REAL ESTATE CENTER

What Factors Determine the Volume of Home Sales in Texas?

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Introduction

Sales volume and product prices are the most important variables in almost all industries. In the real estate brokerage industry, sales volume, whether in terms of number or dollar value of properties sold, is the most important variable, even more important than property prices. The number and volume of properties sold are measures of the output and activities of the real estate sector. As Berkovec and Goodman (1996) point out, newscasters announce stock prices first, followed by the number of shares traded, but when announcing real estate news, they tell the number of homes sold first, then prices.

Between 1992 and 1998, the number of single-family homes sold in Texas rose by 60 percent, or an average annual growth rate of 8.2 percent. The turnover growth has been accompanied by substantial appreciation in house prices. The average price of homes sold has increased from $93,400 in 1992 to $125,300 in 1998, a 34 percent increase during a period in which the Dallas Consumer Price Index (a measure of the inflation rate for Texas) rose by only 14 percent.

What were the main driving forces behind the rapid increase in Texas home sales? Did mortgage rates play an important role? Given the readiness of the Federal Reserve Bank to raise interest rates in the current tight labor markets to curb expected inflation, what would be the impact of higher mortgage rates on home sales? These questions are frequently asked at real estate conventions and conferences.

This paper reports the results of an econometric study of the determinants of single-family home sales in Texas. The study found three factors that influence the level of home sales volume:

- changes in real mortgage rates,
- changes in disposable income and
- changes in the price of houses.

The importance of per capita disposable income as a determinant has increased significantly in recent periods and, under current business conditions, an increase in Texas per capita income of 1 percent in real terms can be expected to increase home sales by 2.41 percent. Higher home prices also have a positive impact on home sales. A 1 percent increase in home prices in real terms is expected to increase home sales by .88 percent. By contrast, increases in real mortgage rates were found to have a negative impact on home sales. An increase of 1 percent in the real mortgage rate (100 basis points) can be expected to decrease home sales by 1.91 percent.

Home Sales

Several studies have revealed that homebuyers buy houses both as consumers and investors. In a survey of housing markets, Case and Shiller (1998) report that 44 to 64 percent of homebuyers consider the investment aspect of owning a house as a major factor in the decision to buy a house. Fewer than 10 percent of homebuyers reported that the investment factor was not an important consideration.

The dual nature of houses as both consumption goods and investment goods has important implications for econometric studies of residential real estate markets. In classical demand analysis, one would expect a negative relationship between a product price and the demand for the product. One would expect a negative relationship between home prices, home sales and housing demand resulting from the effects of higher house prices on family budgets. But, as an investment good, higher home prices mean higher returns on investment in housing and may encourage more home sales, thus contributing to a positive relationship between house prices and home sales. Stein (1995) finds a positive relationship between home prices and housing demand based on the fact that past increases in home prices not only changed homebuyers' expectations about capital gains on homes but also resulted in larger down payments for prospective trade-up buyers. In contrast to Stein's findings, Follain and Velz (1995) report a negative relationship between home sales and house prices.

Another feature of home sales is that a single move may lead to a chain of moves by home sellers and homebuyers.

Econometric Methods

There are three approaches to identify and select variables that might have explanatory power for home sales. The first approach is to consider houses as consumer goods and refer to demand theory for consumption goods as a guide in selecting potential determinants of housing consumption or home sales. In classical demand analysis, demand for a product is derived from an optimization process in which the consumer maximizes a utility function subject to a budget or income constraint. According to the theory of demand, price and income are the most important determinants of the demand for a product.

The second approach is to consider houses as investment goods and refer to the theory of investment to determine which variables should be included in a model of demand for homes.

A third and more pragmatic approach is to consider a number of potential variables to be included in the models of home sales and perform statistical tests to determine which variables should be included or dropped. Given the mixed nature of houses as both investment goods and consumption goods, the third approach was selected.

Empirical studies of housing demand or home sales have found house prices, disposable per capita income, mortgage rates, employment and population to be the main determinants of housing demand or home sales. This study uses these variables and employs a recursive regression method for the estimation of econometric models explaining Texas single-family home sales. A recursive regression methodology is used because the method provides estimates of time-varying coefficients for the variables in the model when the market under investigation has been subject to major changes during the sample period and, as a result, the responses of market participants may have been changing with the unstable market conditions.

The period of observation began with a rapid rise in home prices as well as home sales between 1979 and 1985, followed by the collapse of the property markets, and ended with a period of slow recovery between 1987 and 1992 and a period of rapid growth in the number of home sales since 1993. Under these circumstances, the behavior of market participants may have changed according to changing conditions and, as a result, the coefficients of the home sales models may change over different parts of the sample period. With recursive regressions, the coefficients of the variables in the model are updated recursively in each period. The technique is a suitable method for modeling Texas home sales for the sample period from 1979 to 1998. The recursive home sales model for Texas is specified as:

$$HS = \alpha_0 + \alpha_1 MR + \alpha_2 HP + \alpha_3 PI + \alpha_4 PP + \alpha_5 EM + u \qquad (1)$$

where α_i represents the coefficients of the variables to be estimated, u is the disturbance term, and the variables are:

HS = number of single-family homes sold, or the total dollar value of homes sold in real terms (deflated by the Dallas Consumer Price Index);

MR = real mortgage rate;

HP = the average house price in real terms;

PI = real disposable per capita personal income;

EM = Texas employment and

PP = Texas population.

With recursive regressions, equation (1) is estimated repeatedly in each period t and α_i and the variance of the disturbance term (Φ^2_t) is allowed to vary with t. In each round of estimation, the estimator uses a larger subset of the sample data and provides updated estimates of α_i and Φ^2_t. This process is repeated until all the n observations have been used, providing n-1 estimates of α_i. The recursive least squares can be solved using the ordinary least squares or the instrumental-variable estimation methods. For a formal treatment of recursive regressions see Appendix A.

Empirical Results

Appendix B shows the sources of data for the variables in the model. The available time series of the number of homes sold, as well as the total value of homes sold, includes both new and existing homes. Time series of home prices, Texas per capita disposable income, and values of homes sold are deflated using the Dallas Consumer Price Index. All variables, except the mortgage rate, are transformed into natural logarithm form so that they are translated into units of percentages. Real mortgage rates are calculated by deducting annual inflation rates from nominal rates.

Two models of home sales are estimated using either the number of homes sold or the total dollar value of homes sold as the dependent variable. In both models the explanatory variables are the real mortgage rate, the average price of homes sold, disposable per capita personal income, employment and population.

Table 1 reports the ordinary least squares results for selecting the explanatory variables to be included in the model when the dependent variable is the number of homes sold. Panel A of the table shows that estimated coefficients for employment and population variables are not statistically significant, as suggested by the corresponding t-values for these variables. These results are not counterintuitive. **As long as employment and population growth are not translated into higher incomes, they may have little impact on a consumer's ability to purchase a single-family home.** Thus, employment and population variables are dropped and the model is re-estimated. As panel B of Table 1 shows, dropping the two variables improved the estimated equation, as suggested by the t-values, for the estimated coefficients of real mortgage rate, house price and per capita disposable income.

The signs of the estimated coefficients show a negative relationship between home sales and the real mortgage rate and a positive relationship between home sales and home prices as well as disposable personal income. The positive relationship between home sales and home prices suggests that homebuyers in Texas, on balance, treat houses as investment goods rather than as consumption goods. **Higher home prices help trade-up homebuyers secure the down payment for their next home and increase rates of return on investments in homes.**

Because the variables are in log form, the estimated coefficients are also elasticities and show the responses of homes sales to a 1 percent change in home prices, mortgage rates and per capita disposable income. As panel B of Table 1 shows, the elasticity of home sales in response to per capita income is 2.4. That is, a 1 percent increase in Texas per capita disposable income is expected to increase home sales by 2.4 percent. The large response of home sales to changes in per capita income can be attributed to the existence of a multiplier effect in residential markets, such that the sale of a single home, in response to higher incomes, leads to more home sales.

Table 2 reports the results of the recursive regressions when the dependent variable is the number of homes sold and the estimated coefficients of the explanatory variables in the model are allowed to vary over time. The second column of the table shows that the elasticity of home sales with regard to real mortgage rates varies from –2.47 percent in 1985 to –1.49 percent in 1990 and 1991. The elasticity of home sales in response to a 1 percent change in home prices varies from a high elasticity of 1.84 percent in 1986 to a low elasticity of .59 percent in 1993. Per capita personal income was not a significant determinant of Texas home sales between 1984 and 1988, but since 1989 has become an increasingly important determinant of home sales in terms of the magnitude of its estimated coefficient as well as the statistical significance of the estimated coefficients.

The last row of Table 2 provides the most recent information about Texas home sales and the state's residential markets. The coefficient of real per capita personal income shows that an increase in the state's disposable personal income by 1 percent is expected to increase home sales by 2.41 percent or 3,528 homes. According to the latest forecasts of Texas' economy by the Texas comptroller of public accounts, real per capita personal income is expected to increase by 3.6 percent for 1999. Assuming the same growth rate for the state's disposable personal income, home sales would be expected to increase by 8.7 percent in 1999 if home prices and mortgage rates remained unchanged.

Currently, the real mortgage rate is the second-most important variable affecting home sales after real per capita disposable personal income. An increase in the real mortgage rate by 1 percent is expected to decrease home sales by 1.93 percent or 2,836 homes.

Tables 3 and 4 present the results of re-estimating the home sales model when the dependent variable is the dollar volume of home sales. As expected, the results presented in these tables are similar to those reported by Tables 1 and 2.

Summary and Conclusion

Texas experienced a collapse in the real estate market in the mid 1980s and the state's real estate markets have expanded erratically since that time. This paper argues that a model of home sales with time-varying coefficients is appropriate for the investigation of determinants of Texas home sales. The study employs a recursive regressions method for the estimation of home sales and finds that per capita personal income, mortgage rates and home prices, all in real terms, are the most important determinants of how many houses are sold in Texas each year.

The study also finds that, as expected, the estimated coefficients of these variables have varied significantly over the sample period. These results reveal that the responses of homebuyers to changes in home prices, mortgage rates and personal income may vary according to the magnitudes of these variables, as well as different economic conditions.

Table 1. Ordinary Least Squares Estimates of Texas Home Sales Model (1979–98 Sample)

A. Preliminary Specification

The dependent variable is the number of houses sold. Explanatory variables are the real mortgage rate, real house price, real per capita personal income, employment and population.

Estimated Coefficients

Variable	Coefficient	t-Statistic
Mortgage rate	-2.21**	4.11
House price	0.95**	4.62
Per capita personal income	1.71*	1.70
Employment	1.02	0.72
Population	-0.54	0.41
Constant term	-22.36**	3.34
R-squared	0.96	
Durbin-Watson statistic	2.18	

B. Final Specification

The dependent variable is the number of houses sold. Independent variables are the real mortgage rate, real house price and real per capita personal income.

Estimated Coefficients

Variable	Coefficient	t-Statistic
Mortgage rate	-1.97**	5.12
House price	0.93**	4.85
Per capita personal income	2.45**	18.67
Constant term	-21.83**	7.71
R-squared	0.96	
Durbin-Watson statistic	2.17	

Figures in parentheses are t-values. * indicates significant at 90 percent significance level. ** indicates significant at 95 percent significance level.

Table 2. Estimates of Time-varying Coefficients of the Variables in the Model

The dependent variable is the number of houses sold.

Year	Intercept	Mortgage Rate	Home Price	Per Capita Income
1985	-20.83 (1.35)	-2.10 (2.50)*	1.66 (1.33)	1.45 (0.60)
1986	-12.13 (1.32)	-2.01 (2.75)*	1.84 (1.69)	0.30 (0.18)
1987	-12.54 (1.79)	-1.98 (3.54)**	1.76 (2.55)**	0.45 (0.48)
1988	-13.11 (1.71)	-1.78 (3.07)**	1.22 (2.00)*	1.16 (1.40)
1989	-13.12 (1.59)	-1.54 (2.57)**	0.58 (1.38)	1.93 (2.97)**
1990	-11.61 (1.51)	-1.49 (2.61)**	0.67 (1.76)	1.67 (3.15)**
1991	-12.24 (1.69)	-1.49 (2.71)**	0.60 (1.71)	1.81 (4.11)**
1992	-12.29 (1.82)*	-1.50 (2.94)**	0.60 (1.88)*	1.83 (4.58)**
1993	-13.10 (2.03)*	-1.54 (3.14)**	0.59 (1.90)*	1.92 (5.19)**
1994	-15.34 (2.66)**	-1.63 (3.47)**	0.66 (2.20)**	2.07 (6.68)**
1995	-17.55 (3.21)**	-1.76 (3.83)**	0.74 (2.55)**	2.22 (7.93)**
1996	-17.64 (3.59)**	-1.76(4.09)**	0.74 (2.74)**	2.23 (9.29)**
1997	-20.57 (4.42)**	-1.92(4.36)**	0.87 (3.22)**	2.39 (10.86)**
1998	-20.81 (5.59)**	-1.93(4.71)**	0.88 (3.83)**	2.41 (14.18)**

Figures in parentheses are t-values. * indicates significant at 90 percent significance level.
** indicates significant at 95 percent significance level.

Table 3. Ordinary Least Squares Estimates of Texas Home Sales Model (1979–89 Sample)

A. Preliminary Specification

The dependent variable is the total value of houses sold. Explanatory variables are the real mortgage rate, real house price, real per capita personal income, employment and population.

Estimated Coefficients

Variable	Coefficient	t-Statistic
Mortgage rate	-2.21**	4.10
House price	1.95**	9.48
Per capita personal income	1.71*	1.70
Employment	1.03	0.73
Population	-0.55	0.41
Constant term	-33.83**	5.05
R-squared	0.96	
Durbin-Watson statistic	2.18	

B. Final Specification

The dependent variable is the total value of houses sold. Explanatory variables are the real mortgage rate, real house price and real per capita personal income.

Estimated Coefficients

Variable	Coefficient	t-Statistic
Mortgage rate	-1.97**	5.12
House price	1.93**	10.06
Per capita personal income	2.45**	18.65
Constant term	-33.34**	11.76
R-squared	0.96	
Durbin-Watson statistic	2.16	

Figures in parentheses are t-values. * indicates significant at 90 percent significance level.
** indicates significant at 95 percent significance level.

Table 4. Estimates of Time-varying Coefficients of the Variables in the Model

The dependent variable is the total value of homes sold.

Year	Intercept	Mortgage Rate	Home Price	Per Capita Income
1985	-32.36 (2.08)*	-2.10 (2.50)**	2.66 (2.13)*	1.46 (0.60)
1986	-23.60 (2.55)*	-2.01 (2.73)**	2.84 (2.60)**	0.29 (0.18)
1987	-24.00 (3.40)**	-1.98 (3.53)**	2.76 (3.98)**	0.44 (0.46)
1988	-24.57 (3.20)**	-1.77 (3.02)**	2.22 (3.63)**	1.15 (1.38)
1989	-24.58 (2.97)**	-1.54 (2.55)**	1.58 (3.80)**	1.93 (2.94)**
1990	-23.10 (3.00)**	-1.49 (2.59)**	1.66 (4.32)**	1.67 (3.17)**
1991	-23.73 (3.27)**	-1.49 (2.73)**	1.60 (4.54)**	1.81 (4.06)**
1992	-23.77 (3.51)**	-1.50 (2.94)**	1.60 (4.92)**	1.83 (4.56)**
1993	-24.59 (3.80)**	-1.54 (3.12)**	1.59 (5.05)**	1.92 (5.24)**
1994	-26.83 (4.64)**	-1.63 (3.47)**	1.66 (5.59)**	2.07 (6.71)**
1995	-29.03 (5.30)**	-1.76 (3.82)**	1.74 (5.94)**	2.22 (7.90)**
1996	-29.14 (5.92)**	-1.76 (4.06)**	1.74 (6.37)**	2.23 (9.24)**
1997	-32.07 (6.89)**	-1.92 (4.38)**	1.87 (6.92)**	2.39 (10.87)**
1998	-32.32 (8.68)**	-1.93 (4.68)**	1.88 (8.12)**	2.41 (14.12)**

Figures in parentheses are t-values. * indicates significant at 90 percent significance level.
** indicates significant at 95 percent significance level.

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Appendix A

Recursive regressions

Recursive least squares method provides the estimates of a linear regression model recursively, using ever larger subsets of the sample data. Denoting Y as the dependant variable, X as the independent variable, and u as the disturbance term, the underlying econometric model is given by:

$$Y_t = \beta_t X_t + u_t \qquad t=1, 2, \ldots, n \qquad (A1)$$

where the coefficient β_t and the variance of the disturbance term, Φ^2_t, are allowed to vary with time. Equation (A1) can be solved by the ordinary least squares (OLS) method or by the instrumental variables method. The OLS option gives the following recursive coefficients:

$$\beta_t = (X_r N X_r)^{-1} X_r N\, Y_r, \qquad r = k+1, k+2, \ldots., n \qquad (A2)$$

where $X_r = (x_1, x_2, \ldots, x_r)N$, $Y_r = (y_1, y_2, \ldots. y_r)N$, and n is the number of observations. See Brown, Durbin and Evans (1975).

Recursive standard errors for the OLS method is given by:

$$\Phi^2_r = (y_r - X_r\beta_t)N(\, y_r - X_r\beta_t)/(r-k), \; r = k+1, k+2, \ldots, n. \qquad (A3)$$

Recursive coefficients using the instrumental variables method is given by:

$$\beta_t = (X_r N\, Z_r X_r)^{-1} X_r N Z_r y_r, \qquad r = k+1, k+2, \ldots., n \qquad (A4)$$

where $Z_r = S_r(S_r N S_r)^{-1} S_r N$, $S_r = (s_1, s_2, \ldots, s_r)N$, and s_t, $t=1,2, .., n$ are the s $x1$ vector of observations on the s instrumental variables. Recursive standard errors for the instrumental variables method are estimated using equation (A3) where β_t are recursive coefficients using equation (A4). XN is transpose X.

Appendix B

Table B1. Sources of Texas Data for Home Sales Model

Data	Source
Number of homes sold	Website of Real Estate Center at Texas A&M University
Dollar volume of homes sold	Website of Real Estate Center at Texas A&M University
Home prices	Website of Real Estate Center at Texas A&M University
Mortgage rate	Website of Federal Reserve Bank of St. Louis
Consolidated Texas MSAs CPI	Website of Dallas Federal Reserve Bank
Per capita disposable persona income	Website of U.S. Bureau of Economic Analysis

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