Housing Finance and the Transmission of Monetary Policy

by John Ryding

Since the 1970s, the system of mortgage financing in the United States has undergone tremendous change. The elimination of ceilings on interest rates payable on time deposits and of state-imposed usury ceilings on interest rates chargeable on mortgages has ended bouts of mortgage rationing. Accompanying this process of deregulation has been a surge in financial innovation. The widespread issuance of the adjustable rate mortgage as an alternative to the fixed rate mortgage in the 1980s has helped thrifts and some other mortgage lenders better manage their exposure to varying interest rates. Also over the last decade, the mortgage-backed securities market has grown to become one of the largest fixed-income markets in the United States, increasing the integration of the mortgage market with other capital markets.

In transforming the system of mortgage finance, deregulation and financial innovation have altered the way monetary policy influences the cost and availability of mortgages and, ultimately, residential investment. In the past, one of the powerful channels through which monetary policy affected economic activity was mortgage rationing. Whenever a tightening in monetary policy pushed market interest rates above the interest rate ceilings on time deposits, banks and thrifts experienced an outflow of retail funds that forced these institutions to restrict new credit. Now, however, credit rationing in the mortgage market resulting from the interaction of market interest rates and these ceilings has been eliminated. Consequently, movements in interest rates play a more direct role in allocating funds to mortgage lending.

This article investigates the extent to which deregulation and innovation have changed the responsiveness of housing investment to monetary policy shifts. It gives particular attention to the effects of changes in the federal funds rate, one indicator of the relative ease or restraint of monetary policy. The article concludes that housing investment has become much less sensitive to a rise in the federal funds rate and attributes this development largely to the elimination of deposit rate ceilings. Although other financial innovations have had important effects on the system of housing finance, little evidence is found that they have had a significant effect on the way residential investment responds to monetary policy.

The first section of the article reviews the elimination of interest rate ceilings on both deposits and mortgages, the introduction of adjustable rate mortgages, the growth of securitization of mortgages, and the increase in competition between the thrifts and other mortgage lenders. Empirical evidence on the determination of mortgage interest rates and housing investment is then explored, and a small statistical model of residential investment and mortgage interest rates is presented to examine the changing sensitivity of housing investment to variations in interest rates. A concluding section summarizes the main analytical and empirical results of the article.

Innovation in and deregulation of housing finance

Interest rate ceilings

Interest rate ceilings of one form or another played important roles in the allocation of funds between the mortgage and other financial markets prior to deregulation in the early 1980s. The Federal Reserve's Regula-

tion Q, which had restricted the maximum interest rates that banks could pay on time deposits since 1933, was extended to thrifts in September 1966 during a period of sharply rising short-term interest rates. Furthermore, many states over time passed usury laws that controlled, among other things, the maximum interest rate that lenders could charge on mortgages.[1]

Whenever interest rates on short-term market instruments such as Treasury bills rose significantly above the Regulation Q ceilings (Chart 1), there was a sharp outflow of funds from depository institutions as customers withdrew savings to invest in higher yielding instruments. This diversion of funds, or "deposit disintermediation," created a funding problem for both banks and thrifts. It was particularly severe for the latter group of institutions because of their limited access to alternative sources of funds. During these periods, often referred to as "credit crunches," depository institutions were forced to reduce mortgage lending sharply (Chart 2).

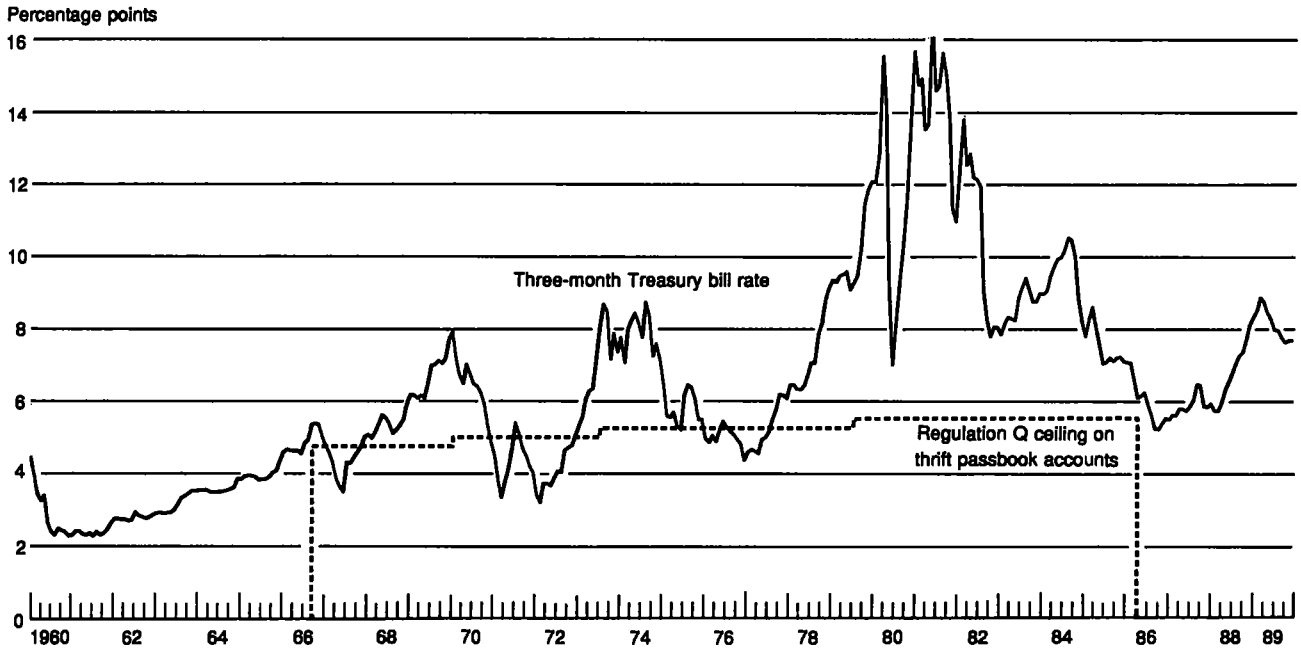
[1]New York, for example, in 1980 still had an 8½ percent ceiling on the rate that could be charged on mortgage lending.

Nevertheless, the interaction of deposit ceilings and high market interest rates stimulated financial innovation that may in fact have reduced the ability of these ceilings to restrain mortgage lending during periods of monetary tightening. Market interest rates remained above rates that thrifts and banks could offer on retail deposits for significant periods of time, producing a growing unsatisfied demand for mortgages at market interest rates then prevailing. This unsatisfied demand in turn encouraged the development of other sources of funding (such as wholesale funding markets or securitization of mortgage assets) and may have induced other financial institutions, not subject to these ceilings, to enter the mortgage market. Thus one might expect the effect of Regulation Q ceilings on mortgage lending to have declined somewhat over time, as the mortgage market evolved in response to disintermediation pressures. This inference is tested by the empirical analysis below, which assesses the extent to which the effectiveness of Regulation Q ceilings in restraining mortgage lending during periods of monetary stringency declined over time.

Partly in recognition of the pressures that periods of

Chart 1

Three-Month Treasury Bill Rate and the Regulation Q Ceiling



Source: Federal Reserve Bank of New York.

disintermediation placed on the ability of depository institutions to raise funds, the authorities increased the minimum denomination of Treasury bills from $1,000 to $10,000 in 1970. Nevertheless, the incentives created by high and rising interest rates in the late 1960s and 1970s spurred the development of alternative deposit-like savings vehicles. For example, money market mutual funds (MMMFs) were introduced in 1972, and by the late 1970s they had become serious competitors with depository institutions (Chart 3).

The process of dismantling Regulation Q ceilings on retail deposits began in June 1978, when depository institutions were allowed to issue six-month money market certificates (MMCs) in denominations of $10,000 or more.[2] The MMCs offered interest rates tied to those available on Treasury bills. The Depository Institutions Deregulation and Monetary Control Act of March 1980 stipulated that Regulation Q ceilings be phased out on time and savings deposits and permitted thrifts and banks to offer individuals interest-bearing negotiable order of withdrawal (NOW) accounts, essentially checking accounts that were not subject to the interest prohibition applying to demand deposits. These relaxations of Regulation Q eased the funding problems during the period of high nominal interest rates at the turn of the decade.

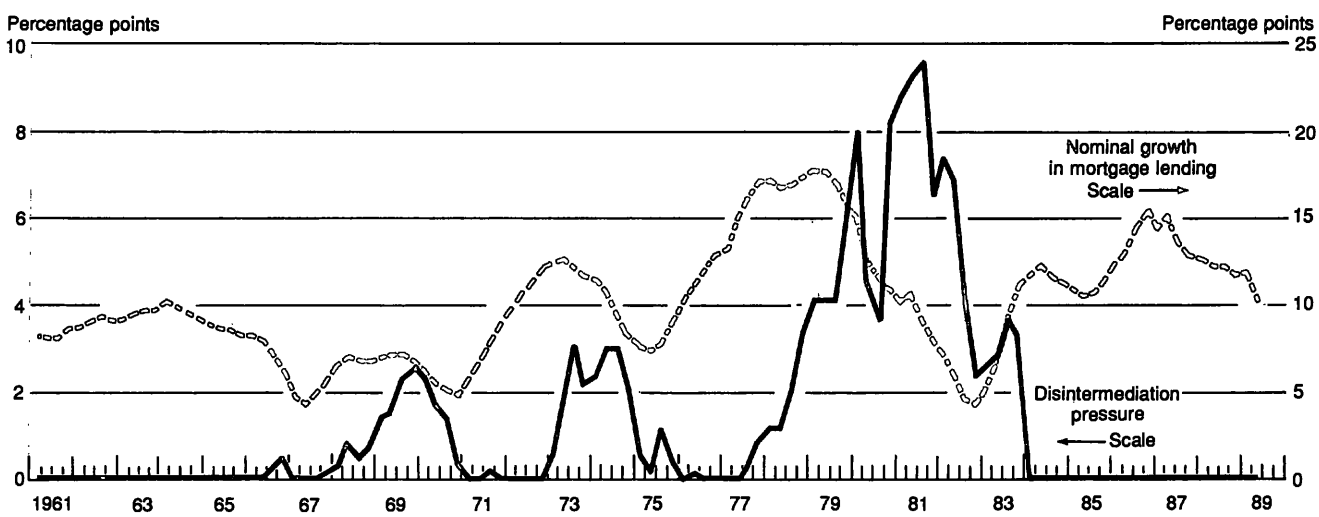
The Garn-St Germain Depository Institutions Act, passed in October 1982, further expanded funding alternatives for banks and thrifts.[3] The act authorized two new types of accounts: money market deposit accounts (MMDAs)—designed to be competitive with MMMFs—and Super-NOW accounts. Both accounts had minimum balances of $2,500, and both were free from interest rate ceilings. MMDAs were permitted beginning in December 1982 and Super-NOW accounts in January 1983. By early 1983, these new accounts effectively eliminated Regulation Q as a significant constraint on banks' and thrifts' ability to raise retail funds, although disintermediation pressures had been lessening for some months before then as a result of a marked reduction in interest rates.

[2]Interest rate ceilings on large certificates of deposit were removed in 1973.

[3]For discussions of the state of the financial health of thrifts during this period, see, for example, R. Dan Brumbaugh, *Thrifts Under Siege* (Cambridge, Mass.: Ballinger, 1988), chap. 2; and Patrick I. Mahoney and Alice P. White, "The Thrift Industry in Transition," *Federal Reserve Bulletin*, March 1985, pp. 137-56. For details on the Garn-St Germain Act and its effects, see Federal Reserve Bank of Chicago *Economic Perspectives*, March-April 1983; and Michael C. Keeley and Gary C. Zimmerman, "Competition for Money Market Deposit Accounts," Federal Reserve Bank of San Francisco *Economic Review*, Spring 1985, pp. 5-27.

Chart 2

Nominal Growth in Mortgage Lending and Disintermediation Pressure



Sources: Board of Governors of the Federal Reserve System, Flow of Funds data; Federal Reserve Bank of New York.

Notes: Before 1984, disintermediation pressure is measured as the three-month Treasury bill rate less the Regulation Q ceiling on thrift passbook accounts when this difference is positive; disintermediation pressure is calculated as zero when the difference is negative. From 1984 on, the value is zero. The shaded areas represent periods when the disintermediation spread is significantly greater than zero.

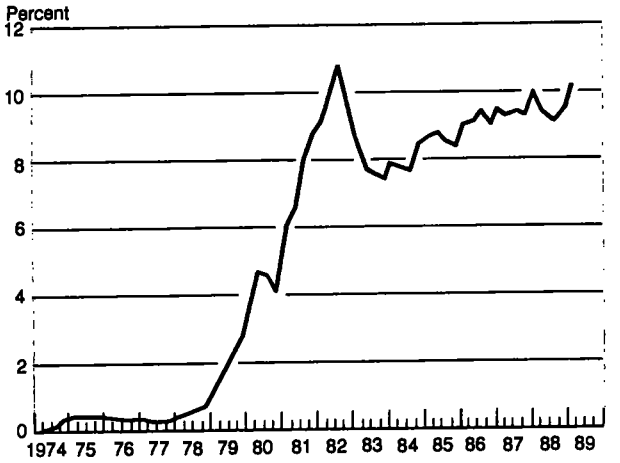
Also important in the allocation of funds for mortgage lending were state-imposed usury ceilings on mortgage interest rates. These ceilings differed substantially from state to state, and studies of the impact of usury ceilings have been very limited in scope. Nevertheless, some research indicates that usury ceilings limited the flow of funds into mortgage lending.[4]

It was argued above that deposit rate ceilings, when binding, acted to reduce new mortgage lending more sharply in response to an increase in market interest rates than would otherwise have occurred. Absent ceilings on mortgage interest rates, such a reduction in mortgage lending could have sharply raised mortgage interest rates, choking off the demand for new mortgages until it matched the smaller volume of funds available. To the extent that mortgage interest rate ceilings prevented mortgage rates from increasing sufficiently to bring demand into line with supply, however, lending would have had to be rationed in other ways (for example, lower loan-to-value ratios). The existence of usury ceilings, therefore, prevents one from deducing whether the change in mortgage interest rates caused by an increase in market rates would be greater or smaller in the regulated environment than in the deregulated environment. The behavior of mortgage interest rates in response to a monetary tightening is investigated empirically below.

[4]For references and a more complete discussion, see Harold C. Nathan, "Economic Analysis of Usury Laws," *Journal of Bank Research*, Winter 1980, pp. 200-211.

Chart 3

Share of Household Liquid Assets Held in Money Market Mutual Funds



Source: Board of Governors of the Federal Reserve System, Flow of Funds data.

Growth of securitization

The secondary mortgage market originated in the depression period with the foundation of the Federal Housing Administration (FHA) in 1934 and the Federal National Mortgage Association (Fannie Mae or FNMA) in 1938. The FHA insured long-term, fixed-rate mortgages, and FNMA was formed to provide a secondary market for FHA-insured loans. Government participation in the mortgage market was further expanded at the end of World War II with the creation of the Veterans Administration (VA) program. FNMA began purchasing VA mortgages in 1948.

The next major institutional development in the secondary market occurred in 1968, when Congress restructured FNMA as a government-chartered private corporation and created the Government National Mortgage Association (Ginnie Mae or GNMA) to assume some of FNMA's functions. Perhaps the most significant development at this time was that GNMA was empowered to guarantee, with the "full faith and credit" of the U.S. Treasury, the timely payment of both principal and interest on its securities backed by FHA-insured or VA-guaranteed loans. GNMA guaranteed its first mortgage-backed security (MBS) issue in February of 1970. Also in 1970, the Federal Home Loan Mortgage Corporation (Freddie Mac or FHLMC) was chartered to develop the secondary market in conventional mortgages (that is, mortgages not guaranteed by the FHA or VA). In the following year, FHLMC issued its first MBS backed by conventional mortgages. FNMA, however, did not begin issuing MBSs until 1981.

The first type of MBSs issued were mortgage pass-through securities. Essentially, these provided an ownership interest in the underlying pool of mortgages that backed the certificates, and all payments of interest and principal (less a servicing fee) were passed through to the holders of the certificates. However, the risk of default on MBSs was substantially lower than the risk of default on whole mortgages because of the agency guarantees.

An important product innovation was launched by FHLMC in 1983, when it issued the first collateralized mortgage obligation (CMO). A CMO is a multiple-class security, each class having a different maturity. The early CMO issues were structured so that, as payments of principal were received (including prepayments), the shorter maturity tranches were completely retired before any payments of principal were made to the holders of the longer maturity tranches. The attractiveness of issuing structured MBSs was greatly enhanced by the Tax Reform Act of 1986, which permitted multi-

ple-class securities to be issued in the form of real estate mortgage investment conduits (REMICs).[5] Since 1986, multiple-class securities have become more complex in structure, with the introduction of interest-only (IO) and principal-only (PO) strips and Planned and Targeted Amortization Classes (PACs and TACS).[6] Chart 4 illustrates the rapid growth in the securitization of the stock of residential mortgages in recent years.

The MBS market encourages a separation of the various functions of mortgage lending, in particular the separation of the origination and servicing functions from the decision to hold mortgages as a portfolio investment. This feature in turn permits institutions that have a comparative advantage in originating and servicing mortgages to expand their activities without the need to raise funds to invest long term in these mortgages. As indicated below, this may have been a significant factor in the expansion of mortgage banks' activities in originating loans in the 1980s. Furthermore, the ability to invest in mortgages without having to originate or service them substantially increases the attractiveness of mortgages as an investment vehicle for institutional investors such as pension funds and fixed income mutual funds.

The development of structured securities such as CMOs and REMICs has also made possible a more efficient distribution across investors of the risk associated with investing in mortgages. Mortgages are subject to prepayment risk. As interest rates fall, mortgagors have an incentive to refinance their mortgages, prepaying the old mortgages. Consequently, investors are left to reinvest these prepayments in the lower interest rate environment, realizing a reduced yield on their original investment. Dividing up the cash flows from the underlying mortgages into tranches with different yields and maturities, and therefore different degrees of prepayment risk, permits a better matching of investor preferences to the risks inherent in mortgage cash flows and potentially increases the number of investors willing to hold some form of mortgage or mortgage security in their portfolios.

Because MBSs are easily tradable in the secondary market, they are much more liquid than mortgages. Hence they can be held as a short-term investment vehicle, an advantage which further widens the potential investor base for mortgages. By attracting a greater pool of investors, MBSs make possible a more efficient pricing of prepayment risks. Furthermore, because MBSs generally have some form of government or agency guarantee, they carry a default risk below that of the mortgages that back them. Taken together, these arguments strongly suggest that the development of the MBS market should have lowered the interest rate spreads between mortgages and other long-term investments, such as Treasury bonds. The extent to which the expansion of the MBS market may have reduced mortgage spreads is investigated below.

The MBS market also helped to alleviate funding pressures during the period of heavy disintermediation in the early 1980s. The secondary market enabled thrifts to sell mortgages or MBSs and to use the proceeds to originate new mortgages. Nevertheless, an argument can be made that such effects were probably not large. For much of the time when deposit rate ceilings were in force, the size of the MBS market was fairly small relative to the total mortgage market (Chart 4). Further, since disintermediation occurred at a time of rising interest rates, many existing mortgages or MBSs were "under water," that is, they had a market price less than the book value of the mortgage or security. Consequently, selling underwater mortgages or MBSs would have resulted in a loss of stated capital at a time when average lending margins were probably coming under pressure (particularly in the 1981-82 period).[7]

Adjustable rate mortgages

Although a few adjustable rate mortgages[8] (ARMs) were originated in the 1970s, widespread issuance of ARMs did not begin until the early 1980s.[9] The high

[5]The 1986 Tax Reform Act enabled the issuer of the security to sell the residual interest — that is, the difference between the cash flows from the mortgages and the payments to the holders of the REMIC — without incurring double taxation on the pass-through of these payments.

[6]PACs and TACs are REMIC classes whose principal paydown follows a set schedule unless the prepayment rate on the underlying mortgages moves outside a certain range. For more details, see Richard Roll, "Stripped Mortgage Backed Securities," *Goldman Sachs*, October 1986; and Richard Roll, "Recent Innovations in Collateralized Mortgage Obligations," *Goldman Sachs*, January 1987.

[7]This disincentive was sharply reduced for thrifts by the Federal Home Loan Bank Board's October 1981 change to thrift accounting procedures. These procedures permitted losses on the sale of assets with below-market coupons to be deferred for accounting purposes but realized in the current year for tax purposes. For more details, see William W. Bartlett, *Mortgage-Backed Securities* (New York: New York Institute of Finance, 1989), pp. 25-27.

[8]Most ARMs include interest rate or payment caps to limit the interest rate risk borne by the borrower. These caps limit the maximum amount by which the interest rate or payments on the mortgage can be adjusted each year. The cap most commonly set is 2 percentage points per year or, over the lifetime of the loan, typically between 5 and 6 percentage points. Subject to these caps, the ARM rate is tied to an index plus a margin (such as the one-year constant maturity Treasury bill rate). In addition, many ARMs have at various times carried initial rates substantially below current market levels (so-called teaser rates).

[9]ARMs are very common in many overseas countries. For example, in the United Kingdom mortgages are typically twenty-five-year variable rate mortgages; the predominant form of mortgage finance in Canada is the rollover mortgage, which needs to be refinanced every one to five years.

and volatile interest rates of the late 1970s and early 1980s, combined with the gradual phaseout of Regulation Q, made it increasingly attractive for depository institutions to manage their interest rate risk carefully. In 1981 the Federal Home Loan Bank Board (FHLBB) authorized federally chartered thrifts to issue or purchase ARMs. Impetus was added to the development of the ARMs origination market with the introduction of FNMA's ARM purchase program in that year and FHLMC's program in the following year. The introduction of the FHLBB's new net worth accounting regulations in October 1981 reduced the disincentive to sell existing mortgages and thereby encouraged thrifts to restructure their balance sheets to match more closely the interest sensitivity of the returns on their assets to the interest sensitivity of their liabilities.

The growth of the ARMs market is illustrated in Chart 5, which shows the share of new originations that are in the form of ARMs. As the chart illustrates, the share of ARMs is closely correlated with the spread between the average interest rate on new fixed rate mortgages and that on new ARMs.

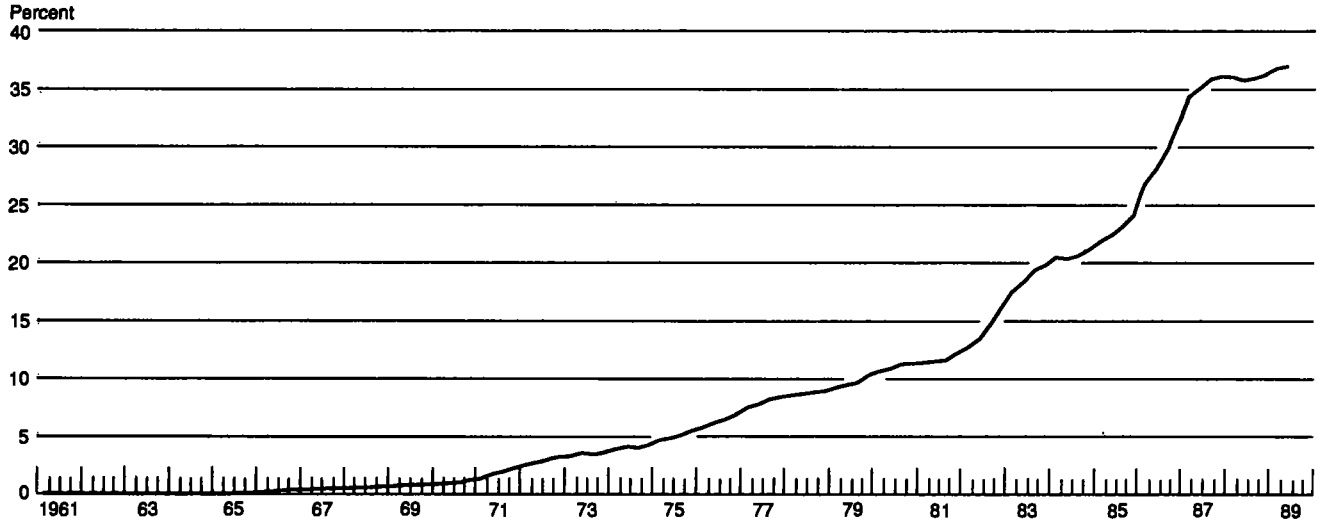
The introduction of the ARM has helped broaden the spectrum of financial instruments, bringing potential benefits to both borrowers and lenders. From the borrower's perspective, an ARM is attractive because it usually carries a lower interest cost than a fixed rate mortgage, although that rate may increase later in the life of the loan. This lower interest rate reflects the customary upward slope of the Treasury yield curve, the transfer of some of the interest rate risk from the lender to the borrower, and the pricing of the prepayment option in the fixed rate mortgage. The availability of ARMs has allowed some borrowers who cannot qualify at the higher fixed interest rate to obtain a mortgage, although they must be willing to bear the interest rate risk.[10] Consequently, ARMs may have increased the demand for housing at a given level of mortgage interest rates. At the same time, however, the demand for housing may have become more sensitive to mortgage interest rate *changes* as a result of the introduction of ARMs. This greater sensitivity could arise because some potential ARMs borrowers may be on the margin of qualifying for an ARM.[11] Still, one would

[10]This mortgage qualification effect might have been more pronounced at times when ARMs carried initial teaser rates. Nevertheless, John L. Goodman, Jr., and Stuart A. Gabriel ("Forecasting Housing Construction: Lessons and Puzzles from Recent Years," Federal Reserve Board, Working Paper no. 69, January 1987) present evidence to suggest that the effects of qualifying at these teaser rates may not have been large. They note, for example, that stricter qualification guidelines for ARMs were introduced in 1984.

[11]Evidence suggests that many ARM debtors have relatively few liquid assets and that their cash flows are vulnerable to being squeezed by rising interest rates. Such evidence is consistent with the view that

Chart 4

Share of Securitized Mortgages Outstanding



Source: Board of Governors of the Federal Reserve System, Flow of Funds data.

Note: The share of securitized mortgages is approximated by pooled mortgages over total mortgages on one- to four-family homes.

expect the degree of this extra sensitivity to be small relative to the reduced sensitivity stemming from the phaseout of Regulation Q.

It may be misleading, however, to consider only the demand effect of ARMs when evaluating the potential impact of this type of mortgage on housing activity. From the lender's perspective, issuing ARMs provides a way of reducing the exposure of its balance sheet to varying interest rates by passing on some of the interest rate risk to borrowers, albeit at the risk of raising the default rate on its loan portfolio. If deposit deregulation had occurred without the parallel development of the ARMs market, it is conceivable that deposit intermediaries, some of whom experienced negative spreads between the average effective interest rate they received on their mortgage portfolios and the average rate of interest paid on deposits in 1981 and 1982, might have been less willing to bid for deposits and originate fixed rate mortgages in the newly deregulated environment. Such an outcome in turn might have limited the available supply of mortgage finance unless other lenders were willing to bear the risk. If the absence of ARMs had reduced the supply of mortgage lending, then either mortgage rates would have been higher than was observed, reflecting the greater scarcity of mortgage funds, or mortgage lending would have been restricted in some other way. Therefore, studies showing that investment in housing during the period 1982-84 can be explained by the level of fixed mortgage rates and concluding on this basis that the introduction of ARMs had little or no impact on housing activity[12] leave open the question whether the introduction of ARMs lowered fixed mortgage rates below what they would have been otherwise.

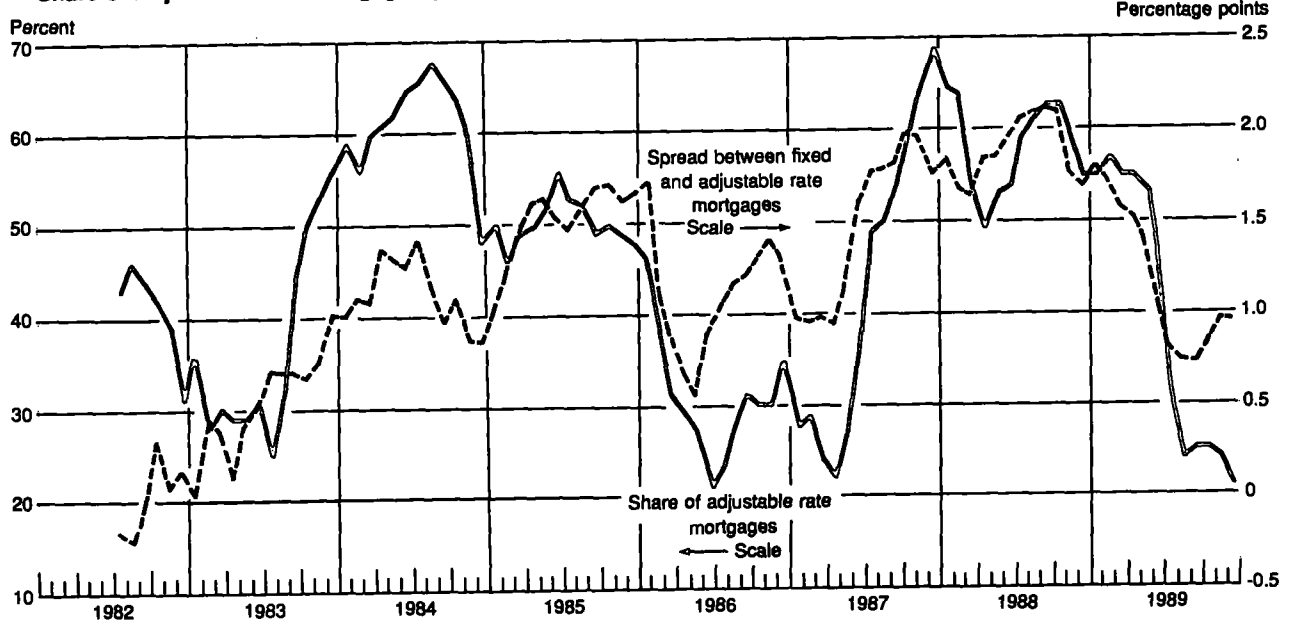
Many analyses of the impact of ARMs on housing demand find some theoretical support for the argument that the availability of ARMs increases the demand for housing. Nevertheless, such effects might be small;

Footnote 11 continued
prospective ARMs borrowers may be more financially constrained than other mortgagors. See John L. Goodman, Jr., Charles A. Luckett, and David W. Wilcox, "Interest Rates and Household Cash Flow," Board of Governors of the Federal Reserve System, December 1988.

[12]These studies include Howard Esaki and Judy Wachtenheim, "Explaining the Recent Level of Single-Family Housing Starts," Federal Reserve Bank of New York *Quarterly Review*, Winter 1984-85, pp. 31-38; and Michael J. Stutzer and William Roberds, "Adjustable-Rate Mortgages: Increasing Efficiency More than Housing Activity," Federal Reserve Bank of Minneapolis *Quarterly Review*, Summer 1985, pp. 10-20.

Chart 5

Share of Adjustable Rate Mortgages (ARMs) and Spread between Fixed Rate Mortgages and ARMs



Source: Department of the Treasury, Office of Thrift Supervision.

there is little empirical evidence to suggest otherwise. Since ARMs have only been available for a limited time and their introduction coincided with other innovations in the mortgage market, the evidence on the impact of ARMs is tentative and the subject merits further investigation as more data accumulate.

Increasing competition in the mortgage market

The market for mortgage originations became much more competitive in the 1980s. With the phasing out of Regulation Q ceilings, thrifts could compete with one another for deposits by raising their interest rates. Furthermore, a number of thrifts attempted to grow quickly, in part by originating new mortgages.[13]

Competitive pressure also was growing from outside the industry, particularly from the mortgage banking industry. Table 1 shows the share of mortgage originations by four broad sectors and clearly illustrates the rise in the share of the mortgage banking industry in the 1980s at the expense of the thrifts. This larger role for the mortgage banks—which specialize in originating loans complying with the requirements for sale or conversion to MBSs issued by FNMA or FHLMC—came at the same time as these agencies were markedly expanding their role in the secondary mortgage market. According to one analyst, Patric Hendershott, the securitized share of new conventional fixed rate loans conforming to FHLMC and FNMA standards rose from 4 percent in the late 1970s to more than 50 percent by the middle of the 1980s.[14] Hendershott argues that this expansion has narrowed the spreads on mortgage rates relative to long-term bonds. Evidence of the potential impact of these developments on mortgage rates is presented in the next section.

[13]For a discussion of this development, see, for example, Andrew S. Carron, "The Thrift Industry Crisis of the 1980s: What Went Wrong?" in *The Future of the Thrift Industry*, Federal Home Loan Bank of San Francisco, December 1988; and Jack M. Guttentag, "Recent Changes in the Primary Mortgage Market," *Housing Finance Review*, July 1984, pp. 221-54.

[14]Patric H. Hendershott, "The Future of Thrifts as Home Portfolio Lenders," in *The Future of the Thrift Industry*.

Table 1

Share of Mortgage Originations by Financial Institutions

Date	Commercial Banks	Mortgage Banks	Thrifts	Other
1971 to 1975	22.9	19.9	52.5	4.6
1976 to 1980	21.7	18.1	56.1	4.1
1981 to 1985	22.5	25.6	47.1	4.7
1986 to 1988	25.8	25.5	47.1	1.7

Source: Department of Housing and Urban Development.

A model of single-family housing investment

This section develops a statistical model of single-family housing investment and mortgage interest rates to investigate the changing relationship between residential investment and interest rates.[15] The section opens with a brief summary of the "stylized facts" and open questions that can be drawn from previous empirical research. The presentation of the model follows, ending with a brief illustration of the model's ability to track historical variations in housing investment. Finally, the effects of a tightening of monetary policy in different subperiods are simulated in order to assess the changing responsiveness of housing investment to changes in interest rates.

Previous work

Although researchers who have examined the determination of residential investment have sometimes reached diverse conclusions, one might summarize their findings as follows:[16]

(i) housing activity was influenced by disintermediation pressures fostered by Regulation Q ceilings, although there is no consensus on the overall strength of this effect;

(ii) the effects of disintermediation were markedly reduced by the late 1970s, and in the period 1978-82 it is not clear that this process significantly reduced housing activity;

(iii) apart from the effects of deposit disintermediation, there is no evidence that housing investment was less responsive to interest rates in the 1980s than in either the 1970s or 1960s;

[15]A more detailed discussion of the derivation of the relationships presented here can be found in John Ryding, "Housing Finance and the Transmission Mechanism of Monetary Policy," in *Studies on Financial Changes and the Transmission of Monetary Policy*, Federal Reserve Bank of New York, May 1990.

[16]Work on modeling residential investment includes: Dwight M. Jaffee and Kenneth T. Rosen, "Mortgage Credit Availability and Residential Construction," *Brookings Papers on Economic Activity*, 2:1979, pp. 333-76; Esaki and Wachtenheim, "Explaining the Recent Level of Single-Family Housing Starts"; M. A. Akhtar and Ethan S. Harris, "Monetary Policy Influence on the Economy—An Empirical Analysis," Federal Reserve Bank of New York *Quarterly Review*, Winter 1986-87, pp. 19-34; Adrian Throop, "Financial Deregulation, Interest Rates, and the Housing Cycle," Federal Reserve Bank of San Francisco *Economic Review*, Summer 1986, pp. 63-78; George A. Kahn, "The Changing Interest Sensitivity of the U.S. Economy," Federal Reserve Bank of Kansas City *Economic Review*, November 1989, pp. 13-34; and Randall J. Pozdena, "Do Interest Rates Still Affect Housing?" Federal Reserve Bank of San Francisco *Economic Review*, Summer 1990, pp. 3-14. These papers, with the exception of that by Pozdena, are briefly critiqued in Ryding, "Housing Finance and the Transmission Mechanism."

(iv) on the basis of tests conducted over a relatively short sample period, financial innovations such as securitization and ARMs have not been found to have a noticeable impact on housing activity.[17]

The model developed here makes it possible to reexamine these assertions.

Structure and testing of the model

The general structure of the model can be explained in simple terms. At its core are two equations, one determining mortgage interest rates and the other housing investment. The first equation relates the average effective mortgage rate on all loans closed (both fixed and adjustable) to Treasury rates, with the spread between these rates depending on a number of variables, as explained below. The second equation relates new single-family housing investment—the measure of housing investment used in this study—to real incomes and mortgage interest rates; in this equation disintermediation pressures affect the cyclical response of housing to interest rates. Since the model is estimated on quarterly data, time series econometric methods, outlined in the Box, are used to determine the time profile of the response of one variable (say, housing investment) to another (say, mortgage rates). Let us examine the individual equations in more detail.

The mortgage rate relationship begins with a long-run relationship linking the mortgage rate and the variables that it may depend on (Table 2, column 1). The selection of variables was guided by the research of other economists and the arguments put forward in earlier sections of this article. The most significant variable (judged by the t-statistics given in parentheses)[18] is the average level of market interest rates, which is a weighted average of the ten-year constant maturity Treasury rate and the three-month Treasury bill rate, where the weights depend on the share of ARMs in new loans closed. As one might expect, this variable has a coefficient close to one, suggesting that a 1 percentage point rise in market rates would eventually lead to a 1 percentage point rise in mortgage rates. Since this coefficient is virtually one, all other variables can be thought of as explaining the spread on mort-

[17]But Barry Bosworth, in "Institutional Change and the Efficacy of Monetary Policy," *Brookings Papers on Economic Activity* 1:1989, pp. 77-110, uses evidence on Canadian housing investment to argue that ARMs have reduced the interest sensitivity of housing in the United States. Alan Blinder and David Romer, in the same volume, cast some doubt on his interpretation of the results, arguing that the most significant change to the transmission mechanism has come from the elimination of disintermediation.

[18]It should be noted, however, that the standard errors and hence t-values from this equation are biased. See James H. Stock, "Asymptotic Properties of Least Squares Estimators of Cointegrating Vectors," *Econometrica*, 1987, pp. 1035-56.

Box: Explanation of Econometric Techniques

The estimation techniques used in this article follow much recent work in time series econometrics. The equation for mortgage interest rates is derived using the Engle-Granger two-step method of cointegration modeling.† This approach involves estimating a first-stage regression between the level of the variable to be explained and other variables on which long-run movements in this variable are thought to depend. Testing whether the variables are cointegrated is done using the Dickey-Fuller test. For example, if Y is thought to depend on X and Z, the first-stage regression is:

$$(1)\quad Y_t = \beta_0 + \beta_1 X_t + \beta_2 Z_t + u_t.$$

If the Dickey-Fuller test suggests that u_t is generated by a stationary process, the estimated residuals, $\hat{u}_t$, from this equation are used as an error correction variable in a dynamic regression of the general form:

$$(2)\quad \Delta Y_t = \sum_{i=0}^{i=I} \alpha_i \Delta X_{t-i} + \sum_{j=0}^{j=J} \delta_j \Delta Z_{t-j} + \sum_{k=1}^{k=K} \gamma_k \Delta Y_{t-k} + \gamma \hat{u}_{t-1} + \varepsilon_t.$$

The selection of the lag lengths I, J, and K depends on the statistical significance of the variables and on whether ε_t appears to be serially uncorrelated (using the Lagrange multiplier test for serial correlation‡) and to have a constant variance (using the test for autoregressive conditional heteroscedasticity, or ARCH, errors§).

The other equations in the article are modeled using a general-to-specific modeling strategy.‖ Illustrating this strategy with our three-variable example, we have a general model of the form:

$$(3)\quad Y_t = \beta_0 + \sum_{i=0}^{i=I} \alpha_i X_{t-i} + \sum_{j=0}^{j=J} \delta_j Z_{t-j} + \sum_{k=1}^{k=K} \gamma_k Y_{t-k} + \varepsilon_t,$$

where the maximum lag lengths I, J, and K are chosen on the basis of the properties of the residuals. The equation can then be restricted in various ways, using F- or t-tests to assess the validity of the restrictions.

†See Robert F. Engle and C.W.J. Granger, "Co-integration and Error Correction: Representation, Estimation, and Testing," *Econometrica*, March 1987, pp. 251-76.

‡See Trevor S. Breusch, "Testing for Autocorrelation in Dynamic Linear Models," *Australian Economic Papers*, 1978, pp. 334-55.

§See Robert F. Engle, "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of U.K. Inflation," *Econometrica*, 1982, pp. 987-1007.

‖For more details see, for example, David F. Hendry, Adrian R. Pagan, and J. Denis Sargan, "Dynamic Specification," in Zvi Griliches and Michael D. Intriligator, eds., *Handbook of Econometrics* (Amsterdam: North Holland, 1983).

Table 2

Equations for the Average Effective Mortgage Interest Rate (1965-I to 1988-IV)

Equation for the Level of the Mortgage Interest Rate†		Equation for the Change in the Mortgage Interest Rate†	
Explanatory Variable	Coefficient	Explanatory Variable	Coefficient
Constant term	1.284	Change in yield on ten-year Treasury bonds	
	(4.50)	Current quarter	0.1720
Weighted average interest rate on Treasury securities‡	0.9931		(3.92)
	(40.77)	One-quarter lag	0.0944
Yield spread on AAA corporate bonds to ten-year Treasury bonds	0.8260		(1.84)
	(5.71)	Change in interest rate on three-month Treasury bills	
Share of mortgage stock securitized	−3.492	One-quarter lag	0.1853
	(3.31)		(6.61)
Rate on Treasury bonds before abolition of usury ceilings	−0.0441	Two-quarter lag	0.1062
	(1.98)		(3.33)
Dummy variable to control for introduction of adjustable rate mortgages	1.351	Change in mortgage interest rate	
	(5.10)	One-quarter lag	−0.2122
			(2.35)
		Two-quarter lag	0.3091
			(5.11)
		Three-quarter lag	0.2611
			(3.86)
		Change in yield spread on AAA corporate bonds to ten-year Treasury bonds	0.2280
			(1.86)
		Lagged deviation in mortgage rate from its long-run level§	−0.1631
			(3.44)
Statistics			
R-Bar²	0.965	R-Bar²	0.797
Durbin-Watson	0.82	Durbin-Watson	2.01
Dickey-Fuller test for cointegration	−4.86	LM test for up to four-period residual autocorrelation	4.54
		Test for up to two-period autoregressive conditional heteroscedasticity	0.64

Note: Figures in parentheses are t-values.
†Average effective rate on all conventional home mortgages closed.
‡The average of the interest rate on three-month Treasury bills and ten-year Treasury bonds. The bill rate is given the weight of ARMs in new mortgages closed (0 before 1982).
§The long-run level of mortgage rates is given by the predicted value from the regression reported in column 1 of this table.

gage interest rates over Treasury rates. Two possible determinants of the spread that were discussed earlier are the growth of the MBS market and the operation of usury ceilings. The coefficient on the MBS term suggests that for each percent of the mortgage stock that has been securitized, the spread on mortgages over Treasury rates has fallen by 3.5 basis points, although considerable statistical uncertainty is attached to this estimate. The proxy variable for the operation of usury ceilings (measured by the level of Treasury bond rates before the abolition of usury ceilings and zero thereafter) suggests that, on average, a rise of 100 basis points in interest rates when usury ceilings were in effect would lead to a decline of about 4 basis points in the spread on mortgages.[19] The spread on mortgages is also modeled as depending on the spread of AAA corporate bonds over Treasuries. One might expect these spreads to be correlated for two reasons. First, because the spread on corporate bonds over Treasuries tends to widen when the economy turns down, it may act as a proxy for the risk of default on mortgages, a risk which is related to the cyclical state of the economy. Second, many corporate bonds are callable, a feature that is similar to the prepayment option embedded in a mortgage, and this spread might therefore be correlated with the incentives to prepay. The coefficient on this variable suggests that, on average, when the spread on corporate bonds widened by 100 basis points, the mortgage spread widened by around 80 basis points. Although this equation explains the trend movements in mortgage rates, it does not explain the shorter run movements closely. The statistical technique used to track short-term rate movements regresses the change in mortgage interest rates on the deviation of mortgage rates from their trend level, as determined by the previous equation, and on changes (current and lagged) of various interest rates (Table 2, column 2).

Housing investment in the model is measured by a proxy for the growth in the stock of single-family housing. Like equations for housing investment obtained by many other researchers, this equation is derived from a stock adjustment equation that links the demand for the stock of housing to real incomes and real post-tax mortgage interest rates.[20] Hence, one would expect the

[19]Preferably, one would want some measure of the average usury ceiling across the country and would only include this term when market rates exceeded this ceiling. Such data are not available, however, and therefore this effect has to be considered fairly tentative.

[20]Some researchers have used a user cost rather than a post-tax real interest rate. The only essential difference between the two measures is that the latter measure adjusts the real post-tax rate for the movement in house prices relative to other prices.

stock of housing to grow as real incomes rise or real mortgage rates fall. Movements in housing investment have been very cyclical, however, and modeling these movements requires a statistical approach that allows for complex lag structures between housing investment and mortgage rates, real incomes, and disintermediation pressures.

The housing investment equation relates the growth in the stock of single-family housing to the growth in real personal disposable income and a number of variables designed to capture the effects of mortgage interest rates and disintermediation (Table 3). The interest rate variables include the level of the real mortgage interest rate and the change in a nominal interest rate, the latter variable perhaps reflecting a short-term cash flow effect.[21] To capture the effects of disintermediation in the housing equation, the spread (when positive) between the three-month Treasury bill rate and the Regulation Q ceiling on savings accounts at thrifts was included. To examine the possibility that the effectiveness of these ceilings in restraining mortgage growth was declining over time, the coefficient on the disintermediation variable was allowed to differ in each of the historical periods when Treasury bill rates exceeded the ceiling. The declining values of these coefficients

Table 3

Equation for Single-Family Housing Investment (1965-I to 1988-IV)

Explanatory Variable	Coefficient
Constant term	0.00177
	(5.66)
Housing investment	
One-quarter lag	1.347
	(14.23)
Two-quarter lag	−0.6293
	(4.39)
Three-quarter lag	0.0958
	(1.18)
Growth in real personal disposable income†	0.00695
	(2.18)
Change in mortgage rate	−0.00027
	(2.20)
Change in real post-tax mortgage rate	−0.00013
	(2.06)
Level of real post-tax mortgage rate lagged one quarter	−0.000064
	(3.37)
Spread between interest rate on three-month Treasury bills and Regulation Q ceilings	
1966-67	−0.00227
	(3.82)
1969-71	−0.00027
	(3.77)
1973-76	−0.00031
	(4.68)
1978-82	−0.000094
	(4.72)
Statistics	
R-Bar²	0.969
Durbin-Watson	2.06
LM test for up to four-period residual autocorrelation	0.72
Test for up to two-period autoregressive conditional heteroscedasticity	1.09

Note: Housing investment is measured as a percent (over 100) of the previous quarter's stock of single-family homes. Figures in parentheses are t-values.
†Measured as the change in the natural log of real personal disposable income.

[21] In the specification search for the housing investment equation, both real and nominal mortgage rates (current and lagged several quarters) were included as explanatory variables. Statistical tests rejected the hypothesis that the real interest rate should enter in difference form only.

Table 4

Equations for Interest Rates on Treasury Bills and Bonds (1965-I to 1988-IV)

Equation for the Interest Rate on Three-Month Treasury Bills		Equation for the Interest Rate on the Ten-Year Constant Maturity Treasury	
Explanatory Variable	Coefficient	Explanatory Variable	Coefficient
Constant	0.1994	Constant	0.1248
	(1.76)		(0.99)
Federal funds rate		Treasury bill rate	
Current quarter	0.7404	Current quarter	0.6727
	(23.41)		(7.07)
One-quarter lag	−0.4924	One-quarter lag	−0.5354
	(7.72)		(5.47)
Treasury bill rate		Change in federal funds rate	−0.1873
One-quarter lag	0.6075		(2.59)
	(7.14)	Yield on ten-year constant maturity Treasury lagged one quarter	0.8722
Two-quarter lag	0.0879		(22.49)
	(2.18)		
Statistics			
R-Bar²	0.981		0.980
Durbin-Watson	2.09		1.72
LM test for up to four-period residual autocorrelation	3.03		2.91
Test for up to two-period autoregressive conditional hetero-scedasticity	9.29		0.13

Note: Figures in parentheses are t-values.

suggest that such a change was in fact taking place, a finding discussed further below. Note that the statistically significant coefficient on this term for the period 1978-82 provides evidence that disintermediation continued to play an important role in the contraction of housing investment during that period, even after the introduction of MMCs.

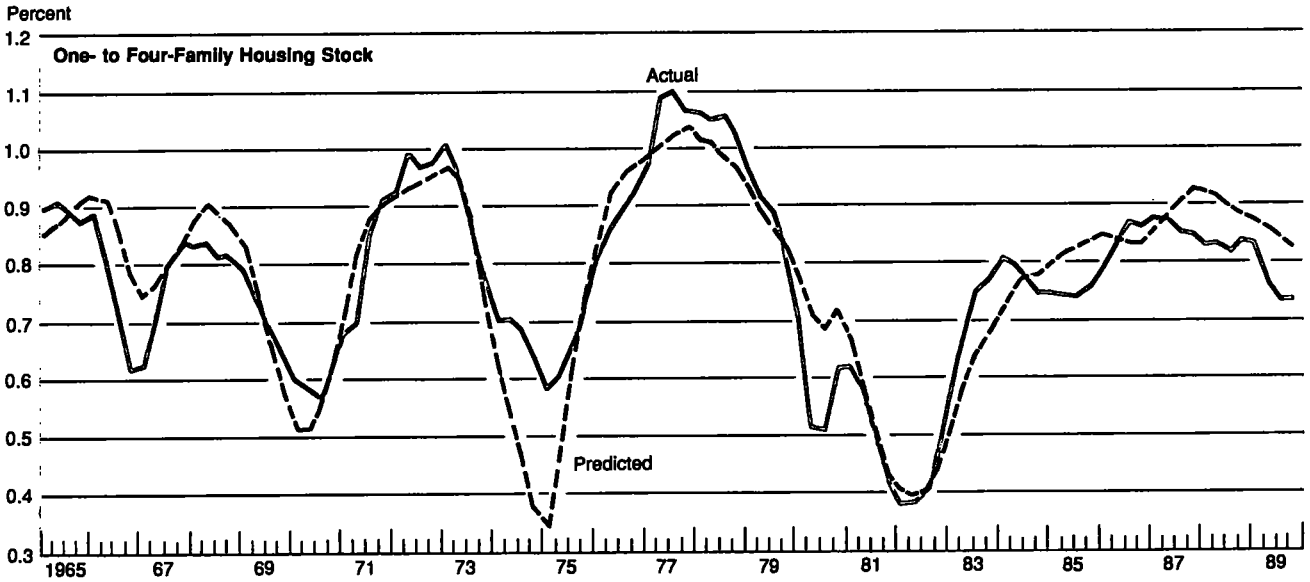
A number of different specifications of the housing equation were examined, and some of the results obtained are worth noting. For example, there was no evidence that housing investment has become significantly more or less sensitive to movements in the average level of mortgage interest rates. However, the widespread use of ARMs opens up the possibility of some additional short-run sensitivity to market interest rates, since an increase in the federal funds rate is typically associated, at least initially, with a sharper rise in short-term interest rates than in long-term interest rates. Consequently, the ARMs rate will rise more quickly than the interest rate on fixed rate mortgages during the initial phase of a monetary tightening. The size of this potential additional sensitivity to interest rates, however, is extremely small relative to the reduction in sensitivity arising from the elimination of disintermediation. Furthermore, even though the average level of mortgage rates may be more responsive, in the short run, to market interest rates, there is no strong evidence that this will affect housing investment. Indeed, when the housing equation was reestimated using the interest rate on fixed rate mortgages alone (rather than the weighted average interest rate), results virtually identical with those presented in Table 3 were obtained. Furthermore, specifications that included the rate on fixed rate mortgages typically showed no significant separate role for the interest rate on ARMs.

To examine the response of housing investment to a tightening in monetary policy, the model includes equations that link the three-month Treasury bill and ten-year constant maturity Treasury interest rates to the federal funds rate. These equations, presented in Table 4, capture the average historical response of these Treasury rates to movements in the federal funds rate. For example, the equations suggest that a 100 basis point rise in the funds rate sustained for one year would raise the three-month Treasury bill rate about 75 basis points by the end of that period, and the yield on ten-year Treasury bonds about 50 basis points.

The ability of a model to track historical developments is one indicator of that model's usefulness. Chart 6 compares the predicted values for quarterly

Chart 6

Housing Investment: Historic Dynamic Tracking



Sources: Federal Reserve Board and model simulation.

housing investment from 1965 to 1988 with the actual values derived from the complete model. The model is solved dynamically, that is, one period's solution for investment or interest rates feeds into that for the next period and provides a strong indication of model adequacy. As the chart suggests, the model appears to follow historical movements in housing investment reasonably closely.

Response of housing activity to monetary policy

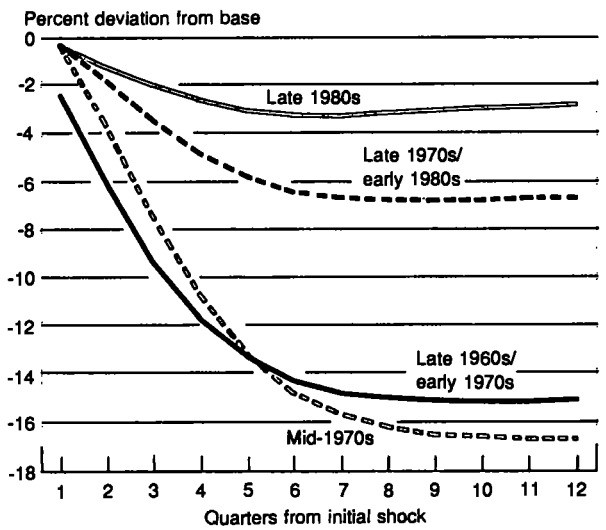
This subsection uses the model presented above to consider the partial response of housing to a monetary policy tightening. The response is partial in the sense that consumer prices and real incomes are held unchanged in the simulation. However, since we are interested in the direct response of housing investment to monetary tightening, this approach would seem appropriate.

Two experiments were constructed to examine the changing response of housing expenditures to a tightening of policy. The first examined the response of the model to a permanent increase in the federal funds rate of 1 percentage point. Four simulations were carried out. The first raised the funds rate alone, with no disintermediation effects. This simulation is labeled "the late 1980s" in Chart 7. In each of the other three simulations, one of the disintermediation spreads[22] was allowed to respond by the increase in the three-month Treasury bill rate (at its peak, this response was about four-fifths of the movement in the funds rate). The chart shows that after three years housing investment would be depressed by over 15 percent if the response were similar to that observed in monetary contractions of the late 1960s or mid-1970s (although the effects of disintermediation appeared to take a little longer to pass through in the mid-1970s). However, if the response were like that exhibited between 1978 and 1982, housing activity would be much less depressed, falling by only about 6 percent. Without disintermediation, the response of housing investment is much smaller (around 2 percent), as shown by the "late 1980s" line. This last result suggests that, contrary to the findings of Throop, much of the response of housing investment in the 1960s and 1970s to periods of monetary tightening was due to the effects of disintermediation (since the model indicates that without disintermediation,

[22]The disintermediation variable for 1966-67 was not shocked because this period of credit rationing was very short and generated very large effects on mortgage lending and housing activity. The strength of these effects may have reflected, to a large extent, the fact that Regulation Q ceilings had only just been extended to thrifts and were biting for the first time.

Chart 7

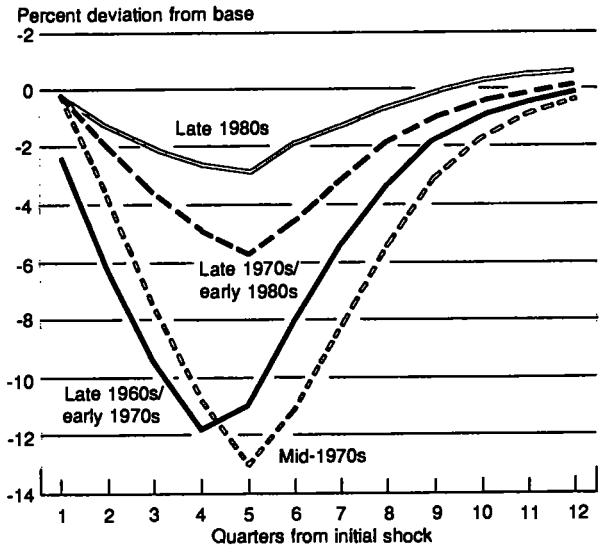
Housing Investment: Response to a Permanent Monetary Tightening



Note: The federal funds rate is raised by 1 percentage point throughout the simulation period.

Chart 8

Housing Investment: Response to a Temporary Monetary Tightening



Note: The federal funds rate is raised by 1 percentage point for one year.

housing investment would have responded rather like the late 1980s line to a monetary tightening), and not due to the interest sensitivity of housing investment per se. This finding accords much more with the results obtained by Benjamin Friedman[23] in simulations carried out on the Federal Reserve Board's model.

It can be argued that the above experiment is somewhat artificial in assuming such a prolonged period of tightening without any response of real growth or inflation. For this reason, a second experiment was conducted in which the funds rate was raised for only one year. The results, presented in Chart 8, echo the general findings from the first experiment.

On the basis of these experiments, one can conclude the following:

(i) the responsiveness of housing investment to a tightening in monetary policy, now that Regulation Q ceilings are no longer in effect, is significantly smaller than in the 1960s or 1970s, notwithstanding the direct effects of short-term rates on ARMs;

(ii) the effectiveness of Regulation Q ceilings in restraining mortgage lending during periods of monetary tightening apparently diminished over time;

(iii) although the response of housing investment was less than previous experience might have suggested, Regulation Q ceilings and disintermediation played an important role in the 1978-82 contraction;

(iv) the effects of a given increase in interest rates on housing investment would be rather smaller now than in 1978-82.

The first two conclusions are generally in agreement with existing work. What had not been established in earlier research, however, is that the process of deposit rate disintermediation resulting from the operation of Regulation Q ceilings appears to have played an important role in the contraction of housing investment in the period between 1978 and 1982.

From the macroeconomic perspective adopted in the statistical part of this study, there is not much evidence that developments in housing finance other than the elimination of Regulation Q ceilings have had a substantial impact on the relationship between housing investment and monetary policy. One development, the growth in the securitization of the stock of mortgage debt, appears to have had the effect of decreasing the spreads between mortgages and other interest rates. But although lower mortgage spreads may make housing more affordable over time, the smaller spreads themselves do not imply an additional change in the response of mortgage rates to a rise in other interest rates. Hence the growth in securitization appears to have had little effect on how housing investment has responded to a tightening in policy.

Conclusion

There have been tremendous innovations in the housing finance market, driven partly by the interaction of the inflationary environment of the late 1970s with the system of regulating deposit rates and partly by federal attempts to promote housing finance with initiatives such as the development of the secondary mortgage market. In analyzing the impact of these innovations, this article confirmed the findings of previous researchers that housing demand should now be considerably less responsive to monetary tightening than in the past. Model simulations showed that deposit disintermediation, induced when market interest rates exceeded Regulation Q ceilings, was the major driving force of the contractions in housing activity in 1966-67, 1969-71, 1974-75, and to a lesser extent, 1978-82. The process of deposit rate deregulation has, therefore, increased the role that mortgage interest rates play in allocating mortgage finance and has eliminated bouts of rationing. In addition, this article provides some evidence that the growth of securitization may have reduced mortgage interest rates relative to other interest rates.

[23]Benjamin M. Friedman, "Effects of Monetary Policy on Real Economic Activity," in *Monetary Policy Issues in the 1990s*, Federal Reserve Bank of Kansas City, 1989.