, showed that the ratio of the change in the level of savings and loan deposits to the value of new single-family homes had a negative and statistically significant relation to interest rates in the primary mortgage market prior to 1979. The evidence in Table 2 is consistent with the view that financial markets have become more integrated over time.¹⁹

Equation II in Table 2 tests for the impact of "supply shocks" at savings institutions on interest rates in the secondary mortgage market us-

ing the rate on GNMA securities as the dependent variable. The findings in equation II indicate that the secondary mortgage market rate is not influenced by changes in the asset mix or the flow of funds at savings institutions. One difference between the estimates for equations I and II is the more rapid adjustment of the secondary mortgage market rate. This, of course, is consistent with the secondary market being more fully integrated with the rest of the capital market.

From a theoretical perspective, in the long-run, adjustments within the capital market would be expected to eliminate any potential for an impact on the mortgage market stemming from a permanent change in the propensity of savings institutions to channel funds to mortgage borrowers. Even in the short-run, to the extent that asset restructuring by thrifts came about as a result of an increase in the level of intermediation at these institutions, the allocation of funds to the mortgage market would not be affected. Indeed, the empirical evidence is consistent with the view that the shift by savings institutions to holding a greater share of their assets in nonmortgage assets has not had an effect on mortgage rates or the allocation of funds to the mortgage market.

III. Conclusion

In recent years, savings and loans have been allowed to venture to a greater extent into non-mortgage activities. Since 1980, their new powers combined with poor earnings have encouraged greater diversification in their asset portfolios, thereby decreasing the relative role of mortgage-related assets in their portfolios. However, the relaxing of asset restrictions does not appear to be the only stimulus to thrifts seeking greater diversification. Changes affecting liabilities likely also have influenced the composition of savings and loan assets. In the future, as earnings improve, the tax incentives that traditionally have made mortgage lending particularly attractive to thrifts will reassert themselves.

The initiatives taken by savings and loans to balance their portfolios have important implications for their survival as effective competi-

tors in financial markets. They also will change the operation of the mortgage market. For example, there is an ever-growing tendency toward the use of mortgage-backed securities. Greater diversification does not, however, appear to have significantly altered the flow of funds to the mortgage market or the relation between mortgage rates and other market rates. In part, the greater interconnection of deposit and mortgage markets with money and capital markets probably has muted any potential impact stemming from asset changes at thrifts. Also, given the exceptionally rapid growth of savings and loan assets in the past two years, it is likely that the nonmortgage activity at savings and loans has been a complement to, rather than a substitute for, their traditional mortgage lending.

FOOTNOTES

1. Throughout the paper, the term "savings and loan associations" refers to all savings institutions insured by the Federal Savings and Loan Insurance Corporation (FSLIC), which includes both savings and loans and certain savings banks.

2. At another level, there is the worry that increased non-mortgage investments would expose the Federal Savings and Loan Insurance Corporation to greater risk. There also is concern that, if savings and loans were to shed their traditional role as mortgage lenders, they would be subject to the same regulations that apply to banks and bank holding companies. Such regulations generally are more stringent than those for thrifts and their holding companies.

3. See *Guide to Federal Income Taxes for Savings Institutions*.

4. Depository institutions that do not meet the thrift test can make tax-sheltered contributions to loan loss reserves that are based on actual losses incurred in the past.

5. The Garn-St Germain Act of 1982 also provides for some additional mortgage powers. For a description, see Federal Reserve Bank of Chicago, *Leveling the Playing Field, A Review of the DIDMCA of 1980 and the Garn-St Germain Act of 1982*.

6. For a discussion of these powers and those given to federally chartered savings banks under MCA, see Federal Reserve Bank of Chicago, *Ibid*.

7. The behavior of savings banks not insured by the FSLIC has been different from that of the FSLIC-insured savings institutions. The former markedly increased the proportion of assets held in nonmortgage loans (see Mahoney, Patrick I. and Alice P. White. "The Thrift Industry in Transition." *Federal Reserve Bulletin*, March 1985, pp. 137-156).

8. Savings and loans also can engage in nonmortgage activities through service corporations. The activities of such subsidiaries are not reflected in the data shown in Table 1.

9. In addition to the lifting of deposit ceilings, the sharp drop in interest rates in the second half of 1982 likely was a crucial factor in the revival of thrift deposit flows.

10. For a discussion of the changes in assets and liabilities at thrift institutions and commercial banks brought on by the introduction of the money market deposit account, see Furlong (1983).

11. The highly liquid MMDA, which by far is the most popular of the deregulated deposit accounts, allows up to six automatic transfers per month (up to three of these by check) and an unlimited number of withdrawals when they are made in person. The overall maturity of deposits at savings and loans also has been shortened as a result of the introduction of nationwide NOW accounts in 1981. NOW accounts are fully transactional.

12. Keeley (1984) points out that deposit deregulation affected the liability structure of commercial banks by causing the substitution of smaller-denomination deposits for large certificates of deposits. For savings and loans, deregulation may have reduced their comparative advantage in attracting small-denomination deposits. This lost comparative advantage may account for some of their increased reliance on large CDs.

13. A number of studies have examined the issue of whether mortgage interest rates are determined by marginal cost or average cost: Jaffee and Rosen, 1979; Pyle, 1982; Anoako-Adu and Ben-Zion, 1983; and Mayer and Nathan, 1983. There is little dispute over the fact that, on theoretical grounds, marginal cost pricing is the preferable approach for modeling the behavior of financial institutions. However, the empirical evidence is mixed. The average cost of funds (or deposits) at mortgage lending institutions has been found to be significant in explaining mortgage interest rates when some measures of the marginal cost of funds, but not others, are used in mortgage rate regressions. Nevertheless, on balance, the empirical evidence indicates that, of the two depictions of behavior, marginal cost pricing is more appropriate.

14. Since the test is whether exogenous shocks to the flow of funds at savings and loans affect the mortgage rate, it is more appropriate to use the small-denomination deposits than some broader measure of liabilities over which these thrifts have greater control.

15. The instrumental variable for M is derived from an equation with the marginal cost of funds, the lagged mortgage rate, the return on assets at FSLIC-insured institutions, the lagged ratio of the stock of mortgages to assets at FSLIC-insured institutions, and the percent change in total financial assets included as the right-hand-side variables. The adjusted R² for this estimated equation was 0.77.

16. To control for the possible effects of the 1980 credit control period on the constant term, equation 3 also was estimated using a bivariate (0,1) dummy for the 1980:2 to 1980:3 period. The coefficient for this variable was not significantly different from zero, and the variable was not included in the estimations reported in Table 2.

17. Based on the discussion in Section I, the composition of savings and loan assets would tend to be tied to core deposit flows. Given the potential for the interrelation between asset and liability management to affect the statistical findings regarding the relation of M to the mortgage rate, equation 3 was estimated with the variable D excluded. However, the estimated coefficient for M still was not significantly different from zero when either the actual or the instrumental values for M were used in the estimation.

18. In keeping with the comment in the previous footnote, equation 3 was estimated with the variable M excluded. The findings regarding the impact of D on the mortgage rate were not materially changed.

It is also possible that savings and loans do attempt to manage small-denomination deposits to some degree. Consequently, the growth rate of small-denomination deposits may be affected by the mortgage rate given the opportunity cost. For example, if mortgage rates for some reason were high relative to other market rates, savings and loans might attempt to attract a larger volume of small-denomination deposits. If this were the case, D would not be independent of the error term in equation 3. Accordingly, equation 3 was estimated using an instrumental variable approach similar to that used for M. In this case, the coefficient for D once again was not significantly different from zero.

19. The conclusions regarding the relation between mortgage rates and small-denomination deposit flows at savings and loans have to be tempered some, based on evidence not shown in Table 2. A series on commitment rates at savings and loans is available from the Federal Home Loan Bank Board (FHLBB). This series was not used in Table 2 because the FHLBB used interest rates on both fixed and variable-rate mortgages through September 1983. The HUD series is based on data for fixed-rate loans.

When equation 3 is estimated using the FHLBB series, the results concerning the relation between R and M are essentially the same as those reported using the HUD series. However, when either the actual or the instrumental variable values for M and D are used, the growth rate in small-denomination deposits has a small negative impact on the mortgage rate, and the effect is statistically significant. The problem is that it is unclear to what extent the mixing of variable- and fixed-rate yields accounts for these results.

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Determining Geographic Markets for Deposit Competition in Banking

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This article provides empirical evidence on the geographic extent of the markets for money market deposit accounts (MMDAs) and Super NOW accounts. Three tests focusing on deposit interest rates were used: an analysis of the cross-sectional variance of rates within as compared to among regions, an analysis of the correlations of rates over time within compared to among regions, and a test of the structure-performance hypothesis using concentration indexes measured with different market geographies.

For the MMDA, no evidence of local markets is found, although all three tests suggest that markets for this account are no larger than states. For the Super NOW, we find evidence of both statewide and local markets, although there is apparently a much higher degree of competition among the local markets than among the states.

In this paper, we provide empirical evidence on the extent of the geographic markets in which competition for banking deposits takes place. This evidence is important for several reasons. First, for antitrust purposes, the competitive effects of proposed bank mergers must be assessed and this cannot be done without knowing the geographic markets for deposits, loans, and other services that banks provide. In particular, the scope of the geographic market is of paramount importance in determining whether a particular proposed merger will have anticompetitive effects. Second, at a more fundamental level, market definition is at the core of economic theory. No economic phenomenon can be properly analyzed without first determining the market in which it takes place.

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Thus, knowing the geographic extent of the markets in which banks compete is useful information for the analysis of banking.

We analyze the geographic extent of the markets for money market deposit accounts (MMDAs) and Super NOWs, two liquid market-return deposit accounts offered by banks and thrifts, which now account for about 21 and 2 percent of total domestic deposits, respectively. Although several different empirical methods are used, all focus on deposit interest rates (prices) to define the markets for these two accounts. Until recently, such an approach was problematic because deposit-rate regulation resulted in (more or less) uniform rates, making interest rate comparisons meaningless.¹ However, now that almost all deposit-rate ceilings have been removed and time-series data on rates at different banks are available, such a study is possible.

This paper is organized as follows. In Section I, a brief review of the theoretical definition of an economic market is provided along with a

discussion of the empirical implications of the theory for actually delineating markets. Section II describes our empirical tests and results. Fi-

nally, Section III presents the summary and conclusions.

I. The Theoretical Definition of a Market and its Measurement

A geographic market is a region in which suppliers and demanders trade and thereby determine prices and quantities. A literal interpretation of this definition would imply that in a given market there is a uniform price. However, in virtually all noncentralized exchanges, goods trade simultaneously at slightly different prices. Part of the reason is that various characteristics (for example, quality) of goods differ and part is because of transportation, transaction and information (search) costs.

A more practical definition of a market might include all suppliers *and* demanders that determine price. For example, if for a buyer at location A, suppliers at locations B and C were equally good substitutes, then locations A, B and C would be in the same market. This definition suggests a procedure for assessing whether a particular supplier was in a particular geographic market. One would analyze whether the demanders in the market found the supplier to be a good substitute for other suppliers in the market. Similarly, in determining whether a particular demander was in the market, one would analyze whether suppliers in the market found that demander to be a good substitute for other demanders in the market.

Thus, both demand *and* supply "substitutability" play key roles in defining markets. This means that to determine the boundaries of a market, one could continue to expand the market geographically, including more suppliers and more demanders, until there was a significant discrete fall in both demand-side and supply-side substitutability.

As this definition suggests, there is no fixed *a priori* condition determining the geographic extent of a market. In some cases, demand- and supply-side substitutability may gradually diminish as distance from the center of a market increases. In other cases, there may be more than one discrete decline. Thus, a particular

geographic area may be somewhat isolated from another even though there is a significant (but not infinite) cross-elasticity of supply or demand between the two areas.

In applying these concepts of market definition to the deposit market, depository institutions (such as banks, savings and loans, and credit unions) may be considered to be demanders of deposits, and individuals, governments and firms, suppliers of deposits.² For some types of deposits (such as those with a large transaction service component), a depositor may consider only depositories within a small region to be good substitutes.³ That is, the supply of these types of deposits may be local. However, as the above discussion implies, a local supply of deposits alone does not mean the deposit market necessarily is local since one needs to consider demand-side substitutability as well. For example, entry and the threat of entry by depository institutions not currently in the area, entry of nondepository institutions offering substitute services, or competition by institutions on the border of a region may effectively make the market much larger.

As discussed in the introduction, a key policy reason for interest in the scope of deposit markets is concern about the competitive effects of mergers and acquisitions on deposit competition. That is, without adequate competition, firms may be able to exert monopsony power and thereby pay below-competitive rates on deposits (and/or provide below-competitive levels of deposit services). The potential degree of monopsony power of a group of depository institutions (acting to maximize profits jointly) depends (inversely) on the elasticity of supply of deposits facing them.⁴

The elasticity of supply of deposits facing a group of firms in turn depends directly on the elasticity of supply of their actual and potential depositors and inversely on the elasticity of de-

mand by other firms for those depositors' deposits. Thus, this elasticity is determined by the same supply and demand substitutability factors determining the market for deposits. Moreover, supply and demand elasticities, which are at the heart of market definition, also determine the actual market power of a group of colluding firms as well as the potential gains from collusion. In particular, if the elasticity of supply of deposits facing a group of firms is very high, then these firms do not constitute a separate market nor do they have the potential to gain from collusion by paying below-competitive rates.⁵

In considering the demand-side elasticities that determine geographic markets, one needs to account for the fact that the demand for deposits is primarily a factor demand (to produce loans). It is possible, however, for the loan and deposit markets to have different geographic scopes. For example, suppose the loan market were national (or even international) in scope. Then, for each individual bank, the loan rate would be fixed and determined exogenously. However, if depositors found it economically infeasible to make deposits outside their local areas and depositories found it infeasible to relocate in order to attract deposits from areas other than their current location, then deposit markets would be local. If some local areas were characterized by monopsony power, or if other factor costs (labor, land, etc.) differed, then deposit rates could differ among localities. Thus, significant geographic differences in deposit rates would be evidence of local deposit markets even if there were no geographic differences in loan rates.

However, *if* all other factor costs were identical and *if* all deposit markets were competitive, then a national loan market would result in uniform deposit rates nationwide. This is because the value of the marginal product of deposits (in producing loans) would be equated to the rate paid on deposits (at the bank level) to maximize profits. Because the value of the marginal product of deposits would be the same in all markets, the rate paid on deposits would be the same in all markets. If such conditions

held, there would be no significant geographic differences in deposit rates.

Empirical Tests

If demand or supply cross-elasticities between two geographic areas were high, then prices in the areas would be similar. This means that differences in prices between two areas is strong evidence that the areas are not in the same markets. That is, significant differences in deposit rates could persist in two areas only if they were in separate markets. There are, however, several difficulties in implementing this test empirically.

First, the data we have contains a measure of only the pecuniary deposit rate; the implicit service flow, that is, quality of service, is not observed. We may therefore observe differences in pecuniary deposit rates even though there are no differences in the total (pecuniary plus nonpecuniary) deposit rate or vice versa. This problem is likely to be much more important for the Super NOW account than the MMDA because the Super NOW's unlimited checking feature means that it will be more widely used for transaction purposes than the limited checking MMDA. In other words, the (unmeasured) service flow from the Super NOW is likely to be much larger than that from the MMDA.

Second, even pecuniary deposit rates are measured with error (due to differences in compounding, tiered rate structures, reporting errors, or differences in required minimum balances).⁶ This too could lead to differences in measured deposit rates when none exist. Finally, we would expect to find some dispersion of true total deposit rates even within a market.⁷ This is because information about deposit rates (or any retail price) is costly for depositors to obtain. In fact, significant dispersions of the prices of virtually all retail goods are observed within markets although, as Stigler (1961) found, the dispersion is smaller for goods for which search costs are lower.

All three factors suggest that measured deposit rates have a stochastic component and therefore that the appropriate test to determine the geographic scope of a market is to analyze

statistically the variations in rates within as compared to across areas. Within a market, rates should vary less than across markets. Similarly, statistical tests can be used to determine whether differences in the average rates in two areas are due to chance.

As long as the error in the measured deposit rate is uncorrelated with the geographic measure of the market being used, standard analysis of variance techniques will be unbiased. It is likely that measurement errors of pecuniary deposit rates are independent of geography. However, quality (implicit service flows) may depend on geography both because of differences in competition as well as differences in the costs of providing quality. Similarly, search costs may be different in different areas because of differences in the cost of time or the quality of transportation services. Analyses of the differences in the level of deposit rates in different areas therefore could be biased. However, neither search costs nor quality are likely to vary over short periods of time, at least relative to the variation in deposit rates. This suggests that another way to measure the geographic extent of a market is to analyze correlations of rates over time.

Rates within a given geographic market should be highly correlated with one another over time and should be more highly correlated with one another than with rates in other geographic markets. This is because shifts in supply or demand in a market will have similar effects on all prices in a given market but will have less of an effect on prices in other markets.

However, deposit rates might be highly correlated with one another in truly different geographic deposit markets if the loan market were national. This is because movements in loan rates, and hence the demand for deposits, would be common in different deposit markets. Even so, rates within markets should be *more* highly correlated with each other than with rates in different markets. For one thing, deposit supply conditions might differ in different markets due to differences in competition. For example, in a monopsonistic market, rates would vary less than in a competitive market with a similar supply of deposits. Moreover,

supply functions would likely have different elasticities in different markets and this would lead to less highly correlated differences in rates in different markets than in the same market.

Finally, rates may also vary over time due to shifts in the supply of deposits. Since supply shifts in different markets would not be perfectly correlated, this too would lead to a higher correlation of rates over time within markets than among markets. Thus, significant differences in the correlations of deposit rates within and among geographic areas can exist only if those geographic areas are separate markets.

A third approach to market definition is based on the structure-performance hypothesis. This hypothesis holds that there is less competition in more concentrated markets, presumably because collusion is easier in more concentrated markets. Thus, we should observe banks in concentrated deposit markets paying lower deposit rates. This relationship can be used to delineate markets by testing the strength of the relationship under different market definitions. Presumably, if a market were defined properly, the predicted relationship between market structure and performance would be stronger than if a market were defined improperly. The usefulness of this test, however, depends on the validity of the structure-performance hypothesis.⁸

Although other tests for defining geographic markets have been suggested, many have serious flaws.⁹ For example, some have suggested analysis of shipment flows. Although two areas that do have significant shipments between them are likely to be in the same market, areas with no shipments between them also may be in the same market. For example, if there were no shipments between locations A and B, but a large number of commonly located buyers in location C are receiving significant shipments from A and B, those buyers will tend to force prices in A and B to identical levels. Any price differential between A and B would cause the buyers in location C to shift all their purchases to the area with the lower price. This would tend to drive down the higher price and raise the lower price until equality is restored.

Another widely used method of defining markets is to delineate the customers of a business in the so-called service area. The concept of using service areas is flawed for the same reason as the shipment-analysis method. It may be true that all consumers shop within only a few miles of home, but a large metropolitan area will be integrated into one large market because of the existence of consumers on the margins between service areas.

What We Expected

Most previous analyses (see Heggstad, 1979) of competition in retail banking have assumed that the relevant market was local. However, there are reasons, at least in states that permit branching, why competition may take place in statewide markets. Virtually all multiple-branch banks in the West pay common rates

on deposits at all branches and this suggests that even if there were differences in the degree of competition in local markets, banks do not find it worthwhile or possible to exploit them by differences in explicit pricing. One reason it may not be worthwhile to pay different rates at different branches is that a depositor could then open an account at the branch with the highest rate but still receive deposit and transaction services at the most convenient branch.¹⁰

Uniform pricing by several of the large banks with branches in virtually all local areas in a state makes it inopportune for other banks to price differently. However, since branching across state lines is not currently permitted, and since entry may not be fully market-determined, markets in different states may be somewhat insulated from one another.

II. Empirical Analysis

In this section, we use the first three empirical methods described in the previous section (analysis of the levels of rates, correlations of rates over time, and the structure-performance hypothesis) to provide evidence about the scope of geographic *deposit* markets in the West. It should be emphasized that we are only analyzing deposit markets and that loan markets may well have different geographic scopes. Further, the markets for different types of deposits may well have different geographic scopes depending, for example, on their transaction service component.

We do not attempt to determine actual deposit markets, rather, we use the data to determine if there is evidence of statewide markets and/or local markets. Local markets are defined as either counties or Rand McNally Metropolitan Areas (RMAs) because such local market definitions are most commonly accepted as valid and because data defining these markets are readily available.

The data for our study are from a monthly Federal Reserve survey (FR2042) of interest rates and deposit quantities at 59 different banks in the Twelfth Federal Reserve District.

Data on the geographic locations in which banks have branches and market concentration come from the Federal Deposit Insurance Corporation's (FDIC's) June 1983 Summary of Deposits Tape.

Our empirical analysis of the scope of geographic markets for bank deposits uses data on two different deposit categories: Money Market Deposit Accounts (MMDAs) and Super NOW Accounts. These accounts are well-suited to our study because both have been free of interest rate ceilings since their introductions on December 14, 1982 and January 5, 1983, respectively. Also, they provide an interesting comparison of a transaction account (the Super NOW) to a liquid savings account (the MMDA).

These data have several limitations. First, banks report only the most common interest rates paid on the largest dollar volume of deposits (of a given type) issued during the seven-day period ending on the last Wednesday of the month.¹¹ Second, deposit rates are reported for banks, not branches. However, as mentioned above, we have verified that these banks did not offer different deposit rates at different

branches. Third, the sample size is relatively small. Only in California, in which we have 29 banks, do we have a relatively large sample size.¹²

In the statistical analysis that follows, we not only use survey observations directly, but we also use a synthetic data base to test for local markets. The basic unit of observation from the survey is a deposit rate of a bank in a month. By combining this bank rate information with structural data (from the FDIC's 1983 Summary of Deposits Tape) on the location of banks' branches, it is possible to create a synthetic data set.

This synthetic data base contains observations on the rates each bank pays in each local geographic "market" area where the bank has a branch. One data base is created for RMAs and another is created for all counties including counties in RMAs. Such synthetic data bases can be created since each bank pays the same rate at all its branches.¹³

In some of the analysis that follows, the bank itself is the unit of observation (that is, one observation per bank per month). In other analyses, the synthetic data are used to make banks in counties (or RMAs) the unit of analysis (one observation per bank per county, or RMA, per

month). However, in the synthetic data set, there is only one observation for each bank in each county (or RMA) regardless of the number of branches that bank has in a county (or RMA).

In Chart 1, we present evidence that the mean rates on MMDAs (across banks) within each state differ fairly substantially across the states in our sample (Nevada is excluded because our sample contains only one bank in that state). These differences in means suggest that different states are in different markets since if the states were in the same market, rates would be more similar.¹⁴ Hawaii, especially, appears to be in a different market since MMDA rates there are very different from the rates in other states in our sample.

In Chart 2, we present a similar plot of mean Super NOW rates by state. For Super NOWs, differences among the states are even more pronounced, both in terms of the levels of the rates and their time patterns. Although differences in the levels of the rates might be explained by differences in the levels of fees or nonpriced services, the dramatic differences in the time *pattern* of the rates cannot be explained by these factors because fees and nonpriced services do not vary rapidly over time.

Chart 1
Mean MMDA Rates by State

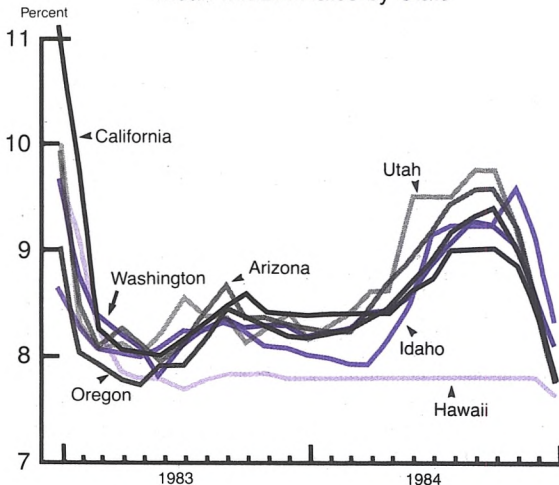
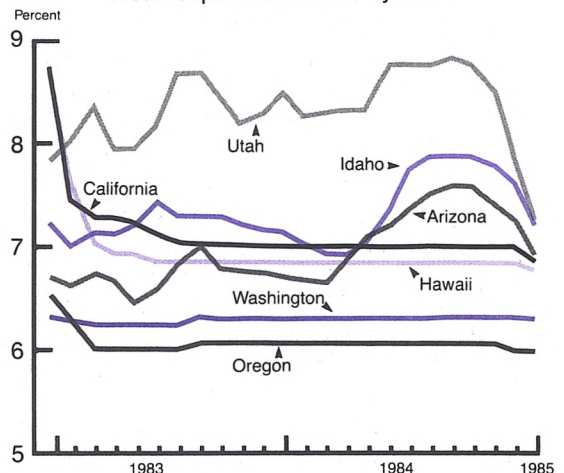


Chart 2
Mean Super NOW Rates by State



Comparisons of the Level of Rates

To determine whether the differences in banks' deposit rates among the states are statistically significant, we analyzed the variances of the rates across banks in different states. Much like the plots in Charts 1 and 2, the idea underlying this comparison is that the prices of competitors within a particular market should be more similar than prices across markets. Thus, if the states do, in fact, represent markets at any moment in time, the variance in rates across banks within each state should be much lower than the overall variance of rates across banks in all states. However, if the markets were smaller geographic areas than states and if these local markets were interconnected, then variances within states might still be lower than the overall variance across states. Thus, a finding of significant state differences would mean that markets were no larger than states and that cross elasticities between states were lower than within states, but it would not necessarily mean that cross elasticities between local areas (such as RMAs or counties) were not also lower than cross elasticities within counties or RMAs.

The analysis-of-variance model used to test for state differences is:

$$R_{it} = a + b_1S_{1it} + \dots + b_7S_{7it} + a_1T_{1it} + \dots + a_NT_{Nit} + E_{it} \quad (1)$$

where:

R_{it}	= the rate paid on deposits (of a given type) by bank i at time t
S_1, \dots, S_7	= state dummy variables
T_1, \dots, T_N	= Monthly time dummy variables
b_s and a_s	= parameters to be estimated
E_{it}	= random error term.

In this model, the variance in the rates paid by individual banks on a given deposit type is decomposed additively into the variance due to state and time.¹⁵ Thus, in this analysis, a bank in a month is the unit of observation. If the states were in separate markets, we should be able to reject the null hypothesis that $b_1 = \dots$

$= b_7 = 0$. That is, we should be able to reject the hypothesis that there are no statistically significant differences among the states in the rates paid on given deposit types. Conversely, significant differences among the states means that variances within the states are lower than the overall variance of rates across states and suggests that deposit markets are no larger than states.

The results of such tests are presented in Table 1. For both deposit types, we can reject the hypothesis at the 1 percent level or better that the rates do not depend on state.¹⁶ Time also has a significant influence on rates. This suggests that some common factor across all states is influencing either the supply or demand for deposits or both. A likely source of this common movement would be common movements in the demand for deposits due to a common movement in the demand for loans. This result, however, also might be due to nationwide competition from the money funds for MMDA deposits. A study by Keeley and Zimmerman (1985) finds that the short-run cross-elasticity between MMDA deposits and the money fund rate is small but statistically significant, and that the long-run cross-elasticity is large. Thus, nationwide movements in money fund rates could explain some of this common movement in MMDA rates over time.

These regression results confirm that state is a much more powerful explanatory factor for Super NOWs (where it explains 59 percent of the variance) than for MMDAs (where it explains 9 percent of the variance). Similarly, these regressions indicate that common factors varying over time are much more important for the MMDA than the Super NOW. (Time explains 61 percent of the variance of MMDA rates but only 9 percent of the variance of Super NOW rates.)

The magnitude of the estimated state differences for MMDAs is fairly large, with a maximum difference of 83 basis points between Hawaii and Utah. For Super NOWs, interstate differences in rates are staggering, with a maximum difference of 231 basis points between Nevada and Utah. These very large estimated differences in rates among states suggest very

TABLE 1

Statistical Tests of Differences in Banks' Rates Across States: Bank-level Data
(Standard Errors in Parentheses)

MMDA Rate (in basis points)

Number of Observations	1475
Minimum of Dependent Variable	725
Maximum of Dependent Variable	1300
Mean of Dependent Variable	852
R ²	.71

State Coefficients (California is the omitted state)

<u>AZ</u>	<u>HI</u>	<u>ID</u>	<u>NV</u>	<u>OR</u>	<u>UT</u>	<u>WA</u>
7*	-66***	-19***	-55***	-10***	17***	-15***
(3)	(4)	(4)	(7)	(3)	(4)	(3)

F-test for state differences = 65***
(% of Variance Explained by State = 9%)

F-test for time differences = 126***
(% of Variance Explained by Time = 61%)

Super NOW Rate (in basis points)

Number of Observations	1334
Minimum of Dependent Variable	552
Maximum of Dependent Variable	975
Mean of Dependent Variable	704
R ²	.69

State Coefficients (California is the omitted state)

<u>AZ</u>	<u>HI</u>	<u>ID</u>	<u>NV</u>	<u>OR</u>	<u>UT</u>	<u>WA</u>
-9***	-15***	30***	-110***	-64***	121***	-83***
(4)	(4)	(4)	(7)	(4)	(4)	(3)

F-test for state differences = 354***
(% of Variance Explained by State = 59%)

F-test for time differences = 17***
(% of Variance Explained by Time = 9%)

***Significant at the 1% level

**Significant at the 5% level

*Significant at the 10% level

strongly that Super NOW deposit markets are not larger than states.

Similar tests also were performed to determine if there are significant differences across counties (or RMAs) in deposit rates. In these tests, we used our synthetic data base in which the unit of observation is the rate paid by a given bank in a county (or RMA) in a given month. The data from all the states is pooled, and the model estimated is:

$$R_{ijt} = a + b_1S_{1ijt} + \dots + b_7S_{7ijt} + \gamma_1C_{1ijt} + \dots + \gamma_M C_{Mijt} + a_1T_{1ijt} + \dots + a_nT_{nijt} + E_{ijt} \quad (2)$$

where:

R_{ijt} = the rate paid on deposits (of a given type) by bank i in county j (or RMA j) at time t .

S_1, \dots, S_7 = state dummy variables

T_1, \dots, T_n = time dummy variables

C_1, \dots, C_M = county (or RMA) dummy variables

$a_s, b_s,$ and γ_s = parameters to be estimated

E_{ijt} = a random error term.

The results of these regressions, reported in Table 2, show that for the MMDA, we cannot reject the hypothesis that rates do not differ across RMAs or counties once we control for state differences. Thus, for the MMDA, this test provides no evidence of local markets.

In these regressions, state explains a much smaller percent of the overall variance than in the bank-level regressions because a much larger proportion of the observations in the synthetic data base are in California. However, the estimated state differences are still significant at the 1 percent level and are approximately the same magnitude as those reported in Table 1. Thus, these results also suggest that MMDA deposit markets are not larger than states.

For Super NOWs, we can reject at the 1 percent level the null hypothesis of no local differences in rates. Thus, for the Super NOW, there is evidence of local markets. This result is consistent with the notion that transaction services

are provided in local markets since the Super NOW has a much higher transaction service component than the MMDA. Because a large transaction service component is likely to be associated with a more local supply of deposits, it would not be surprising to find that Super NOW deposit markets were local while MMDA markets were statewide.

However, the percentage of the variance of Super NOW rates explained by RMA or county is about 1/20th of that explained by state. Thus, the local differences in rates are generally much smaller than interstate differences. Further, the largest estimated difference in Super NOW rates between two RMAs after controlling for state effects is only 37 basis points, a small difference compared to the over 200 basis point maximum difference found between two states. This suggests that cross-elasticities among counties or RMAs are much larger than among states.

To a certain extent, the results in Table 2 are dominated by large banks with numerous branches. Since in the synthetic data base each large bank contributes many observations with identical rates (in any given month), such a large number of identical rates virtually guarantees that there will not be large estimated differences in rates among local areas within a state. To determine how sensitive our results in Table 2 are to the inclusion of large, multi-branch banks, we reestimated the model (Equation 2) for California only, both with and without the 5 largest California banks.

As expected for the MMDA, estimated mean inter-RMA differences in rates are somewhat larger when the 5 largest banks are excluded. Further, we can reject the hypothesis that rates do not differ among the RMAs at the 1 percent level. However, whereas the largest difference in rates between two RMAs is 25 basis points, most of the estimated differences are very small and most inter-RMA differences are not significant (the results are essentially driven by one RMA).

Furthermore, when we perform the same analysis at the county level, we cannot reject the null hypothesis of no differences in MMDA rates among counties. Thus, at the county level,

TABLE 2

Statistical Tests of State, RMA, and County Differences: Synthetic Data
(Standard Errors in Parentheses)

MMDA Rate (in basis points)

		RMA DATA				
		STATE		RMA		TIME
F-Tests		77***		.54		1342***
% of Variance		1%		0%		80%
Number of Observations	7750					
Minimum of Dependent Variable	725					
Maximum of Dependent Variable	1300					
Mean of Dependent Variable	857					
R ²	.81					
<i>State Coefficients</i>						
<u>AZ</u>	<u>HI</u>	<u>ID</u>	<u>NV</u>	<u>OR</u>	<u>UT</u>	<u>WA</u>
7**	-66***	-17***	-55***	-11***	6	-5
(3)	(4)	(4)	(6)	(3)	(4)	(4)

COUNTY DATA

		STATE		COUNTY		TIME
F-Tests		60***		.83		2004***
% of Variance		1%		0%		71%
Number of Observations	19050					
Minimum of Dependent Variable	725					
Maximum of Dependent Variable	1300					
Mean of Dependent Variable	854					
R ²	.73					
<i>State Coefficients</i>						
<u>AZ</u>	<u>HI</u>	<u>ID</u>	<u>NV</u>	<u>OR</u>	<u>UT</u>	<u>WA</u>
5*	-65***	-17***	-54***	-20***	3	-5
(3)	(4)	(4)	(7)	(5)	(7)	(4)

Super NOW Rate (in basis points)

RMA DATA

	<u>STATE</u>	<u>RMA</u>	<u>TIME</u>
F-Tests	439***	5***	233***
% of Variance	19%	1%	34%

Number of Observations	7322
Minimum of Dependent Variable	552
Maximum of Dependent Variable	975
Mean of Dependent Variable	700
R ²	.73

State Coefficients

<u>AZ</u>	<u>HI</u>	<u>ID</u>	<u>NV</u>	<u>OR</u>	<u>UT</u>	<u>WA</u>
-10***	-15***	30***	-111***	-93***	124***	-93***
(3)	(4)	(4)	(6)	(4)	(4)	(4)

COUNTY DATA

	<u>STATE</u>	<u>COUNTY</u>	<u>TIME</u>
F-Tests	219***	3***	271***
% of Variance	7%	3%	30%

Number of Observations	18044
Minimum of Dependent Variable	552
Maximum of Dependent Variable	975
Mean of Dependent Variable	694
R ²	.75

State Coefficients

<u>AZ</u>	<u>HI</u>	<u>ID</u>	<u>NV</u>	<u>OR</u>	<u>UT</u>	<u>WA</u>
-15***	-16***	29***	-112***	-110***	118***	-70***
(3)	(4)	(4)	(7)	(5)	(7)	(4)

***Significant at the 1% level

**Significant at the 5% level

*Significant at the 10% level

the MMDA results do not depend upon the inclusion of the five largest banks. This means that there is no evidence of local markets for MMDAs using county data even when the 5 largest banks are excluded. However, if the 5 largest banks were not in almost all local areas and paying uniform statewide rates, local areas might indeed be more insulated from one another.

The results for the Super NOW are similar. They show larger, statistically significant, inter-RMA (and inter-county) differences in California and a doubling from one to two percent of the percentage of variance explained by RMA when the five largest banks are excluded. However, for the Super NOW, the maximum difference in rates between RMAs is only 40 basis points (25 basis points between counties). This is very small compared to the inter-state differences. Thus, the five largest banks do not appear to be driving these results.

To summarize the results of Tables 1 and 2, we find no significant differences in MMDA rates among counties or RMAs, but we do find significant differences among states. Thus, there is evidence that the state and not the RMA or county is the market in which competition for MMDAs takes place. For the Super NOW, there are significant differences at the state, county and RMA levels, although neither county nor RMA explains a very large part of the variance in rates (not due to time). Thus, there is evidence of discrete changes in supply and demand substitutability at both the local (county or RMA) and state levels, with a larger change at the state level.

Correlations of Rates Over Time

Another test of the extent of geographic deposit markets is to compare within-area correlations to across-area correlations. If a given geographic region were a market, then rates within that area should be more highly correlated with one another than with rates in other areas.

In Table 3, we present the results of just such a test. First, we calculated a mean rate for each county (or RMA) in our sample. The mean is

the simple average of the rates paid by the banks with branches in the county. Second, we focused on California because it contains more banks (thus giving us better estimates of the rates in different counties) and also because the presence of several banks with large statewide branches would suggest that California is likely to be a deposit market. For each county (or RMA) in California, we computed the correlation over time of the mean rate in that county (or RMA) with mean rates in every other county (or RMA). This resulted in a matrix with $(n^2 - n)/2$ correlation coefficients where n is the number of counties (or RMAs).

Next, we computed similar correlation matrices of California counties with counties in other states for each of the other states separately. This resulted in 7 matrices of $n \times m_j$ correlation coefficients, where n is the number of counties (RMAs) in California and m_j is the number of counties (or RMAs) in state j . Finally, we computed summary statistics over these eight matrices of correlation coefficients. If our hypothesis that California is a single deposit market were correct, we would expect the means of the correlations of counties (or RMAs) in California with each other to be significantly greater than the means of the correlations of California counties (RMAs) with other states' counties (or RMAs).

The results in Table 3 indicate that both mean MMDA and Super NOW deposit rates in each California county (RMA) are very highly correlated with mean MMDA and Super NOW rates, respectively, in every other California county (RMA). The mean CA-CA correlation is .997 for MMDAs and .988 for Super NOWs using RMA data. Correlations of rates over counties is also large, but smaller than the correlations over RMAs. This might be expected since RMAs, being metropolitan areas, are more homogeneous than counties, which include both urban as well as rural areas.

The results in Table 3 also show that for both the MMDA and Super NOW, correlations of counties within California are much higher than correlations of California counties with out-of-state counties. This same result also is found when using RMA data. All differences in the

TABLE 3
Means of Within and Cross-State Correlation: Synthetic Data
(Standard Deviations in Parentheses)

	CA-CA	CA-AZ	CA-HI	CA-ID	CA-NV	CA-OR	CA-UT	CA-WA
<i>MMDA Rate</i>								
COUNTY DATA								
mean	.995 (.004)	.752* (.027)	.867* (.015)	.392* (.029)	.846* (.020)	.588* (.027)	.669* (.040)	.813* (.034)
N	1653	812	232	2204	638	2088	1218	2146
min	.973	.666	.828	.306	.809	.503	.477	.667
max	1.000	.809	.907	.463	.894	.675	.779	.888
RMA DATA								
mean	.997 (.002)	.735* (.011)	.864* (.011)	.408* (.023)	.848* (.018)	.627* (.053)	.715* (.035)	.825* (.028)
N	378	84	28	84	56	140	84	224
min	.987	.717	.827	.360	.813	.582	.675	.748
max	1.000	.769	.880	.450	.878	.756	.784	.882
<i>Super NOW Rate</i>								
COUNTY DATA								
mean	.981 (.023)	-.272* (.059)	.959* (.015)	-.132* (.077)	.940* (.041)	.690* (.265)	-.290* (.062)	-.004* (.364)
N	1653	812	232	2204	638	2088	1218	2146
min	.859	-.469	.908	-.365	.795	0	-.430	-.637
max	1.000	-.104	.977	.036	.982	.950	-.007	.828
RMA DATA								
mean	.988 (.012)	-.257* (.059)	.964* (.011)	-.171* (.075)	.955* (.024)	.652* (.053)	-.205* (.082)	-.046* (.217)
N	378	84	28	84	56	140	84	224
min	.925	-.394	.927	-.253	.892	.498	-.312	-.604
max	1.000	-.122	.983	.037	.985	.752	-.011	.387

*Mean significantly different from the CA-CA mean at the 1% level

means are statistically significant at the 1 percent level or better. Thus, this evidence suggests that markets are not larger than states.

This same type of test could be performed to determine whether the correlation of rates within a county (or RMA) was larger than the correlation of rates in that county (or RMA) with rates in other counties (or RMAs). However, given the very high RMA-RMA correlations (in California) reported in Table 3 (.998 for the MMDA), the correlations of rates within particular RMAs cannot be much higher. Further, since correlations of rates in California counties or RMAs with counties or RMAs outside the state are generally considerably lower than the within-California correlations, the very high within-state correlations cannot be due solely to common nationwide movements in the demand for loans.

These results, however, may be partly due to the existence of many multiple-branch banks (with branches in only one state) that price uniformly within states. An alternative test is to see if *banks* in California have rates that are more highly correlated with other California

banks' rates than are California banks' rates with out-of-state banks' rates. Such tests are reported in Table 4. The results confirm that the time patterns of rates of California banks are significantly more similar to each other than they are to non-California banks. Thus, the data at the bank level also support the hypothesis of statewide MMDA and Super NOW deposit markets for California.

Structure-Performance Tests

The final method of investigating the geographic scope of banking deposit markets employed in this paper tests the structure-performance hypothesis at different levels of geographic market definition. It measures market concentration (and hence competitiveness) using the Herfindahl index (the sum of the squares of each bank's market share) at two different market levels—one assuming markets are statewide and the other assuming markets are local. The first index, the state Herfindahl¹⁷, is simply a measure of concentration at the state level; the local Herfindahl is a similar number defined separately for each local "mar-

TABLE 4
Means of Within and Cross-State Correlations: Individual Bank Rate Data
(Standard Deviations in Parentheses)

	CA-CA	CA-Other States
<i>MMDA Rate</i>		
Mean	.899 (.127)	.659* (.184)
N	406	870
min	.332	.043
max	.997	.950
<i>Super NOW Rate</i>		
mean	.655 (.337)	.167* (.446)
N	378	784
Min	-.549	-.988
Max	.999	1.000

*Mean significantly different from the CA-CA mean at the 1% level.

ket", either county or RMA. Both concentration measures were obtained from our 1983 FDIC Summary of Deposits Tape.

According to the structure-performance hypothesis, rates in more concentrated, and hence less competitive markets, are expected to be lower. Thus, if the state were the relevant market, we would expect the state Herfindahl to be negatively related to deposit rates, whereas if the county or RMA were the relevant market, the local Herfindahl should be negatively related to deposit rates.

To test these hypotheses, we used our synthetic database in which an observation is a bank in a county (or RMA) in a month, so that we could directly enter both the local and state Herfindahl indexes in our regression model. In addition to entering these two measures of concentration in our regressions, we included a number of other variables to control for other factors influencing banks' deposit rates.

Two key control variables are a bank's deposits as a percentage of total deposits of all banks in the state and its percentage of local deposits in a county or RMA (as of June 30, 1983). These variables were included primarily because a study by Smirlock (1985) found that they were significantly related to bank profitability in a model that included market concentration (Herfindahl) measures. He argued that concentration was a proxy for market share and that a higher market share, in turn, was achieved by better operated, more efficient (and thus more profitable) banks. It is unclear, however, whether banks with larger market shares would pay lower deposit rates, although it is plausible they would if they achieved their larger market shares by offering better quality services. In contrast, if they were more profitable because of superior lending abilities, they might pay higher rates on deposits.

Other control variables include the number of branches, both in the state and in the local area, as well as a dummy if the bank had 5 or fewer branches in the state. Presumably, the number of branches is positively related to the level of convenience. If so, banks with more branches would be paying higher implicit rates

and therefore could pay correspondingly lower explicit rates on deposits.

We also included as control variables the percent of large, \$100,000 and over, Certificates of Deposit (CDs) (as of November 30, 1982) and the growth rate of total deposits from November 1981 to November 1982. Banks with a larger percentage of CDs may be more risky, or they may be more aggressive seekers of deposits generally, or they may have greater incentives to substitute less costly MMDAs for CDs. In all three cases, they would either have to or be willing to pay higher rates on MMDAs. Banks in rapidly growing deposit markets, however, would be able to pay lower deposit rates because an exogenous increase in the supply of deposits relative to demand would drive down deposit rates.

The final two control variables were measured contemporaneously with the MMDA and Super NOW rate. One is a linear time trend and the other is the national average rate on money market mutual funds. Presumably, deposit rates should follow a national open-market rate, at least to some extent, because of common nationwide movements in the demand for loans or because of nationwide competition for deposits from the money funds.

The results of these analyses are presented in Table 5. For the MMDA, the state Herfindahl but not the local Herfindahl is significantly negatively related to rates, as expected. This suggests that for the MMDA, deposit markets are statewide and not local in scope. However, the magnitude of the state Herfindahl coefficient is not large. For the county model, the estimated coefficient of $-.0067$ implies a difference of only 67 basis points between a perfectly competitive market and a perfectly monopsonistic market. Thus, MMDA markets may be even larger than states because such a small difference in rates among states implies a very elastic supply of deposits on a statewide basis.

For the MMDA, we also find significant negative effects of banks' state market shares on rates. The coefficient in the RMA model, for example, implies that a bank with 100 percent of the state market would pay 41 basis points

TABLE 5
 Test of the Structure-Performance Hypothesis: Synthetic Data
 (Standard Errors in Parentheses)

	<i>MMDA Rate</i>		<i>Super NOW Rate</i>	
	<u>RMA</u>	<u>COUNTY</u>	<u>RMA</u>	<u>COUNTY</u>
N	7750	19,050	7322	18,044
mean	856.66	853.61	699.59	693.85
R ²	.28	.30	.27	.18
SEE	55.06	52.83	46.42	56.74
Intercept	424.32***	413.89***	690.06***	628.36***
State Herfindahl	-.0038* (.0022)	-.0067*** (.00097)	.054*** (.0019)	.046*** (.0011)
Local Herfindahl	-.00082 (.0015)	.00055 (.00044)	-.0087*** (.0013)	.00094* (.00049)
# of Branches	-.00015 (.017)	.013 (.022)	-.042*** (.014)	-.035 (.024)
5 or Fewer Branches in State	-11.93*** (3.96)	-5.47* (3.19)	27.69*** (3.85)	44.97*** (4.25)
# of Branches in State	.016*** (.0028)	.016*** (.0016)	.063*** (.0024)	.045*** (.0018)
Deposit Growth	-37.80*** (6.05)	-35.83 (3.64)	-98.51*** (5.23)	-85.25*** (4.00)
Percent CDs	6.78 (5.17)	9.16*** (3.27)	47.63*** (4.49)	55.47*** (3.61)
Time	-6.51*** (.14)	-5.51*** (.088)	-2.43*** (.13)	-2.02*** (.10)
Money Fund Rate	.64*** (.012)	.63*** (.0073)	.072*** (.010)	.11*** (.0080)
Percent of State Deposits	-.41*** (.10)	-.28*** (.053)	-2.19*** (.091)	-1.35*** (.058)
Percent of Local Deposits	.022 (.090)	-.073* (.039)	.40*** (.078)	-.025 (.043)

***Significant at the 1% level

**Significant at the 5% level

*Significant at the 10% level

less than one with a zero market share. Again, this is not a large effect, but it is consistent with Smirlock's findings that banks with larger market shares are more profitable.¹⁸

The estimated coefficients of the number-of-branches variables are not as expected. Banks with more branches in the state actually pay higher rates and banks with 5 or fewer branches pay lower rates. Perhaps banks with fewer branches offer some more-than-compensating high-quality service, such as personalized attention, that might account for these findings.

We do find that, as expected, banks in more rapidly growing markets pay lower rates, and that banks with larger percentages of CDs pay higher rates. MMDA rates also track the money fund rate but on less than a point-for-point basis (the estimated coefficient is approximately .6). This strong correlation of MMDA rates with money fund rates might be due to common movements in the demand for loans, and hence deposits, to competition for deposits from the money funds, or to both.

For the Super NOW, the coefficients on the Herfindahl variables are puzzling. Although the coefficients of the state Herfindahls are statistically significant, they are positive, not negative as expected. Thus, the state differences in the level of Super NOW rates are not explained by the concentration-competition hypothesis. However, in the RMA model, the local Herfindahl coefficient is negative and significant, although in the county model, it is positive and significant at the 10 percent level. Thus, the structure-performance tests for the Super NOW provide conflicting evidence for the local market hypothesis.

These tests also do not support the state market hypothesis. The positive Herfindahls may be proxying for some other variable, like service quality. Quality of service is likely to be much more important for the Super NOW, with its large transaction component, than the MMDA which has only limited transaction features. For example, if more highly concentrated markets were also markets where providing quality service is expensive, then keeping deposits in such markets (assuming they are competitive) would require higher explicit rates to

compensate for the lower quality of services.

Consistent with a high service component, we find that Super NOW rates do not respond to open-markets rates to anywhere near the same extent as do MMDA rates. The coefficient on the money-fund-rate variable is only 1/9 to 1/6 as large as the coefficients in the MMDA model, depending on whether county or RMA estimates are compared. This low correlation also suggests that neither common movements in the demand for loans nor nationwide competition from the money funds drives Super NOW rates. Also consistent with the hypothesis of a high service component connected with Super NOW accounts is the much larger effect of a bank's market share for Super NOWs than MMDAs—the effect is over 4 times as large. The estimated effects of deposit growth are negative, as expected, and percent of CDs has a positive effect on the Super NOW rate.¹⁹

Unlike the MMDA results, banks with five or fewer branches pay higher Super NOW rates, as one might expect, although the total number of branches in the state has a positive although small coefficient. Also, unlike the MMDA results, the number of branches in the RMA does have a significant negative, although small, effect and this is consistent with the idea that Super NOWs have a large service component that depends on the number of branches in a local area. In summary, the structure-performance results for the Super NOW are consistent with the account's much larger service component (compared to the MMDA), but they provide no direct information on whether the markets for Super NOWs are local or statewide.

Qualifications Due to Unmeasured Quality Competition

All three of these tests are based solely on measures of explicit interest rates. Implicit interest (in the form of transactions services, for example) may be quantitatively important especially for the Super NOW. Below, we consider how the inability to measure nonpecuniary returns could affect our results.

First, as mentioned previously, if quality (that is, implicit interest) were unrelated to

geographic area, our results would be unbiased because the error term in both the analysis-of-variance and structure-performance models would capture the quality component and be uncorrelated with the explanatory variables. However, if quality were correlated with geographic area, both models would be biased, although the correlation analysis, under certain assumptions, would not be similarly affected. Below, we consider two hypotheses of how quality might be related to geographic area.

First, consider Stigler's (1964) theory of quality competition that within non-competitive markets competition takes place along various quality dimensions. Within such markets, we would observe uniform explicit rates that were below competitive levels even though true rates, including the quality component, were higher and perhaps more variable. Thus, this type of quality competition would tend to bias the results of both the analysis-of-variance and structure-performance tests toward a finding of larger geographic differences in rates than actually existed. This in turn could lead us to conclude that markets are smaller than they are in reality.

Another possible correlation of quality with geographic area would exist if the provision of quality were more expensive in some areas or if it were kept below market levels by regulation

(for example, by laws that restricted branching or that limited banking hours). If such areas were in competition with unregulated areas or areas with lower costs of providing quality, it is likely there would be compensating differences in explicit rates. Thus, compensating explicit rates also might cause us to conclude that markets are smaller than they are in reality.

A third possibility is that, because of the difficulty (that was mentioned previously) of paying different explicit rates in different geographic locations within a state with unrestricted branching, banks would compete through quality competition. If this were correct, true rates would exhibit larger differences than explicit rates. This would bias our results toward finding no differences in rates among local markets when they actually do exist.

Although both the analysis-of-variance and structure-performance tests are likely to be biased by unmeasured quality differences (although the sign and magnitude of the bias are unknown), the correlation analysis is not biased as long as the provision of quality does not vary over time. (If quality varies much less than explicit rates then the bias is likely to be small.) This is because adding constants to the rates in two areas (reflecting different quality components) does not affect correlations of the rates over time.

III. Summary and Conclusions²⁰

For the Super NOW, we find statistically significant and large state differences in the level of rates. This suggests that Super NOW deposit markets are not larger than states and that competition within states differs from that across states possibly because of prohibitions on interstate branching. The correlation analysis also points to Super NOW deposit markets no larger than states since Super NOW rates in counties (or RMAs) in California are much more highly correlated with each other than with rates in counties (or RMAs) in other states.

There is also evidence of statistically significant differences in the level of rates among

RMAs (or counties) within states. These significant inter-RMA or inter-county rate differences within the states suggests local Super NOW deposit markets that are smaller than states. However, the magnitude of the differences in Super NOW rates among counties or RMAs is small compared to inter-state differences. So, although there may be distinct local markets for Super NOWs, there is apparently a much higher degree of competition among the local markets within states than among the states.

The structure-performance tests yield unexpected results for the Super NOW—rates are positively, not, as expected, negatively related

to the Herfindahl measure of concentration. This result may be due to the high (unmeasured) service component of the Super NOW yield.

Not only is the service component of the Super NOW yield likely large, but differing service charges and minimum balance requirements also may account for some of the observed differences in explicit rates. However, it is unclear whether and how such factors would be correlated with geographic area and, hence, how they could be biasing our results.

For the MMDA, the results of all three tests—analysis of variance, correlations over time, and the structure-performance hypothesis—provide consistent evidence that MMDA markets are not larger than states.

In addition, we do not find significantly different MMDA rates among RMAs or counties. Also, mean rates on MMDAs among counties or RMAs within California are almost perfectly correlated with one another and are more highly correlated with one another than with counties or RMAs in other states. Moreover, although MMDA rates are negatively related to concentration levels measured on a statewide basis, they are not related to concentration measured on the county or RMA level.

Thus, none of these tests provides support for the hypothesis of local MMDA deposit markets, at least within California. This may not be surprising given the statewide branch banking in the 12th District and the uniform pricing by multiple branch banks within a state. In California especially, where the 5 largest banks have huge branch networks and are represented in virtually all of the RMAs or counties, it is almost a foregone conclusion that mean rates in all RMAs or counties would be similar.²¹

If unrestricted branching within a state does in fact lead to statewide MMDA deposit markets, then regional or national branching may lead to regional or nationwide MMDA deposit markets. Thus, as interstate banking progresses we would expect to see MMDA deposit markets expand geographically.

These MMDA results also demonstrate how misleading conclusions drawn from the so-called service area method of defining deposit markets may be. It is likely that most banks' MMDA deposits come from a relatively small geographic area near the bank, but there is very little doubt that MMDA deposit markets are much larger.

FOOTNOTES

1. See Garcia (1983) for an early attempt to analyze geographic deposit rate differentials to determine the geographic markets for MMDAs. Also, see Wall and Ford (1984) and Watro (1985) for examples of studies that also analyze deposit rate levels in different geographic areas to determine the geographic extent of a market.

2. Depository institutions may also be considered to be suppliers of deposit services, such as check clearing and the exchange of currency for deposits. However, since banks pay net interest on most deposits, the value of deposits as inputs into the production of loans must exceed the cost of deposit services. Thus, depository institutions may be viewed as net demanders of deposits.

3. Time and convenience factors associated with check clearing and cashing may lead depositors to prefer local banks.

4. The ratio of the deposit rate in a market with a single buyer to the rate in a competitive market is $1/(1 + 1/\epsilon_s)$, where ϵ_s is the elasticity of supply of deposits. For example, if the elasticity is 2, the rate in the monopsonistic market will only be 2/3 of what it would be in a competitive market.

5. See Posner (1976) for an interesting discussion of the

congruence between supply and demand elasticities and market definition. His discussion focuses on the market power of sellers rather than buyers, however.

6. There is some error in measuring interest rates because information on the method of compounding is not available in our data set. However, different compounding methods have relatively small effects on interest rates for short-term accounts (such as the MMDA and Super NOW) where interest is usually paid monthly and sometimes weekly.

Another difficulty in measuring interest rates comes from the fees many banks charge for maintaining accounts. For Super NOWs, this is likely to be an especially important problem since the fees are significant. Unfortunately, our survey data contain no information on fees. However, in a study in which such fee data were obtained, Watro (1985) does not find a statistically significant relationship between service charges and deposit rates.

Another difficulty in measuring interest rates is that some banks use "tiered" structures in which the rates depend on deposit quantities. This introduces another source of error into our measure of deposit rates. A closely related difficulty in measuring rates properly is that different banks have different minimum balance requirements. However,

Watro (1985) does not find a statistically significant relationship between minimum balance requirements and the level of rates.

7. See Wall (1984) for evidence that deposit rates differ with markets.

8. See Gilbert (1984) for an extremely critical review of the structure-performance literature. See Heggstad (1979) for a more supportive summary of the findings.

9. See Wolken (1984) for a comprehensive review of the literature on geographic markets in banking.

10. Evidence supporting the hypothesis that it is not some administrative cost burden that leads banks to pay uniform rates within states is the fact that the two bank holding companies in our sample with banks in different states pay different rates in different states.

11. Some banks pay different rates on personal and non-personal MMDA accounts, generally with higher rates on personal accounts. We discovered that some banks in our sample are reporting the average rate on both types of accounts rather than the most common rate. This introduces another source of error into our measurement of MMDA rates.

12. Out of a total of 59 banks, the numbers by state are as follows: Arizona, 5; California, 29; Hawaii, 4; Idaho, 4; Utah, 4; Nevada, 1; Oregon, 5; Washington, 7. However, although sample sizes are small, the banks included hold over 80 percent of all bank deposits in the Twelfth Federal Reserve District. See the Data Appendix in Keeley and Zimmerman (1985) for a more detailed description of the FR 2042 data.

13. The synthetic data bases contain the same data information that could have been obtained by directly sampling one branch in each "market" area of each of the banks in our sample. However, since we had determined that all banks in our sample paid the same rate at all branches, sampling each bank instead of its branches was far more economical. The results should not depend on which of these two ways the sample was drawn as long as both samples were random.

14. Mean rates in this chart are weighted means across banks (using bank-level data) with the number of branches of a bank being the weight. Thus, these rates represent the expected rate a depositor would be paid at a randomly selected branch.

15. A model with state and time interactions also was estimated. However, the hypothesis that the state-time interactions had no effect on the rate could not be rejected. Thus, only the results from the simpler additive model are reported.

16. We also estimated the model without Hawaii to see if there were significant differences among the other states. For both deposit types, excluding Hawaii, we can also reject the hypothesis (at the 1 percent level or better) that rates do not depend on state.

17. The state Herfindahl values are Arizona = 2704, California = 1596, Hawaii = 2896, Idaho = 2189, Nevada = 3332, Oregon = 2329, Utah = 1505, Washington = 1195.

18. In the RMA model, when the percentage of state and percentage of RMA deposit variables were excluded, the state Herfindahl variable was negative, statistically significant, and larger in magnitude ($-.0071$ vs. $-.0038$). The local Herfindahl was not statistically significant. In the county model, the coefficient of the state Herfindahl variable behaved similarly when the two market share variables were excluded. However, the local Herfindahl was statistically significant, but small in magnitude ($-.00099$).

19. In the RMA model, when the percent of state and percent of RMA deposit variables were excluded, the state Herfindahl and RMA Herfindahl's are still positive and negative, respectively, and are significant. In the county model, when the market share variables are excluded, the coefficient of the state Herfindahl variable is not appreciably changed, but the coefficient of the county Herfindahl becomes negative ($-.0033$) and statistically significant.

20. All conclusions are based on our empirical findings, which depend on the sample and data we used. See the beginning of Section II and footnotes 6, 11, 12, and 13 for a discussion of the limitations of the sample and data.

21. Two other studies of MMDA markets by Watro (1985) and Wall and Ford (1984), unlike this study, do find significant local differences in MMDA rates. However, both of these studies ignore the markets of the branches of multibranch banks. Instead of including observations for all the branches of multibranch banks, they include only one observation for the home office and use the home office's location to define the geographic market in which that bank is participating. Further, in the Wall and Ford study, SMSA differences are estimated without controlling for state differences. Thus, the results of these two studies are not directly comparable to ours.

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Interest Rate Volatility and Alternative Monetary Control Procedures

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This study examines the volatility of short-term interest rates during three sample periods each corresponding to the use of different operating guides for monetary policy: the 1970s, October 1979 through September 1982, and October 1982 through December 1984. Interest rate volatility was highest in the 1979–1982 period although the experience was not homogeneous. Since October 1982, short-run interest rate volatility has been the same as that experienced in the 1970s. Based on these data and a standard money demand/supply model, some comparisons are made of the various monetary policy operating regimes.

During the past decade, the Federal Open Market Committee has employed three different operating procedures to implement its stated policy of a gradual return to noninflationary growth rates for the monetary aggregates M1, M2, and M3. Prior to October 1979, monetary policy was conducted by setting short-run targets for the federal funds rate. During the period from October 1979 until the fall of 1982, the FOMC placed more emphasis on controlling the supply of nonborrowed reserves to the banking system. Since the fall of 1982, the FOMC has implemented monetary policy in terms of targets for borrowed reserves. The differences among these various

procedures have been discussed extensively (including Wallich, 1984, Axilrod, 1985, and Gilbert, 1985).

Each of these operating procedures has different implications for interest rate volatility. A graphical analysis of these implications can be found in Gilbert (1985). It is a widely, if not universally, accepted proposition that the implication of a change to a reserve-oriented operating procedure—such as that implemented by the FOMC in October 1979—is an increase in the short-term variability of interest rates, particularly very short-term interest rates. The rationale for this proposition is that under the federal funds rate operating procedure in effect during the 1970s, the various stochastic shocks to financial markets originating in the private sector of the economy were not allowed to affect interest rates in the short-run because they were offset through appropriate open market operations. With a reserve aggregate operating procedure, however, the reserve aggregate is maintained at a constant value in the face of

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such shocks, and prices (interest rates) function as the market equilibrating mechanism in the short-run.

One of the traditional concerns raised in opposition to a reserve aggregate operating procedure is that the interest rate variability under such a regime would be so large that it would interfere with the efficient functioning of financial markets. Consequently, one of the pressing questions in any evaluation of the 1979–82 monetary experiment is the extent to which the nonborrowed reserves operating procedures imposed additional volatility upon market interest rates. An extensive study of interest rate behavior in the 1970s compared to interest rate behavior during 1979–80 is available in the work of Dana Johnson, *et al.* (1981).

One purpose of this paper is to reexamine Johnson's investigation in light of what we know from the structure of various money market models such as those constructed by the staffs of the Board of Governors of the Federal Reserve and the Federal Reserve Bank of San Francisco, and to extend the examination of interest rate volatility into the period since the fall of 1980.

The latter is important since there are at least two reasons to believe that the experience in 1979–80 may not represent interest rate variability under an established reserve control procedure. First, the 1979 switch to the nonborrowed reserves procedure was one without precedent in the history of the Federal Reserve System, and it may have prompted a considerable period of learning for market participants. Second, in March 1980, a significant external shock was imposed upon financial markets with the implementation of credit controls. The results presented below suggest that the increase in interest rate volatility experienced during 1979–80 was not sustained uniformly throughout the nonborrowed reserves operating experiment (1979–82) and that alternative, and more appropriate, measures of interest rate volatility show considerably smaller increases during the 1979–82 period relative to the previous experience than do the measures used by Johnson, *et al.*

A second purpose of this study is to compare the results of the federal funds rate operating procedure with the borrowings procedure employed since late 1982. Wallich indicates that the latter was introduced to avoid uncertainties associated with targeting nonborrowed reserves in a period of rapid financial innovation, and, at the same time, to allow interest rates more responsiveness (such as the federal funds rate to market forces) than existed under the pre-1979 procedures.

We show that the standard money demand-money supply framework used for analyzing monetary control problems indicates that increased volatility of interest rates does not imply a reduction in the short-term variability of money around a target value when switching from a federal funds rate control procedure to a borrowings control procedure. Furthermore, the interest rate volatility observed under either of these operating procedures is a measure of the lack of precision in short-run monetary control, given a stable money demand function and constant precision in forecasting the income variables in the money demand function.

Finally, we compare the volatility of interest rates and borrowings in the 1969–79 period with the respective measures for the sample from the fall of 1982 through January 1984. The data suggest that there has been little, if any, change in the volatility of either the federal funds rate or borrowings from the Federal Reserve under the two regimes. This suggests that the borrowing procedure in effect since the fall of 1982 shares the monetary control problems that were encountered during the 1970s with the federal funds rate control procedure.

In Section I, the question of an appropriate measure of interest rate volatility is discussed. In Section II, comparisons of interest rate volatility are presented in samples drawn from different operating procedures. In Section III, the behavior of interest rates and monetary aggregates under federal funds rate and borrowings targeting procedures are compared, and the similarity of behavior across the two regimes is documented. Conclusions are stated in Section IV.

I. Appropriate Measures of Interest Rate Volatility

Johnson, *et al.* focus on the standard deviation of levels and changes in various interest rates, including the federal funds rate and yields on various maturities of Treasury securities averaged over one-week periods.¹ They observe increases in volatility (standard deviation) of weekly average first differences of the federal funds rates of more than 250 percent comparing the October 1979 through September 1980 period with the period of January 1968 through September 1979.

They also attempt to remove the effect of large cyclical swings in the funds rate (presumably low frequency) movements by focusing on deviations from centered moving averages of various lengths. Using these measures, they find increases in federal funds rate volatility of 280 to 460 percent under the reserve aggregate operating procedures.

There is reason to believe that these measures overstate the increase in volatility that should be attributed to the change in operating procedures. There was a considerable change in the level of the funds rate from the earlier period to the 1979–80 period. During the 1969–79 period, the funds rate averaged 7.05 percent, while during 1979–80 it averaged 12.78 percent. Thus, any first difference in interest rates in the later period corresponds to a smaller percentage change. This means that the difference in the levels of interest rates between the two samples is a significant factor in biasing the comparison of the behavior of interest rates under the two operating procedures.

Consider the following model of the demand and supply for money:

$$\ln m_t^D = \gamma_0 + \gamma_1 \ln Y_t - \gamma_2 \ln r_t^f + \mu_1 \quad (1)$$

$$\ln m_t^S = \delta_0 + \delta_1 \ln RU_t + \delta_2 \ln r_t^f + \delta_3 \ln r_t^D + \mu_2 \quad (2)$$

$$\ln m_t^S = \ln m_t^D = \ln m_t \quad (3)$$

where

m_t^D = demand for money balances

Y_t = income measure

r_t^f = fed funds rate

m_t^S = supply of money balances

RU_t = nonborrowed reserves

r_t^D = discount rate

μ_1, μ_2 = stochastic disturbances.

This model is borrowed from Pierce and Thomson (1972), but respecified in log-linear terms. The respecification is broadly consistent with the observed structure of econometric money market models (Tinsley, *et al.*, 1982; Judd and Scadding, 1981; Anderson and Rasche, 1982) that are very close to log-linear over a broad range of shocks. Questions of speed of adjustment to equilibrium are not important for the question being addressed here, so the model in equations 1–3 has been specified in equilibrium form for simplicity.

Consider the reduced form equation for the federal funds rate derived from this model under a nonborrowed reserves operating procedure (RU exogenous):

$$\ln r_t^f = \phi_0 + \phi_1 \ln Y_t + \phi_2 \ln r_t^D - \phi_3 \ln RU_t + \eta_t \quad (4)$$

where

$$\phi_0 = \frac{\gamma_0 - \delta_0}{\gamma_2 + \delta_2}; \quad \phi_1 = \frac{\gamma_1}{\gamma_2 + \delta_2};$$

$$\phi_2 = \frac{\delta_3}{\gamma_2 + \delta_2}; \quad \eta_t = \frac{\mu_1 - \mu_2}{\gamma_2 + \delta_2}; \quad \sigma_3 = \frac{\delta_1}{\gamma_2 + \delta_2}$$

Now consider percentage changes of the federal funds rate over very short periods of time during which the income variable can be assumed unchanged, the discount rate is kept constant, and the nonborrowed reserves target is not changed. Under these circumstances:

$$\ln r_t^f - \ln r_{t-1}^f = (\eta_t - \eta_{t-1})$$

Thus, the implication of such a model is that over very short intervals, the *percentage change* in the federal funds rate under a reserve aggregate control procedure should have a constant variance (that is, be homoskedastic). This conclusion suggests that if volatility of the first difference of the federal funds rate with a reserve aggregate control procedure when the level of

the funds rate is relatively low is compared with its volatility under the same operating procedure when the level of the funds rate is relatively high, then the latter regime would exhibit greater volatility by this measure than the former even though the variances of the structural disturbances are the same in the two situations. Since the available econometric evidence suggests that log-linearity is a better approximation to the structure of U.S. financial markets than linearity, the comparisons presented in Johnson, *et al.* may have inadvertently been biased.

The argument presented above concerns the appropriate interpretation of observed interest rate behavior in a macroeconomic context. But the fundamental concern with interest rate volatility is motivated by microeconomic questions, namely that interest rate changes cause capital gains or losses for bond holders. There are reasons to believe that arithmetic changes in interest rates do not provide a good measure of capital gains or losses accruing to bondholders, and that percentage changes in interest rates may be a preferable measure of the magnitude of the wealth effects that will occur as a result of monetary policy actions.

Consider the impact of equal arithmetic changes in interest rates from a low initial level of rates compared with a high initial level of

rates. It is well known that bond prices move inversely with yields to maturity (the first partial derivative of prices with respect to yields is negative) and that the size of the price change increases for a given change in yield as the maturity of the bond increases.

It is also true that for a given maturity, the size of the price change for a given arithmetic change in yield varies with the base from which the yield changes. In particular, the higher the initial level of the yield to maturity, the *smaller* will be the absolute value of the bond price change for a given arithmetic change in the yield (Malkiel, 1966, Theorem 4, p. 55).²

Hence if the major cause for concern about interest rate changes is the dollar value of the capital gain or loss accruing to bondholders, the arithmetic change does not give a good measure of the relative size of the problem when the level of yields is different.

In contrast, percentage changes in interest rates may give a good measure of relative capital gains or losses to bondholders, particularly if we are concerned with such gains or losses in percentage terms. The general formula is complicated, and it is easier to see the rationale for this conclusion by focusing on securities at opposite ends of the maturity spectrum, as shown in Table 1.

TABLE 1
Measuring Gains and Losses to Bondholders
Percentage Change in Interest Rates

One period discount bond	One period coupon bond	Consol
$P = (1 - r)F$	$P = \frac{(1 + C)F}{(1 + i)}$	$\frac{CF}{i}$
$\frac{\partial \ln P}{\partial \ln r} = \frac{-r}{(1 - r)}$	$\frac{\partial \ln P}{\partial \ln i} = \frac{-i}{1 + i}$	-1
$\frac{\partial^2 \ln P}{\partial \ln r^2} = \frac{-r}{(1 - r)^2}$	$\frac{\partial^2 \ln P}{\partial \ln i^2} = \frac{-i}{(1 + i)^2}$	0

P = bond price
i = yield to maturity
C = coupon rate
F = face value
r = discount rate

At the very longest maturity, the elasticity of bond prices with respect to yield to maturity is constant. At the short end of the maturity spectrum—one period bonds or discount securities (bills), the elasticity of security prices with respect to the yield to maturity varies considerably relative to its own magnitude, but the elas-

ticity is so small that the implied capital gains or losses are not very large. For example, for three-month bills with discounts at annual rates in the range of four to ten percent, the elasticity of bill prices with respect to the discount is in the range of .01 to .025.

II. Volatility of Rates Under Different Operating Procedures

The basic tests in Tables 4–9 of the Johnson, *et al.* study have been reconstructed in Table 2, but using logs of the various interest rates instead of levels.³ The only significant difference in the data is that the sample from January 1968 through September 1979 used by Johnson, *et al.* has been truncated to January 1969 through September 1979 because the 1968 data were not readily available. The omission of 1968 is also preferable since the original change from contemporaneous to lagged reserve accounting occurred during that year. We recalculated all of the standard deviations reported in the original study and were able to replicate the reported numbers to within one or two basis points. These comparisons are available in Appendix B.

The results in Table 2 are quite remarkable.⁴ The comparison of the 1969–79 period with the sample for October 1979 through September

1980 differs considerably when measured in percentage changes. The standard deviation of the week-to-week percentage changes in the latter sample is from 1.8 to 2.2 times as large as the corresponding standard deviation in the former sample, depending on the rate being compared. The larger increases in the standard deviations tend to be at the *longer* end of the maturity spectrum. The corresponding ratios of standard deviations measured in terms of arithmetic changes is 2.6 to 3.5. Thus, the choice of units of measurement for interest rate volatility is a substantial factor in assessing how much of an increase actually occurred in 1969–79. However, the use of percentage changes *does not* alter the conclusion that interest rate volatility increased during the 1979–80 period over what had been previously experienced.

The interesting experiment is to extend the analysis beyond the fall of 1980. Four separate

TABLE 2
Standard Deviations of Percentage Change of Various Interest Rates (Weekly Data)

Sample	Fed Funds Rate Regime	Nonborrowed Reserves Regime				Borrowed Reserves Regime		
	Jan. 69–Sept. 79	Oct. 79–Sept. 80	Oct. 80–Sept. 81	Oct. 81–Sept. 82	Oct. 79–Sept. 82	Oct. 82–Jan. 84	Feb. 84–Dec. 84	Oct. 82–Dec. 84
Fed funds rate	.039	.071	.053	.049	.059	.046	.038	.042
3-Mo. Bill	.033	.059	.047	.052	.054	.022	.019	.021
6-Mo. Bill	.028	.053	.041	.041	.046	.025	.017	.022
52 Wk. Bill	.026	.047	.033	.036	.040	.023	.016	.021
3-Year Note	.021	.042	.028	.028	.034	.021	.015	.019
5-Year Note	.017	.037	.032	.025	.032	.019	.015	.017
10-Year Note	.013	.029	.023	.025	.026	.018	.014	.016
20-Year Note	.012	.025	.022	.023	.024	.017	.013	.015

samples are identified for this purpose: October 1980 through September 1981, October 1981 through September 1982, October 1982 through January 1984, and February 1984 through December 1984. The first two of these samples are drawn from the era of nonborrowed reserve control procedure and allow observation of changes in interest rate behavior as the period progressed and markets gained experience with the new regime (they also avoid the contamination of the experiment with credit controls). The third sample covers the period from the abandonment of nonborrowed reserves control in favor of borrowed reserves targets (Wallich 1984, Axilrod 1985, Gilbert 1985) to the end of lagged reserve requirements; and the fourth sample covers the period of contemporaneous reserve requirements with borrowed reserves targets.

The volatility of interest rates remains higher, relative to the experience of 1969–79, throughout the three years of the nonborrowed reserve operating procedure experiment. However, interest rate volatility over this three-year period is not constant. There is a reduction in volatility of interest rates uniformly across the maturity spectrum from the 1979–80 period to the 1980–81 period measured as the standard deviation of week-to-week percentage changes.

During the latter period, the volatility measure was from 1.2 to 1.9 times the corresponding measure in the 1969–79 base period.

Across the maturity spectrum, the volatility dropped by 15 to 33 percent of the observation for 1979–80. The observed volatility in the 1980–81 sample appears to be repeated in the 1981–82 sample. In some cases, the computed volatility in the 1981–82 sample is slightly higher than in the 1980–81 sample; in other cases, exactly the reverse is observed. The changes appear to be quite random across the maturity spectrum, suggesting a constant variance (homoskedasticity) during the two-year period.

The introduction of borrowed reserves targets appears to have altered rate volatility once again. The standard deviations of the week-to-week percentage change in rates decline uniformly after September 1982. In the case of short- and intermediate-term rates, the volatility measure returns to the pre-1979 level, although the 10- and 20-year maturities continue to exhibit volatility on the order of 1.5 times the pre-1979 observations in the 1982–84 period. After the return to contemporaneous reserve accounting in February 1984, interest rate volatility across the maturity spectrum is no greater than that observed prior to 1979, and, in the case of three- and six-month Treasury

TABLE 3
F-Statistics for Equality of Variance Compared
to 1969–79 Sample

Interest Rates	Sample Periods				
	1979–80	1980–81	1981–82	1982–84	1984
Federal Funds	3.35*	1.86*	1.54*	1.35	.94
3-Month T. Bills	3.38*	2.18*	2.62*	.46	.33
6-Month T. Bills	3.54*	2.17*	2.15*	.77	.37
52-Week T. Bills	3.31*	1.63*	1.90*	.78	.39
3-Year T. Note	4.29*	1.88*	1.93*	1.00	.58
5-Year T. Note	4.73*	3.53*	2.74*	1.22	.73
10-Year T. Note	4.91*	3.30*	3.52*	1.82*	1.17
20-Year T. Bond	4.76*	3.66*	3.94*	1.99*	1.22
df(1969–79 = 559)	51	51	51	69	47
5% Critical F	1.38	1.38	1.38	1.34	1.39

*Significant at 5% level

bills, volatility seems to have declined sharply in the most recent period.

These observations suggest several hypotheses. First, it appears that in the 1980–82 period, interest rates were less volatile than during 1979–80, but, second, interest rates exhibited more volatility in that period than under the federal funds rate control regime. A third hypothesis is that, in terms of interest rate volatility, the borrowings control procedure pursued since the fall of 1982 is no different than the pre-1979 control regime. These hypotheses will be tested below.

One very simple procedure to test these hypotheses is to test the idea that the variance of the various percentage changes in interest rates is constant among different sample periods. The 1969–79 sample is used as an initial base for such comparisons. The relevant F statistics are presented in Table 3. The results presented there indicate that, for the three samples drawn during the nonborrowed reserves control period, interest rate volatility increased significantly across the maturity spectrum. For the two samples subsequent to the “deemphasis” of M1, the statistics in Table 3 generally support the conclusion that interest rate volatility is not significantly greater than it was during the 1970s. The exceptions to this general statement

are the very longest maturities in the sample period from 1982 to January 1984.

These results are consistent with the second and third hypotheses above. Since the standard deviations in the 1982–January 1984 sample are larger than those in the 1969–79 sample for all rates except the three-month, six-month and 52-week bill rates (although not generally significantly so), it is interesting to base the tests for equality of variance on the interest rate volatility observed after the nonborrowed reserves control experiment. This procedure determines whether there was a significant reduction in interest rate volatility after the fall of 1982. The F-statistics for these tests are presented in Table 4.

The results for the federal funds rate here are somewhat surprising. The test statistics suggest that the volatility of the federal funds rate in the 1980–82 period was not significantly greater than that observed from the fall of 1982 through January 1984. In spite of this conclusion, the evidence suggests that volatility at all other points on the maturity spectrum declined significantly after the end of the nonborrowed reserves control experiment.

Finally, a test of the first hypothesis that interest rate volatility in 1980–82 is significantly lower than that experienced in 1979–80 is re-

TABLE 4
F-Statistics for Equality of Variance Compared
to 1982–January 1984 Sample

Interest Rate	Sample Periods			
	1979–80	1980–81	1981–82	Feb–Dec 1984
Federal Funds	2.48*	1.38	1.14	.69
3-Month T. Bills	7.42*	3.65*	3.61*	.73
6-Month T. Bills	4.58*	2.81*	2.78*	.47
52-Week T. Bills	4.22*	2.08*	2.49*	.50
3-Year T. Note	4.28*	1.88*	1.92*	.55
5-Year T. Note	3.88*	2.90*	1.83*	.60
10-Year T. Note	2.70*	1.82*	1.93*	.64
20-Year T. Bond	2.42*	1.86*	2.01*	.62
df(1982–84 = 69)	51	51	51	47

*Significant at 5% Level

ported in Table 5. The results of this test support the hypothesis that a significant reduction in the volatility of short-term and intermediate-term rates occurred between 1979–80 and 1980–82.

Several conclusions appear to be warranted from this analysis. First, the period of reserve aggregate operating guides was accompanied by an increase in volatility that was not as large as has been previously measured because of differences in the level of interest rates before and after October 1979, and because the twelve months subsequent to 1979 appear to be influenced by special factors.

Nevertheless, it is not appropriate to use the volatility observed in 1980–82 as a measure of the increased interest rate volatility that would be observed under a pure reserve aggregate control regime. On the one hand, these observations are probably biased downward since the 1979–81 operation procedure was not a regime in which fixed reserve paths were maintained but one in which gradual adjustment was made

back to such paths when deviations occurred. On the other hand, the interest rate volatility observed during this period may be biased upward compared to what could be achieved under a fixed reserve path operating guide because lagged reserve accounting was in effect throughout the period.

A third conclusion is that it is probably inappropriate to regard changes in the volatility of very short-term rates as necessarily affecting the volatility of longer term rates. Certainly volatility increased uniformly across the maturity spectrum in 1979. However, when the volatility of the funds rate dropped dramatically starting in late 1980, longer term rate volatility did not immediately follow. Furthermore, in the period since February 1984, it appears that the volatility of Treasury bill rates of various maturities has been reduced significantly below the volatility of the same rates prior to October 1979, even though the volatility of the federal funds rate in the two sample periods is unchanged.

TABLE 5
F-Statistics for Equality of Variance
Compared to 1980–82 Sample

Interest Rates	Sample Period
	1979–80
Federal Funds	1.95*
3-Month T. Bills	1.38
6-Month T. Bills	1.61*
52-Week T. Bills	1.84*
3-Year T. Note	2.19*
5-Year T. Note	1.61*
10-Year T. Note	1.40
20-Year T. Note	1.22
df(1980–82 = 103)	51

*Significant at 5% Level

III. Are the New Operating Procedures Different From Those of the 1970s?

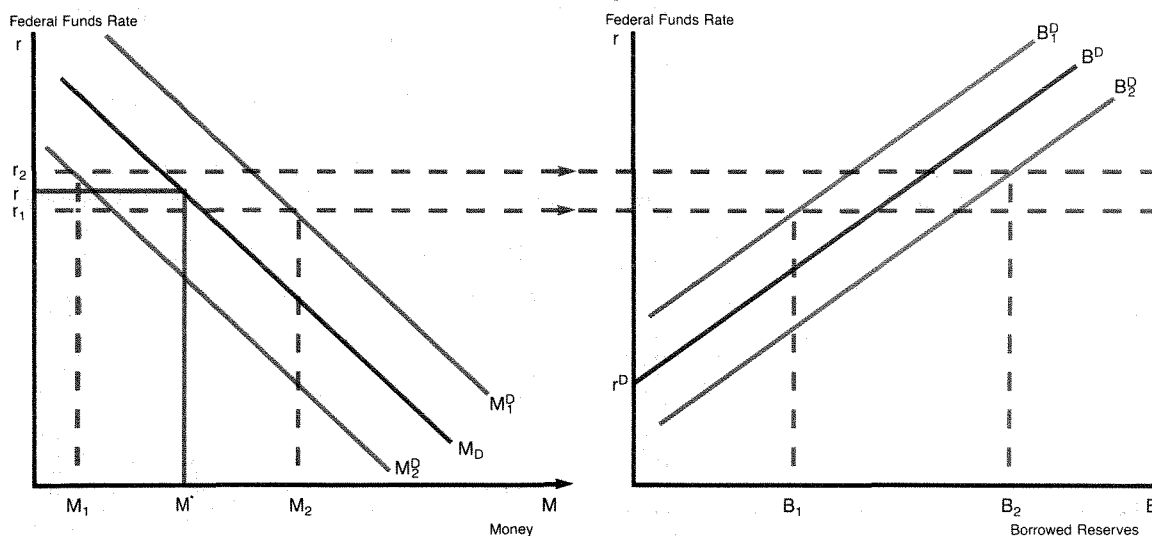
The information presented in Tables 2-5 suggests that there is considerable similarity between the volatility of interest rates across the maturity spectrum during the 1970s and in the period since the fall of 1982. Federal Reserve officials are on record as indicating that the present procedures are not a return to the techniques of the 1970s:

Since the fall of 1982, the nonborrowed-reserves strategy and its automaticity have given way to a technique that allows the funds rate to be determined by the market, through the targetting of discount window borrowing from one reserve maintenance period to the next, implemented by allowing a flexible nonborrowed-reserves path. ...The relation of the borrowing level to the funds rate, which has been one of the most familiar features of the money market, always has been relatively loose. Since a chosen level of borrowings is consistent with any of a range of values of the funds rate, current operating procedures cannot be regarded as a form of rate-pegging (Wallich, 1984, p. 26).

In spite of assertions such as this, short-run interest rate pegging and borrowings targeting are fundamentally similar monetary control procedures. This can be seen from Figures 1 and 2 which illustrate a federal funds rate target procedure (the practice of the 1970s) and a borrowed reserves target procedure (the practice since fall 1982), respectively.⁵ The curve labeled M^D in the left hand side of the figure represents a short-run money demand function, while the curve labeled B^D in the right hand side of the figure represents the demand for borrowed reserves by depository institutions. Both are drawn as functions of the federal funds rate (r), and it is assumed that the demand for borrowed reserves is zero when the federal funds rate is less than the discount rate (r^D). These are simplifying assumptions for purposes of illustration.

The exact positions of both the money demand curve and the demand for borrowed reserves curve are not known with certainty by the monetary authorities, nor are they constant. Rather, both fluctuate randomly over time.⁶ It is assumed that those fluctuations occur within the ranges defined by the dotted

Figure 1
Federal Funds Rate Target Procedure



curves M_1^D and M_2^D and by B_1^D and B_2^D . These ranges of fluctuation are assumed the same for both operating procedures.

With a federal funds rate operating procedure, the monetary authorities, in principle, keep the federal funds rate within a small interval around the rate (F) that they believe is consistent with their monetary objective (M^*). This range is represented by r_1 and r_2 .⁷ With the federal funds rate constrained to the range r_1 – r_2 , the money stock will be observed to fluctuate in the range M_1 to M_2 in the short-run, and borrowed reserves will be observed fluctuating in the range B_1 to B_2 , with the specific outcomes dependent upon the size of the random fluctuations to M^D and B^D .⁸ Movements of the federal funds rate outside the range r_1 – r_2 are prevented by the monetary authorities through injections or withdrawals using open market operations of whatever nonborrowed reserves are required to keep the funds rate within the specified range.

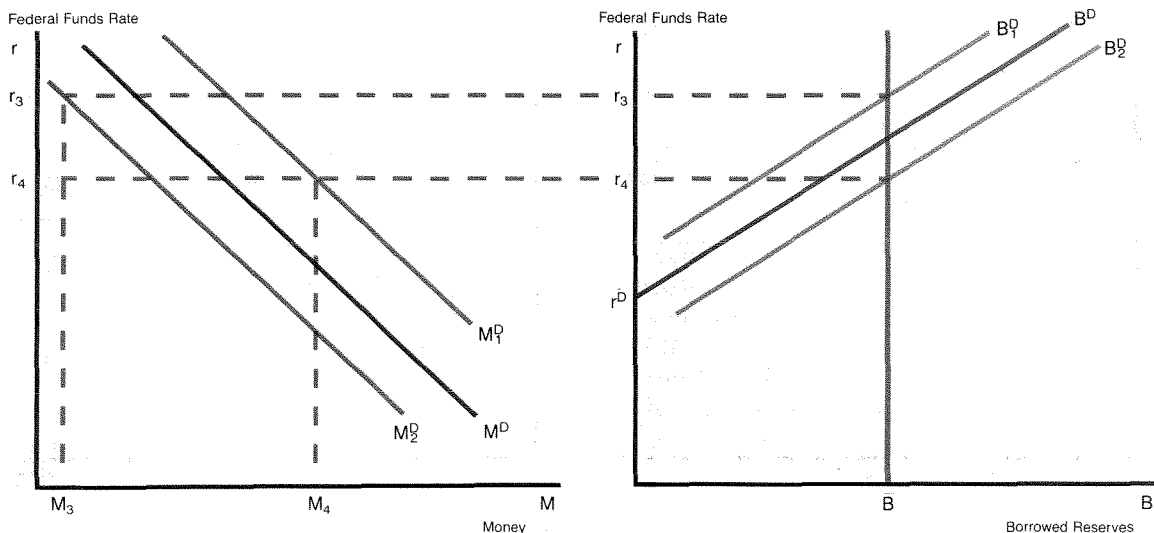
When a target is established for borrowed reserves, the operating procedure works in fundamentally the same fashion, except in this case the range of funds rate fluctuation is implicitly determined by the random fluctuations in the demand for borrowings rather than being explicitly stated in the operating procedure.

Assume that the monetary authorities establish and exactly achieve a target for borrowed reserves \bar{B} (Figure 2). With this fixed supply of borrowed reserves to depository institutions, the federal funds rate will be observed to fluctuate in the range r_3 – r_4 with the particular outcome dependent only upon the size of the random fluctuation in the demand for borrowed reserves.

The observed interest rate within the (r_3 – r_4) range is not affected by random fluctuations in the demand for money under this operating procedure. The observed outcome in terms of money stock, M , will be in the range M_3 – M_4 depending on the particular random fluctuations to the demand for borrowed reserves and the demand for money. Under the assumption of exact control of the amount of aggregate borrowed reserves available to depository institutions, the funds rate can fluctuate outside the range r_3 – r_4 only by a deviation of borrowed reserves from \bar{B} . If borrowed reserves were to deviate from \bar{B} , the monetary authorities would inject or withdraw nonborrowed reserves to maintain borrowings at \bar{B} , and, implicitly, to maintain the federal funds rate in the range r_3 – r_4 .

In practice the monetary authorities probably cannot achieve the borrowed reserve target exactly, but can keep the supply of borrowed re-

Figure 2
Borrowed Reserves Target Procedure



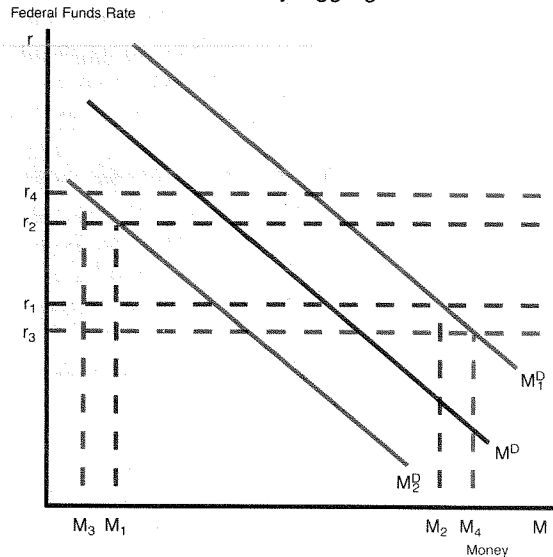
serves within a small range around \bar{B} . The addition of such “noise” to the operating procedure does not affect the conclusion drawn from Figure 2 in any fundamental way. For given random shocks to the demand for borrowed reserves ($B_1^D - B_2^D$), the implied range of interest rate fluctuations ($r_3 - r_4$) will be larger the larger the “noise” around the borrowed reserves target.⁹ Nevertheless, the establishment of a borrowed reserves target implies the establishment of a permissible range of fluctuation for the funds rate, and that range is maintained by the automatic provision or withdrawal of nonborrowed reserves through open market operations whenever market forces attempt to drive the rate outside the implicit range.¹⁰

The ranges of federal funds rate fluctuation in Figures 1 and 2 represent the degree of funds rate volatility that will be observed under the two operating procedures. The size of this range is explicitly set as part of the federal funds rate operating procedures.¹¹ With a borrowed reserves operating procedure, the size of this range can be influenced, above some minimal amount determined by random shocks to the demand for borrowed reserves, by the amount of random fluctuation in borrowed reserves that is permitted around the target value.¹² The implication of the volatility measures computed in Section II is that the volatility of the funds rate implicit in the borrowed reserve operating procedure since the fall of 1982 has been basically the same as the volatility of the federal funds rate explicitly permitted under the 1970s operating procedure.

What are the implications of this conclusion for the short-run volatility of the monetary aggregates? Figure 3 examines the implications for the volatility of monetary aggregates of operating procedures that establish ranges of fluctuation for the funds rate, whether explicit or implicit (as with a borrowed reserves target).

First, consider the implication of widening the permissible range of funds rate fluctuation from $r_1 - r_2$ to $r_3 - r_4$, as indicated in Figure 3. With an unchanged range of fluctuation of the short-run money demand function (M_1^D to M_2^D), more short-run volatility would be observed in

Figure 3
The Short-Run Relation
of Funds Rate Volatility to the
Monetary Aggregates



the monetary aggregates the wider the range of funds rate fluctuation. In Figure 3, the wider range of funds rate fluctuation ($r_3 - r_4$) implies fluctuations of the money stock in the range M_3 to M_4 compared with fluctuations in the range M_1 to M_2 with the funds rate restricted to the narrower range ($r_1 - r_2$). Thus, if the borrowed reserves control procedure had introduced more volatility into the funds rate, it could have been expected to introduce more short-run volatility into the monetary aggregates.¹³

This comparison of funds rates and borrowed reserves operating procedures stands in contrast to the results obtained from a comparison of a funds rate and nonborrowed reserves operating procedure. In the latter case, the monetary authorities would allow more interest rate volatility by not automatically conducting open market operations to change the stock of nonborrowed reserves. In the extreme, nonborrowed reserves would be fixed regardless of observed fluctuations in interest rates.

Generally, as operating procedures move towards a smaller response of the supply of nonborrowed reserves to interest rate fluctuations, rate stability decreases (volatility increases)

and the precision of short-run monetary control increases. Thus, in moving from a federal funds rate operating procedure toward a pure non-borrowed reserves operating procedure, a trade-off exists between interest rate volatility and the precision of short-run monetary control.¹⁴ This trade-off does not exist when comparing federal funds rate operating procedures with borrowed reserves operating procedures because both of those operating procedures allow the *automatic* changes in the supply of non-borrowed reserves to depository institutions in response to any shock that pushes the target variable to an extreme of the predetermined range of fluctuation.

Inertia in Adjusting Policy Guides

Although federal funds rate operating procedures as implemented in the 1970s and borrowed reserves operating procedures as implemented since fall 1982 may appear virtually the same from the perspective of their effects on short-run interest rate volatility and the short-run precision of monetary control, it is possible that the longer run precision of monetary control could improve from the switch. It could improve if there were less inertia in adjusting the operating guide under the borrowed reserves control procedure than under the federal funds rate control procedure.

The presence of inertia in adjusting the operating guides, whether interest rate or borrowings, introduces positive serial correlation into deviations of the money stock from its target value.¹⁵ This positive serial correlation is stronger the more infrequent the adjustment of the target value for the operating guide and, conversely, weaker the more frequent the adjustment of the target value for the operating guide. Consequently, a change in operating procedure that did not affect the precision of short-run monetary control but that reduced the serial correlation in the deviations of the money stock from its target value would reduce the longer run variation of average money stock measures around the longer run average target value.

The inertia in adjusting the target value of the operating guide is the source of the funda-

mental criticism of the historical interest rate and free reserves (borrowings) targeting regimes: unless the monetary authorities are prepared to adjust the target variables quickly and correctly in response to new information, deviations from the desired path of the monetary aggregates are likely to persist.

The results discussed above suggest that a simple indicator of the short-run precision of monetary control with either an interest rate operating guide or a borrowed reserves operating guide is the short-run volatility of interest rates. With the same money demand function for the two control procedures, the larger the variability of interest rates, the worse the precision of short-run monetary control. The data on federal funds rate volatility during the periods 1969–79 and 1982–84 suggest that short-run monetary control is unlikely to improve under the procedures used by the FOMC since the fall of 1982 compared to the experience of the 1970s. If the proposition that the stability of the short-run money demand function has deteriorated in the 1980s were correct, then a strong case could be made that the operating procedure in effect since fall 1982 will produce less precise short-run monetary control than did the procedures implemented in the 1970s.

If it is assumed that the random shocks to the demand for borrowings are uncorrelated with the random errors in interest rates under the interest rate operating procedure, and that they are also uncorrelated with the random errors in the supply of borrowings under the borrowings control procedure, then the volatility of observed borrowings gives an equivalent measure of the precision of monetary control. Under these assumptions, and with a stable demand function for borrowed reserves under the two procedures, equal volatility of interest rates implies equal volatility of borrowings.

This conclusion appears to be supported by the data. The standard deviation of week to week percentage changes in adjustment borrowings (seasonal plus adjustment borrowings) for those weeks when the federal funds rate exceeded the discount rate is .513 (.493) in 1969–79 and .664 (.556) in October 1982–January 1984.

It is possible, despite the experience with the post-1982 borrowed reserves operating procedure which suggests no improvement for short-run monetary control over that experienced under the federal funds rate control procedure of the 1970s, that intermediate-run or longer run monetary control is improved by a reduction in the inertia in adjusting the operating guide. Changes in the precision of intermediate-run monetary control (one- to six-months) should be evidenced by distinctly different patterns in the time series properties of interest rates. A crude test of this hypothesis can be performed by estimating ARIMA models for the federal funds rate for the 1969–79 sample period and for the sample since October 1982. The resulting models are:

*January 1969–September 1979*¹⁶

$$\begin{aligned} \ln FF_t - \ln FF_{t-1} = & \\ & a_t - .1460a_{t-1} + .2268a_{t-4} \\ & \quad (.0409) \quad (.0405) \\ & + .1321a_{t-9} + .1040a_{t-11} \\ & \quad (.0415) \quad (.0408) \\ & + .1008a_{t-13} \\ & \quad (.0419) \\ \text{s.e.} = .0371 \quad \chi^2_{(df=37)} = 44.48 \\ & \chi^2_{(.05)(df=37)} \approx 52.2 \end{aligned}$$

October 1982–January 1984

$$\begin{aligned} \ln FF_t - \ln FF_{t-1} & \\ & + .3941 (\ln FF_{t-1} - \ln FF_{t-2}) \\ & \quad (.1117) \\ = a_t + .7199a_{t-12} & \\ & \quad (.1033) \\ \text{s.e.} = .0317 \quad \chi^2_{(df=22)} = 18.42 \\ & \chi^2_{(.05)(df=22)} = 33.92 \end{aligned}$$

February 1984–December 1984

$$\begin{aligned} \ln FF_t - \ln FF_{t-1} = a_t + .4192a_{t-2} \\ & \quad (.1416) \\ \text{s.e.} = .0348 \quad \chi^2_{(df=23)} = 21.88 \\ & \chi^2_{(.05)(df=23)} = 35.17 \end{aligned}$$

At first glance, these estimates suggest that the time series properties of the federal funds

rate are strikingly different among the sample periods discussed above, for which the variance of weekly changes is similar. There is clearly a distinct change associated with the introduction of contemporaneous reserve requirements, but the strong second order moving average term in the post-January 1984 sample appears consistent with the change to a two-week reserve averaging period.

The difference between the 1969–79 sample and the 1982–84 sample, however, is not as great as it appears. The latter sample exhibits more seasonality at approximately three-month intervals as indicated by the large twelfth order moving average factor. However, when the log of the federal funds rate is written in moving average form, the impact of innovations is remarkably similar for at least the first six weeks. The first terms of the moving average polynomials for the two sample periods for the log of the federal funds rate are:

January 1969–September 1979

$$\begin{aligned} \ln FF_t = a_t + .854 (a_{t-1} + a_{t-2} + a_{t-3}) \\ + 1.081(a_{t-4} + a_{t-5} + a_{t-6}) + \dots \end{aligned}$$

and expressed in the same form:

October 1982–January 1984

$$\begin{aligned} \ln FF_t = a_t \\ + .69(.88a_{t-1} + 1.11a_{t-2} + 1.02a_{t-3}) \\ + .72(1.01a_{t-4} + .99a_{t-5} + 1.00a_{t-6}) \\ + \dots \end{aligned}$$

The only substantial difference between the effects of the first six lagged innovations in the two sample periods is that in the earlier sample lags 1–3 have the same weight as lags 4–6. It also appears that the three-week average of recent innovations (lags 1–3) has slightly less weight in the more recent period (.69 vs. 854), but no measure of the significance of the difference is available. Even though the statistical significance of these differences cannot be determined, it seems appropriate to conclude that there is no large difference in the intermediate-run time series behavior of the federal funds rate under the two control procedures. This evidence is consistent with the hypothesis that the inertia in the setting of the operating guide un-

der current procedures, in terms of the speed with which interest rates (and hence the money stock) are allowed to adjust, is similar to the

inertia in the 1970s under the federal funds rate operating guide.

IV. Conclusion

The available evidence suggests that interest rate volatility increased across the maturity spectrum with the introduction of the "new operating procedure." Subsequently, in 1980–82 the volatility of rates declined. It is not possible to discriminate whether this represents learning by market participants, contamination of the 1979–80 data by the credit control experience, or a revision of the implementation of the non-borrowed reserves operating procedure over time. By 1981–82, the volatility of the federal funds rate was not significantly greater than in 1969–79. Since the fall of 1982, volatility across the maturity spectrum has been the same as that experienced in the 1970s.

Since the volatility and time series of the federal funds rate under lagged reserve requirements and an operating procedure that targeted borrowings between the fall of 1982 and January 1984 replicates very closely the behavior of this rate under the fed funds rate operating procedure in effect prior to October 1979, it appears that the two operating procedures have similar implications for the short-run control of the growth of monetary aggregates.

Both operate through the money demand function and both share the common property that inertia in adjusting the target to new in-

formation will produce persistent drift in the monetary aggregate from its target value. However, if the stability of econometric money demand functions has deteriorated in the 1980s compared to the 1970s, as is frequently alleged, then a borrowings operating procedure that produces essentially the same funds rate volatility as the funds rate operating procedure, will not improve the precision of short-run monetary control.

The outlook for longer run monetary control under the two operating procedures is primarily determined by the degree of inertia in adjusting the operating targets. If it is more feasible for the FOMC to adjust a borrowed reserves target correctly in response to new information than it would be to adjust a federal funds rate target, then a borrowed reserves operating procedure could improve longer run monetary control even though short-run control could be less precise than under the funds rate operating procedure. Since the FOMC continues publicly to maintain the objective of gradually reducing the rate of monetary growth to non-inflationary levels, final judgment on the effectiveness of the current operating procedure must be deferred until the success or failure of current monetary policy is established.

Appendix A

Money Market and Monetary Control Implications of Alternative Operating Procedures

Some framework broad enough to evaluate the effects of the three alternative operating procedures on monetary aggregates and interest rates yet simple enough to produce useful conclusions is necessary. The vehicle used here is an extension of the money market model of equations 1 through 3 in the text.

The model is presented below.

$$(1) \ln M = \gamma_0 + \gamma_1 \ln Y + \gamma_2 \ln r + \mu_1$$

$$(2) \ln M = p + \delta_1 \ln RR + \mu_2$$

$$(3) \ln BOR = \alpha_0 + \alpha_1 (\ln r - \ln r^d) + \mu_3$$

$$(4) \ln TR = w_1 \ln RU + (1 - w_1) \ln BOR + \mu_4$$

$$(5) \ln TR = \ln RR + \ln \left(1 + \frac{ER}{RR} \right) = \ln RR + \mu_5$$

$$(6) v_1 \ln r + v_2 \ln RU + v_3 \ln BOR = v_1 (\ln \bar{r} + \varepsilon_1) + v_2 (\ln \bar{RU} + \varepsilon_2) + v_3 (\ln \bar{BOR} + \varepsilon_3)$$

for $v_1 = 1.0$; $v_2 = v_3 = 0.0$

$$\text{or } v_2 = 1.0; v_1 = v_3 = 0.0$$

$$\text{or } v_3 = 1.0; v_1 = v_2 = 0.0$$

Note: Greek letters can be polynomials in the lag operator B ; i.e.

$$\gamma_1 = \gamma_1(B) = \gamma_{10} + \gamma_{11}B + \gamma_{12}B^2$$

$$\text{and, } \gamma_1^* = \gamma_{11}B + \gamma_{12}B^2 + \dots \text{ for any polynomial}$$

Equation 1 is the money demand equation used above. Equation 2 is a reserve requirement that allows for stochastic fluctuations in reserve requirements ($p + \mu_1$) as a result of shifts in reserves among different types of banks and the possibility of lagged reserve accounting by changing the parameters of the polynomial δ .¹⁷

Equation 3 is a borrowings function that relates borrowings by financial institutions to the spread (in percentage terms) between market rates and the discount rate. Equation 4 is a Taylor series expansion of the log of total reserves in terms of the log of nonborrowed reserves and the log of borrowings with an approximation error (μ_4) to represent the higher order terms of the expansion. Equation 5 is a statement of the identity between total reserves, required reserves and excessive reserves, with an assumption that the excess reserve ratio can be approximated by a stochastic process (μ_5). Finally, equation 6 allows the interest rate (r),

nonborrowed reserves (RU) or borrowings (BOR) to be set as an exogenous variable by suitable choice of the parameters, v_i .

Note that the control regimes are mutually exclusive: a nonzero value for one of the v_i requires that the other two v_j be set at zero.

The model has been specified to capture the relevant properties of empirical money market models, yet to retain log-linearity so that explicit reduced form expressions can be derived for $\ln r$, $\ln M$, $\ln RU$ and $\ln BOR$. The general reduced form equations (without regard to the control regime) are functions of the potential exogenous variables: income (γ), the discount rate (\bar{r}), nonborrowed reserves (RU) and borrowings (BOR). The stochastic terms in these reduced form equations are functions of the stochastic μ_s and ε_s in equations 1 through 6. Finally, the coefficients in the reduced forms are complicated functions of the structural parameters of the model and the control regime variables— v_1 , v_2 , and v_3 .

The model is not complete without a specification of the "policy rule" that governs how the operating procedure is adjusted over time.¹⁸ Two extreme cases are interesting. The first is complete adjustment each period to any new information in the attempt to keep the monetary aggregate on its target path. The second regime is one of inertia in which the control variable is adjusted infrequently.

A. Continual Adjustment of Control Variable: Interest Rate Operating Guides

In this situation, the reduced form equations for interest rates and the monetary aggregate are:

$$(7) \quad \ln r_t = \ln \bar{r}_t + \varepsilon_t$$

$$(8) \quad \ln M_t = \gamma_0 + \mu_1 + \gamma_2 \varepsilon_1 + \gamma_1 \ln Y_t + \gamma_2 \ln \bar{r}_t$$

and the policy rule governing the adjustment of $\ln \bar{r}_t$ is:

$$(9) \quad E_{t-1}^f \ln M_t = \ln M^*$$

where $E_{t-1}^f \ln M_t$ is the monetary authorities' forecast of $\ln M_t$ based on information available at $t - 1$ and $\ln M_t^*$ is the desired value of the

monetary aggregate at t .

From (8):

$$(10) \quad E_{t-1}^f \ln M_t = \gamma_0 + \mu_1^* + \gamma_2^* \varepsilon_1 + \gamma_{10} E_{t-1}^f \ln Y_t + \gamma_1^* \ln Y_t + \gamma_{20} \ln \bar{r}_t + \gamma_2^* \ln \bar{r}_t$$

so

$$(11) \quad \ln \bar{r}_t = \frac{1}{\gamma_{20}} (\ln M^* - \gamma_0 - \mu_1^* - \gamma_2^* \varepsilon_1 - \gamma_{10} E_{t-1}^f \ln Y_t - \gamma_1^* \ln Y_t - \gamma_2^* \ln r_t)$$

and

$$(12) \quad (\ln M_t - \ln M^*) = \mu_{1t} + \gamma_{20} \varepsilon_{1t} + \gamma_{10} (\ln Y_t - E_{t-1}^f \ln Y_t)$$

This is the standard result (Thomson and Pierce, 1972) that under an interest rate control procedure with constant adjustment, deviations from monetary targets depend upon stochastic money demand fluctuations and errors in fore-

casting income. The additional term here is generated by the error in hitting the interest rate target, ε_{1t} . As long as the income forecast errors are not serially correlated, deviations of money growth from targets should not exhibit serial correlation.

B. Continual Adjustment of Control Variable: Borrowing Operating Guide

In this situation, the reduced form equations for borrowings and the monetary aggregate are:

$$(13) \quad \ln \text{BOR}_t = \varepsilon_{3t} + \ln \overline{\text{BOR}}_t$$

$$(14) \quad \ln M_t = \left[(\gamma_0 + \mu_{1t}) + \left(\frac{\gamma_2}{\alpha_1} \right) \varepsilon_{3t} - (\alpha_0 + \mu_{3t}) \left(\frac{\gamma_2}{\alpha_1} \right) \right] + \gamma_1 \ln Y_t + \ln r_t^d + \left(\frac{\gamma_2}{\alpha_1} \right) \ln \overline{\text{BOR}}_t$$

and the policy rule covering the adjustment of $\ln \text{BOR}_t$ is the same as in equation 9: We assume that the discount rate is set exactly by the monetary authority and is not changed.¹⁹

The resulting behavior of the monetary aggregate relative to the target value is described by:

$$(15) \quad (\ln M_t - \ln M^*) = \mu_{1t} + \gamma_{10} (\ln Y_t - E_{t-1}^f \ln Y_t) + \gamma_{20} \left(\frac{\varepsilon_{3t} - \mu_{3t}}{\alpha_{10}} \right)$$

C. Infrequent Adjustment of the Control Variable To New Information: Interest Rate Operating Guide

The criticism levied against monetary control procedure in the 1970s and the free reserves procedures of the 1950s and 1960s was not directed against the regimes described above. Rather, as is now generally acknowledged, in those periods, targets were changed only infrequently, or only by small amounts, in spite of the availability of new information.

Consider a regime where $\ln \bar{r}_\tau$ is set at a value based on information available at time $t-n$ and maintained at that value for n subsequent periods, that is, set $\ln \bar{r}_\tau$ so that $E_{t-n}^f \ln M_\tau = \ln M^*$ for $\tau = t-n+1, \dots, t$.

then

$$(16) \quad (\ln M_\tau - \ln M^*) = (\mu_{1\tau} - E_{t-n}^f \mu_{1\tau}) + \gamma_1 (\ln Y_\tau - E_{t-n}^f \ln Y_\tau) + \gamma_2 [\ln \bar{r}_\tau + \varepsilon_{1\tau} - E_{t-n}^f (\ln \bar{r}_\tau + \varepsilon_{1\tau})]$$

$$= \mu_{1\tau} + \sum_{i=t-n}^{\tau} \gamma_{1\tau-i} (\ln Y_\tau - E_{t-n}^f \ln Y_\tau) + \sum_{i=t-n}^{\tau} \gamma_{2\tau-i} \varepsilon_{1\tau}$$

for $\tau = t-n+1, \dots, t$

In a regime where $\ln \overline{\text{BOR}}_t$ is set at a value based on information available at $t-n$ and maintained at that value for n subsequent periods, that is, set $\ln \overline{\text{BOR}}_\tau$ so that $E_{t-n}^f \ln M_\tau = \ln M^*$ for $\tau = t-n+1, \dots, t$ then:

$$(17) \quad (\ln M_\tau - \ln M^*) = \mu_{1\tau} + \sum_{i=t-n}^{\tau} \gamma_{1\tau-i} (\ln Y_\tau - E_{t-n}^f \ln Y_\tau) + \sum_{i=t-n}^{\tau} \gamma_{2\tau-i} \left(\frac{\varepsilon_{3\tau} - \mu_{3\tau}}{\gamma_1} \right)$$

APPENDIX B

Standard Deviations of First Differences of Various Interest Rates (Weekly)

Sample	Fed Funds Rate Regime	Nonborrowed Reserves Regime			Borrowed Reserves Regime	
	Jan 69–Sept 79	Oct 79 Sept 80	Oct 80 Sept 81	Oct 81 Sept 82	Oct 82 Jan 84	Feb 84 Dec 84
Federal Funds Rate	.28	.95	.87	.63	.43	.39
3-Month Bill	.21	.64	.69	.56	.18	.17
6-Month Bill	.18	.57	.57	.48	.21	.16
52-Week Bill	.17	.51	.43	.43	.20	.16
3-Year Note	.14	.49	.39	.40	.22	.18
5-Year Note	.12	.43	.44	.36	.21	.18
10-Year Note	.09	.33	.31	.35	.20	.18
20-Year Bond	.08	.29	.29	.33	.19	.17

FOOTNOTES

1. The results reported in Johnson, *et al.* Tables 4–9 were reproduced with the data set employed in this study. The current data set replicates the previously reported results with a high degree of accuracy.

2. This point also appears in the bond duration literature where the *percentage* change in bond prices for a given *absolute* change in yield to maturity is shown to be proportional to the duration of the bond. Since for a given maturity and coupon rate, duration *decreases* with increases in yield to maturity, the percentage (and absolute) change in bond price for a given change in yield to maturity is lower the higher the initial yield (see Yawitz, 1977).

3. The discussion here focuses on week-to-week percentage changes in the various rates (measured as log first differences). Measures of interest rate volatility were also constructed using percentage deviations from various length centered moving geometric averages. These measures were compared with the measure reported in Johnson, *et al.* for deviations from centered moving arithmetic averages. The results of these comparisons are consistent with the comparisons reported here between arithmetic and percentage changes in rates.

In particular, the same pattern of significant increases in interest rate volatility in the 1979–80 period, and declining volatility in subsequent sample periods, is observed when the computations are performed relative to centered geometric moving averages.

4. Volatility measures were also tabulated for the 1969–70 and 1973–75 subsamples considered by Johnson, *et al.* Measurements of rate volatility in percentage changes for these subsamples share the homoskedasticity property that Johnson, *et al.* found in the arithmetic measures of volatility.

5. The figures presented here are graphical representations of the short-run money demand and money supply model in Appendix A.

6. The random variation in the money demand function is represented by μ_1 in the model in Appendix A; the random fluctuation in the demand for borrowed reserves by μ_3 .

7. In Appendix A, the fluctuation of the federal funds rate under a funds rate operating procedure is represented by ε_1 .

8. In Figures 1A and 1B we assume that the fluctuations of the federal funds rate in the range r_1 – r_2 are independent of shocks to the money demand function. In practice, during the 1970s, the Fed's Trading Desk was given the authority to move the federal funds rate systematically toward an extreme of the range established by the FOMC when the growth of money stock was observed to deviate from the established short-run path. This procedure implies a nonzero covariance between money demand shocks and deviations of the funds rate from the midpoint of the r_1 – r_2 range. The general expression for the variability of the money stock under this control procedure is given by equation 12 in Appendix A, which can accommodate nonzero covariance between ε_1 , the funds rate fluctuation, and μ_1 —the shock to money demand.

9. In terms of the model in Appendix A, the variability of the funds rate is determined by the expression:

$$\frac{\varepsilon_{3t} - \mu_{3t}}{\alpha_{10}}$$

which represented the effect of random disturbances to the demand for borrowed reserves (μ_{3t}) and the range of fluctuation in the supply of borrowed reserves (ε_{3t}). The interest rate fluctuations are amplified or attenuated by the interest elasticity of the demand for borrowed reserves, but are not affected by the parameters of or residual variance in the demand for money.

10. Recent directives give the Desk authority to change the degree of restraint on reserve positions systematically when the growth of the money stock is observed to deviate

from the paths established by the FOMC. This procedure implies a nonzero covariance between fluctuations in borrowed reserves supplied and shocks to money demand. In the discussion here, a zero covariance is assumed. The general expression that allows for nonzero covariances is given in equation 15 of Appendix A.

11. ε_{it} in the model of Appendix A.

12. $\frac{\mu_{3t} - \varepsilon_{3t}}{\alpha_{10}}$ in the model of Appendix A.

13. This can be seen by comparing either equations 12 and 15 or 16 and 17 in Appendix A. The only difference between 12 and 15 or 16 and 17 is the replacement of ε_{it} in 12 and 15 by

$$\frac{\varepsilon_{3t} - \mu_{3t}}{\alpha_{10}}$$

in 15 and 16. But those terms just represent the volatility of interest rates under the two operating procedures. Hence, if a funds rate operating procedure is compared with a borrowed reserves operating procedure under the assumption that the variance of the random component of money demand and the precision of forecasting income are unchanged, then the operating procedure with the larger volatility of interest rates will exhibit less precision in short-run monetary control.

14. Graphically, the movement from a federal funds operating procedure to a pure nonborrowed reserves operating procedure is a change from a horizontal "money supply function" to a vertical "money supply function." Intermediate cases, where the operating procedure allows for some response in the supply of nonborrowed reserves to interest rate fluctuations, are represented by positively sloped "money supply functions."

15. This serial correlation is introduced through the distributed lag terms in the estimated short-run money demand equation, and occurs even if the underlying random disturbances in the model (μ_{1t} , μ_{2t} , ε_{1t} and ε_{3t}) are not serially correlated.

16. a_t represents a shock to the federal funds rate. The χ^2 statistic measures the probability that the a 's are not serially correlated. A tabulated χ^2 value below the critical value signifies that the probability of serial correlation in the a 's is below conventionally accepted levels of statistical significance.

17. By suitable choice of the coefficients in the polynomial δ , the model can even handle different marginal and average reserve requirements such as proposed by Poole (1976). A potential criticism of this model is that it does not adequately account for the expectational behavior of either households and firms with respect to the demand for money or banks with respect to their demand for borrowed reserves from the Federal Reserve System.

An elegant analysis of short-run money market behavior has been constructed recently by Goodfried, *et al.* (1983). It attempts to incorporate rational expectations with respect to future interest rate behavior on the part of money demanders and banks, a sophisticated supply function for borrowed reserves that captures "administrative pressure" at the discount window, and a gradual adjustment rule for the supply of nonborrowed reserves. The dynamic properties of this model closely replicate the dynamic properties of a simple model such as that in Table 10. Therefore, conclusions drawn from a model such as that in Table 10 should be applicable over a broad range of potential models.

18. We assume that the monetary authorities have no time advantage with respect to current developments, so the setting of the policy variable (r , RU or BOR) for time = t is based solely on information available through time = $t - 1$.

19. In fact, the discount rate at the N.Y. Federal Reserve Bank changed on only three occasions in the period October 1982 through January 1984, and only twice during 1984, so discount rate changes are not a major consideration in current operating procedures.

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