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INTRODUCTION

Most home sales occur during the middle part of any given year due to the
highly seasonal nature of household formations and relocations. Many existing
household moves are planned around school calendars to minimize the impact of
the move on children. Weather conditions tend to be favorable for moving and
home construction during spring and summer. These seasonal changes in demand
pressure should cause some seasonality in home sale prices. However, the
amount of seasonal price fluctuations for homes has received very little
attention from a quantitative standpoint yet they have substantial impact upon
home buyers and sellers.

This report presents evidence of quantifiable seasonal fluctuations in
residential real estate markets. This evidence resulted from statistical
estimates of the amount of seasonal variation in home prices. Estimation of
these fluctations reveal a pattern of changes which conform to the above a
priori notions of the residential real estate market. The same directional
pattern existed in Texas and the United States, however, the amplitude of the
Texas cycle rose above that for the U.S. When seasonal mean sale prices are

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compared to those for the first quarter, the model predicts a slight strengthening of price in the second quarter, a substantial increase in the third quarter, with fourth quarter prices weakening into the first quarter of the next quarter. The volume of sale activity has a seasonal pattern similar to the seasonal price movements.

The long-term trend of appreciating property values tended to mask the seasonal price changes. A general year to year rise in mean sale prices by more than a 13 percent compounded rate in Texas and nearly 12 percent nationwide persisted throughout the period studied. This rate has begun to increase in the past three years in both markets.

When business patterns similar to these in the 1973-1979 period exist in the general economy, the econmetric estimates of these seasonal fluctuations predict expected price levels with reasonable accuracy. Departures from these predicted values seem to occur in response to substantial economic changes in the business environment or from anomalies in the market of larger cities.

THE DATA

The Texas Real Estate Research Center has collected average sale price data by metropolitan areas, on a quarterly basis, for more than 500,000 homes sold between 1973 and 1979 from reports submitted by the 32 major Multiple Listing Services throughout the state. Price data for the United States during 1973-1979 was obtained from the National Association of Realtors.[1]

This study examines the pattern of home sale price changes over that period of time. The investgation explores the seasonal pattern of home sale price fluctuations in both Texas and the United States. The study includes a seasonal price index for each season of the year, an annual price index for each year in the study, and an analysis of the accuracy of these indexes in fitting the data employed. These statistics are provided for both Texas and the United States.

Methodology

The analysis involves the examination of the data in two statistical models. The first model assumes that year-to-year and season-to-season prices are multiples of each other. In other words, an expected home sale price in 1976 would equal a known sale price in 1973 times a factor. Similarly, the sale price for a home in the third quarter of any given year would equal a known sale price from the first quarter of that year times a factor. This type of relationship is called, multiplicative, because the estimated sale price at any given point is a multiple of a known sale price from another time.

The statistical estimation of this type of relationship conforms to a statistical technique called analysis of variance (ANOVA). The technique requires classification of the data into major classes called "year" and "season" in this study. These class variables are further divided into specific levels such as 1973, 1974, etc. and winter, spring, summer, and fall.

In order to estimate the effect of year and season upon sale price, it is necessary to use the natural logarithum of the sale price as the dependent variable of the model. This follows because the multiplicative relationship conforms to the following statistical model.[2]

$$Y_{ij} = Y_0 \alpha_i \beta_j \epsilon_{ij}$$

$$\ln(Y_{ij}) = \ln(Y_0) + \ln(\alpha_i) + (\beta_j) + \ln(\epsilon_{ij})$$

Y_{ij} = price for year i and season j

Y_0 = benchmark price

α_i = time effect of year i

β_j = seasonal effect of season j

ϵ_{ij} = random variation for year i and quarter j

and ln indicates the natural logarithm of the sale price.

The logarthimic transformation of price permits a least squares estimate of the effect of year and season on the general price level for homes. Season and year are class variables. Taking the antilog of α_i and β_j produces an estimate of the percentage change in prices for each year and season. "Year" abstracts the trend in prices from year to year while quarter provides an estimate of the seasonal variation in those prices. The seasonal index reflects the market price response to seasons within the year.

The second statistical model provides an estimate of seasonal variations in sale prices after all of the non-seasonal quarter-to-quarter price changes have been removed. The previous model provides an index of the total change in prices from season-to-season. This means that these changes include non-seasonal price variations within the year. The second model provides an estimate of the purely seasonal variations after all time related price trends have been removed.

The second model requires the assumption of a continuous period-to-period trend in prices over time. In other words the price of a home in 1975 is assumed to consist of an average sale price in 1973 plus some added amount for the number of quarters which have elapsed since then, plus a seasonal variation. This model is additive rather than multiplicative.

For this study, the trend in time is complex and of little interest since it primarily serves to remove non-seasonal fluctuations. For this reason we do not discuss this time trend.

The additive relationship conforms to the following model:

$$Y_{ti} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3 + \beta_i + \epsilon_{ti}$$

Where

α_0 = a constant term

t = time trend beginning with winter, 1973, = 1 and ending with fall, 1979 = 28

α_1 = linear component of time related price changes

α_2 = quadratic component of time related price changes

α_3 = cubic component of time related price changes

β_i = seasonal effect of season j

ϵ_{ti} = random variation for time = t and season = j

This model can be estimated by use of the statistical technique known as regression analysis. The results of the statistical estimates for seasonal variations are dollar amounts. For comparisons these dollar amounts are converted into percentage changes.

Limitations

The use of these statistical methods implies two assumptions which may limit the scope of the conclusions. First, quality of the residences sold is assumed to have remained unchanged over the period studied. Although the quality of new homes may have changed, the data represents a mix of homes.

That mix probably did not vary greatly over this period, and almost certainly did not vary from season-to-season within any year. Therefore, limitations imposed by this assumption probably do not affect the seasonal indexes and should only slightly affect the yearly indexes.

Second, the data set contains aggregated figures of actual sales prices. This requires the assumption that the average sale price adequately represents the experience of the residential real estate market. This assumption places a greater restriction upon the interpretation of the seasonal effects. If conditions in a local real estate market deviate markedly from the average conditions the seasonal effects may not be valid for that local market. This set of circumstances may severly limit the use of the specific percentage figures in such a location. However, the general pattern of seasonal variations may remain valid.

The conclusions presented remain valid as long as conditions in real estate markets approximate the conditions observed from 1973-1979. This restriction may severly limit the usefulness of the annual indexes as possible forecasting tools. As conditions in the markets change, the character of year to year price changes may also change substantially. The seasonal patterns may continue to persist as estimated, however their use should be tempered with informed judgment of local market conditions.

FINDINGS

Table 1a and Table 1b provide a summary of the statistical analysis of a least square fit of the two models. The high R^2 statistics indicates a good statistical fit between the model and the data. The F values and significance levels indicate a significant relationship between both the quarter and time related variations to the change in mean sale prices. The Durbin-Watson "d" statistics reveal no evidence of serial autocorrelation in the data. Thus

based upon several different statistical test, the estimates of the time
related and seasonal or quarterly variations of the mean sales prices fit the
data well.

Estimates of Price Adjustments

The price index coefficients for each quarter or year appears in Table 2a
for the log model or Table 2b for the additive model with the first quarter of
each year or the year 1973 serving as the basis of comparisons for the other
periods.

The information presented in the third column of Table 2a contains
estimates of the change in average selling price for the second, third, and
fourth quarters when compared to the first quarter of any given year for Texas
and the United States ignoring the effects of price trends within the year.
Thus, home prices in both Texas and the nation were approximately 5 percent
higher during the second quarter than they were in the first quarter. During
the third quarter, Texas sale prices averaged are nearly 14 percent above the
spring price levels while nationwide, they ranged approximately 8 percent
higher. Average sale prices start descending during the fourth quarter for
both markets down to their seasonal lows during the first quarter of each
year.

Column 4 of Table 2 shows the seasonal price fluctuations compared to an
annual average price as a base rather than the first quarter. The t
statistics and associated significance levels indicate strong relationships
for each of the estimates. Although the second quarter estimate for Texas is
less reliable than the others, the estimate remains significant at the 0.02
level. The estimated seasonal effect suggests the Texas housing market is
more seasonally volatile than the market for homes nationwide. Statistically
there is no significant difference between the Texas and the national index
figures during the first two quarters. However, a statistical significance

difference does exist between the two for the last half of the year. Of course the actual sales price represented by the first quarter base index will be different each year due to the cyclical changes over the years. Table 2b shows the seasonal changes to be much smaller when an adjustment is made for within-the-year trends in prices.

Table 3 indicates the annual changes in the mean sales price of houses sold during 1973 through 1979 with the initial year serving as a basis of 100 to faciliate comparisons with other years. For example, the mean sales prices in Texas in 1979 were 210.48 percent of their 1973 level. For the United States, the 1979 mean sale prices was 194.86 percent of the 1973 level. Figure 1 depicts these annual price levels graphically.

The annual compound growth rate of mean sales prices of houses using 1973 as the basis is shown in column 4 of Table 3. For example, between 1973 and 1975, the annual compound growth rate was 13.50 percent. By 1977 the annual rate had dropped to 12.26 percent. Over the entire 1973-1979 period the annual compound rate was 13.21 percent. Growth rates of mean sales prices of houses across the United States were somewhat lower for the years in the table.

Predicted vs. Observed Values

Figures 2 and 3 present plots of the data contained in Table 4. The data reflects both the observed values and log model predictions for the 1973 to 1979 study period for Texas and the United States. With some exceptions, the seasonal patterns of the predicted values coincide well with the patterns of the observed values for both markets.

Table 1a. Summary of the Statistical Analysis of the
Seasonal Changes in Home Sale Prices for Texas
and the United States, 1973-1979
Logarithmic Model

(1) Area	(2) Source of Variation	(3) Mean Square	(4) F Value	(5) R^2	(6) Level of Significance	(7) Durbin Watson(d)
Texas	Model	0.181397	153.13	.987	0.0001	1.89
	quarter	0.068483	19.27		0.0001	
	year	1.564088	220.06		0.0001	
	Error	0.001185				
U.S.	Model	0.153195	809.73	.997	0.0001	2.18
	quarter	0.023399	41.23		0.0001	
	year	1.355360	1193.98		0.0001	
	Error	0.000189				

Table 1b. Summary of the Statistical Analysis of the
Seasonal Changes in Home Sale Prices for Texas
and the United States, 1973-1979
Additive Model

(1) Area	(2) Source of Variation	(3) F Value	(4) R^2	(5) Level of Significance	(6) Durbin Watson(d)
Texas	Model	286.73	.988	.0001	2.00
	quarter	6.39		.0003	
	T	16.12		.0006	
	T^2	3.82		.0639	
	T^3	9.29		.0061	
U.S.	Model	1119.59	.997	.0001	1.45
	quarter	13.65		.0001	
	T	26.56		.0001	
	T^2	3.74		.0675	
	T^3	23.31		.0001	

Table 2a. Seasonal Changes in Sale Price
of Homes in Texas and the United States:
UNADJUSTED FOR TIME TRENDS

(1)	(2)	(3)	(4)	(5)	(6)
		Seasonal Price Indexes[a]			
		first Qtr.	Annual avg.	t	Level of
Area	Quarter	price=100%	price=100%	Statistics	Significance
Texas	First	100.0%	93.2%	--	--
	Second	104.9%	97.7%	2.60	0.0183
	Third	113.7%	105.9%	6.96	0.0001
	Fourth	110.7%	103.1%	5.53	0.0001
U.S.	First	100.0%	95.4%	--	--
	Second	105.0%	100.1%	6.64	0.0001
	Third	107.8%	102.8%	10.26	0.0001
	Fourth	106.7%	101.7%	8.84	0.0001

Table 2b. Seasonal Changes in Sale Prices
of Homes in Texas and the United States:
ADJUSTED FOR TIME TRENDS

(1)	(2)	(3)	(4)	(5)	(6)
		Seasonal Price Indexes[a]			
		first Qtr.	Annual avg.	t	Level of
Area	Quarter	price=100%	price=100%	Statistics	Significance
Texas	First	100.0%	97.8%	--	--
	Second	101.6%	99.4%	0.97	0.345
	Third	106.7%	104.4%	3.88	0.001
	Fourth	100.6%	98.4%	0.34	0.741
U.S.	First	100.0%	99.3%	--	--
	Second	102.3%	101.2%	3.07	0.006
	Third	102.3%	101.2%	3.03	0.007
	Fourth	98.3%	97.6%	-2.20	0.040

[a] The price indexes result from taking the antilog of the regression
coefficient.

Table 3. Annual Changes in the Sale Price of
Homes in Texas and the United States: 1973-1979
(Base Year = 1973)

(1) Area	(2) Yr.	(3) Annual Price Index	(4) % Annual Compounded Growth Rate Since 1973	(5) t Statistic	(6) Level of Significance
Texas	1973	100.00	--	--	--
	1974	119.30	19.30	7.25	0.0001
	1975	128.83	13.50	10.41	0.0001
	1976	140.17	11.91	13.88	0.0001
	1977	158.80	12.26	19.00	0.0001
	1978	182.43	12.78	24.70	0.0001
	1979	210.48	13.21	30.58	0.0001
U.S.	1973	100.00	--	--	--
	1974	109.17	9.17	9.02	0.0001
	1975	118.66	8.93	17.59	0.0001
	1976	128.40	8.69	25.70	0.0001
	1977	143.28	9.41	36.98	0.0001
	1978	167.53	10.87	53.06	0.0001
	1979	194.86	11.76	68.59	0.0001

a The price index results from taking the antilog of the regression
coefficient.

Examination of the mean sale prices of houses displayed in Figure 2 reveals an interesting departure between actual values and predicted values in Texas. The actual seasonal change from the first to the second and from the third to the fourth quarters roughly parallels the changes in the expected values. However, the observed value for the third quarter mean falls substantially below the predicted value. This deviation from the expected pattern arises from the financial crisis experienced in 1974. Beginning about July, 1974 mortgage funds became scarce and home sales lagged. The data suggests that a downward adjustment in selling prices occured in the third quarter and persisted through the fourth quarter at approximately the same level.

The 1975 and 1977 deviations from expected patterns seem related to anomalies in the MLS reports from a few large markets in Texas. The divergences from the predicted patterns suggest that local market conditions for those communities differed from the normal patterns of the real estate market.

In general, the predicted values closely correspond to the observed values especially in the national model. Absolute values of the residuals in the Texas model ranged from $6 to $2,090 with a mean of $729 while the national figures ranged from $10 to $1,551 with a mean of $381. The maximum error occured in predicting the 1974 seasonal adjustment while the smallest corresponded to the 1978 prediction. In Texas, the average absolute value of residuals was $729, less than 2 percent of the mean sale price for the period. The maximum residual represented 5.6 percent of the mean and 7.3 percent of the observed value associated with the residual. In the United States, the average absolute value of residuals was $381, or 0.9 percent of the mean sale price. The maximum residual represented 3.6 percent of the mean and 2.8 percent of the observed sale price in that quarter. Thus, these

Table 4. Observed and Predicted Mean Sale Prices
for Homes in Texas and the United States: 1973-1979

Year	Season	Observed Mean Price Texas	Observed Mean Price U.S.	Predicted Mean Price Texas	Predicted Mean Price U.S.	Residual Texas	Residual U.S.
1973	Winter	$23,087	31,567	$23,234	31,307	- 147	260
	Spring	23,691	32,900	23,371	32,874	- 680	26
	Summer	27,209	33,667	26,410	33,760	799	- 93
	Fall	25,848	33,200	25,724	33,409	124	- 209
1974	Winter	28,954	34,700	27,719	34,177	1,235	523
	Spring	30,907	36,000	29,075	35,888	1,832	112
	Summer	30,449	36,866	31,508	36,855	-1,059	11
	Fall	28,600	35,800	30,690	36,472	-2,090	- 672
1975	Winter	29,626	37,500	29,930	37,149	- 304	351
	Spring	30,641	39,267	31,394	37,008	- 753	259
	Summer	33,614	39,867	34,021	40,059	- 407	- 192
	Fall	34,715	39,200	33,138	39,642	1,577	- 442
1976	Winter	32,682	40,500	32,567	40,198	115	302
	Spring	33,303	42,167	34,160	42,211	- 857	- 44
	Summer	38,179	43,100	37,018	43,347	1,161	- 247
	Fall	35,734	42,867	36,057	42,897	- 323	- 30
1977	Winter	36,509	44,867	36,895	44,857	- 386	10
	Spring	39,976	47,000	38,699	47,103	1,277	- 103
	Summer	40,724	48,000	41,938	48,371	-1,214	- 371
	Fall	41,153	48,333	40,849	47,868	304	465
1978	Winter	42,391	50,900	42,385	52,451	6	-1,551
	Spring	44,159	54,500	44,459	55,076	- 300	- 576
	Summer	48,125	57,233	48,179	56,559	- 54	674
	Fall	47,292	57,600	46,928	55,972	364	1,628
1979	Winter	47,924	60,367	48,903	61,005	- 979	- 638
	Spring	50,843	64,267	51,295	64,059	- 452	208
	Summer	56,483	66,367	55,587	65,784	896	583
	Fall	54,857	65,000	54,144	65,100	713	- 100

*Source: Observed Texas data developed by the Texas Real Estate Research
Center; national data was obtained from the National Association of Realtors.

statistical estimates of the econometric model of seasonal residential real estate price fluctuations closely fit the observed data over the period studied in both market areas. The estimates should perform well for predictions of future market movements when market conditions approximate those of the studied period.

Seasonal Changes and the Number of Sales

The volume of sales activity also has a seasonal pattern which is quite similar to the seasonal price movements. The relative number of transactions occuring during the different times of the year are shown in Table 5. Using the first quarter level of activity as an index base, column 2 indicates there are typically 22.2 percent more homes sold in the second quarter than in the first quarter. The number of sales generally increase during the third quarter at a level 36.3 percent above the base period and then decline to the seasonal low of the first quarter. Column 3 shows the same seasonal pattern but compares each quarter's volume to the annual average level of activity. The associated t statistic and level of significance were very strong for each quarter which indicates that the index numbers are reliable.

Table 5. Seasonal Changes in the
Number of Home Transactions in Texas

(1) Season	(2) First Quarter Volume = 100%	(3) Annual Avg. Volume = 100%	(4) t Statistic	(5) Level of Significance
First qtr. (J.F.M.)	100.0%	85.2%	--	--
Second qtr. (A.M.J.)	122.2%	104.1%	4.71	0.0002
Third qtr. (J.A..S.)	136.3%	116.1%	6.93	0.0001
Fourth qtr. (O.N.D.)	110.9%	94.5%	3.25	0.0045

1. _Existing Home Sales 1979_, Economics and Research Division of the National
    Association of Realtors, Washington, D.C., 1980, p. 35.

2. Bernard Ostle, and Richard W. Mensing, _Statistics in Research_ (Ames:
    Iowa State University Press, 1975), p. 353.