

Explaining the Recent Level of Single-Family Housing Starts

Considering the high mortgage rates in the current recovery, housing activity has been quite strong. Single-family housing starts averaged about 1.1 million units at an annual rate over the first eight quarters of this economic recovery, about the same as the average in the 1975 expansion. However, fixed-rate mortgage (FRM) rates have averaged about 13.5 percent in the current recovery, almost 4.5 percentage points higher than the average in the 1975 upturn. In this article, we analyze why single-family starts reached their 1975 levels even though rates are much higher now.

Two recent developments in the mortgage market may explain the strength of housing in the face of such high interest rates: adjustable-rate mortgages (ARMs) and deposit deregulation. The housing sector may have benefited from ARMs, which often link monthly mortgage payments to short-term interest rates. When short-term rates are lower than long-term rates, the lower initial monthly payments on an ARM may allow more households to obtain mortgage financing. Deregulation (which removed ceiling rates on most deposit accounts) may have spurred housing activity by increasing funds at thrifts and the amount of available mortgage credit. In addition to these developments, the rapid growth of the secondary market may also have had an effect.

In this article, we present yet another explanation for the similar level of housing starts in the 1975 and 1983 recoveries. Our findings point to the transition of the

“baby boom” generation into the prime homebuying age bracket as an important factor in this expansion.

Our analysis is based on a model of housing demand that takes into account various factors traditionally considered to affect housing starts. We used this model to test the hypothesis that ARMs have increased the level of starts in this recovery. Next, we examined the role of deregulation and the secondary market in explaining the level of starts. None of these developments, alone or in combination, fully describe the current situation. Demographics, as our analysis shows, is also a major factor behind the high level of housing starts in this recovery. Our results imply that in the late 1980s and 1990s, as the baby boom generation moves out of the prime homebuying age group, this stimulus to single-family housing demand will recede.

Demand for single-family housing

In this section, we look at how various factors influence the level of single-family housing starts.¹ The level of these starts can be explained by four principal factors: interest rates, deposit flows to thrifts, household liquidity, and demographics (Appendix 1).

Interest rates affect the demand for single-family housing through two channels. First, by altering the cost of capital of homeownership and the cost of capital of rental housing, real aftertax mortgage rates influence the

¹We tested to see if multi-family starts could be explained by the same factors as single-family starts. Our results showed that the coefficients of the estimated equations for single- and multi-family starts were very different. This is probably because most multi-family units started are rental units. We focused on modeling the demand for single-family housing, which accounts for over 60 percent of total starts.

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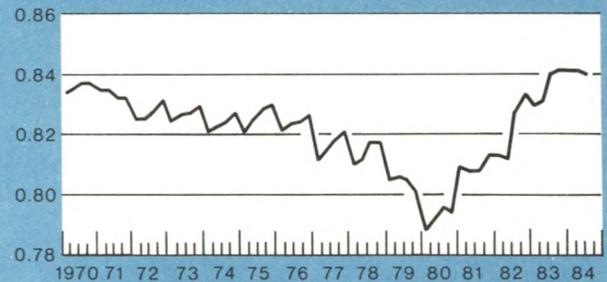
Table 1

Estimated Impact of Various Factors on the Level of Single-Family Housing Starts

| Variable | Change | Estimated effect on starts (in thousands of units, SAAR) |
|--|--------------|--|
| Adult population 25 to 34 years of age | + 1 million | + 85 |
| Per household liquidity | + 1 thousand | + 54 |
| Deposit flows to S&Ls | + 1 billion | + 4 |
| Nominal mortgage rate | | |
| - 1 percentage point | | + 146 |
| Qualification index | | + 105 |
| Cost of capital of: | | |
| homeownership | | + 209 |
| rental housing | | - 168 |

Chart 1

The Cost of Capital of Homeownership Relative to the Cost of Capital of Rental Housing



Source: The Federal Reserve-M.I.T.-University of Pennsylvania (FMP) econometric model.

household's decision to buy rather than rent a home. Everything else being equal, more households will decide to buy if the cost of homeownership falls relative to the cost of renting. In our model, therefore, housing starts should rise when the cost of capital of homeownership falls relative to the cost of renting, as proxied by the cost of capital of rental housing. These two cost of capital measures take account of the differences in both the tax treatment and the expected price appreciation for owner-occupied and rental housing (Chart 1).² We estimate that a one-percentage-point decrease in mortgage rates increases starts by about 50 thousand units through its effect on the relative cost of capital of homeownership (Table 1).

Second, mortgage rates are also important because lenders commonly rely on rules of thumb that set limits on monthly mortgage payments as a share of household income. For example, the Federal National Mortgage Association (FNMA) suggests that monthly mortgage payments not exceed 28 percent of the household's stable monthly income.³ So the share of qualifying

households rises as the mortgage rate declines (Chart 2). We constructed an index representing the share of households that meet these qualification requirements and found that, through this affordability channel, a one-percentage-point decrease in interest rates raises starts by about 100 thousand units (Table 1).⁴

Overall, we estimate that a one-percentage-point decline in interest rates increases the level of single-family starts by approximately 150 thousand units (at an annual rate) through these two channels. This interest rate effect is in line with estimates from previous studies.⁵

Deposit flows to thrift institutions also affect the level of housing starts. Since thrifts are primarily mortgage lenders, deposit inflows increase the supply of available mortgage credit and put downward pressure on mortgage rates. This effect of deposit flows is captured by the interest rate variables discussed earlier. Besides reducing the mortgage rate, deposit flows to thrifts may also improve the non-price terms of mortgage loans,⁶ such as loan-to-price ratios or terms to maturity, which

²For a detailed definition of the cost of capital measures used in our analysis refer to Appendix 2. An analysis of the role of the cost of capital in explaining the strength of the housing market in the 1970s can be found in Patric Hendershott, "Real User Costs and the Demand for Single-Family Housing", *Brookings Papers on Economic Activity*, 1980-II, pages 401-44.

³Stable monthly income is defined as gross monthly income from the borrower's primary source of employment, plus acceptable secondary income. Further, the FNMA suggests that a household's "total obligations-to-income ratio", which includes monthly mortgage payments plus other obligations such as auto and consumer loan payments, should not represent more than 36 percent of the borrower's stable monthly income. For further details, see Section 102 of the Federal National Mortgage Association's Underwriting Guidelines, January 3, 1983, pages 5-8.

⁴To compute this index we assumed that income is distributed lognormally with a standard deviation estimated from 1983 disaggregated income data; the house price is the median price of a new single-family home; and the household makes a 20 percent downpayment on the home purchase.

⁵For example, Jaffee and Rosen found that a one-percentage-point decrease in nominal rates raises single-family starts by about 140 thousand units. Dwight Jaffee and Kenneth Rosen, "Mortgage Credit Availability and Residential Construction", *Brookings Papers on Economic Activity*, 1979-II, pages 333-66.

⁶At the start of the pickup in deposit flows in early 1982, the percentage of all major lenders offering mortgages (of any type) with loan-to-price ratios of 95 percent was about 35 percent. By the

increase housing starts. We estimate that a \$1 billion deposit inflow to savings and loans increases single-family starts by about 4 thousand units through this channel (Table 1).

Before deregulation and the elimination of usury ceilings, deposit outflows could also result in credit rationing in the mortgage market. When usury ceilings prevented mortgage rates from rising in response to a scarcity of funds, non-price rationing was used to allocate credit. Housing starts dropped as a result (Appendix 1).

Household liquidity (short-term assets less short-term liabilities per household) is an important factor that reflects two determinants of housing demand. First, this measure represents funds that are easily liquidated for a downpayment on a house. Second, we assume that changes in household liquidity reflect changes in permanent income. An increase in permanent income makes it more likely that a household will buy a home. So a rise in household liquidity increases housing starts. According to our estimates, a \$1000 increase in per household liquidity (in 1972 dollars) raises the level of single-family housing starts by about 50 thousand units (Table 1).

Finally, demographic factors are a key determinant of the level of single-family housing starts. The prime homebuying age is between 25 and 34 years, when many individuals buy their first home. According to one survey of homebuyers, the average age of a first-time homebuyer was about 29 years in 1983.⁷ The percentage of households that own a home (*i.e.* the homeownership rate) also shows its largest rise for the 25 to 34 age group. In 1983, the homeownership rate was about 18 percentage points higher for the 25 to 29 year than for the 20 to 24 year age group. The homeownership rate increases by about the same amount between the 25 to 29 year and the 30 to 34 year age brackets.⁸ So the larger the population share in this prime homebuying age group, the higher the demand for single-family housing. An increase of one million people in this age group (holding the total adult popu-

lation constant) results in an 85 thousand unit increase in the level of single-family starts, according to our estimates (Table 1).

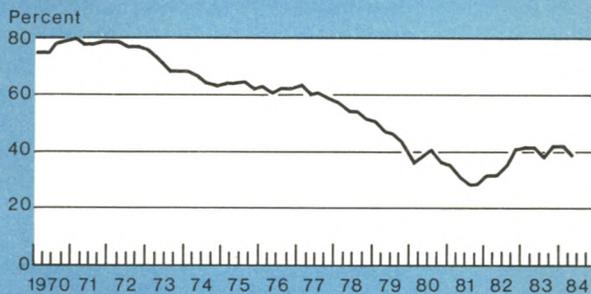
We have outlined our model of housing demand, but we still must explain why housing starts have reached the same levels as in 1975, when rates were much lower. In this article we show that ARMs, deposit deregulation, and the secondary mortgage market cannot fully account for this phenomenon. We find that demographic factors were also important in this recovery.

Impact of adjustable-rate mortgages

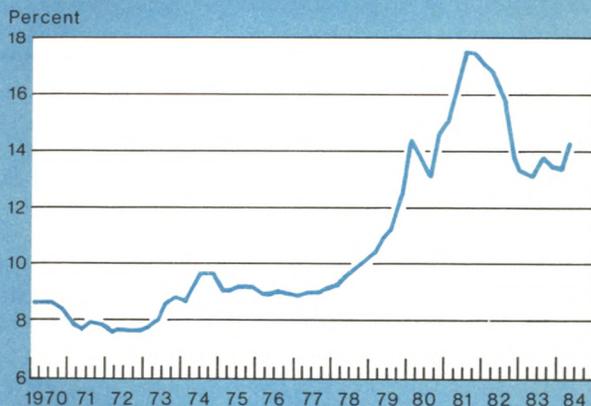
The current recovery is the first in which adjustable-rate financing played an important role. Since federally-

Chart 2

Index of Share of U.S. Households Meeting Qualification Requirements for a Fixed-Rate Mortgage on a Median-Priced New Single-Family House



Fixed-Rate Mortgage Rate



Sources: Federal Housing Administration, and United States: Department of Commerce, Department of Housing and Urban Development, Bureau of the Census.

Footnote 6, continued

second quarter of 1984, over 45 percent of lenders offered these mortgages. The terms to maturity of mortgage loans have also increased, from 24.7 years in December 1982 to 27.1 years in April 1984. "Conventional Home Mortgage Rates...", Federal Home Loan Bank Board (various issues 1982-84).

⁷The Chicago Title Insurance Company's Survey of Homebuyers samples homebuying trends in 11 major metropolitan markets. The average age of a repeat buyer surveyed was about 37 years. Chicago Title Insurance Company, *The Guarantor*, January/February 1984, page 12.

⁸United States Bureau of the Census, "Household and Family Characteristics: March 1983", Current Population Reports, Series P-20, Number 388, May 1984.

chartered thrifts were authorized to originate ARMs in April 1981, ARM issuance has grown considerably and currently accounts for about 60 percent of all conventional mortgage loans closed (Chart 3). ARM rates, which are often linked to short-term rates, have averaged about 200 to 250 basis points lower than FRM rates in 1984, in part reflecting the positive slope of the yield curve.

There are two ways ARMs may affect housing starts. First, some lenders may base qualification requirements on the initial ARM rate rather than the higher FRM rate. This loosening of lenders' credit standards would allow more households to qualify for financing and increase housing starts. Second, some households may base their decision to buy a home on the initial ARM rate (or at some other rate less than the FRM rate), even though the rate paid on the ARM may go up later. This could occur because they expect interest rates to increase by less than the amount embodied in the yield curve and/or they plan to sell or refinance their house after a short time. This would reduce the perceived relative cost of capital of homeownership and increase housing starts.

While some lenders may indeed be qualifying borrowers at low initial ARM rates, it is not clear to what extent overall credit standards have been reduced. A June 1984 survey by the United States League of Savings Institutions indicated that 63 percent of the savings institutions offering ARMs used the same underwriting standards for ARMs as for FRMs, while 31 percent used stricter underwriting standards for ARMs. Only about 5 percent of the thrifts surveyed used less stringent underwriting standards on ARMs than on FRMs.⁹

Nor is it clear that ARMs have affected the perceived cost of capital of homeownership. People who expect interest rates to rise by less than the amount indicated by the yield curve may base their relative cost of capital on the lower ARM rate. However, homebuyers who anticipate the future increases in interest rates embodied in the yield curve will base their decision on the FRM rate. So the impact of ARMs through this channel depends on households' expectations of future interest rate movements.

We adapted our empirical model to see to what extent looser credit standards or lower relative cost of capital on ARMs has increased the level of housing starts. An index of the share of households that qualify based on the initial ARM rate, but not the FRM rate, was added to our basic equation. The difference between the cost of capital of homeownership based on the FRM and the ARM rate was also included (Table 2).

⁹ARMs: A Study of Adjustable-Rate Mortgages Being Made by Savings Institutions, United States League of Savings Institutions, 1984.



We found that the coefficients of both the ARM-related variables were small and not significantly different from zero. Then, we tested the impact of ARMs on the level of housing starts in several other ways and could not find an ARM-related variable significantly different from zero.¹⁰ As a further test, we checked to see how our basic equation for single-family starts, which uses the FRM rather than the ARM rate, predicts out-of-sample. We estimated the equation through the third quarter of 1982 and then extrapolated eight quarters out-of-sample. The mean absolute percentage error of the forecast is only 6 percent and there is no noticeable tendency to underpredict the level of housing starts (Table 3). The equation predicts the sharp upturn in housing starts in 1983, as well as the dip in starts in the third quarter of 1984, without including any effect of ARMs.

Since data on ARMs have only been available for a short time, it is possible that ARMs have had some effect that we were not able to isolate econometrically. However, these tests do suggest that the effect of ARMs is probably not large enough to be a major factor in

¹⁰Variables included in other equations to pick up the effect of ARMs were: the spread between the FRM and the ARM rate; the difference between monthly payments as a percentage of personal income based on FRM and ARM rates; the percentage of total loans closed that were ARMs; and a dummy variable for the period that ARMs were available. The ARM-related variables discussed in the text were also weighted by the percentage of total mortgage loans closed that were ARMs. None of these variables had large coefficients and none were significantly different from zero at the five percent level of confidence. The coefficients were often of the wrong sign. The largest impact we were able to find used the percentage of total loans closed that were ARMs, which gave an increase of about 22,000 starts at an annual rate.

explaining the high level of single-family housing starts at current interest rates.

Effect of deposit deregulation and the secondary market

Deregulation eliminating ceiling rates on deposit accounts has made it easier for thrifts to raise funds

during periods of high interest rates. Previously, thrift institutions experienced large deposit outflows when market interest rates rose above regulated ceiling rates on deposit accounts. In the early 1980s, despite the phase-in of some new deregulated time deposit accounts, thrifts continued to lose funds. But by late 1982, the introduction of money market deposit accounts (MMDAs)—which are highly liquid, government-insured, and pay a market rate of interest—reversed this trend (Chart 4).

The rapid growth of the secondary mortgage market has also made it easier for thrifts to raise funds. By selling off mortgages in the secondary market, thrifts can continue to originate new mortgages even in the face of deposit outflows. In response to the deposit outflows in the early 1980s, thrifts raised a large amount of funds in the secondary market.

Without deregulation of deposit accounts, the high level of interest rates in the current recovery would have resulted in disintermediation. If deposit outflows had continued at the same rate as before the introduction of MMDAs, and if there were no well-developed secondary market, we estimate that housing starts would have averaged about 100 to 200 thousand units less (at an annual rate) in this recovery.¹¹ However, deposit flows and net sales of mortgages in the secondary market by thrifts increased by an average of about 10 percent (at an annual rate, in 1972 dollars) over the first eight quarters of both the 1975 and 1983 expansions. So deregulation and the secondary market cannot explain the similar level of starts in the 1983 and 1975 recoveries if funds raised by thrifts still have the same effect on housing starts as in the past.

But have deregulation and the secondary market changed the overall impact of these funds on housing starts? This could account for the high level of single-family starts in this recovery even if the growth in deposits and net sales in the secondary market were not above average. The removal of rate ceilings on deposits, which has given thrifts a more stable deposit base, may have made them willing to lend out more funds and hold less in more liquid assets. The development of the secondary mortgage market may also have had a similar effect.¹² On the other hand, this may be offset by the recent broadening of thrift asset powers

¹¹The lower estimate uses our basic equation and our estimated effect of deposit flows on mortgage rates. The higher estimate comes from the Jaffee and Rosen (1979) equations for single-family starts and the mortgage rate.

¹²We also tested for a direct impact of net sales of mortgages by thrifts in the secondary market on housing starts. We found that their effect was not significantly different from zero. However, the secondary market may have an indirect effect on starts by lowering mortgage rates.

Table 2

Index of Share of Households that Meet Lenders' Qualification Requirements and the Cost of Capital: ARM Versus FRM Rates

In percent

| Period | FRM rate | ARM rate | Index of share of households qualifying based on ARM rate but not FRM rate | Difference between the cost of capital of homeownership based on FRM rate and ARM rate |
|----------|----------|----------|--|--|
| 1982-I | 17.1 | 15.0 | 7.0 | 2.3 |
| 1982-II | 16.7 | 15.2 | 4.8 | 1.7 |
| 1982-III | 15.7 | 14.8 | 2.9 | 1.1 |
| 1982-IV | 13.8 | 13.6 | 0.6 | 0.4 |
| 1983-I | 13.3 | 12.8 | 2.0 | 0.8 |
| 1983-II | 13.2 | 12.1 | 4.8 | 1.2 |
| 1983-III | 13.8 | 11.8 | 8.6 | 2.1 |
| 1983-IV | 13.5 | 11.7 | 7.6 | 1.8 |
| 1984-I | 13.4 | 11.3 | 9.0 | 2.1 |
| 1984-II | 14.3 | 11.2 | 13.0 | 3.0 |
| 1984-III | 14.4 | 11.8 | 10.8 | 2.6 |

Sources: Federal Housing Administration, Federal Home Loan Bank Board, Federal Reserve-M.I.T.-University of Pennsylvania econometric model, and the United States: Department of Commerce, Department of Housing and Urban Development, and Bureau of the Census.

Table 3

Actual and Forecasted Single-Family Housing Starts, 1982-IV to 1984-III*

In thousands of units

| Quarter | Actual starts | Predicted starts | Forecast error | Percentage error |
|----------|---------------|------------------|----------------|------------------|
| 1982-IV | 813 | 771 | 42 | 5.1 |
| 1983-I | 1,056 | 1,079 | -22 | -2.1 |
| 1983-II | 1,101 | 1,188 | -86 | -7.8 |
| 1983-III | 1,070 | 1,164 | -94 | -8.8 |
| 1983-IV | 1,037 | 997 | 41 | 3.9 |
| 1984-I | 1,278 | 1,097 | 182 | 14.2 |
| 1984-II | 1,137 | 1,191 | -54 | -4.8 |
| 1984-III | 977 | 992 | -15 | -1.6 |

*The equation in Appendix 1 was re-estimated from 1959-IV to 1982-III and an eight-quarter out-of-sample forecast was made. The mean absolute forecast error is 6.0 percent.

Table 4

Factors Affecting Housing Starts Over the First 8 Quarters of Recovery 1975-1977 and 1982-1984

Thousands of single-family starts, annual rate

| | 1982-84* | 1975-77* | Change | Effect on starts |
|--|----------|----------|---------|------------------|
| Starts per household | 0.0125 | 0.0143 | -0.0018 | -130 |
| Households (in millions) | 85.1 | 72.7 | +12.4 | +160 |
| Percentage of adult population 25-34 years of age | 0.2276 | 0.2013 | +0.0263 | +336 |
| Average household liquidity (in thousands of 1972 dollars) | 9.907 | 8.173 | +1.734 | +79 |
| Cost of capital of owner-occupied housing (in percent) | 11.79 | 8.37 | +3.42 | -138 |
| Cost of capital of rental housing (in percent) | 14.12 | 10.14 | +3.98 | |
| Dummy for credit rationing | 0 | 0.25 | -0.25 | +24 |
| Percentage growth in S&L deposits | 2.66 | 2.60 | +0.06 | +1 |
| Percentage of households qualifying for a mortgage | 41.45 | 62.99 | -21.54 | -526 |
| Residual | † | † | † | +94 |
| Actual starts | 1059 | 1029 | +30 | † |

*Averages for first eight quarters of recovery.
†Not applicable.

to include more non-mortgage assets. Even if thrifts are willing to make a larger amount of loans, not all of these funds will necessarily go to the mortgage market. All in all, it is not clear that deposit deregulation and the secondary market can fully explain the similar level of starts in 1975 and 1983.

Impact of demographics

What else is important in explaining the high level of starts at current interest rates? As discussed earlier, the average level of single-family starts in the first five quarters of the 1975 and 1983 expansions were virtually the same. However, other things being equal, the 4.5 percentage point difference in mortgage rates should have kept starts about 675 thousand units lower (at an annual rate) in 1983 (Table 4).

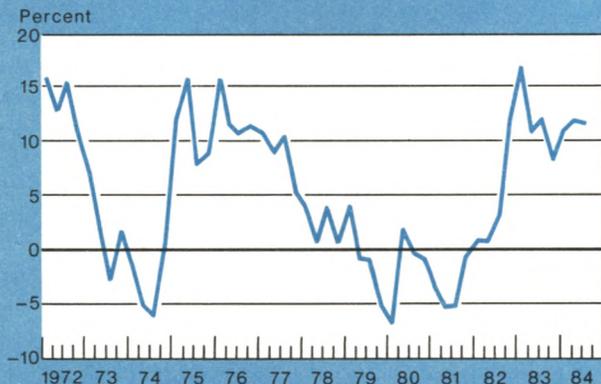
We find that demographic factors offset a large part of the effects of higher nominal interest rates in this recovery, contributing almost 350 thousand units (Table 4). Actually, this result is not particularly surprising in light of past analyses of the housing sector, which have frequently cited demographics as an important determinant of housing demand.¹³ The number of individuals age 25 to 34 increased from about 15 percent of the population in 1976 to about 17 percent in 1983 (Chart 5). This represents an increase of about 3.6 million households in the prime homebuying age group. About two-thirds of these households are in the 30 to 34 year age group with a homeownership rate of about 60 percent, while one-third are in the 25 to 29 year category with a homeownership rate of about 40 percent. Multiplying the homeownership rates by the increased number of households in each age bracket since 1976 gives an increase in housing starts of about 200 thousand units at an annual rate.¹⁴

Our econometric estimate of the impact of the baby boom generation is higher than this rough calculation, but this may partly reflect the relationship between our demographic variable and other demographic factors that may influence housing starts. Our demographic variable may be picking up other demographic trends, such as the increase in the number of households in the 35 to 44 or the 20 to 24 year age brackets, which also have high marginal rates of homebuying. Although separating out these effects is difficult, the transition of the baby boom generation into the prime homebuying age group seems to have been one reason that single-

Chart 4

Growth in Small Time and Savings Deposits at Savings and Loan Institutions

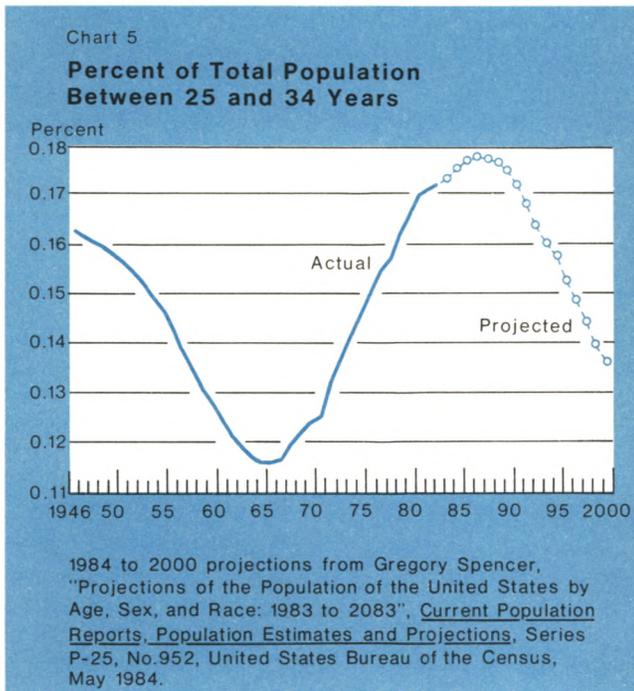
Annual rate, in 1972 dollars



Source: Flow of Funds, FMP econometric model.

¹³For a survey of the impact of demographics on the housing sector see Louise B. Russell, *The Baby Boom Generation and the Economy*, The Brookings Institution, 1982, pages 102-19.

¹⁴The number of additional starts would be somewhat less, since some households either buy an existing home or enter the age bracket already owning a home.



family housing starts reached such a high level at current interest rates.

Conclusions

The changing composition of the population is a key factor in explaining the high level of single-family housing starts in this recovery despite high mortgage rates. A large and steady rise in the number of people age 25 to 34 offsets a large part of the dampening effect of higher market interest rates. In addition, increased credit availability and a rise in household liquidity have contributed to the strength of single-family housing in this expansion. We found little evidence that the increasing use of adjustable-rate mortgages has contributed to single-family housing demand in the current recovery.

This result has important implications for the future. The population share in the 25 to 34 year age bracket will decrease as the baby boom generation matures (Chart 5). This prime homebuying age group is expected to decline from 17.2 percent of the total population in 1983 to about 15.5 percent in 1993. This means that demographics will have less of a stimulative effect on single-family housing starts in the future.

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Appendix 1: The Empirical Model of Single-Family Housing Demand

The results presented in the table are the coefficient estimates of the following equation from 1959-IV to 1984-III:

$$(1) \text{STARTS} = a_0 + a_1 \text{PCTFAM}_{.1} + a_2 \text{HHLIQ}_{.1} + a_3 \text{MSLDT}_{.1} + a_4 \text{DCR}_{.1} + a_5 \text{RCHO}_{.1} + a_6 \text{RCHR}_{.1} + a_7 \text{DEM}_{.1} + e_0$$

where:

STARTS = single-family housing starts per household (in thousands of units, SAAR).

PCTFAM = an index representing the share of households who meet qualification requirements for a fixed-rate mortgage on the median-priced new single-family house.

HHLIQ = four-quarter average of short-term assets minus short-term liabilities per household (in 1972 dollars).

MSLDT = real growth in small time and savings deposits at savings and loans (in percent).

DCR = a dummy variable for credit rationing caused by disintermediation. DCR = 1 if the growth of deposits at savings and loans over two quarters earlier is negative or less than 1 percent at a compound annual rate. Otherwise DCR = 0. (It is also assumed that with the relaxation of usury ceilings on mortgage rates after 1978, scarcity of funds is reflected in the mortgage rate and credit rationing no longer occurs.)

RCHO = the cost of capital of owner-occupied housing. (Appendix 2 for definition of this variable.)

RCHR = the cost of capital of rental housing. (Appendix 2 for definition of this variable.)

DEM = ratio of the population in the 25 to 34 year age group to the total U.S. adult population.

Regression of Per Household Single-Family Housing Starts on Selected Variables, 1959-IV to 1984-III

| Variable | Coefficient | t-statistic | Mean value of variable |
|--|-------------|-------------|------------------------|
| Constant | -0.042 | -2.6 | 1.0 |
| Index of share of qualifying households | 0.0334 | 3.9 | 0.66 |
| Cost of capital of owner-occupied housing (in percent) | -0.0029 | -2.0 | 8.89 |
| Cost of capital of rental housing (in percent) | 0.0020 | 1.6 | 10.68 |
| Share of adult population age 25 to 34 | 0.1755 | 3.7 | 0.195 |
| Average household liquidity (in thousands of 1972 dollars) | 0.00063 | 1.7 | 7.61 |
| Change in deposits at S&Ls (in percent) | 0.0003 | 2.4 | 1.52 |
| Dummy for credit rationing | -0.0013 | -3.0 | 0.13 |

$\bar{R}^2 = 0.91$ Estimated rho = 0.62 Durbin Watson = 2.16
 S.E. = 0.0010 Number of observations = 99
 Mean of dependent variable = 0.01511 S.E./Mean = 0.066

e_0 = a randomly distributed error term.

The coefficients are of the expected sign. We tested for possible shifts in the equation at several points in time. In particular we tested for shifts: at the end of 1979 when the Federal Reserve shifted its policy target; at the end of 1982 when the introduction of MMDAs resulted in large deposit inflows to thrifts; and at the end of 1981 when thrifts started issuing ARMs. A joint F-test of the stability of all the coefficients at the 5 percent level of confidence supported the null hypothesis that the equation is stable over time. Similar tests were conducted to determine the stability of the individual slope coefficients. They were all found to be stable.

Appendix 2: Cost of Capital Definitions*

RCHO = the cost of capital of owner-occupied housing
 $= (\text{PEH}/\text{PCON}) [(1-T)(\text{RMEFF} + 100 \text{UTP}) + 2.4 - 0.6 \text{PRHDOT}]$

RCHR = the cost of capital of rental housing
 $= (\text{PEH}/\text{PCON}) [(1-T)\text{VWRH}/(1-T)] + ((1-T) \text{RMEFF} + 2.4 - 0.6 \text{PRHDOT}) + 100 \text{UTP}]$

where:

$T = 0.01 \text{UTPF} + \text{TPS}/\text{YTF}$

UTPF = effective personal income tax rate

UTP = property tax rate

TPS = state and local government tax receipts

YTF = taxable income

PEH = price deflator for residential construction

PCON = price deflator for consumption

RMEFF = effective fixed-rate mortgage rate

VWRH = percentage depreciation allowance for rental housing

PRHDOT = expected increase in the rent index for residential structures (computed from a distributed lag on past increases in the index).

*From the Federal Reserve-M.I.T.-University of Pennsylvania econometric model.