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Are Real Interest Rates Good Measures of Monetary Policy?

*By Patrick J. Lawler**

During the past decade the Federal Reserve has placed increasing importance on the monetary aggregates as policy guides. Unfortunately, the same decade has seen a deterioration in the predictability of the relationships between these measures and other economic variables.

However, better alternatives are hard to find. One obvious possibility, the level of interest rates, has been tried before and found wanting. When inflation is accelerating rapidly, small rises in interest rates are unlikely to slow it down. As inflation increases, borrowers are increasingly able to pay higher interest rates because the value of the money they must pay back at a later date will be smaller. Thus, a large increase in inflation coupled with a small rise in interest rates is likely to stimulate the economy. It has been possible for interest rates to rise over a long period of time and yet have inflation accelerating as well, which renders actual, or nominal, interest rates of little value in assessing monetary policy.

If, however, nominal interest rates can be adjusted for the rate of inflation, this objection can be overcome. Real interest rates, equal to the difference between nominal interest rates and the rate of inflation, appear to be a solution.[1] Unfortunately, the rate of inflation needed to make the adjustment properly is the rate expected by borrowers and lenders over the life of the loans or deposits on which the interest will be paid. This number is unobservable, so the true real interest rates are, to some extent, a matter of conjecture. Furthermore, many factors can be expected to change the relationships between real interest rates and other economic variables, causing problems perhaps even more serious than those recently experienced with the monetary aggregates.

Nevertheless, real interest rates have considerable appeal as a measure of policy. Unlike monetary aggregates, real interest rates figure directly in the purchasing decisions of consumers and businesses. The

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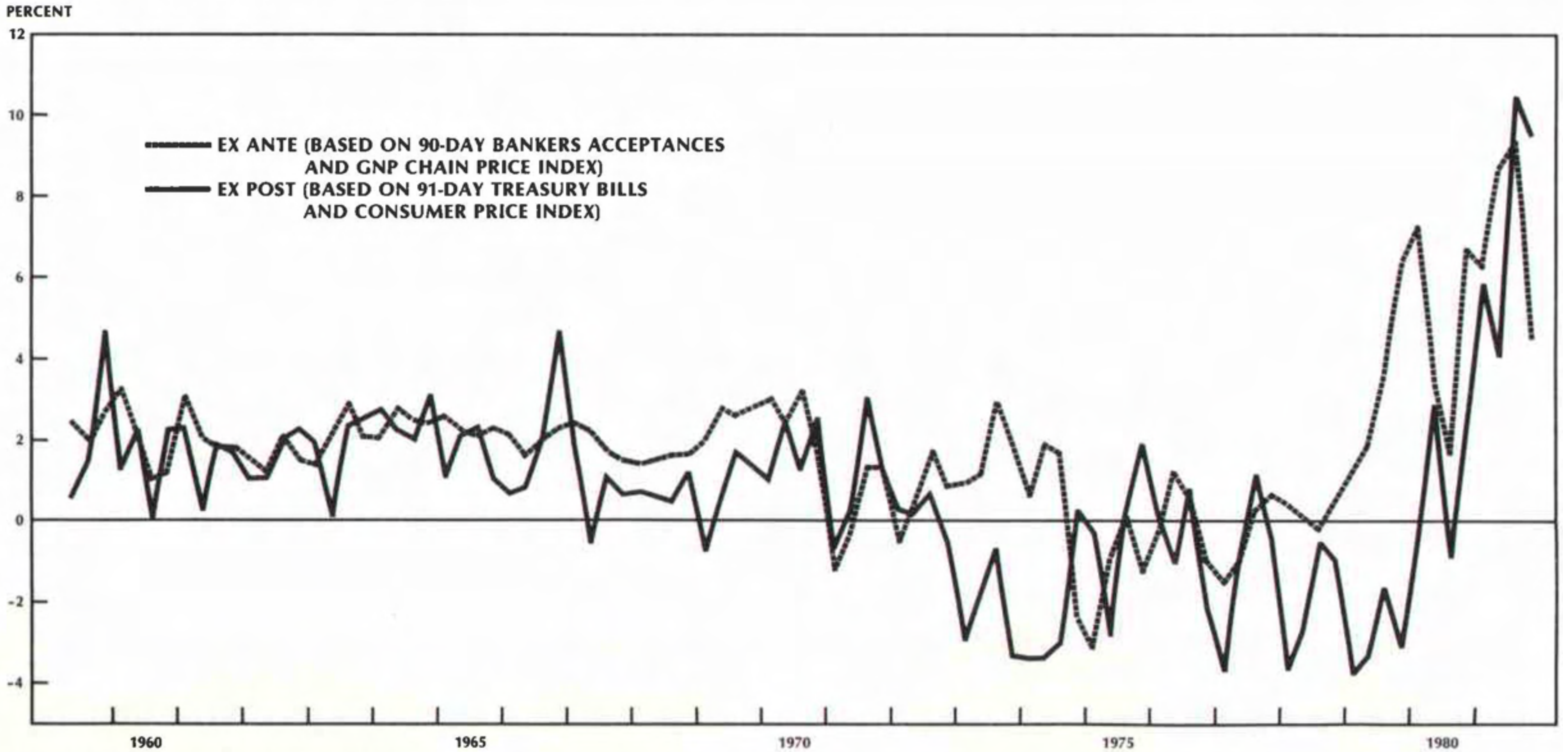
1. This definition of real rates is precisely correct only if all rates are measured as instantaneous rates. If they are compound annual rates, the compound real rates are equal to:

$$\frac{1 + \text{compound nominal rates}}{1 + \text{compound inflation rate}} - 1.$$

CHART 1

Some measures of short-term real interest rates have been lower than others, but all have climbed sharply in recent quarters



SOURCES OF PRIMARY DATA: Board of Governors, Federal Reserve System.
U.S. Department of Commerce.
U.S. Department of Labor.

higher are real rates, other things equal, the more costly are current outlays. If the money for a purchase is borrowed, more interest must be paid. If it is not borrowed, more interest is forgone by not leaving the money invested elsewhere. Although economists have sometimes argued about the extent to which money "matters," it is impossible to argue that real interest rates do not matter.

This article examines the problems in measuring real interest rates and considers some of the many factors that may affect the economic implications of a particular level of real interest rates. A primitive nonmonetary macro model is estimated in order to examine the quantitative relationships of real rates with measures of production and inflation. While changes in real rates appear to have significant influence on the economy, the implications of specific levels of real rates appear to change over time. An attempt to maintain a constant real interest rate would probably destabilize the economy.

Measurement problems

There is no uniquely best measure of the real interest rate. For every nominal interest rate, there is an associated real rate. There are short-term real rates and long-term real rates; real rates on government securities, corporate securities, bank loans, bank deposits; and so forth. For each of these, there are as many real rates as there are measures of expected inflation.

Ways to measure expected inflation fall generally into three categories. One procedure is simply to assume that market participants predict inflation accurately. To determine the real interest rate on a security, one would then need only look at the nominal rate paid and the actual rate of inflation over the life of the security. The difference between these two is called an *ex post* real rate since it can only be determined after a loan is paid off. Because actual inflation is sometimes surprisingly high or surprisingly low, these rates may be substantially different from those actually considered by borrowers or lenders. Another problem is picking an appropriate measure of inflation. If a household lends money to a corporation, either a consumer or a producer price index could be used with equal justification. Over short periods these indexes often behave very differently, so the distinction is important.

Another possibility is to use averages of survey responses, such as the Livingston data.[2] These have the advantage of being based on actual expectations but suffer from a number of deficiencies. Survey questions are sometimes vague or include only one specific price series over one specific length of time, and the questions may change over time. Also, the respondents (including academics and even Federal Reserve economists) may have little personal incentive to respond thoughtfully or accurately.

The third method is to use proxies for expected inflation based on past inflation or econometric forecasts of inflation. These measures have several advantages. Proxies can be produced for any price series that seems appropriate over any time span; they can be produced earlier than *ex post* data; and they are not influenced by surprise events that occur after the loan is contracted. On the other hand, they fail to reflect information about the future that is possessed by market participants but is not extractable from past data.

The choices made can affect the resulting real rate series significantly. Chart 1 shows two different three-month real interest rate series. The one with the solid line is an *ex post* real interest rate based on U.S. Treasury bills and the consumer price index. The exact formula is:

$$\frac{100\,(1 + RB_t)}{(CPI_t/CPI_{t-1})^4} - 100.$$

RB_t is the quarterly average of the average percentage yield of 91-day bills sold at weekly auctions during quarter t.[3] CPI_t is the average level of the consumer price index in quarter t. The resulting real rate is an *ex post* rate because the inflation rate is measured over the period during which the bills were in existence. This rate might be appropriate for a household that considers purchasing Treasury bills and predicts inflation perfectly.

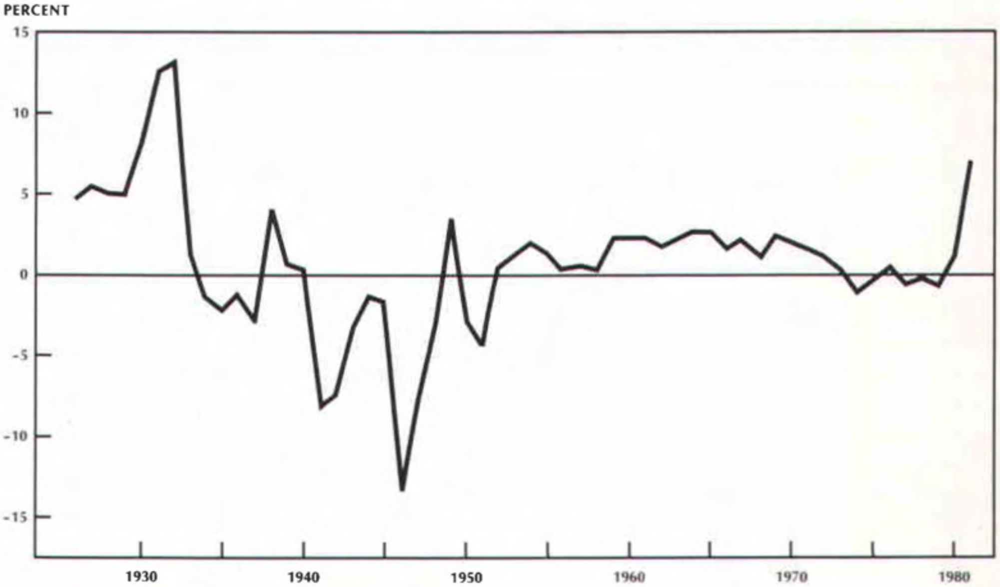
2. Collected by Joseph Livingston, a Philadelphia newspaper columnist, from selected business, government, and academic forecasters.

3. The Treasury bill discount rate is adjusted to a compound 365-day yield basis, which makes it comparable with the measure of price inflation. If D is the discount rate:

$$RB = \left(1 + \frac{.91\,D}{360 - .91\,D}\right)^{\frac{365}{91}} - 1.$$

CHART 2

Short-term real interest rates in 1981 were still below those in 1932



SOURCES OF PRIMARY DATA: Board of Governors, Federal Reserve System.
U.S. Department of Labor.

The alternative three-month real rate, shown with the broken line, uses a similar formula but with three differences. First, it uses the rate on bankers acceptances instead of Treasury bills because the former better reflects the rates businesses must pay to raise cash. This rate is very highly correlated with the familiar rates on commercial paper, and the series exists in a consistent form over a much longer period. Second, instead of the CPI, it uses the GNP chain price index. This series has a much more plausible treatment of housing costs, covers all goods and services produced within the country, and weights price increases for different categories of goods and services according to the value of production in the previous quarter rather than in an arbitrary period, as the CPI does. Third, as a proxy for expected inflation, the average inflation over the prior six months rather than the future three months is used.

These changes produce a rate with, presumably, much broader applicability. They also produce a rate that is, on average, higher than the other. For both series, the average rate in the 1960's is substantially higher than that during most of the 1970's. Recently, however, rates have jumped to much higher levels than during any of the past 20 years.

Indeed they are the highest real rates since the Great Depression, as shown by the annual series in Chart 2. This measure of the short-term real rate uses annual averages of the 90-day bankers acceptance rate and changes in the CPI. Real rates were comparatively stable between 1952 and 1980, a period of relatively small fluctuations in economic activity.

No long-term real rates are presented here. Neither survey data nor plausible proxies for long-term inflation expectations are available. *Ex post* longer-term real rates would only be available a long time after the rates were negotiated and, therefore, not be of much help. Recent inflation rates are probably suitable proxies for short-term inflation expectations, since inflation tends to change slowly over time. However, as seen recently, long-term inflation expectations may be dependent on such factors as political negotiations affecting future budgets. These factors are virtually impossible to model correctly. Common stock earnings or dividends as ratios of stock prices offer theoretically appealing alternatives, but actual movements in these series are hard to explain in terms of real interest rates.[4]

Factors affecting desirable levels of real rates

While interest rates are critical to the economic decisions of households and firms, many factors can affect the degree of restraint that a given real rate imposes on aggregate economic activity. One of the most difficult to analyze, and yet one of the most important, is the effect of the rate of inflation. The very idea of real interest rates is predicated on the notion that they represent the proper way of adjusting for changes in the rate of inflation. In the 1960's, some economists argued that because inflation reduces the real value of money balances, lower real rates of interest are necessary to achieve a given level of output when inflation is high.[5] However in the 1970's, other economists argued that because interest payments are deductible by the borrower and taxable to the lender, much higher real rates are necessary when inflation is high.[6]

To see their argument, consider the following example. Suppose that both borrower and lender face marginal tax rates of 50 percent, that there is no inflation, and that an interest rate of 5 percent is agreed on. The net after-tax cost to the borrower, and yield to the lender, is 2½ percent. Now suppose the rate of inflation increases to 10 percent. If the rate of interest rises to only 15 percent, the after-tax cost to the borrower and yield to the lender will be only 7½ percent. With an adjustment for the rate of inflation, the after-tax real interest rate is minus 2½ percent. Nominal interest rates would have to rise to 25 percent in order to keep real after-tax interest rates constant at 2½ percent. The increase of 10 percentage points in inflation would require an increase of 10 percentage points in the real rate as well.

This example may well represent the relation between interest rates, inflation, and taxes for some lenders and some borrowers. However, several factors may offset these effects for the economy as a whole. Marginal tax rates for households are generally much lower than the 50 percent used in the example. For a quick estimate, consider that for the four quarters ending just before last October's tax cut, the increase in personal income taxes collected at Federal, state, and local levels was just 20.6 percent of the increase in personal income over the same period. Even that figure is an overestimate, though. Many taxpayers take a standard deduction and so cannot deduct interest payments, and municipal bond interest is not taxable for anyone. Nor do tax considerations directly affect the decisions of governments and nonprofit organizations.

Other aspects of the tax system tend to offset the benefits to business borrowers of the tax deductibility of interest payments. Businesses usually borrow money in order to invest in plant, equipment, or inventories. In the first two cases, inflation lowers the present value of depreciation deductions taken against future taxes. In the third case, inflation generates inventory profits on which taxes must be paid. On the whole, the current tax structure probably does not greatly increase real after-tax returns to business investment when inflation and nominal interest rates rise equally.

Furthermore, because inflation increases nominal rates and thus makes it harder for households to qualify for fixed-payment mortgages and installment loans on automobiles, higher inflation rates may actually reduce household spending at a given level of real interest rates. For the economy as a whole, it is no doubt true that inflation does somewhat affect the responses of households and firms to a given level of real rates. But the net effects for the econ-

4. One problem may be that stock prices are affected by changes in expectations about future real dividends as well as by changes in the long-term real rate of interest.
5. Robert Mundell, "Inflation and Real Interest," *Journal of Political Economy* 71 (June 1963):280-83, and James Tobin, "Money and Economic Growth," *Econometrica* 33 (October 1965):671-84.
6. Michael R. Darby, "The Financial and Tax Effects of Monetary Policy on Interest Rates," *Economic Inquiry* 13 (June 1975): 266-76, and Martin Feldstein, "Inflation, Income Taxes, and the Rate of Interest: A Theoretical Analysis," *American Economic Review* 66 (December 1976):809-20.

omy may be small; even the direction is uncertain.[7]

Perhaps more important in affecting the stringency of real rates are changes in financial regulatory structure and financial institutions. Elimination of deposit rate ceilings, for example, reduces disintermediation and credit rationing. If credit is more easily available at a given level of interest rates, those rates permit more borrowing. Similarly, a switch from conventional mortgages (for which it is difficult for prospective homeowners to qualify when inflation is rapid) to more creative financing can strengthen housing demand. Any given level of real rates becomes more stimulative and an increase in real rates less restrictive. Changes in fiscal policy also can be expected to alter the relation between real rates and economic activity. Spending increases and tax cuts raise aggregate demand at any fixed level of real interest rates. An attempt by policymakers to restrain the economy after such changes would result in higher real rates than would otherwise have been needed. Stimulative fiscal policy and financial deregulation may account, in part, for the recent period of extraordinarily high rates.

Also important are other economic developments that change the expected rate of return to capital goods. For example, a jump in the rate of technological progress or perhaps a sharp increase in Government demand for material during a war can substantially raise the desired stock of capital at a given real rate. It can be argued that the soaring price of energy in the middle 1970's sharply lowered the desired capital stock since price-induced reductions in energy use lowered the marginal product of most capital goods.[8] An easy way to reduce energy use is to substitute labor for energy-using equipment. This line of argument might go a long way toward explaining the failure of very low real interest rates to produce much of an economic boom in the middle 1970's. On the other hand, the middle 1960's were an unusually profitable period for corporations, and the likely rate of return on new capital undoubtedly appeared to be very high. Thus, real interest rates were quite high in the middle 1960's; yet the economy was strong. Similarly, the increased Government demand for goods during the Vietnam War in the late 1960's helped keep the economy strong in spite of high real interest rates for several more years.

In principle, changes in long-term real rates should also affect the appropriate levels of short-term real rates. Spending on investment goods presumably responds to changes in the expected real return on alternative financial investments. But as discussed before, long-term real rates are essentially unobservable. Some economists have assumed that long-term real rates are constant, using long-term nominal rates minus a constant as a measure of long-term inflation expectations. Others have even made the same assumption with respect to short-term rates, but such claims appear easy to refute.[9]

In the late 1960's and early 1970's, the Federal Reserve proved itself quite adept at controlling nominal short-term interest rates. Inflation rates change gradually because of inertia in decisionmaking and long-term contracts. As an extreme case, suppose the Federal Reserve sells off a large portion of its short-term portfolio on a single day. Nominal short-term interest rates will surely soar, but short-term expectations of inflation are unlikely to increase at all. In fact, they may decrease following an ensuing panic.

In sum, there is no reason to believe that the Federal Reserve cannot control short-term real rates if it so chooses. After all, a monetary policy specified in terms of the money stock works through its effects on short-term real rates—which, in turn,

7. This position is supported by evidence that real interest rates tend to fall, not rise, when inflation increases. See John H. Wood, "Interest Rates and Inflation," *Economic Perspectives*, Federal Reserve Bank of Chicago, May/June 1981, pp. 3-12.

8. John A. Tatom, "Energy Prices and Capital Formation: 1972-1977," *Review*, Federal Reserve Bank of St. Louis, May 1979, pp. 2-11.

9. See Eugene F. Fama, "Short-Term Interest Rates as Predictors of Inflation," *American Economic Review* 65 (June 1975): 269-82, and Charles R. Nelson and G. William Schwert, "Short-Term Interest Rates as Predictors of Inflation: On Testing the Hypothesis That the Real Rate of Interest Is Constant," *American Economic Review* 67 (June 1977):478-86, for opposing views. More recent evidence is contained in Frederic S. Mishkin, "The Real Interest Rate: An Empirical Investigation," in *The Costs and Consequences of Inflation*, ed. Karl Brunner and Allan H. Meltzer, Carnegie-Rochester Conference Series on Public Policy, vol. 15 (Amsterdam: North-Holland Publishing Company, 1981), pp. 151-200, and in R. W. Hafer and Scott E. Hein, "Monetary Policy and Short-Term Real Rates of Interest," *Review*, Federal Reserve Bank of St. Louis, March 1982, pp. 13-19.

affect long-term real rates. Precise measurement may be impossible but perhaps no worse a problem than with money. On the other hand, there is ample reason to believe that the appropriate choice of rates may change unpredictably over time for reasons other than attempts to stabilize the economy over the course of recurring business cycles.

A rudimentary macro model based on real interest rates

If real interest rates are to be useful measures of monetary policy, they should exhibit a stable relationship with the targets of policy, especially with the levels of production and inflation. It is also desirable that the relationships be simple. One of the appealing aspects of monetary aggregates is the apparent one-to-one relation between money growth rates and inflation in the long run.

The following rudimentary model of the economy may provide a basis for assessing the empirical value of real interest rates as policy indicators. Suppose that the level of economic activity, relative to some norm such as the potential gross national product, is purely a function of current and lagged values of national economic policy variables and random shocks. Let the policy variables be a measure of the high-employment surplus of the Federal budget, S, and a short-term real interest rate, R:

$$(1)\ Y_t/Y_t^* = f(S_t, S_{t-1}, \ldots, S_{t-m}, R_t, R_{t-1}, \ldots, R_{t-n}) + u_t,$$

where Y/Y^* is GNP as a percentage of potential GNP, u is a random shock, and the subscripts denote time. Further assume that the derivative of Y/Y^* with respect to any of the policy variables is negative: a lower real interest rate or higher Government spending increases aggregate demand.

To complete the model, suppose further that high levels of GNP, relative to its potential, increase inflation, $\dot{P}$, and low levels decrease it. Similarly, relatively high rates of inflation in prices of imported goods, $\dot{PM}$, gradually increase prices of domestically produced goods:

$$(2)\ \Delta\dot{P}_t = g[Y_t/Y_t^*, (\dot{PM} - \dot{P})_t, (\dot{PM} - \dot{P})_{t-1}, \ldots, (\dot{PM} - \dot{P})_{t-k}] + v_t,$$

where v is a random inflation shock. This is a Phillips-type curve that is vertical in the long run but not in the short run. In principle, other changes in supply conditions besides those indicated by import prices affect the inflation rates. However, none have been as important or as easy to quantify.

This model also has the property that a large permanent reduction in real interest rates would permanently raise production, which would cause an ever-increasing rate of inflation. Ultimately, such a policy would not be tenable; the economy would collapse. At high enough rates, inflation must directly affect production. But within the range of recent historical experience in the United States, this effect can perhaps be ignored.

The model provides a framework for investigating the empirical effect of real interest rates on the level of production (equation 1) and, indirectly (by substituting equation 1 into equation 2), on changes in inflation. A more complicated and disaggregated model that examined the effects of real rates on spending and production decisions for a variety of commodities and services might yield better results. But the usefulness of real rates as a policy indicator would be less clear because knowledge of a whole host of parameters would be necessary to evaluate any particular policy.

Some data and estimation considerations

For the first equation, real interest rates were measured by the broken-line series graphed earlier. An adjusted version of the high-employment budget surplus was used. As many have noted, the conventional measure of the surplus is severely underestimated during periods of rapid inflation.[10] It in-

10. Patrick J. Lawler, "The Case for an Inflation-Adjusted Deficit," Federal Reserve Bank of Dallas Research Paper no. 7802 (Dallas, 1978); Jeremy J. Siegel, "Inflation-Induced Distortions in Government and Private Saving Statistics," *Review of Economics and Statistics* 61 (February 1979):83-90; Phillip Cagan, "The Real Federal Deficit and Financial Markets," *AEI Economist*, November 1981, pp. 1-6; Richard W. Kopcke, "Is the Federal Budget Out of Control?" *New England Economic Review*, Federal Reserve Bank of Boston, November/December 1981, pp. 5-15; Marcelle Arak, "Are Tax Cuts Stimulatory?" *Review of Economics and Statistics* 64 (February 1982):168-69; Willem H. Buiter, "Comment on T. J. Sargent and N. Wallace: 'Some Unpleasant Monetarist Arithmetic,' " NBER Working Paper Series, no. 867 (Cambridge, Mass.: National Bureau of Economic Research, March 1982); and Brian Horrigan and Aris Protopapadakis, "Federal Deficits: A Faulty Gauge of Government's Impact on Financial Markets," *Business Review*, Federal Reserve Bank of Philadelphia, March/April 1982, pp. 3-16.

cludes all interest payments as expenditures; yet for the most part, these payments should more properly be thought of as early returns of principal because they compensate lenders for the inflation-caused reductions in the real value of their principal. Since this article is directly concerned with the relationship between interest rates and inflation, it would not be appropriate to ignore this problem. Accordingly, the Government's real capital gain on the value of its outstanding debt—the product of the rate of inflation and the net public debt—was added to the surplus. The sum was divided by potential GNP in current prices. By this measure the only annual deficits in the past 23 years were in 1967, 1968, and 1972.

Two variants of equation 1 were estimated. The first assumes a completely linear relation between all policy variables and GNP. Thus, the difference between a 9-percent real rate and a 10-percent real rate has the same significance as the difference between a 2- and a 3-percent rate. That is intuitively unappealing. When the economy is pushed to very low levels of unemployment by low real rates, it seems likely that further reductions in real rates would have a relatively small stimulative effect. Similarly, when high real rates have seriously depressed the economy, even higher rates should not greatly reduce consumers' desires to buy "necessities." Therefore, an alternative series was created as follows:

$$R' = \frac{R - 2}{|R - 2|^{1/2}}.$$

This is equivalent to the square root of the absolute difference of R from what is roughly the median value of R in the past 20 years, with the original sign restored. After this transformation the differences between real rates of 2 and 3 percent, 3 and 6 percent, and 6 and 11 percent are all of equal importance.

Regressions for both versions force the lag structures of the coefficients to have polynomial distributions, second degree for S and third degree for R and R', with no endpoint restrictions. The lag lengths were chosen arbitrarily, and the sample period is the largest for which data are available.

The concurrent values of the policy variables were eliminated because of feared simultaneity problems. The current state of the economy may well, indeed should, affect the policies chosen. If policymakers had perfect foresight, they would be able to keep GNP expanding at exactly its potential growth rate, and all the coefficient estimates would be zero. If they had good foresight but acted to offset foreseen shocks only partially, the coefficients would have positive signs instead of the expected negative signs. This problem biases the absolute values of the coefficients downward, particularly for the variables with the shortest lags. Real rates lagged one quarter were also dropped from the regressions after trial runs in which the one-quarter lag coefficients were estimated separately from the imposed polynomial structure of the other coefficients as being minuscule, insignificant values.

Estimated effect on GNP

The estimates of both versions of the first equation showed substantial evidence of serially correlated errors. A Cochrane-Orcutt procedure estimated the autocorrelation coefficients to be 0.96 in both cases. Thus, the errors essentially follow a random-walk pattern. This type of error has a serious policy implication. There is no long-run tendency to return to "normal." If the economy is unexpectedly strong in one quarter, holding to what had appeared to be the appropriate policy will not ultimately work out as desired. This contrasts dramatically with the behavior of standard money demand equations. Even though most money equations show autocorrelated residuals, the influence of past disturbances drops sharply within a year or two. But in the real rate equation the errors persist indefinitely.

Any or all of the factors discussed earlier in the article as sources of shifts in the relation between the real rate and GNP may account for the autocorrelation. However, since they do not lend themselves easily to quantification, it is impossible to know which are responsible. The problem would be serious if the results could be explained by a small number of sharp shifts in the constant term. An examination of the residuals suggested four possible dates, and the equations were reestimated with dummy variables covering the periods between the potential shifts. Only one of the dummies was significant, and the autocorrelation coefficient remained over 0.9, implying that shifts in the relationship are frequent rather than rare. The significant dummy covered the period after the imposition of

TABLE 1

Real interest rates and adjusted budget deficits have been important in determining the strength of the U.S. economy

$$100\Delta(Y_t / Y_t^*) = a_0 + \sum_{i=1}^{4} a_i \Delta S_{t-i} + \sum_{i=5}^{15} a_i \Delta R(\text{or } R')_{t-i+3} + u_t.$$

Sample period = 1962:Q4-1981:Q4	Using R	Using R'
Constant	.011 (.1)	-.002 †
Sum of coefficients of changes in S	-.717 (-2.2)	-.792 (-2.4)
Changes in R or R'		
Lagged 2 quarters	-.188 (-2.5)	-.319 (-2.4)
Lagged 3 quarters	-.149 (-2.4)	-.278 (-2.9)
Lagged 4 quarters	-.130 (-2.0)	-.251 (-2.5)
Lagged 5 quarters	-.127 (-1.9)	-.232 (-2.3)
Lagged 6 quarters	-.132 (-2.0)	-.218 (-2.3)
Lagged 7 quarters	-.139 (-2.2)	-.205 (-2.2)
Lagged 8 quarters	-.143 (-2.1)	-.190 (-1.9)
Lagged 9 quarters	-.138 (-1.9)	-.167 (-1.6)
Lagged 10 quarters	-.116 (-1.6)	-.134 (-1.3)
Lagged 11 quarters	-.073 (-1.0)	-.087 (-.8)
Lagged 12 quarters	-.002 †	-.022 (-.1)
Sum of coefficients of changes in R or R'	-1.337 (-2.8)	-2.104 (-2.8)
$\bar{R}^2$	.15	.14
SER	.88	.89
DW	1.73	1.74
F	2.91	2.75

† Absolute value less than .05.

NOTE: Figures in parentheses are t statistics.
$\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom.
SER is the standard error of the regression.
DW is the Durbin-Watson autocorrelation test statistic.
F is a test statistic for regression significance.

TABLE 2

The measured effects of real interest rates are little changed by using annual observations of GNP over the past half century

$$\Delta(Y/Y^*)_t = b_0 + \sum_{i=1}^{2} b_i \Delta FP_{t-i+1} + \sum_{i=3}^{14} b_i \Delta R(\text{or } R')_{t-\frac{i}{4}+\frac{1}{8}} + w_t.$$

Sample period = 1930-81	Using R	Using R'
Constant	-.001 †	-.101 (-.2)
Sum of coefficients of changes in FP	.090 (.6)	.271 (2.1)
Sum of coefficients of changes in R	-1.307 (-2.4)	
Sum of coefficients of changes in R'		-2.409 (-1.6)
$\overline{R}^2$	.38	.23
SER	3.90	4.36
DW	1.42	1.17
F	3.24	2.07

† Absolute value less than .05.

NOTE: Figures in parentheses are t statistics.
$\overline{R}^2$ is the coefficient of determination adjusted for degrees of freedom.
SER is the standard error of the regression.
DW is the Durbin-Watson autocorrelation test statistic.
F is a test statistic for regression significance.

credit controls in 1980. In any case, these results support the proposition that there is no enduringly "correct" level of real rates. The same level of real rates is consistent with different ratios of GNP to its potential at different times.

The value of the autocorrelation coefficient suggested that the correct relationship is in the form of first differences of the variables in equation 1, so it was reestimated on that basis. The results are reported in Table 1. Although the $\overline{R}^2$'s are low, the relationship, as measured by the F statistic, is significant. The sums of coefficients for both policy variables are significant and of the right sign. The coefficients of the furthest lagged of the real rate variables were estimated as virtually zero even though there were no endpoint restrictions.

The parameter values suggest that changes in real interest rates have a potent effect on the economy. A permanent increase of 1 percentage point in real rates would cause an estimated reduction of 1.3 percent in GNP in the first version. The second implies that an increase from 2¼ percent to 3¼ percent would have the same effect, but at higher rates, larger increases would be necessary. Both versions estimate that these increases would be roughly equivalent to a $40 billion tax increase.

The regression in Table 2 amplifies these results by using annual observations starting in 1930. The

$\Delta(Y/Y^*)$ series was extended backward from 1949 by using Knowles' data.[11] Changes in real Federal Government purchases of goods and services as a ratio of potential output, *FP*, were used as the fiscal policy measure. Lagged quarterly values of real interest rates were defined as before except the CPI, instead of the GNP chain price index, was used to create the inflation expectations proxy. The results are very similar to those in Table 1, making the estimates of the effects of changes in real rates appear to be surprisingly robust with respect to changes in data and time period.

Nevertheless, the estimated coefficients might be slightly different if real rates were widely accepted as the appropriate measure of monetary policy. Then, economic decisionmakers might respond differently to observed changes in real rates, assuming that if the changes were intentional, they would reveal information about the Federal Reserve's intentions for future policy. But the coefficients that would likely be most affected would be those for the concurrent and once-lagged policy variables, which have been deleted.

Estimated effect on inflation

The second equation in the model provides an indirect means of estimating the effects of changes in real interest rates on changes in the inflation rate. The estimated equation is:

$$\Delta\dot{P}_t = \underset{(-2.1)}{-6.97} + \underset{(2.1)}{26.90}\,(Y/Y^*)_t - \underset{(-1.6)}{19.75}\,(Y/Y^*)_{t-1} + \sum_{i=0}^{5} c_i\,(\dot{PM} - \dot{P})_{t-1} + v_t.$$

$$\underset{(1.4)}{\Sigma c_i = .017}; \text{rho} = -.45; \bar{R}^2 = .28;$$

$$\text{SER} = 1.12; \text{DW} = 2.14; \text{sample period} = 1960{:}Q3\text{-}1981{:}Q4.$$

Inflation was measured by percentage changes in the GNP chain price index. For relative import price inflation, the difference between percentage changes in the import chain price index and the GNP chain price index was used. A lagged value of Y/Y^* was added to allow for effects of the economy's growth rate on inflation. All data are quarterly.

Because Y/Y^* and its lagged value are highly collinear, their standard errors are high. But it is reassuring that their sum of 7.15 has a significant *t* statistic (2.1). The estimates imply that the GNP consistent with nonaccelerating inflation is 97.5 percent of potential GNP. They also imply, given actual GNP experience, that without the past decade's increase of 50 percent in the relative price of imports, the inflation rate would now be 3.4 percentage points lower than it is.[12] But that estimate is subject to a very high standard error. Of course, this model makes no allowance for the possibility that changes in expectations about future monetary policy might affect current inflation. It is, therefore, subject to the criticism that changes in policy regimes may affect the coefficients.

Substituting the first equation into the second provides an estimate of the effect of changes in real interest rates on changes in the rate of acceleration of inflation. Thus, using the first version of equation 1, a permanent decrease of 1 percentage point in the real rate would, in addition to what would otherwise occur, raise the rate of inflation by 0.10 percentage point in the first year. In the second and third years, the rise would be an additional 0.29 and 0.43 percentage point, respectively. And in the fourth and succeeding years, inflation would accelerate by an additional 0.38 percentage point.

Concluding comments

Real interest rates are an apparently attractive alternative to monetary aggregates as indicators of monetary policy because they are more directly pertinent to the purchasing and production decisions that shape the economy. However, closer examina-

11. James W. Knowles, "The Potential Economic Growth in the United States," Study Paper No. 20 in *Study of Employment, Growth, and Price Levels*, Material Prepared for Consideration by the Joint Economic Committee, 86th Cong., 2d sess. (Washington, D.C.: Government Printing Office, 1960), p. 37.

12. This is a very different result than would be expected if growth in the money stock were assumed to be unaffected by import prices. See Michael R. Darby, "The International Economy as a Source of and Restraint on U.S. Inflation," in *Inflation: Causes, Consequents, and Control*, ed. William A. Gale (Cambridge, Mass.: Oelgeschlager, Gunn & Hain, 1981), pp. 115-31.

tion reveals that, like money, real rates are hard to measure and that the relationships between real rates and key macroeconomic variables are potentially subject to shifts much as money demand functions are, though for different reasons.

Empirical investigation of a simple, nonmonetary macro model provides some evidence that functional relationships have shifted. But changes in real rates do have a significant impact on real GNP and, indirectly, on changes in the inflation rate. In its simplest version the model estimates that a permanent increase of 1 percentage point in real rates would ultimately reduce GNP by 1.3 percent and lower inflation by about 0.4 percentage point per year more than would otherwise occur.

While this research does not suggest that real interest rates are superior to monetary aggregates as policy measures, there may be some role for them during periods when the behavior of the monetary aggregates is especially hard to understand.

Effect of Population Changes on Owner-Occupied Housing in Texas in the 1980's

*By Bronwyn Brock**

Residential construction proceeded at a rapid pace in the United States in the 1970's. In that period of high inflation, the prices of one-family homes increased faster than prices of other consumer goods, which made owner-occupied housing a desirable inflation hedge. From 1970 to 1980, the prices of new one-family homes rose 162.6 percent, compared with a rise of 93.4 percent in the implicit price deflator for personal consumption expenditures. Owner-occupied housing as a proportion of total occupied housing units peaked at 65.2 percent in 1978 before declining to 64.4 percent in 1979. This proportion was 62.9 percent in 1970 and 61.9 percent in 1960.

Monetary and Federal housing policies contributed to conditions that favored investment in housing. Inflation rates were high, and real mortgage interest rates were low, often negative. Federal income tax provisions that allowed the deduction of mortgage interest payments and Federal institutions that financed, insured, and guaranteed mortgages and provided a secondary market for them helped to encourage the growth of owner-occupied housing in the 1970's.

The housing industry is currently undergoing many structural changes that are slowing flows of capital, labor, and materials to this sector. The changing financial environment is subjecting mortgage borrowers to higher interest rates and greater competition for lendable funds from governments and corporations. Fixed-rate mortgages have been widely replaced by variable interest mortgages, which distribute some of the risk of rising interest rates to borrowers.[1] The high costs of financing home purchases are severely limiting sales, slowing the pace of increases in house prices to the pace of increases in prices in general. In 1981 the price index of new one-family homes rose 8.5 percent, and the implicit price deflator for personal consumption expenditures rose 8.3 percent.

Although these factors will slow the growth of housing in the 1980's, demography promises strong housing demand as members of the post-World

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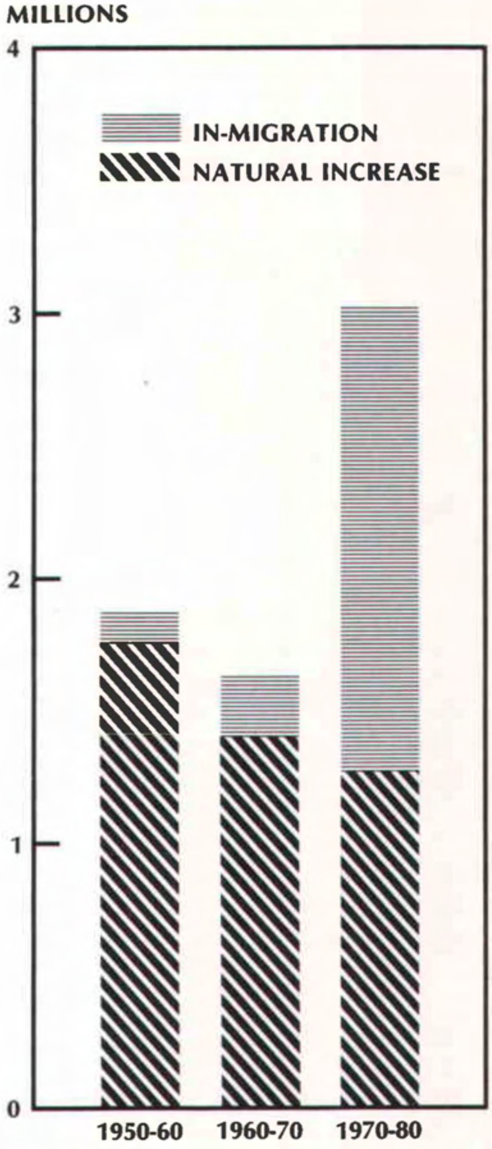
1. See Bronwyn Brock, "Mortgages with Adjustable Interest Rates Improve Viability of Thrift Industry," *Voice of the Federal Reserve Bank of Dallas*, February 1981, pp. 1-8.

Population Growth in Texas



SOURCES: National Center for Health Statistics.
Texas Department of Health.
U.S. Department of Commerce,
Bureau of the Census.

War II baby boom reach 25 to 34 years of age. The household formation rate jumps dramatically from the pre-25 years to the ages of 25 to 34, when a first home is usually purchased. In the 1980's, over 79 million individuals, or 35.1 percent of the U.S. population, will be in this age group, which includes people born between 1945 and 1965.

Demographic forces will provide a stronger boost to the demand for housing in Texas than in the United States. The state had a more rapid rate of population growth than the nation as a whole in the 1970's. Over half of that increase resulted from the shift of the American population from the Frost Belt to the Sun Belt. A disproportionate number of the heads of mobile households are young and college-educated and earn incomes that would enable them to buy homes. Texas will have a larger proportion of population than the United States in the 25-to-34 age group in the 1980's. The greater pressure on demand for homes will result in more construction and higher increases in the prices of homes in Texas.

Population growth

As part of a fast-growing region, Texas accounted for a significant portion of the increase in the U.S. population from 1970 to 1980. Slightly over 13 percent of the population increase in the United States in this period occurred in Texas, when the state's population grew 2.4 times as fast as the nation's. In 1970, 5.5 percent of the U.S. population lived in Texas. By 1980, that proportion had increased to 6.3 percent.

The population growth in Texas was part of a shift in the nation's population from the Frost Belt to the Sun Belt. From 1970 to 1980, the population of the Northeast increased 0.2 percent, and the population of the North Central region increased 4.0 percent. The population of the South and West regions increased 20 percent and 24 percent, respectively. In that decade the states of the South and West regions accounted for 89.9 percent of the population growth in the United States. From 1970 to 1980, in-migration accounted for 57.7 percent of the Texas population growth. This proportion compares with 13.2 percent from 1960 to 1970 and 6.1 percent from 1950 to 1960.

In-migration probably adds more to housing demand than population growth from natural increases because in-migration provides a quicker increase in the number of new households buying their first homes. An impression of the distinctive characteristics of the migrants to Texas can be obtained from the results of the March 1980 Current Population Survey for the United States. Each month the U.S. Bureau of the Census surveys approximately 63,000 households for information on the labor force and unemployment rates. The March survey also provides information on the mobility, age, education levels, and income of the American population. The survey results relating to heads of households and primary individuals, or single-member households, are reviewed here, as this group is most indicative of the potential demand for owner-occupied housing.

RELATIVE RATES OF GROWTH OF HOUSING AND POPULATION

	Housing units		Population	
	Texas	United States	Texas	United States
Period	Percent change		Percent change	
1950-60 . . .	31.7	26.8	24.2	19.4
1960-70 . . .	21.5	17.8	16.9	13.3
1970-80 . . .	44.9	28.7	27.1	11.5

SOURCES: U.S. Department of Commerce, Bureau of the Census.
Federal Reserve Bank of Dallas.

The Current Population Survey indicates that 20.2 percent of the heads of households and single-member households in the United States changed their states of residence between 1975 and 1980. The corresponding proportion for Texas is 25.2 percent.

A comparison of movers and nonmovers suggests that interstate migrants are likely to stimulate the demand for owner-occupied housing in their new states of residence. Heads of migrating households and migrating primary individuals tend to be younger and more educated than those not making interstate moves. They also tend to be concentrated in the middle of the income distribution and can probably expect higher income increases than those for nonmigrants. Heads of households and primary individuals migrating between 1975 and 1980 were

COMPARISONS OF PEOPLE MIGRATING ACROSS STATE BOUNDARIES BETWEEN 1975 AND 1980 AND PEOPLE NOT MAKING INTERSTATE MOVES

Heads of households, single-member households	Percentage distribution of those 15 and over, by age group: 15 to 24	25 to 34	35 to 44	45 and over
Migrants	16.8	41.0	17.8	24.4
Nonmigrants	6.2	19.0	17.4	57.4

Heads of households, single-member households	Percentage distribution of those under 45, by education level: At least some college	High school graduate	High school dropout
Migrants	59.7	27.6	12.7
Nonmigrants	42.1	37.7	20.2

All household members	Percentage distribution, by income group: Less than $5,000	$5,000 to $9,999	$10,000 to $14,999	$15,000 to $24,999	$25,000 and over
Migrants	7.9	14.8	18.1	30.9	28.2
Nonmigrants	9.4	14.5	15.4	28.9	31.9

NOTE: Percentages may not add to 100.0 because of rounding.
SOURCES: U.S. Department of Commerce, Bureau of the Census.
Federal Reserve Bank of Dallas.

twice as likely to be in the primary household formation age group of 25 to 34. And they were 2.7 times as likely to be in the 15-to-24 age group, which will be forming households within the decade. A greater proportion of the migrants had at least some college education. Almost half of the migrating households earned $10,000 to $24,999 annually, but many of these households will move into higher income groups as their careers advance, enabling them to purchase their own homes.

Age distribution

The most salient feature of the Texas and U.S. age distributions is the large increases in the 15-to-34 age groups from 1970 to 1980. By then, both Texas and the United States had significantly greater proportions of their populations in these groups than in any other decade since World War II. In 1950, 31.8 percent of the Texas population and 30.3 percent of the U.S. population were 15 to 34 years old. These proportions declined slightly in 1970 to 31.0 percent in Texas and 29.7 percent in the United States. By 1980, these proportions had jumped significantly because of the maturing postwar baby-boom generation.

Texas had a slightly greater proportion of its population in the 15-to-34 age groups in 1980 than did the United States. Texas had 36.6 percent of its population in these groups, compared with 35.2 percent for the United States. Most of the difference shows up in the 20-to-29 age groups. In 1970 the difference in the proportions of the Texas and U.S.

AGE DISTRIBUTION OF POPULATION
(Percent of total population)

	1970		1980	
Age	Texas	United States	Texas	United States
Under 15	29.7	28.4	24.7	22.6
15 to 19	9.8	9.4	9.5	9.4
20 to 24	8.6	8.1	10.0	9.4
25 to 29	6.8	6.6	9.2	8.6
30 to 34	5.8	5.6	7.9	7.8
35 to 39	5.6	5.5	6.2	6.2
40 to 49	11.4	11.9	9.9	10.1
50 and over	22.4	24.4	22.7	26.0

NOTE: Percentages may not add to 100.0 because of rounding.
SOURCES: U.S. Department of Commerce, Bureau of the Census.
Federal Reserve Bank of Dallas.

populations that were ages 15 to 24 was 0.9 percentage point. That slightly greater bulge in the Texas age distribution shifted to the 20-29 groups in 1980, bolstered by the migration to Texas in the 1970's. The difference in the proportions of the Texas and U.S. populations in the 20-29 groups in 1980 was 1.2 percentage points. Thus, the Texas baby-boom generation, which was already relatively large, has been further enlarged by the in-migration of the 1970's.

Relative rates of growth of population and housing

A look at the pattern of construction per capita and the increases in home prices and residential rents in Texas and the United States in the 1970's further supports the argument that housing demand will be stronger in Texas than in the nation as a whole. Differences in the per capita rates of growth of owner-occupied and renter-occupied housing in Texas indicate that a relatively low rate of construction for owner-occupied housing was accompanied by increases in an index of homeownership costs in Texas in excess of increases in the corresponding index for the United States. In contrast, high per capita rates of construction and high vacancy rates for renter-occupied housing in Texas helped to keep rent increases in the state down to the pace of the average U.S. rent increase, which was below the pace of inflation.

The number of owner-occupied housing units per capita in Texas exceeded that in the United States from 1950 to 1970 but was below the U.S. level in 1980. Owner-occupied housing units per capita increased 12.6 percent in Texas and 16.8 percent in the United States from 1970 to 1980. The number of renter-occupied housing units per capita in Texas was below that in the United States from 1950 to 1980, but the difference narrowed considerably in the 1970's, accompanying the rise in the state's young population. Renter-occupied housing units per capita increased 14.8 percent in Texas and 8.6 percent in the United States from 1970 to 1980. The current high cost of financing home purchases is likely to encourage continued strong demand for renter-occupied housing.

The mix of owner-occupied and renter-occupied housing units in Texas did not change from 1960 to 1980. Owner-occupied housing units accounted for about 65 percent of all housing units built in the state in this period. If a greater number of one-family homes had been built, the increase in the index of homeownership costs in Texas might have been smaller than actually occurred.

The slower growth in owner-occupied housing

HOUSING UNITS PER CAPITA

Year	TOTAL		Owner-occupied		Renter-occupied	
	Texas	United States	Texas	United States	Texas	United States
1950 . . .	.311	.304	.161	.156	.123	.127
1960 . . .	.329	.325	.188	.183	.102	.113
1970 . . .	.342	.338	.198	.196	.108	.116
1980 . . .	.390	.390	.223	.229	.124	.126

SOURCES: U.S. Department of Commerce, Bureau of the Census.
Federal Reserve Bank of Dallas.

units per capita in Texas relative to the growth in renter-occupied housing units per capita was accompanied by larger increases in prices of owner-occupied housing units. From 1970 to 1980, the homeownership component of the consumer price index (CPI) rose 11.1 percent (compound annual rate) in Houston, 10.4 percent in Dallas-Fort Worth, and 9.3 percent in the United States.[2] In the same period the residential rent component of the CPI rose 5.5 percent (compound annual rate) in Houston, 5.7 percent in Dallas-Fort Worth, and 5.5 percent in the United States. Prices for consumer goods, as measured by the implicit price deflator for personal consumption expenditures, increased 6.8 percent (compound annual rate) in this period. Because of the prospective bulge in household formation in Texas, home prices in the state are likely to continue rising more rapidly than in the nation.

2. The homeownership component of the consumer price index includes home purchase price; financing, insurance, and taxes; and maintenance and repair. In December 1980 the home purchase price accounted for 39.9 percent of the homeownership component.

Summary

High financing costs are drastically slowing the residential construction industry. Starts of new one-family homes have declined far from their peak in 1977-78, but the decline has been smaller in Texas than in the United States. A fast-growing population, a high proportion of in-migrants who can expect rising incomes, and a greater proportion of population in the 25-to-34 age group are likely to support sales of owner-occupied houses in Texas in the 1980's.